Supplement 2: USDA Natural Resources Conservation Service – Delaware Conservation Practice Standards

USDA
NATURAL RESOURCES
CONSERVATION SERVICE
DELAWARE
CONSERVATION PRACTICE
STANDARD

WASTE STORAGE FACILITY

CODE 313
(Reported by No.)

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
- 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 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.

CONSIDERATIONS

General

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

Uncontaminated water should 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.

Freeboard for waste storage tanks should be considered.

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

Due consideration should be given to environmental concerns, economics, the overall waste management system plan, and safety and health factors.

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 1 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 1 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, flattened and/or armored downstream side slopes

5. Secondary containment

Table 1 - 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 1 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 2 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 2 may be significantly affected.

Table 2 - 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 2 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 minimizing the impact of odors.

An anaerobic lagoon instead of a waste storage pond should be considered for sites located in rural areas where odors are a concern. This should be especially considered where odors would affect neighboring farms having enterprises that do not cause odors and/or neighbors who earn a living off-farm. The recommended

loading rate for anaerobic lagoons at sites where odors must be minimized is one-half the value given in Agricultural Waste Management Field Handbook, (AWMFH) Figure 10-22.

For sites located near urban areas, practices such as the following should be considered to reduce odor emissions:

1. Covering the storage facility with a suitable cover.
2. Using naturally aerated or mechanically aerated lagoons.
3. Using composting in conjunction with a solid waste system rather than a liquid or slurry system.
4. Using a methane digester and capture system.

Table 3 – Rainfall-Runoff-Evaporation Data Summary 1/

Month (1)	Rainfall (Inches) (2)	Runoff (Inches) (3)	Evaporation (Inches) (4)	Net Rainfall (2) – (4) (Inches) (5)
January	3.55	1.92	1.08	2.47
February	2.96	1.63	1.08	1.88
March	4.04	2.22	1.80	2.24
April	3.39	1.86	2.52	0.87
May	3.81	2.10	3.60	0.21
June	3.71	2.30	4.68	-0-
July	4.66	2.89	5.40	-0-
August	5.62	3.77	5.04	0.58
Sept.	3.93	2.63	4.32	-0-
Oct.	3.12	1.90	3.24	-0-
Nov.	3.47	2.12	2.16	1.31
Dec.	3.06	1.65	1.08	1.98
TOTALS	**45.32**	**26.99**	**36.00**	**11.54**

Note: Evaporation from ponds containing manure will be less than the above due to a dry crust developing on the surface. For ponds with high solids concentration, the evaporation computations should be omitted.

1/This table was compiled from rainfall data in the soil survey reports for each county and using the procedures in Agricultural Waste Management Field Handbook Notice 1.

CRITERIA

General Criteria Applicable 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.

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.

Storage period. The storage period is the maximum length of time anticipated between emptying events. The storage period shall be based on the timing required for environmentally safe waste utilization considering the climate, crops, soil, equipment, and local, state, and federal regulations. The minimum storage period shall be 30 calendar days in Kent and Sussex Counties, and 45 calendar days in New Castle County.

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, and other wastes accumulated during the storage period

(b) Normal precipitation less evaporation on the surface area (at the design storage volume level) of the facility during the storage period

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

(d) 25-year, 24-hour precipitation on the surface (at the required design storage volume level) of the facility

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

(f) Residual solids after liquids have been removed. A minimum of 6 inches shall be provided for tanks

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

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.

Accumulated solids removal. Provision 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, if any.

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

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

Liners. Liners shall meet or exceed the criteria in NRCS Practice Standard 521, Pond Sealing or Lining.

Additional Criteria for Waste Storage Ponds

Soil and foundation. The pond shall be located in soils with an acceptable permeability that meets all applicable regulation, or the pond shall be lined. Information and guidance on controlling seepage from waste impoundments can be found in the AWMFH, Appendix 10D.

The pond shall have a bottom elevation that is a minimum of 2 feet above the seasonal high water table unless features of special design are incorporated that address buoyant forces, pond seepage rate and non-encroachment of the water table by contaminants. The water table may be lowered by use of perimeter drains, if feasible, to meet this requirement.

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 plus the volume allowance for residual solids after liquids have been removed. 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 O&M plan.

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

Embankments. The minimum elevation of the top of the settled embankment shall be 1 foot above the waste storage pond's required volume. This 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 4. 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 4 – Minimum Top Widths

Total embankment Height, ft.	Top Width, ft.
15 or less	8
15 – 20	10
20 – 25	12
25 – 30	14
30 – 35	15

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 5 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.

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 of impermeable soil between the floor slab and the bedrock or an alternative that will achieve equal protection.

Table 5 - Presumptive Allowable Bearing Stress Values[1]

Foundation Description	Allowable Stress
Crystalline Bedrock	12000 psf
Sedimentary Rock	6000 psf
Sandy Gravel or Gravel	5000 psf
Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel	3000 psf
Clay, Sandy Clay, Silty Clay, Clayey Silt	2000 psf

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

Liquid tightness. Applications such as tanks, that require liquid tightness shall be designed and constructed in accordance with standard engineering and industry practice 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, and frost or ice pressure and load combinations in compliance with this standard and applicable local building codes.

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. If soil strength tests are not available, the presumptive lateral earth pressure values indicated in Table 6 shall be used.

TABLE 6 - LATERAL EARTH PRESSURE VALUES[1]

Soil		Equivalent fluid pressure (lb/ft^2/ft of depth)			
		Above seasonal high water table[2]		Below seasonal high water table[3]	
Description[4]	Unified Classification[4]	Free-standing walls	Frame tanks	Free-standing walls	Frame tanks
Clean gravel, sand or sand-gravel mixtures (maximum 5% fines)[5]	GP, GW, SP, SW	30	50	80	90
Gravel, sand, silt and clay mixtures (less than 50% fines) Coarse sands with silt and and/or clay (less than 50% fines)	All gravel sand dual symbol classifications and GM, GC, SC, SM, SC-SM	35	60	80	100
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	75	90	105
Low to medium plasticity silts and clays with little sand and/or gravel (50% or more fines)	CL, ML, CL-ML	65	85	95	110
High plasticity silts and clays (liquid limit more than 50)[6]	CH, MH	-	-	-	-

[1] For lightly compacted soils (85% to 90% maximum standard density.) Includes compaction by use of typical farm equipment.
[2] Also below seasonal high water table if adequate drainage is provided.
[3] Includes hydrostatic pressure.
[4] All definitions and procedures in accordance with ASTM D 2488 and D 653.
[5] Generally, only washed materials are in this category
[6] Not recommended. Requires special design if 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 6 under the column "Frame tanks," which gives pressures comparable to the at-rest condition.

- **Flexible or yielding wall.** Use the values shown in Table 6 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 where the stored waste is not protected from precipitation. A value of 60 lb/ft^2 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 will be operated near the wall, an additional two feet of soil surcharge shall be considered in the wall analysis.

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 EP 393.2, Manure Storages, 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 is to have a roof, snow and wind loads shall be as specified in ASAE EP288.5, Agricultural Building Snow and Wind Loads. If the facility is to serve as part of a foundation or support for a building, the total load shall be considered in the structural design.

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 standard plans.

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.

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.

- 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. Where applied point loads are minimal and liquid-tightness is not required, such as barnyard and feedlot slabs subject only to precipitation, and the subgrade is uniform and dense, the minimum slab thickness shall be 4 inches with a maximum joint spacing of 10 feet. Joint spacing can be increased if steel reinforcing is added based on subgrade drag theory.

For applications where liquid-tightness is required such as floor slabs of storage tanks, the minimum thickness for uniform foundations shall be 5 inches and shall contain distributed reinforcing steel. The required area of such reinforcing steel shall be based on subgrade drag theory as discussed in industry guidelines such as American Concrete Institute, ACI 360, "Design of Slabs-on-Grade".

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 shall be used.

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.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design.

The plan shall contain the operational requirements for emptying the storage facility. This shall include the requirement that waste shall be removed from storage and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan. In addition, for ponds, the plan shall include an explanation of the permanent marker or recorder installed to indicate the maximum operating level. The plan shall include a strategy for removal and disposition of waste with least environmental damage during the normal storage period to the extent necessary to insure the pond's safe operation. This strategy is for the removal of the contribution of unusual storm events that may cause the pond to fill to capacity prematurely with subsequent design inflow and usual precipitation prior to the end of the normal storage period. Development of an emergency action plan should be considered for waste storage facilities where there is a potential for significant impact from breach or accidental release. The plan shall include site-specific provisions for emergency actions that will minimize these impacts.

SUPPORTING DATA FOR DOCUMENTATION

Field Data and Survey Notes.

The following is a list of the minimum data needed:

a. Plan view sketch.

b. Soil borings with depth to water table identified for liquid storage structures.

c. Type, size, and number of animals the structure is designed to serve.

d. Topographic survey as needed for the siting of the structure and its appurtenances.

e. Profile and cross-section of the site if a grading plan is needed.

Design Data

Record on appropriate engineering paper. For guidance on the preparation of engineering plans see Chapter 5 of the Engineering Field Handbook (EFH), Part 650. The following is a list of the minimum required design data

a. Locate the practice on the farm plan map in the case file.

b. Determine soil type and any special restrictions.

c. Determine peak runoff from the contributing drainage area for the required design storm in accordance with Chapter 2, EFH Part 650 or by other approved method.

d. Size the structure in accordance with the AWMFH, Part 651 or by other approved methods.

e. Show job class on the plan.

f. Plan view sketch, and final grading plan as required.

g. References to components supplied by others (pumps, etc.).

h. Maximum operating level (elevation)

i. Structural details of all components with dimensions and special requirements noted.

j. Special safety requirements

k. Seeding, fertilizing, and mulching requirements.

l. Written Operation and Maintenance plan that includes the location and description of permanent marker that denotes the maximum operating level to the operator with the number of months of storage the structure will provide.

Construction Check Data/As-Built Plans

Record on survey notepaper, SCS-ENG-28, or other appropriate engineering paper. Survey data will be plotted in red. The following is a list of minimum data needed for As-Built documentation:

a. Documentation of site visits on CPA-6. The documentation shall include the date, who performed the inspection, specifics as to what was inspected, all alternatives discussed and decisions made and by whom.

b. Check notes recorded during or after completion of construction showing dimensions and elevations of the structure, as appropriate.

c. Statement on seeding and fencing.

d. Final quantities and documentation for quantity changes. Materials certifications as appropriate.

Sign and date check-notes and plans by someone with appropriate approval authority. Include statement that practice meets or exceeds plans and NRSC practice standards.

USDA
NATURAL RESOURCES
CONSERVATION SERVICE

DELAWARE CONSERVATION
PRACTICE STANDARD

COMPOSTING FACILITY

CODE 317
(Reported by No.)

DEFINITION

This is a treatment component of an agricultural management system for the biological stabilization of organic material.

PURPOSES

To reduce the pollution potential of organic agricultural wastes to surface and ground water.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Organic waste material is generated by agricultural production or processing;
- A composting facility is a component of a planned agricultural waste management system; and,
- A composting facility can be constructed, operated and maintained without polluting air and/or water resources.

CONSIDERATIONS

Develop an initial compost mix with a Carbon to Nitrogen ratio of at least 30:1 to reduce most offensive odors.

Minimize odors and nitrogen loss by selecting carbonaceous material that, when blended with the nitrogenous material; provides a balance of nutrients and porous texture for aeration.

When composting in unroofed windrows, maximize solar warming by aligning piles north to south configured with moderate side slopes.

Locate compost facilities so prevailing winds and landscape elements such as building arrangement, landforms, and vegetation minimize odors and protect the visual resource.

Direct surface runoff away from the compost facility. Direct contaminated runoff from compost facilities to an appropriate storage or treatment facility for further management.

Do not locate piles (windrows) across the slope to prevent ponding and sogginess.

Protect compost facilities from the wind. Wind protection may help prevent excess drying of the compost and allow for better heat buildup in cold weather.

This practice has the potential to affect National Register listed cultural resources or eligible (significant) cultural resources. These may include archeological, historic, or traditional cultural properties. Care should be taken to avoid adverse impacts to these resources. Follow NRCS state policy for considering cultural resources during planning.

CRITERIA

General Criteria Applicable To All Purposes

Laws and Regulations. The installation and operation of the composting facility shall comply with all federal, state, and local laws, rules, and regulations.

Safety. Safety and personal protection features and practices shall be incorporated into the facility and its operation as appropriate to

minimize the occurrence of equipment hazards and biological agents during the composting process.

Roofs. All composting facilities in which animal carcasses are being composted shall have a roof or some other type of cover to prevent excess moisture from causing runoff and leaching problems.

Facility Siting. The bottom elevation of the composting facility shall be above the seasonal high water table and on soils with an acceptable permeability that does not allow materials to contaminate the ground water, and meets all applicable regulations, or the facility shall be installed on concrete slabs or other appropriate liners.

Ideally, compost 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.

Compost Mix. Develop a compost mix that encourages aerobic microbial decomposition and avoids nuisance odors. Table 1 presents the recommended compost recipe for composting poultry moralities. Figure 1 shows the recommended layering for dead bird composting.

Table 1

Ingredient (Parts)	Volumes (Parts)	Weights
Straw	1	0.1
Poultry	1	1
Manure	2.0	1.5
Water*	.5	.75

*More or less water may be necessary

Carbon-Nitrogen Ratio. The initial compost mix shall result in a Carbon to Nitrogen ratio between 30:1 and 40:1. Compost with a greater carbon to nitrogen ratio can be used if nitrogen immobilization is not a concern.

Carbon Source. A dependable source of carbonaceous material with a high carbon to nitrogen ratio (C: N) shall be stored and available to mix with nitrogen rich waste materials.

Bulking Materials. Add bulking materials to the mix as necessary to enhance aeration.

The bulking material may be the carbonaceous material used in the mix or a non-biodegradable material that is salvaged at the end of the compost period. If a non-biodegradable material is used, provision shall be made for its salvage.

Moisture Level. Provision may be made for maintaining adequate moisture in the compost mix throughout the compost period within the range of 40 to 65 percent.

Care shall be taken to prevent excess moisture from accumulating in the compost. Facility covers or roofs may be required to provide for a suitable product.

Temperature of Compost Mix. Manage the compost to attain and then maintain the internal temperature for the duration required to meet management goals.

When the management goal is to reduce pathogens, the compost shall attain a temperature greater than 130°F for at least 5 days as an average throughout the compost mass.

This temperature and time criterion may be achieved during either primary or secondary composting stages or as the cumulative time of greater than 130°F in both stages.

Turning/Aeration. The frequency of turning/aeration shall be appropriate for the composting method used, and to attain the desired amount of moisture removal and temperature control while maintaining aerobic degradation.

Facility Type. Selection of the composting facility/method shall be based on the availability

of raw material, the desired quality of final compost, equipment, labor, time, and land available.

Facility structural elements such as permanent bins, concrete slabs, and roofs shall meet the requirements of Conservation Practice Standard 313, Waste Storage Facility.

Facility Size. Size the compost facility to accommodate the amount of raw material planned for active composting plus space required for curing.

Dimensions selected for elements of the compost facility shall accommodate equipment used for loading, unloading, and aeration.

Sizing of facilities for composting dead animals shall be based on normal mortality loss records for the operation. Or, if not available, locally established mortality rates for the type of operation shall be used.

Compost Period. Continue the composting process long enough for the compost mix to reach the stability level where it can be safely stored without undesirable odors. It shall also possess the desired characteristics for its use, such as lack of noxious odor, desired moisture content, level of decomposition of original components, and texture. The compost period shall involve primary and secondary composting as required to achieve these characteristics.

Test the finished compost as appropriate to assure that the required stabilization has been reached.

Use of Finished Compost. Land application of finished compost shall be in accordance with Conservation Practice Standards 590, Nutrient Management, and 633, Waste Utilization.

Vegetation. Disturbed areas shall be established with vegetation or otherwise stabilized as soon as practical after construction. Seedbed preparation, seeding, fertilizing, and mulching shall conform to NRCS Conservation Practice Standard 342, Critical Area Planting.

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.

OPERATION AND MAINTENANCE

Develop an operation and maintenance plan that is consistent with the purposes of this practice, and the life of the composting facility. Recipe ingredients and sequence that they are layered and mixed shall be given in the plan.

Safety requirements for operation of the composting facility shall be provided.

Manage the compost piles for temperature, odors, moisture, and oxygen, as appropriate. Make adjustments throughout the composting period to insure proper composting processes.

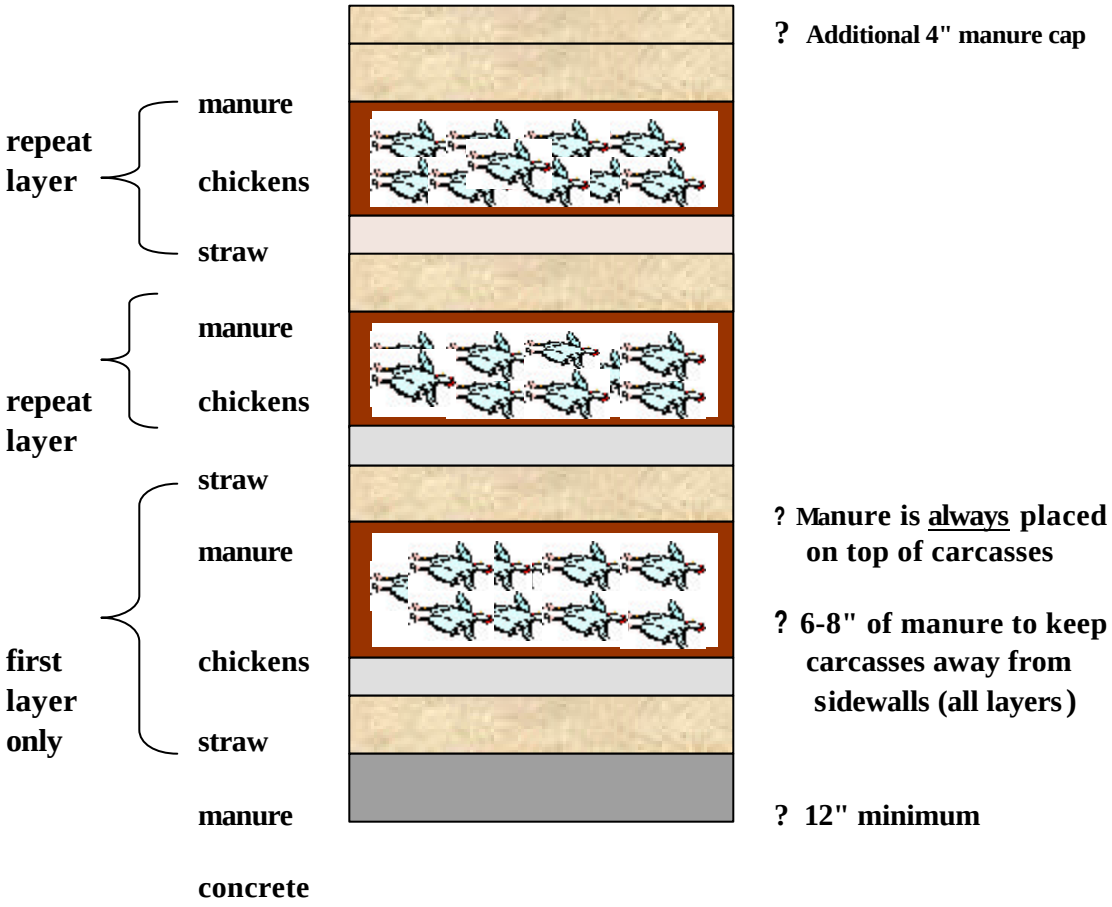
Closely monitor temperatures above 165°F. Take action immediately to cool piles that have reached temperatures above 185°F.

The operation and maintenance plan shall state that composting is a biological process. It requires a combination of art and science for success. Hence, the operation may need to undergo some trial and error in the start-up of a new composting facility.

SUPPORTING DATA FOR DOCUMENTATION

The following is a list of the minimum data and documentation to be recorded in the case file:

Recommended Layering for Dead Bird Composting



Planning Information, Field Data and Survey Notes

1. Field location of the compost facility. Also note the location of the compost facility on the conservation map.

2. Description of the objectives of the practice, including the desired functions which the compost facility is expected to provide.

3. Soils investigation logs and notes, as appropriate for site conditions and the proposed design.

4. Topographic survey of the site, as appropriate for site conditions and the proposed design.

Design Data

1. Location map with the site identified.

2. Soil survey map with the site identified.

3. Computations establishing the design capacity of the compost facility.

4. Details of grading/drainage plan as needed.

5. A set of plans and specifications for the compost facility, as appropriate.

Construction Check Data/As Built Plans

1. Check notes recorded during and after completion of construction showing as-built conditions of the practice.

2. Red line the construction plans to indicate the construction's conformance to the design.

3. Sign and date check-notes and plans by someone with appropriate approval authority. Include statement that practice meets or exceeds plans and NRCS practice standards.

REFERENCES

1. NRCS National Engineering Handbook (NEH) Part 637 Environmental Engineering, Chapter 2, "Composting".

2. NRCS National Engineering Handbook (NEH) Part 651 Agricultural Waste Management Field Handbook (AWMFH), Chapter 10, "Component Design".

3. Rynk, R. (Ed.) (1992) On-Farm Composting Handbook. NRAES-54. Ithaca NY: Northeast Regional Agricultural Engineering Service.

4. Dougherty, M. (Ed.) (1999) Field Guide To On-Farm Composting. NRAES-114. Ithaca NY: Northeast Regional Agricultural Engineering Service.

USDA
NATURAL RESOURCES
CONSERVATION SERVICE
DELAWARE
CONSERVATION PRACTICE
STANDARD

RESIDUE MANAGEMENT; NO-TILL AND STRIP TILL

CODE 329A
(Reported in Acres)

DEFINITION

Managing the amount, orientation, and distribution of crop and other plant residues on the soil surface year-round, while growing crops in narrow slots or tilled strips in previously untilled soil and residue.

PURPOSES

This practice may be applied as part of a conservation management system to support one or more of the following resource concerns:

- Reduce sheet and rill erosion.
- Reduce wind erosion.
- Maintain or improve soil organic matter content and tilth.
- Conserve soil moisture.
- Provide food and escape cover for wildlife.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all cropland and other land where crops are grown.

This standard includes tillage and planting methods commonly referred to as no-till, zero till, slot plant, row till, zone till, or strip till.

CRITERIA

General Criteria Applicable to All Purposes

Loose residues to be retained on the field shall be uniformly distributed on the soil surface. Residues shall not be disturbed except as follows:

Planters or drills shall be equipped to plant directly through untilled residue or in a narrow strip prepared by planter attachments such as rotary tillers, sweeps, multiple coulters, or row cleaning devices.

If row cultivation or spot treatment for weed escapes, leveling ruts, or similar operations become necessary, tillage shall be limited to operations which minimize burial of surface residue and shall be limited to specific areas where the problem exists.

Additional Criteria to Reduce Sheet and Rill Erosion

The amount of residue needed to reduce erosion within the soil loss tolerance (T), or any other planned soil loss objective, shall be determined using the Revised Universal Soil Loss Equation (RUSLE) erosion prediction technology. Partial removal of residue by means such as baling or grazing shall be limited to retain the amount and distribution needed. Calculations shall account for the effects of other practices in the conservation management system.

Seedbed preparation, planting, and fertilizer placement should disturb no more than one fourth of the row width. To reduce the potential for erosion within rows, the row area formed by the planting operation should be level with or

slightly above the adjacent row middles.

Additional Criteria to Maintain or Improve Soil Organic Matter Content and Tilth

Erosion shall be not exceed the soil loss tolerance (T).

The cropping sequence must contain at least 50% perennial crops or 50% high residue producing crops.

Low residue producing crops in the rotation shall be planted using a conservation tillage method that retains a minimum of 50% residue surface cover after planting.

Cover crops shall be used in the crop sequence where prior crop residues after harvest provide less than 50% surface cover.

Partial removal by means such as baling or grazing shall be limited to retain the amount and distribution needed

Additional Criteria to Conserve Soil Moisture

A minimum of 50% residue surface cover shall be maintained throughout the year. Residue shall be evenly distributed and maintained on the soil surface. Partial removal of residue by means such as baling or grazing shall be limited to retain the amount and distribution needed.

Additional Criteria to Provide Food and Escape Cover for Wildlife

Residue height, amount, and time period shall be determined using an approved habitat evaluation procedure. Residues shall not be removed unless it is determined by the habitat evaluation procedure that removal would not adversely affect habitat values. Stubble shall be maintained standing over winter.

PLANNING CONSIDERATIONS

Partial removal of plant residue by such means as baling or grazing may produce negative impacts on resources. The effects of residue removal shall be considered when evaluating the impacts on soil, water, air, plant, and animal resources. These activities should not be performed if the result is excess removal of plant residues.

No-till or strip till may be practiced throughout the crop sequence, or may be managed as part of a system which includes other tillage and planting methods such as mulch till. Maintaining a continuous No-till system will maximize the improvement of soil organic matter content, particularly near the soil surface. Also, when no-till is practiced continuously, soil reconsolidation provides additional resistance to sheet and rill erosion and ephemeral erosion.

Production of adequate amounts of crop residues necessary for the proper functioning of this practice can be enhanced by selection of high residue producing crops and crop varieties in the rotation, use of cover crops, and adjustment of plant populations and row spacing.

Leaving rows of unharvested crop standing at intervals across the field can enhance the value of residues for wildlife habitat.

PLANS AND SPECIFICATIONS

Specifications for establishment and operation of this practice shall be prepared for each field or treatment unit according to the Criteria, Considerations, and Operation and Maintenance described in this standard. Specifications shall be recorded using approved specification sheets, job sheets, narrative statements in the conservation plan, or other acceptable documentation.

OPERATION AND MAINTENANCE

Proper adjustment, operation, and maintenance of equipment is essential for successful implementation of this practice.

SUPPORTING DATA AND DOCUMENTATION

1. Identify resource concern(s) to be treated (see **PURPOSES**).

2. Ensure that field location, acreage, crop rotation and percent residue needed to address identified resource concern(s) are recorded as needed in the conservation plan.

3. Soil loss calculations if needed.

REFERENCES

1. Conservation Tillage Information Center, Conservation Tillage – A Check List for U.S. Farmers, 1996

2. Lamarca, Carlos Crovetto, Stubble Over the Soil: The Vital Role of Plant Residue in Soil Management to Improve Soil Quality, 1996.

3. Renard, K.G., G.R. Foster, G.A. Weesies, D.K. McCool, and D.C. Yoder, coordinators. Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE). USDA Agricultural Handbook No. 703, 1997.

4. Natural Resources Conservation Service, Delaware RUSLE Manual (FOTG), March, 1995.

5. Natural Resources Conservation Service, National Agronomy Manual.

6. USDA, Agriculture Research Service, Conservation Research Report No. 41, Crop Residue Management To Reduce Erosion and Improve Soil Quality - Appalachia and Northeast, Washington, D.C., August, 1995.

USDA
NATURAL RESOURCES
CONSERVATION SERVICE
DELAWARE
CONSERVATION PRACTICE
STANDARD

RESIDUE MANAGEMENT; MULCH TILL

CODE 329B
(Reported in Acres)

DEFINITION

Managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round, while growing crops where the entire field surface is tilled prior to planting.

PURPOSES

This practice may be applied as part of a conservation management system to support one or more of the following resource concerns:

- Reduce sheet and rill erosion.
- Reduce wind erosion.
- Maintain or improve soil organic matter content and tilth.
- Conserve soil moisture.
- Provide food and escape cover for wildlife.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all cropland and other land where crops are grown.

This standard includes tillage methods commonly referred to as mulch tillage, or chiseling and disking. It applies to tillage for annually planted crops and to tillage for planting perennial crops.

CRITERIA

General Criteria Applicable to All Purposes

Loose residue to be retained on the field shall be uniformly distributed on the soil surface. Residue should be uniformly distributed during or immediately following harvest.

Tillage implements shall be equipped to operate through plant residues without clogging and to maintain residue on or near the surface by undercutting or mixing.

Planters, drills, or air seeders shall be equipped to plant in residue distributed on the soil or mixed in the tillage layer.

The number, sequence, and timing of tillage and planting operations, and the selection of ground-engaging components shall be managed to achieve the planned amount, distribution, and orientation of residue after planting or at other essential time periods. Acceptable alternative tillage sequences shall be initially determined by a residue budget using locally applicable data on residue production and residue reduction by tillage machines. Further adjustments shall be made as needed during the tillage sequence based on field measurements of remaining residue.

Additional Criteria to Reduce Sheet and Rill Erosion.

The amount of residue needed to reduce erosion within the soil loss tolerance (T), or any other planned soil loss objective, shall be determined using the Revised Universal Soil Loss Equation (RUSLE) erosion prediction technology. Partial

removal of residue by means such as baling or grazing shall be limited to retain the amount and distribution needed. Calculations shall account for the effects of other practices in the conservation management system.

Tillage operations shall be limited to methods that leave residue on the surface and maintain the planned cover conditions.

Additional Criteria to Maintain or Improve Soil Organic Matter Content and Tilth

Erosion shall be not exceed the soil loss tolerance (T).

The cropping sequence must contain at least 50% perennial crops or 50% high residue producing crops.

Low residue producing crops in the rotation shall be planted using a conservation tillage method that retains a minimum of 50% residue surface cover after planting.

Cover crops shall be used in the crop sequence where prior crop residues after harvest provide less than 50% surface cover.

Partial removal by means such as baling or grazing shall be limited to retain the amount and distribution needed. Calculations shall account for the effects of other practices in the conservation management system.

Additional Criteria to Conserve Soil Moisture

A minimum of 50 percent residue surface cover shall be maintained throughout the year. Residue shall be evenly distributed and maintained on the soil surface. Partial removal by means such as baling or grazing shall be limited to retain the amount and distribution needed

Additional Criteria to Provide Food and Escape Cover for Wildlife

The amount of residue and height of stubble needed to provide cover shall be determined using an approved habitat evaluation procedure. Residues shall not be removed unless it is determined by the habitat evaluation procedure that removal would not adversely affect habitat values. Stubble shall be maintained standing over the winter. Tillage shall be delayed until spring, in order to maintain waste grain on the soil surface during the winter.

PLANNING CONSIDERATIONS

Partial removal of plant residue by such means as baling or grazing may produce negative impacts on resources. The effects of residue removal shall be considered when evaluating the impacts on soil, water, air, plant, and animal resources. These activities should not be performed if the result is excess removal of plant residues.

Mulch till may be practiced continuously throughout the crop sequence, or may be managed as part of a residue management system which includes other tillage methods such as No-till.

Production of adequate amounts of crop residues necessary for the proper functioning of this practice can be enhanced by selection of high residue producing crops and crop varieties in the rotation, use of cover crops, and adjustment of plant populations and row spacing.

Where improvement of soil tilth is a concern, use of undercutting tools will enhance accumulation of organic material in the surface layer. Soil organic matter content is also increased with the use of high residue producing crops and cover crops.

Leaving rows of unharvested crop standing at intervals across the field can enhance the value of residues for wildlife habitat.

PLANS AND SPECIFICATIONS

Specifications for establishment and operation of this practice shall be prepared for each field or treatment unit according to the Criteria, Considerations, and Operation and Maintenance described in this standard. Specifications shall be recorded using approved specification sheets, job sheets, narrative statements in the conservation plan, or other acceptable documentation.

OPERATION AND MAINTENANCE

Proper adjustment, operation, and maintenance of equipment is essential for successful implementation of this practice.

SUPPORTING DATA AND DOCUMENTATION

1. Identify resource concern(s) to be treated (see **PURPOSES**).

2. Ensure that field location, acreage, crop rotation, and percent residue needed to address identified resource concern(s) are recorded in the conservation plan.

3. Type(s) of tillage implements used.

4. Soil loss calculations if needed.

REFERENCES

1. Conservation Tillage Information Center, Conservation Tillage – A Check List for U.S. Farmers, 1996

2. Lamarca, Carlos Crovetto, Stubble Over the Soil: The Vital Role of Plant Residue in Soil Management to Improve Soil Quality, 1996.

3. Renard, K.G., G.R. Foster, G.A. Weesies, D.K. McCool, and D.C. Yoder, coordinators. Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE). USDA Agricultural Handbook No. 703, 1997.

4. Natural Resources Conservation Service, Delaware RUSLE Manual (FOTG), March, 1995.

5. Natural Resources Conservation Service, National Agronomy Manual.

6. USDA, Agriculture Research Service, Conservation Research Report No. 41, Crop Residue Management To Reduce Erosion and Improve Soil Quality - Appalachia and Northeast, Washington, D.C., August, 1995.

USDA
NATURAL RESOURCES
CONSERVATION SERVICE
DELAWARE
CONSERVATION PRACTICE
STANDARD

RESIDUE MANAGEMENT; SEASONAL

CODE 344
(Reported in Acres)

DEFINITION

Managing the amount, orientation, and distribution of crop and other plant residues on the soil surface during part of the year, while growing crops in a clean tilled seedbed.

PURPOSES

This practice may be applied as part of a conservation management system to support one or more of the following resource concerns:

- Reduce sheet and rill erosion.
- Provide food and escape cover for wildlife.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all cropland and other land where crops are grown.

This standard includes residue management methods practiced during part of the year from harvest until residue is buried by tillage for seedbed preparation.

CRITERIA

General Criteria Applicable to All Purposes Named Above

Loose residues to be retained on the field shall be uniformly distributed on the soil surface. Residues should be uniformly distributed during or immediately following harvest.

Additional Criteria to Support Specific Purposes Named Above

- **Reduce Sheet and Rill Erosion.**

The amount of residue needed to reduce erosion within the soil loss tolerance (T), or any other planned soil loss objective, shall be determined using the Revised Universal Soil Loss Equation (RUSLE) erosion prediction technology. Partial removal of residue by means such as baling or grazing shall be limited to retain the amount and distribution of residue needed. The remaining residue shall be maintained on the surface through periods when sheet and rill erosion has the potential to occur, or until planting, whichever occurs first. Calculations shall account for the effects of other practices in the conservation management system.

Any tillage that occurs during the management period shall be limited to methods that leave residue on the surface and maintain the planned cover conditions.

- **Provide Food and Escape Cover for Wildlife**

The amount of residue, height of the stubble, and length of the management period necessary for meeting habitat requirements for the target species or wildlife population shall be determined using an approved habitat evaluation procedure.

Residues shall not be removed unless it is determined by the habitat evaluation procedure that removal would not adversely affect habitat values.

Tillage shall be delayed until the end of the management period to maintain the food and cover value of the residue. Stubble shall be maintained standing over winter.

PLANNING CONSIDERATIONS

Partial removal of plant residue by such means as baling or grazing may produce negative impacts on resources. The effects of residue removal shall be considered when evaluating the impacts on soil, water, air, plant, and animal resources. These activities should not be performed if the result is excess removal of plant residues.

Production of adequate amounts of crop residues necessary for the proper functioning of this practice can be enhanced by selection of high residue producing crops and crop varieties in the rotation, use of cover crops, and adjustment of plant populations and row spacing.

When planting on a clean seedbed, exposure to erosion can be minimized by performing secondary tillage no more than three days before planting and by limiting the number of secondary tillage operations to the minimum needed for adequate seedbed preparation.

When planting on a clean seedbed in areas with limited moisture, performing secondary tillage no more than three days before planting can increase moisture for germination.

The value of residues for wildlife habitat can be enhanced by leaving rows of unharvested crop standing at the edge of the field.

PLANS and SPECIFICATIONS

Specifications for establishment and operation of this practice shall be prepared for each field or treatment unit according to the Criteria, Considerations, and Operation and Maintenance described in this standard. Specifications shall be recorded using approved job sheets, narrative statements in the conservation plan, or other acceptable documentation.

OPERATION AND MAINTENANCE

Proper adjustment, operation, and maintenance of equipment is essential for successful implementation of this practice.

Monitor residue remaining when corn stalks are mechanically removed for fodder or bedding at start of field operations. Adjust equipment setting if removal percentage is too high to meet residue remaining target.

If livestock grazes crop residue, monitor fields on a regular basis and remove livestock when remaining residue meets minimum requirements.

SUPPORTING DATA and DOCUMENTATION

1. Identify resource concerns to be treated.

2. Ensure that field location, acreage, crop rotation, and percent residue needed to address identified resource concerns are recorded in the conservation plan.

3. Soil loss calculations if needed.

REFERENCES

1. Renard, K.G., G.R. Foster, G.A. Weesies, D.K. McCool, and D.C. Yoder, coordinators. Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE). USDA Agricultural Handbook No. 703, 1997.

2. Delaware RUSLE Manual (FOTG), USDA NRCS.

3. National Handbook of Conservation Practices, USDA Natural Resources Conservation Service.

4. Conservation Research Report No. 41, Crop Residue Management To Reduce Erosion and Improve Soil Quality - Appalachia and Northeast, USDA Agricultural Research Service, Washington, D.C., August, 1995.

5. Lamarca, Carlos Crovetto. Stubble Over the Soil: The Vital Role of Plant Residue in Soil Management to Improve Soil Quality, 1996.

6. National Agronomy Manual, USDA Natural Resources Conservation Service.

USDA
NATURAL RESOURCES
CONSERVATION SERVICE
DELAWARE
CONSERVATION PRACTICE
STANDARD

WASTE TREATMENT LAGOON

CODE 359
(Reported by No.)

DEFINITION

A waste treatment impoundment made by constructing an embankment and/or excavating a pit or dugout.

PURPOSES

To biologically treat waste, such as manure and wastewater, and thereby reduce pollution potential by serving as a treatment component of a waste management system.

CONDITIONS WHERE PRACTICE APPLIES

- Where the lagoon is a component of a planned agricultural waste management system.
- Where treatment is needed for organic wastes generated by agricultural production or processing.
- On any site where the lagoon can be constructed, operated, and maintained without polluting air or water resources.
- A water supply is adequate to fill the lagoon about half full before operation and to maintain the design depth when the lagoon becomes fully operational.
- To lagoons utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads.

CONSIDERATIONS

General

Lagoons should be located as close to the source of waste as possible.

Solid/liquid separation treatment should be considered between the waste source and the lagoon to reduce loading.

The configuration of the lagoon should be based on the method of sludge removal and method of sealing.

Due consideration should be given to economics, the overall waste management system plan, and safety and health factors.

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 embankment 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 1 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 1 may be significantly affected:

- An auxiliary (emergency) spillway
- Additional freeboard
- Storage volume for the wet year rather than normal year precipitation
- Reinforced embankment – such as, additional top width, flattened and/or armored downstream side slopes
- Secondary containment
- Water level indicators or recorders

Table 1 – 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 archeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places

The following 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 1 may be significantly affected:

- Outlet gate locks or locked gate housing
- Secondary containment
- Alarm system
- Another means of emptying the required volume

Considerations for minimizing the potential of lagoon liner seepage

Consideration should be given to providing an additional measure of safety from lagoon seepage when any of the potential impact categories listed in Table 2 may be affected.

Table 2 – Potential Impact Categories for Liner Seepage

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 carbonate rock (limestone or dolomite)

Should any of the potential impact categories listed in Table 2 be affected, consideration should be given to the following:

- A clay liner designed in accordance with procedures of Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D with a thickness and coefficient of permeability so that specific discharge is less than 1 x 10^{-6}cm/sec.
- A flexible membrane liner.
- A geosynthetic clay liner (GCL) flexible membrane liner.
- A concrete liner designed in accordance with slabs on grade criteria in NRCS Practice Standard 313, Waste Storage Facility, for fabricated structures requiring water tightness.

Table 3 – Rainfall – Runoff Evaporation Data Summary – Paved Areas

Month (1)	Rainfall (Inches) (2)	Runoff (Inches) (3)	Evaporation (Inches) (4)	Net Rainfall (2) – (4) (Inches) (5)
January	3.55	1.92	1.08	2.47
February	2.96	1.63	1.08	1.88
March	4.04	2.22	1.80	2.24
April	3.39	1.86	2.52	0.87
May	3.81	2.10	3.60	0.21
June	3.71	2.30	4.68	-0-
July	4.66	2.89	5.40	-0-
August	5.62	3.77	5.04	0.58
Sept.	3.93	2.63	4.32	-0-
Oct.	3.12	1.90	3.24	-0-
Nov.	3.47	2.12	2.16	1.31
Dec.	3.06	1.65	1.08	1.98

Note: Evaporation from ponds containing manure will be less than the above due to a dry crust developing on the surface. For ponds with high solids concentration, the evaporation computations should be omitted.

Table 4 – Rainfall – Runoff Evaporation Data Summary – Unpaved Areas

Month	Rainfall (Inches)	Runoff (Inches)	Evaporation (Inches)	Net Rainfall (2) – (4) (Inches)

Note: Evaporation from ponds containing manure will be less than the above due to a dry crust developing on the surface. For ponds with high solids concentration, the evaporation computations should be omitted.

Considerations for minimizing the impact of odors

For sites located where odors are a concern, the following should be considered:

- Reduce loading rates of anaerobic lagoons to at least one half the values of AWMFH Figure 10-22.
- Covering the lagoon with a suitable cover.
- Using naturally aerated or mechanically aerated lagoons.
- Using composting in conjunction with a solid waste system rather than a liquid or slurry system.
- Using an anaerobic digester and biogas capture system.

Table 5 – Production and Composition of Livestock, Poultry, and Milking Center Wastes Lb/day/1000 lbs. Live Weight

Animal	Manure	BOD	Volatile Solids

CRITERIA

General Criteria for all Lagoons:

Laws and Regulations. All federal, state, and local laws, rules and regulations governing the construction and use of waste treatment lagoons must be followed.

Location. The lagoon should be located near the source of waste and as far from neighboring dwellings as practicable, a minimum distance of 300 ft. To minimize the potential for contamination of streams, lagoons 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. Lagoons 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.

Lagoons should be located so they have as little drainage area as possible. If a lagoon has a drainage area, the volume of normal runoff during the treatment period and 25-year, 24-hour storm event runoff shall be included in the required volume of the lagoon.

Soil and foundation. The lagoon shall be located in soils with an acceptable permeability that meets all applicable regulations, or the lagoon shall be lined.

Information and guidance on controlling seepage from waste impoundments can be found in the AWMFH, Appendix 10D.

The lagoon shall have a bottom elevation that is a minimum of 2 feet above the seasonal high water table unless special design features are incorporated that address buoyant forces, lagoon seepage rates, and non-encroachment of the water table by contaminants. The water table may be lowered by use of perimeter drains to meet this requirement.

Flexible membranes. Flexible membrane liners shall meet or exceed the requirements of flexible membrane linings specified in NRCS Practice Standard 521, Pond Sealing or Lining, Flexible Membrane Lining.

Required volume. The lagoon shall have the capability of storing the following volumes:

- Volume of accumulated sludge for the period between sludge removal events;
- Minimum treatment volume (anaerobic lagoons only);
- Volume of manure, wastewater, and other wastes accumulated during the treatment period;
- Volume of runoff from the lagoon's drainage area during the treatment period;
- Depth of normal precipitation less evaporation on the surface area (at the required volume level) of the lagoon during the treatment period;
- Depth of the 25-year, 24-hour storm precipitation on the surface area (at the required volume level) of the lagoon;
- 25-year, 24-hour runoff volume from the facility's drainage area.

Treatment period. The treatment period is the detention time between drawdown events. It shall be the greater of either 60 days; or the time required to provide the storage that allows environmentally safe utilization of waste considering the climate, crops, soil, and equipment requirements; or as required by local, state, and Federal regulations.

Waste loading. Daily waste loading shall be based on the maximum daily loading considering all waste sources that will be treated by the lagoon. Laboratory test data should be used if available. If test data is not available, Chapter 4 of the AWMFH may be used for estimating waste loading, or refer to Figure 1, Figure 2, and Table 4.

Embankments. The minimum elevation of the top of the settled embankment shall be 1 foot above the lagoon's required volume. This 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 6. 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 6 – Minimum Top Widths

Total embankment Height, ft.	Top Width, ft.
15 or less	8
15-20	10
20-25	12
25-30	14
30-35	15

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

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. Inlets 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.

Outlet. Outlets from the required volume shall be designed to resist corrosion and plugging. No outlet shall automatically discharge from the required volume of the lagoon.

Facility for drawdown. Components that facilitate safe drawdown of the liquid level in the lagoon shall be provided. Access areas and ramps used to withdraw waste shall have slopes (10% or flatter) that facilitate a safe operating environment. Docks, wells, pumping platforms, retaining walls, etc., shall permit drawdown without causing erosion or damage to liners.

Sludge removal. Provision shall be made for periodic removal of accumulated sludge to preserve the treatment capacity of the lagoon.

Erosion protection. Embankments and disturbed areas surrounding the lagoon shall be protected to control erosion. This includes the inside slopes of the lagoon as needed to protect the integrity of the liner.

Safety. Design shall include appropriate safety features to minimize the hazards of the lagoon.

Safety. Design shall include appropriate safety features to minimize the hazards of the facility. The lagoon shall be fenced around the perimeter and warning signs posted to prevent unauthorized access and accidents. Ramps used to empty liquids shall have a slope of 4 horizontal to 1 vertical or flatter. Those used to empty semi-solids, or solids shall have a slope of 10 horizontal to 1 vertical or flatter unless special traction surfaces are provided. Ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to ensure the safety of humans and livestock. 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. Lagoons and uncovered fabricated structures containing liquid or slurry above ground surface shall be fenced and warning signs posted to prevent children and others from using them for other than their intended purpose

Additional Criteria for Anaerobic Lagoons

Loading rate. Anaerobic lagoons shall be designed to have a minimum treatment volume based on Volatile Solids (VS) loading per unit of volume. The maximum loading rate shall be as indicated in AWMFH Figure 10-22 or according to state regulatory requirements, whichever is more stringent.

Operating levels. The maximum operating level shall be the lagoon level that provides the required volume less the 25-year, 24-hour storm event precipitation on the surface of the lagoon and its drainage area. The maximum drawdown level shall be the lagoon level that provides volume for the required minimum treatment volume plus the volume of accumulated sludge between sludge removal events. Permanent markers shall be installed at these elevations. The proper operating range of the lagoon is above the maximum drawdown level and below the maximum operating level. These markers shall be referenced and described in the O&M plan.

Depth requirements. The minimum depth at maximum drawdown shall be 6 feet. If subsurface conditions prevent practicable construction to accommodate the minimum depth at maximum drawdown, a lesser depth may be used, if the volume requirements are met.

Additional Criteria for Naturally Aerobic Lagoons

Loading rate. Naturally aerobic lagoons shall be designed to have a minimum treatment surface area as determined on the basis of daily BOD_5 loading per unit of lagoon surface. The required minimum treatment surface area shall be the surface area at maximum drawdown. The maximum loading rate shall be as indicated by AWMFH Figure 10-25 or according to state regulatory requirements, whichever is more stringent.

Operating levels. The maximum operating level shall be the lagoon level that provides the required volume less the 25-year, 24-hour storm event on the lagoon surface and its drainage area. The maximum drawdown level shall be the lagoon level that provides volume for the volume of manure, wastewater, and clean water accumulated during the treatment period plus the volume of accumulated sludge between sludge removal events. Permanent markers shall be installed at these elevations.

The proper operating range of the lagoon is above the maximum drawdown level and below the maximum operating level. These markers shall be referenced and described in the O&M plan.

Depth requirements. The minimum depth at maximum drawdown shall be 2 feet. The maximum liquid level shall be 5 feet.

Additional Criteria for Mechanically Aerated Lagoons

Loading rate. Mechanically aerated waste treatment lagoons' treatment function shall be designed on the basis of daily BOD_5 loading and aeration equipment manufacturer's performance data for oxygen transfer and mixing. Aeration equipment shall provide a minimum of 1 pound of oxygen for each pound of daily BOD_5 loading.

Operating levels. The maximum operating level shall be the lagoon level that provides the required lagoon volume less the 25-year, 24-hour storm event precipitation on the lagoon and its drainage area, and shall not exceed the site and aeration equipment limitations. A permanent marker or recorder shall be installed at this elevation. The proper operating range of the lagoon is below this elevation and above the minimum treatment elevation established by the manufacturer of the aeration equipment. This marker shall be referenced and described in the O&M plan.

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.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for design. The plan shall contain the operational requirements for drawdown and the role of permanent markers. This shall include the requirement that waste be removed from the lagoon and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan. In addition, the plan shall include a strategy for removal and disposition of waste with least environmental damage during the normal treatment period to the extent necessary to insure the lagoon's safe operation. This strategy shall also include the removal of unusual storm events.

Development of an emergency action plan should be considered for lagoons where there is a potential for significant impact from breach or accidental release. The plan shall include site-specific provisions for emergency actions that will minimize these impacts.

SUPPORTING DATA FOR DOCUMENTATION

Field Data and Survey Notes.

The following is a list of the minimum data needed:

a. Plan view sketch.

b. Soil borings with depth to water table identified.

c. Type, size, and number of animals the structure is designed to serve.

d. Topographic survey as needed for the siting of the structure and its appurtenances and for a grading plan if needed.

e. Profile and cross-section of the site if a grading plan is needed.

Design Data

Record on appropriate engineering paper. For guidance on the preparation of engineering plans see Chapter 5 of the Engineering Field Handbook (EFH), Part 650. The following is a list of the minimum required design data

a. Locate the practice on the farm plan map in the case file.

b. Determine soil type and any special restrictions.

c. Determine peak runoff from the contributing drainage area for the

required design storm in accordance with Chapter 2, EFH Part 650 or by other approved method.

d. Size the structure in accordance with the guidance in this practice standard, the AWMFH, Part 651 or by other approved methods.

e. Include the Miss Utility statement.

f. Show job class on the plan.

g. Plan view sketch, and final grading plan as required.

h. References to components supplied by others (pumps, etc.).

i. Maximum and minimum operating levels (elevations).

j. Structural details of all components with dimensions and special requirements noted.

k. Special safety requirements

l. Seeding, fertilizing, and mulching requirements.

m. Written Operation and Maintenance plan that includes the location and description of permanent marker that denotes the maximum and minimum operating levels.

Construction Check Data/As-Built Plans

Record on survey notepaper, SCS-ENG-28, or other appropriate engineering paper. Survey data will be plotted in red. The following is a list of minimum data needed for As-Built documentation:

a. Documentation of site visits on CPA-6. The documentation shall include the date, who performed the inspection, specifics as to what was inspected, all alternatives discussed and decisions made and by whom.

b. Check notes recorded during or after completion of construction showing dimensions and elevations of the structure, as appropriate.

c. Statement on seeding and fencing.

d. Final quantities and documentation for quantity changes. Materials certifications as appropriate.

Sign and date check-notes and plans by someone with appropriate approval authority. Include statement that practice meets or exceeds plans and NRSC practice standards.

USDA
NATURAL RESOURCES
CONSERVATION SERVICE

DELAWARE CONSERVATION
PRACTICE STANDARD

DIVERSION

CODE 362
(Reported by Ft.)

DEFINITION

A channel constructed across the slope generally with a supporting ridge on the lower side.

PURPOSES

This practice may be applied for one or more of the following purposes:

- Break up concentrations of water on long slopes, on undulating land surfaces, and on land that is generally considered too flat or irregular for terracing.
- Divert water away from farmsteads, agricultural waste systems, and other improvements.
- Collect or direct water for water-spreading or water-harvesting systems.
- Increase or decrease the drainage area above ponds.
- Protect terrace systems by diverting water from the top terrace where topography, land use, or land ownership prevents terracing the land above.
- Intercept surface and shallow subsurface flow.
- Reduce runoff damages from upland runoff.
- Reduce erosion and runoff on urban or developing areas and at construction or mining sites.
- Divert water away from active gullies or critically eroding areas.
- Supplement water management on conservation cropping or stripcropping systems.

CONDITIONS WHERE PRACTICE APPLIES

This applies to all cropland and other land uses where surface runoff water control and/or management is needed. It also applies where soils and topography are such that the diversion can be constructed and a suitable outlet is available or can be provided.

CONSIDERATIONS

A diversion in a cultivated field should be aligned and spaced from other structures or practices to permit use of modern farming equipment. The side slope lengths should be sized to fit equipment widths when cropped.

At non-cropland sites, consider planting native vegetation in areas disturbed due to construction.

Consider planting native plant species beneficial to wildlife. Minimize adverse effects to existing wetlands. Diversion of upland water to prevent entry into a wetland may convert a wetland by changing the hydrology. Any construction activities should minimize disturbance to wildlife habitat. Opportunities should be explored to restore and improve wildlife habitat, including habitat for threatened, endangered, and other species of concern.

On landforms where archeological sites are likely to occur, use techniques to maximize identification of such sites prior to planning,

design, and construction.

This practice has the potential to affect National Register listed cultural resources or eligible (significant) cultural resources. These may include archeological, historic, or traditional cultural properties. Care should be taken to avoid adverse impacts to these resources. Follow NRCS state policy for considering cultural resources during planning.

CRITERIA

Criteria Applicable to All Purposes

Capacity. Diversions as temporary measures, with an expected life span of less than 2 years, shall have a minimum capacity for the peak discharge from the 2-year frequency, 24-hour duration storm.

Diversions that protect agricultural land shall have a minimum capacity for the peak discharge from a 10-year frequency, 24-hour duration storm.

Diversions designed to protect areas such as urban areas, buildings, roads, and animal waste management systems shall have a minimum capacity for the peak discharge from a storm frequency consistent with the hazard involved but not less than a 25-year frequency, 24-hour duration storm. Freeboard shall be not less than 0.3 ft.

Design depth is the channel storm flow depth plus freeboard, where required.

Cross-Section. The channel may be parabolic, V-shaped, or trapezoidal. The diversion shall be designed to have stable side slopes.

The ridge shall have a minimum top width of 4 feet at the design depth. The ridge height shall include an adequate settlement factor.

The ridge top width may be 3 feet at the design depth for diversions with less than 10 acres drainage area above cropland, pastureland, or woodland.

The top of the constructed ridge at any point shall not be lower than the design depth plus the specified overfill for settlement.

The design depth at culvert crossings shall be the culvert headwater depth for the design storm plus freeboard.

Grade and Velocity. Channel grades may be uniform or variable. Channel velocity shall not exceed that considered non-erosive for the soil and planned vegetation or lining.

Maximum channel velocities for permanently vegetated channels shall not exceed those recommended in the NRCS Engineering Field Handbook (EFH) Part 650, Chapter 7, or Agricultural Research Service (ARS) Agricultural Handbook 667, Stability Design of Grass-Lined Open Channels (Sept. 1987).

When the capacity is determined by the formula $Q = A\ V$ and the V is calculated by using Manning's equation, the highest expected value of "n" shall be used.

Location. The outlet conditions, topography, land use, cultural operations, and soil type shall determine the location of the diversion.

Protection Against Sedimentation. Diversions normally should not be used below high sediment producing areas. When they are, a practice or combination of practices needed to prevent damaging accumulations of sediment in the channel, shall be installed. This may include practices such as erosion control practices, tillage practices, vegetated filter strip, or structural measures. Install practices in conjunction with or before the diversion construction.

If movement of sediment into the channel is a problem, the design shall include extra capacity for sediment or periodic removal as outlined in the operation and maintenance plan.

Outlets. Each diversion must have a safe and stable outlet with adequate capacity. The outlet may be a grassed waterway, a lined waterway, a vegetated or paved area, a grade stabilization structure, an underground outlet, a stable watercourse, a sediment basin, or a combination of these practices. The outlet must convey runoff to a point where outflow will not cause damage. Vegetative outlets shall be installed and established before diversion construction to insure establishment of vegetative cover in the outlet channel.

The release rate of an underground outlet, when combined with storage, shall be such that the design storm runoff will not overtop the diversion ridge.

The design depth of the water surface in the diversion shall not be lower than the design elevation of the water surface in the outlet at their junction when both are operating at design flow.

Vegetation. Disturbed areas that are not to be cultivated shall be seeded as soon as practicable after construction. Planting shall be specified in accordance with practice standard for Critical Area Planting (Code 342) for seeding.

Lining. If the soils or climatic conditions preclude the use of vegetation for erosion protection, non-vegetative linings such as gravel, rock riprap, cellular block, or other approved manufactured lining systems may be used.

PLANS AND SPECIFICATIONS

Plans and specifications for this practice shall be prepared in accordance with the previously listed criteria. Plans and specifications shall contain sufficient detail concerning site preparation and establishment to ensure successful management of the practice. Appropriate conservation practice standards shall be used for designing and installing structural and vegetative measures. Documentation shall be in accordance with the section "Supporting Data and Documentation" in this standard.

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) plan shall be developed for use by the client. The plan shall include specific instructions for maintaining diversion capacity, storage, ridge height, and outlets.

The minimum requirements to be addressed in the operation and maintenance plan are:

1. Provide periodic inspections, especially immediately following significant storms.

2. Promptly repair or replace damaged components of the diversion as necessary.

3. Maintain diversion capacity, ridge height, and outlet elevations, especially if high sediment yielding areas are in the drainage area above the diversion. Establish necessary clean-out requirements.

4. Each inlet for underground outlets must be kept clean and sediment buildup redistributed so that the inlet is at the lowest point. Inlets damaged by farm machinery must be replaced or repaired immediately.

5. Redistribute sediment as necessary to maintain the capacity of the diversion.

6. Vegetation shall be maintained and trees and brush controlled by hand, chemical, and/or mechanical means.

7. Keep machinery away from steep sloped ridges. Keep equipment operators informed of all potential hazards.

SUPPORTING DATA FOR DOCUMENTATION

Field Data and Survey Notes

Record on survey notepaper, SCS-ENG-28, or other appropriate format. The following is a list of the minimum data needed:

1. Plan view sketch.

2. Profile of the existing ground at the location of the diversion.

3. Cross-sections of the existing ground at the location of the diversion (minimum of one per reach not to exceed 300 feet.)

4. Lengths of each reach and total length.

5. Profile and cross-section of outlet and special precautions if needed.

Design Data

Record on appropriate engineering paper. For guidance on the preparation of engineering plans see Chapter 5 of the Engineering Field Handbook - Part 650. The following is a list of the minimum required design data:

1. Locate the practice on the farm plan map in the case file.

2. Determine soil type and any special restrictions.

3. Determine peak runoff from the contributing drainage area for the required design storm in accordance with Chapter 2, Engineering Field Handbook - Part 650 or by other approved method.

4. Design each reach in accordance with Chapter 9, Engineering Field Handbook - Part 650, or other source.

5. Show job class on the plan. Indicate the location, description, and elevation of the temporary benchmarks used in the design survey. Provide a location map, which indicates the job site.

6. Plan view sketch, profile of diversion and cross-sections of each design reach to be shown on the construction plans.

7. Details of the diversion outlet or other structural components needed.

8. Show on the plans the planting plan. This must meet the criteria, specifications and documentation requirements of the conservation standard for Critical Area Planting (Code 342).

9. Estimated quantities and cost estimate.

Construction Check Data/As-Built Plans

Record on survey notepaper, SCS-ENG-28, or other appropriate format. Survey data will be plotted on the as-built plans in red. The following is a list of minimum data needed for as-built documentation:

1. Documentation of site visits. The documentation shall include the date, who performed the inspection, specifics as to what was inspected, all alternatives discussed and decisions made and by whom.

2. Check notes recorded during or after completion of construction showing grade and cross section of constructed reaches and outlets including length, width, and depth.

3. Measure total length constructed.

4. Statement on seeding and outlet stability.

5. Final quantities and documentation for quantity changes. Material certifications as appropriate.

6. Signature and date on check-notes and plans of someone with the appropriate engineering job approval authority. Include a signed statement that constructed practice meets or exceeds the construction plans and NRCS practice standards.

USDA
NATURAL RESOURCES
CONSERVATION SERVICE

DELAWARE CONSERVATION
PRACTICE STANDARD

POND

CODE 378
(Reported by No.)

DEFINITION

A water impoundment made by constructing an embankment or by excavating a pit or dugout.

In this standard, ponds constructed by the first method are referred to as embankment ponds, and those constructed by the second method are referred to as excavated ponds. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at the auxiliary spillway elevation is 3 feet or more.

PURPOSES

To provide water for livestock, fish and wildlife, recreation, fire control, and other related uses, and to maintain or improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This standard establishes the minimum acceptable quality for the design and construction of low-hazard ponds where:

- Failure of the dam will not result in loss of life; damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities.

- The product of the storage times the effective height of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the auxiliary spillway. The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no auxiliary spillway, the top of the dam is the upper limit.

- The effective height of the dam is 35 feet or less.

CONSIDERATIONS

The visual design of ponds should be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added for visual interest and to attract wildlife.

Project location and construction should minimize the impacts to existing fish and wildlife habitat.

When feasible, structure should be retained, such as trees in the upper reaches of the pond and stumps in the pool area. Upper reaches of the pond can be shaped to provide shallow areas and wetland habitat.

If fish are to be stocked, consider criteria and guidance in conservation practice standard 399,

Fishpond Management.

Stockpiling topsoil for placement on disturbed areas can facilitate revegetation.

Consider placement and selection of vegetation to improve fish and wildlife habitat and species diversity.

Water Quantity.

Consider effects upon components of the water budget, especially:

- Effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.
- Variability of effects caused by seasonal or climatic changes.
- Effects on downstream flows and impacts to the environment such as wetlands, aquifers, and social and economic impacts to downstream uses or users.
- Potential for multiple purposes.

Water Quality.

- Consider effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that are carried by runoff.
- Effects on the visual quality of onsite and downstream water resources.
- Short-term and construction-related effects of this practice on the quality of downstream water courses.
- Effects of water level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.
- Effects on wetlands and water-related wildlife habitats.
- Effects of water levels on soil nutrient processes such as plant nitrogen use or denitrification.
- Effects of soil water level control on the salinity of soils, soil water, or downstream water.
- Potential for earth moving to uncover or redistribute toxic materials such as acid soils.

This practice has the potential to affect National Register listed cultural resources or eligible (significant) cultural resources. These may include archeological, historic, or traditional cultural properties. Care should be taken to avoid adverse impacts to these resources. Follow NRCS state policy for considering cultural resources during planning.

CRITERIA

Criteria Applicable to All Purposes

All federal, state and local requirements shall be addressed in the design.

A protective cover of vegetation shall be established on all exposed areas of embankments, spillways and borrow areas as climatic conditions allow, according to the guidelines in conservation practice standard 342, Critical Area Planting.

Site Conditions. Site conditions shall be such that runoff from the design storm can be safely passed through (1) a natural or constructed auxiliary spillway, (2) a combination of a principal spillway and an auxiliary spillway, or (3) a principal spillway.

Drainage Area. The drainage area above the pond must be protected again erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area shall be large enough so that surface runoff and groundwater will provide an adequate supply of water for the intended purpose unless an alternate water source exists to serve this purpose. The quality shall be suitable for the water's intended use.

Reservoir Area. The topography and geology of the site shall permit storage of water at a depth and volume that will ensure a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for

a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable.

Design Criteria for Embankment Ponds

Geological Investigations. Pits, trenches, borings, review of existing data or other suitable means of investigation shall be conducted to characterize materials within the embankment foundation, auxiliary spillway and borrow areas. Soil materials shall be classified using the Unified Soil Classification System.

Foundation Cutoff. A cutoff of relatively impervious material shall be provided under the dam if necessary to reduce seepage through the foundation. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments as required and be deep enough to extend into a relatively impervious layer or provide for a stable dam when combined with seepage control. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes shall not be steeper than one horizontal to one vertical.

Seepage Control. Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage could create swamping downstream, (3) such control is needed to insure a stable embankment, or (4) special problems require drainage for a stable dam. Seepage may be controlled by (1) foundation, abutment, or embankment filters and drains; (2) reservoir blanketing; or (3) a combination of these measures.

Embankment. The minimum top width for a dam is shown in Table 1. If the embankment top is to be used as a public road, the minimum width shall be 16 feet for one-way traffic and 26 feet for two-way traffic. Guardrails or other safety measures shall be used where necessary and shall meet the requirements of the responsible road authority. For dams less than 20 feet in height, maintenance considerations or construction equipment limitations may require increased top widths from the minimum shown in Table 1.

Table 1. Minimum top width for dams

Total height of embankment	Top Width
feet	*feet*
Less than 10	6
10 - 14.9	8
15 - 19.9	10
20 - 24.9	12
25 - 34.9	14
35 or more	15

Side Slopes. The combined upstream and downstream side slopes of the settled embankments shall not be less than five horizontal to one vertical, and neither slope shall be steeper than two horizontal to one vertical. All slopes must be designed to be stable, even if flatter side slopes are required. Downstream or upstream berms can be used to help achieve stable embankment sections.

Slope Protection. If needed to protect the slopes of the dam from erosion, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation, shall be provided (Technical Releases 56, "A Guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments" and 69, "Riprap for Slope Protection Against Wave Action" contain design guidance).

Freeboard. The minimum elevation of the top of the settled embankment shall be 1 foot above the water surface in the reservoir with the auxiliary spillway flowing at design depth. The minimum difference in elevation between the crest of the auxiliary spillway and the settled top of the dam shall be 2 feet for all dams having more than a 20-acre drainage area or more than 20 feet in effective height.

Settlement. The design height of the dam shall be increased by the amount needed to insure that after settlement the height of the dam equals or exceeds the design height. This increase shall not be less than 5 percent of the height of the dam, except where detailed soil testing and laboratory analyses or experience in the area show that a lesser amount is adequate.

Principal Spillway. A pipe conduit, with needed appurtenances, shall be placed under or

through the dam, except where rock, concrete, or other types of lined spillways are used, or where the rate and duration of flow can be safely handled by a vegetated or earth spillway.

For dams with a drainage area of 20 acres or less, the principal spillway crest elevation shall not be less than 0.5 feet below the auxiliary spillway crest elevation. For dams with a drainage area over 20 acres, this difference shall not be less than 1.0 feet.

When design discharge of the principal spillway is considered in calculating peak outflow through the auxiliary spillway, the crest elevation of the inlet shall be such that the design discharge will be generated in the conduit before there is discharge through the auxiliary spillway.

Pipe conduits designed for pressure flow must have adequate anti-vortex devices. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the auxiliary spillways. The diameter of the principal spillway pipe shall not be less than 4 inches. Pipe conduits used solely as a supply pipe through the dam for watering troughs and other appurtenances shall not be less than 1-1/4 inches in diameter.

If the pipe conduit diameter is 10 inches or greater, its design discharge may be considered when calculating the peak outflow rate through the auxiliary spillway.

Pipe conduits shall be ductile iron, welded steel, corrugated steel, corrugated aluminum, reinforced concrete (pre-cast or site-cast), or plastic. Pipe conduits through dams of less than 20 feet total height may also be cast iron or unreinforced concrete.

Pipe conduits shall be designed and installed to withstand all external and internal loads without yielding, buckling, or cracking. Rigid pipe shall be designed for a positive projecting condition. Flexible pipe shall be designed for a maximum deflection of 5 percent. The modulus of elasticity for PVC pipe shall be assumed as one-third of the amount designated by the compound cell classification to account for long-term reduction in modulus of elasticity. Difference reductions in modulus may be appropriate for other plastic pipe materials.

The minimum thickness of flexible pipe shall be SDR 26, Schedule 40, Class 100, or 16 gage as appropriate for the particular pipe material. Connections of flexible pipe to rigid pipe or other structures shall be designed to accommodate differential movements and stress concentrations.

All pipe conduits shall be designed and installed to be water tight by means of couplings, gaskets, caulking, waterstops, or welding. Joints shall be designed to remain watertight under all internal and external loading including pipe elongation due to foundation settlement.

Pipe conduits shall have a concrete cradle or bedding if needed to provide improved support for the pipe to reduce or limit structural loading on pipe to allowable levels.

Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable devices such as a Saint Anthony Falls stilling basin or an impact basin may be used to provide a safe outlet.

All steel pipe and couplings shall have protective coatings in areas that have traditionally experienced pipe corrosion, or in embankments with saturated soil resistivity less than 4000 ohms-cm or soil pH less than 5. Protective coatings shall be asphalt, polymer over galvanizing, aluminized coating or coal tar enamel as appropriate for the pipe type. Plastic pipe that will be exposed to direct sunlight shall be ultraviolet-resistant and protected with a coating or shielding, or provisions provided for replacement as necessary.

Cathodic Protection. Cathodic protection is to be provided for coated welded steel and galvanized corrugated metal pipe where soil and resistivity studies indicate that the pipe needs a protective coating, and where the need and importance of the structure warrant additional protection and longevity. If cathodic protection is not provided for in the original design and

installation, electrical continuity in the form of joint-bridging straps should be considered on pipes that have protective coatings. Cathodic protection should be added later if monitoring indicates the need.

Seepage Control. Seepage control along a pipe conduit spillway shall be provided if any of the following conditions exist:

1. The effective height of dam is greater than 15 feet.

2. The conduit is of smooth pipe larger than 8 inches in diameter.

3. The conduit is of corrugated pipe larger than 12 inches in diameter.

Seepage along pipes extending through the embankment shall be controlled by use of a drainage diaphragm, unless it is determined that anti-seep collars will adequately serve the purpose.

Drainage Diaphragm. The drainage diaphragm shall function both as a filter for adjacent base soils and a drain for seepage that it intercepts. The drainage diaphragm shall consist of sand meeting the requirements of ASTM C-33, for fine aggregate. If unusual soil conditions exist such that this material may not meet the required filter or capacity requirements, a special design analysis shall be made.

The drainage diaphragm shall be a minimum of 2 feet thick and extend vertically upward and horizontally at least three times the outside pipe diameter, and vertically downward at least 18 inches beneath the conduit invert. The drainage diaphragm shall be located immediately downstream of the cutoff trench, but downstream of the centerline of the dam if the cutoff is upstream of the centerline.

The drainage diaphragm shall be outletted at the embankment downstream toe using a drain backfill envelope continuously along the pipe to where it exits the embankment. Drain fill shall be protected from surface erosion.

Anti-seep Collars. When anti-seep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe but not more than 25 feet. The minimum spacing shall be 10 feet. Collar material shall be compatible with pipe materials. The anti-seep collar(s) shall increase by at least 15 percent the seepage path along the pipe.

Trash Guard. To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser unless the watershed does not contain trash or debris that could clog the conduit.

Other Outlets. A pipe with a suitable valve shall be provided to drain the pool area if needed for proper pond management or if required by State law. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function.

Auxiliary Spillways. Auxiliary spillways convey large flood flows safely past earth embankments and have historically been referred to as "Emergency Spillways".

An auxiliary spillway must be provided for each dam, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The following are minimum criteria for acceptable use of a closed conduit principal spillway without an auxiliary spillway: a conduit with a cross-sectional area of 3 $ft.^2$ or more, an inlet that will not clog, and an elbow designed to facilitate the passage of trash.

The minimum capacity of a natural or constructed auxiliary spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2, less any reduction creditable to conduit discharge and detention storage.

The auxiliary spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. The routing shall start either with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days' drawdown, whichever is higher. The 10-day drawdown shall be computed from the crest of the auxiliary spillway or from the

elevation that would be attained if the entire design storm were impounded, whichever is lower. Auxiliary spillways shall provide for passing the design flow at a safe velocity to a point downstream where the dam will not be endangered.

Constructed auxiliary spillways are open channels that usually consist of an inlet channel, a control section, and exit channel. They shall be trapezoidal and shall be located in undisturbed or compacted earth or in-situ rock. The slide slopes shall be stable for the material in which the spillway is to be constructed. For dams having an effective height exceeding 20 feet, the auxiliary spillway shall have a bottom width of not less than 10 feet.

Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crease elevation of the spillway. The inlet channel may be curved to fit existing topography. The grade of the exit channel of a constructed auxiliary spillway shall fall within the range established by discharge requirements and permissible velocities.

Structural Auxiliary Spillways. If chutes or drops are used for principal spillways or auxiliary spillways, they shall be designed according to the principles set forth in the Part 650, Engineering Field Handbook and the National Engineering Handbook, Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2, less any reduction creditable to conduit discharge and detention storage.

Table 2. Minimum Auxiliary Spillway Capacity

Drainage Area (Ac.)	Effective height of dam[1] (Ft.)	Storage (Ac-Ft)	Minimum design storm [2,3] Principle Spillway Frequency[4]	Emergency Spillway Frequency[4]
20 or less	20 or less	<than 50	5	10
20 or less	<than 20	<than 50	10	25
>than 20	20 or less	<than 50	10	25
>than 20	10 or less	<than 100	10	50
All Others			25	50

1. As defined under "Conditions where Practice Applies."
2. Select rain distribution based on climatological region.
3. Minimum duration 24 hours
4. Years

Additional Criteria for Excavated Ponds

Runoff. Provisions shall be made for a pipe and auxiliary spillway, if needed, that will meet the capacity requirements of Table 2. Runoff flow patterns shall be considered when locating the excavated pond and placing the spoil.

Side Slopes. Side slopes of excavated ponds shall be stable and shall not be steeper than one horizontal to one vertical. If livestock will water directly from the pond, a watering ramp of ample width shall be provided. The ramp shall extend to the anticipated low water elevation at a slope no steeper than three horizontal to one vertical.

Inlet Protection. If surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion.

Excavated Material. The material excavated from the pond shall be placed so that its weight will not endanger the stability of the pond side

slopes and it will not be washed back into the pond by rainfall. It shall be disposed of in one of the following ways:

1. Uniformly spread to a height that does not exceed 3 feet, with the top graded to a continuous slope away from the pond.

2. Uniformly placed or shaped reasonably well, with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 feet from the edge of the pond.

3. Shaped to a designed form that blends visually with the landscape.

4. Used for low embankment construction and leveling of surrounding landscape.

5. Hauled away.

SPECIFICATIONS

Plans and specifications for establishment of this practice shall be prepared in accordance with the previously listed criteria. Plans and specifications shall contain sufficient detail to ensure success of the practice. Documentation shall be in accordance with the section "Supporting Data and Documentation" in this standard.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall be prepared for each management unit. The plan shall provide specific instructions for operating and maintaining the system to insure that it functions properly. It shall also provide for periodic inspections and prompt repair or replacement of damaged components. Appropriate job sheet(s), fact sheets, or other information sheets may be used to serve as the management plan as well as supporting documentation and shall be provided to the client. These sheets shall be referenced in the conservation plan narrative.

SUPPORTING DATA AND DOCUMENTATION

The following is a list of the minimum data and documentation to be recorded in the case file:

1. Extent of planting in acres, field number, and the location of the practice marked on the conservation plan map;

2. Assistance notes shall include dates of site visits, name or initials of the person who made the visit, specifics as to alternatives discussed, decisions made, and by whom;

3. Completed copy of the appropriate job sheet(s) or other specifications and operation and management plan.

Field Data and Survey Notes

The following is a list of the minimum data needed:

1. Plan view sketch.

2. Establish and describe a temporary benchmark.

3. Soil investigation logs and notes.

4. Survey of storage area to develop topography and storage volumes.

5. Location and elevation of soil borings.

6. Location and description of trees and other obstacles that may need to be removed.

7. Profile along centerline of embankment.

8. Profile along centerline of principal spillway.

9. Profile along centerline of emergency spillway.

Design Data

Record on appropriate engineering paper. For guidance on the preparation of engineering plans see Chapter 5 of the Engineering Field Handbook - Part 650. The following is a list of the minimum required design data:

1. Determine pond class and list appropriate spillway design criteria, including map.

2. Develop a stage-storage/discharge curve for the site.

3. Determine peak runoff from the contributing drainage area for the required design storm in accordance with Chapter 2, EFH, Part 650 or by other approved method.

4. Size the principal spillway in accordance with Chapter 3, EFH, Part 650, or other source.

5. Size the emergency spillway in accordance with Chapter 11, EFH, Part 650, or other source.

6. Provide for the safe outlet of discharge from the pond.

7. Provide for the control of erosion during and following construction.

8. Drawings should show the following as a minimum: profile along centerline of dam; profile along centerline of emergency spillway; cross section through dam at principal spillway, cross section through emergency spillway; plan view; and construction details and notes and soil logs.

9. Show job class on the plan.

10. Estimated Quantities.

11. Planting plan with seed, lime, fertilizer requirements.

Construction Check Data/As-Built Plans

Record on survey notepaper, NRCS-ENG-28, or other appropriate engineering paper. Survey data will be plotted in red on the as-built plans. The following is a list of minimum data needed for As-built documentation:

1. Profile notes along centerline of top of completed embankment.

2. Cross section notes at one or more locations on the completed embankment.

3. A profile along the centerline of the principal spillway extending at least 100 feet downstream of the fill.

4. The elevation of the principal spillway crest.

5. The elevation of the principal spillway conduit invert (inlet and outlet).

6. The diameter, length, thickness and type of material for the riser.

7. The diameter, length, and type of material for the conduit.

8. Cross-section and profile notes of emergency spillways, as appropriate, to determine whether planned grade and dimensions have been met.

9. The size and type of anti-vortex and trash.

10. Statement as to the condition or adequacy of vegetation on the embankment, emergency spillway, and other disturbed areas.

11. Type and location of fencing and safety features where appropriate.

12. Final quantities and documentation for quantity changes. Materials certifications as appropriate.

13. Sign and date check-notes and plans by someone with appropriate approval authority. Include statement that practice meets or exceeds plans and NRCS practice standards.

USDA
NATURAL RESOURCES
CONSERVATION SERVICE
DELAWARE
CONSERVATION PRACTICE
STANDARD
RIPARIAN FOREST BUFFER

CODE 391
(Reported in Acres)

DEFINITION

An area of trees and/or shrubs located adjacent to and up-gradient from water bodies.

PURPOSES

This practice may be applied for one or more of the following purposes:

- Reduce excess amounts of sediment, organic material, nutrients, pesticides, and other pollutants in surface runoff and reduce excess nutrients and other chemicals in shallow groundwater flow;
- Create shade to moderate water temperatures to improve habitat for fish and other aquatic organisms;
- Provide a source of detritus and large woody debris for fish and other aquatic organisms;
- Provide riparian habitat and corridors for wildlife.

CONDITIONS WHERE PRACTICE APPLIES

This practice may be applied on stable areas adjacent to permanent or intermittent ditches, streams, lakes, ponds, wetlands, and areas with ground water recharge. (For areas with unstable banks refer to the conservation practice standard for Streambank & Shoreline Protection, Code 580.)

CONSIDERATIONS

Assess the severity of bank erosion and its influence on existing or potential riparian trees and shrubs. Watershed-level treatment or bank stabilization activities may be needed before establishing a riparian forest buffer. (Refer to the conservation practice standard for Streambank and Shoreline Protection, Code 580, and to Chapter 18 of the Engineering Field Handbook.) Complex ownership patterns of riparian areas may require group planning for proper buffer design, function, and management.

Consider the need for a vegetated strip to serve as a level spreader and filter strip, when concentrated flow, ephemeral, or sheet and rill erosion and sedimentation is a concern up-gradient of a planned woody buffer. Consider the use of structural practices when vegetative measures alone will not provide sufficient erosion control.

Consider joining existing and new buffers to increase the continuity of cover and further moderate water temperatures, improve wildlife habitat, and enhance water quality functions.

Consider using a mix of species with growth forms that are tall and wide-crowned and drooping in order to increase the shading effect. Protecting the south or southwest side of the watercourse will provide the greatest temperature control. Buffers established on both sides of watercourses will provide multiple values.

Select tree and shrub species that are native to Delaware and have multiple values such as those suited for timber, biomass, nuts, fruit, browse, nesting, aesthetics, and tolerance to locally used herbicides. Consider species that re-sprout when establishing species nearest to watercourses or bodies.

Avoid tree and shrub species that may be alternate hosts to undesirable pests or that may be considered noxious or undesirable. Species diversity should be considered to avoid loss of function due to species-specific pests.

The location, layout, and density of the buffer should complement natural features in riparian areas. Avoid layouts and locations that would concentrate flood flows or return flows. Low, flexible-stemmed shrubs will minimize obstruction of local flood flows.

Consider the positive and negative impacts beaver, muskrat, deer, rabbits, groundhogs, and other local species may have on the successful management of the riparian area and stream system.

CRITERIA

Criteria Applicable To All Purposes

The location, layout, and density of the riparian forest buffer shall be selected to accomplish the intended purpose of the practice, conditions of the site, and the objectives of the land user. Dominant vegetation shall consist of natural regeneration, existing, or planted trees and/or shrubs.

The riparian forest buffer shall consist of an area that begins at the top of the bank and extends a minimum distance of 35 feet measured horizontally on a line perpendicular to the water body.

At least two, and if necessary three, planting and management zones shall be used (see Figure 1), as follows:

1. Zone 1 is an area of trees and/or shrubs immediately adjacent to and extending 15 feet perpendicular to the water body. **Selection of locally native species to Delaware is required for this zone.** After the buffer is established, disturbance within Zone 1 shall be limited to occasional removal of some tree and shrub products such as high value trees, provided the intended purpose is not compromised by the loss of vegetation or harvesting disturbance.

2. Zone 2 is an area of trees and/or shrubs at least 20 feet wide located up-gradient of Zone 1. **Selection of locally native species to Delaware is required in this zone.** After the buffer is established, more intensive management may be allowed in Zone 2, as long as the intended purpose is not compromised.

3. Zone 3 is a herbaceous zone at least 24 feet wide and up-gradient of Zone 2. Zone 3 shall be added to the forest buffer when concentrated flow, ephemeral, or sheet and rill erosion is a concern up-gradient of Zone 2. Introduced and non-invasive species, i.e., not likely to spread beyond the planted area and displace native species, may be planted in of Zone 3, although native species to Delaware should be used whenever feasible. Refer to the conservation practice standard for Riparian Herbaceous Cover, Code 390, for design criteria to be used for Zone 3. Structural measures shall be used when erosion cannot be controlled by vegetative practices alone.

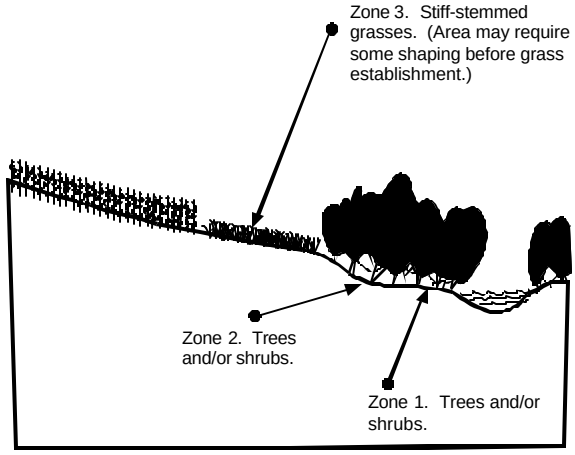


Figure 1. Planting and management zones for riparian forest buffer.

All plantings shall consist of a mixture of two or more species to achieve greater diversity.

Species selected for planting shall be suited to the seasonal variation of soil moisture on the planting site. Plant types and species shall be selected based on their compatibility in growth rates, shade tolerance, and other characteristics.

Natural regeneration may be used to establish a buffer if the following conditions are met: (1) there is an adequate natural seed source of desired species in adjacent areas; (2) site conditions are favorable for establishing the desired number and distribution of seedlings within a specified time period; and (3) noxious or invasive species are not likely to jeopardize the stand.

A number of regeneration factors must be evaluated before determining that natural regeneration is appropriate for a site. **Consult with the field forester before recommending regeneration**. These factors include (but are not limited to):

- The quality and spacing of seed trees;
- Seed tree height;
- Seed dispersal characteristics;
- Prevailing wind direction;
- Frequency of seed crop production;
- Time of year for seed fall;
- Seedbed requirements;
- Seed viability and dormancy factors;
- Potential for seed germination;
- Seedling growth rates; and,
- Shade-tolerant vs. intolerant species.

Planting is usually preferred over natural regeneration because it is easier to control the mix and distribution of species, and it takes less time for woody plants to become established and reach maturity.

Site preparation for planting or natural regeneration shall be done at a time and manner to insure survival and growth of selected species.

Livestock shall be controlled or excluded as necessary to achieve and maintain the intended purpose. Water course crossings and livestock watering shall be located and sized to minimize impact to buffer vegetation and function. (Refer to the conservation practice standards for Fence, Code 382, and Stream Crossing, Code 232.)

Plant and animal pests present on the site shall be controlled to the extent feasible to achieve and maintain the intended purpose of the buffer.

Additional Criteria for Water Quality

To reduce excess amounts of sediment, organic material, nutrients, pesticides, and other pollutants in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow.

For the purpose of water quality, forest buffer size shall be determined by the size of the floodplain. The minimum width of the tree and shrub portion (Zones 1 and 2) will be 100 feet OR 30 percent of the geomorphic floodplain whichever is less, but not less than 35 feet. A geomorphic floodplain is defined as the area adjacent to a river or stream that is built of alluvial sediments that are associated with the present depositional activity.

Note: The geomorphic floodplain does not include older landforms, such as terraces, that were formed by similar processes but under different hydrologic conditions. These upland terrace positions no longer flood and subsequently do not receive additional alluvial sediments. See Figure 2 for examples that illustrate appropriate widths for Zones 1 and 2.

In order to adequately address water quality, the buffer width may need to be expanded to include important resource features such as wetlands, steep slopes, areas that are occasionally or seasonally flooded, or critical habitats.

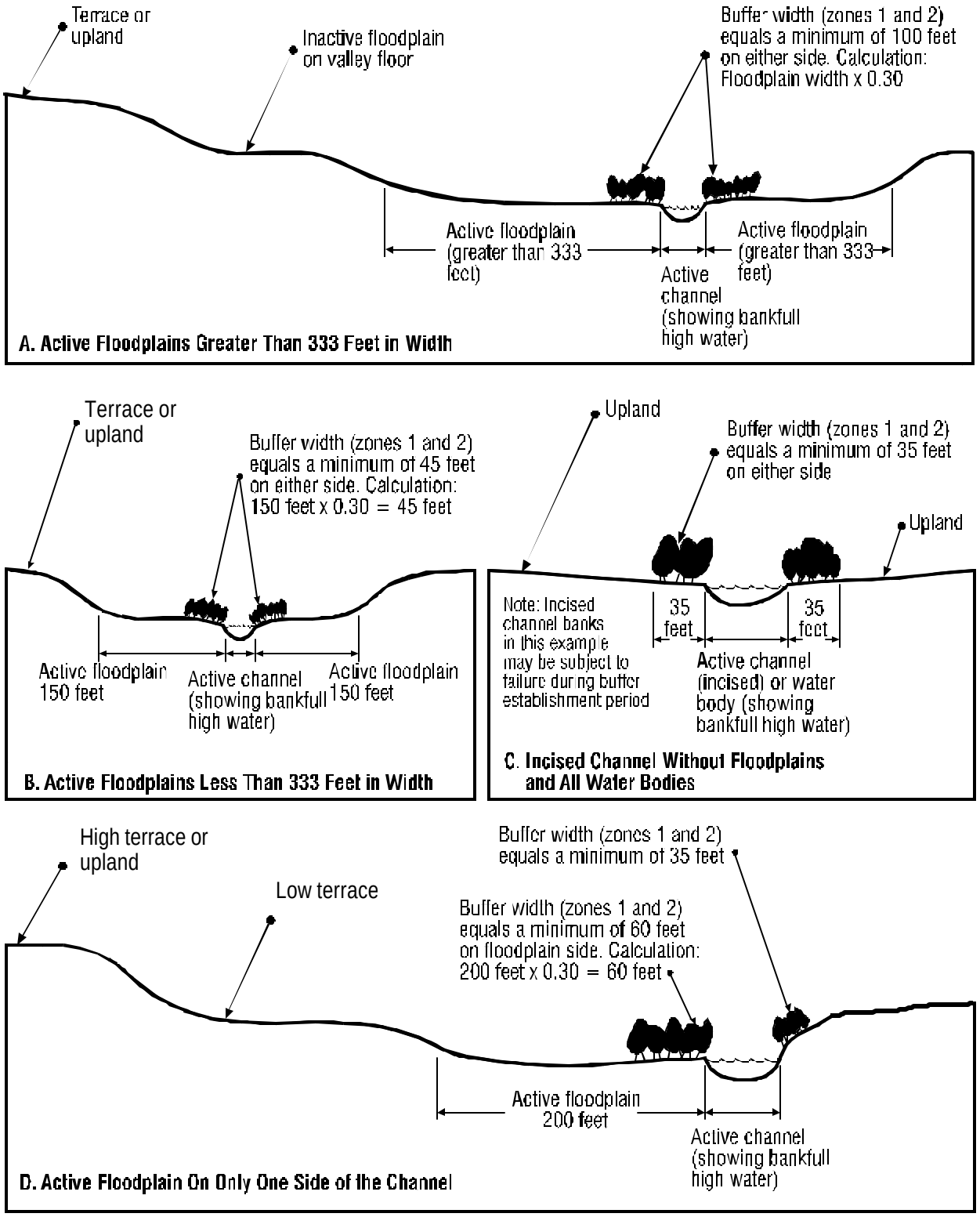


Figure 2. Examples of riparian forest buffer widths for water courses and water bodies.

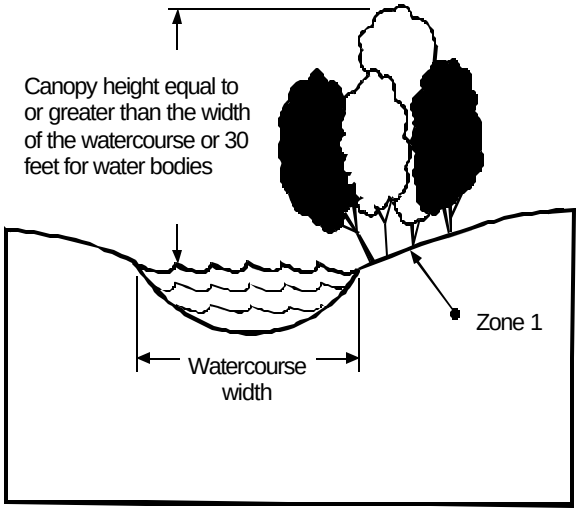


Figure 3. Canopy height for water temperature control.

Additional Criteria for Water Temperature

To create shade to moderate water temperatures to improve habitat for fish and other aquatic organisms.

A buffer for controlling water temperatures shall be established or maintained on south and west sides of water courses and water bodies, insofar as practical. The buffer canopy shall be established to achieve at least 50 percent crown cover with average canopy heights equal to or greater than the width of the water course or 30 feet for water bodies. (See Figure 3.) Note: Buffers for water courses wider than 30 feet may be valuable but will only have site-specific effects.

Buffer species shall include those trees and/or shrubs with sufficient height potential. Place drooping or wide-crowned trees and shrubs nearest the water course or water body for shade. Shoreline or channel relief (e.g., deeply incised channels) and topographic shading shall be taken into account in selecting species.

Additional Criteria for Woody Debris

To provide a source of detritus and large woody debris for fish and other aquatic organisms.

Within Zone 1 at a minimum, establish, favor, or manage species capable of producing stems and limbs of sufficient size to provide an eventual source of large woody debris for in-stream habitat for fish and other aquatic organisms.

Additional Criteria for Wildlife

To provide wildlife habitat, including travel corridors for wildlife.

Select trees and shrubs that provide food, cover, and shelter for the desired wildlife species. Refer to the conservation practice standard for Conservation Cover, Code 327, (Tables 3 and 4), and the Maryland Wildlife Biology and Management Handbook for more information.

Select buffer widths for wildlife habitat based on the individual wildlife species or groups of species desired. Widths in the following table include the sum of buffer widths on one or both sides of water courses or water bodies and may extend beyond riparian boundaries. (In such cases, refer to the conservation practice standard for Conservation Cover, Code 327, for design of upland forests).

Wildlife Species	Minimum Buffer Width in Feet
Bald eagle nesting, cavity nesting ducks, heron rookery	600
Neotropical migrants	300
Beaver, dabbling ducks, mink, salmonids	300
Deer	200
Frog, salamander	100

Table 1. Minimum buffer widths for wildlife habitat.

Note: Specific cost-share programs or other funding sources may impose criteria in addition to, or more restrictive than, those specified in this standard.

PLANS AND SPECIFICATIONS

Plans and specifications for establishment of riparian forest buffers shall be prepared in accordance with the previously listed criteria. Plans and specifications shall contain sufficient detail concerning site preparation and establishment to ensure successful installation of the practice.

Tree and/or shrub species for Zones 1 and 2 shall be specified and established in accordance with the conservation practice standard for Conservation Cover, Code 327. Tree/shrub establishment goals shall be based on the primary purpose of the buffer, using the planting rates as shown in Table 5, Code 327. Grasses and forbs for Zone 3, if needed, shall be specified and established in accordance with the conservation practice standard for Riparian Herbaceous Cover, Code 390.

In addition, follow the establishment recommendations provided in the Delaware job sheets for tree and shrub plantings, warm season grass plantings, and cool season grass plantings. The completed job sheet(s) can serve as the planting plan for the buffer.

OPERATION AND MAINTENANCE

Job Sheet(s) or site specific management plans shall be developed and provided to the client to assure performance of the practice as intended. At a minimum, the following components shall be addressed:

Frequency of Inspections

At a minimum, require annual inspections of the riparian buffer during the establishment period, which is normally 2 - 3 years.

Vegetation in the Riparian Buffer

Describe what inspections are required to determine whether the desired vegetation is present in suitable quantity, quality, and distribution to achieve the purposes of the buffer.

Describe the extent of management needed to maintain vegetation in the desired species composition or age classes (if applicable) or no management required (e.g., natural area).

Continue to replace dead trees or shrubs and control undesirable vegetative competition until the buffer is, or will progress to, a fully functional condition.

As applicable, continue to control concentrated flow or mass soil movement in Zone 3 to maintain buffer function.

For purposes of moderating water temperatures and providing detritus and large woody debris, maintain a minimum of 50 percent canopy cover in the riparian forest buffer. To achieve benefits provided by large woody debris, natural mortality of trees and large shrubs may need to be supplemented by periodically falling and placing selected stems or large limbs within water courses and water bodies to reach original design specifications.

To provide habitat and corridors for wildlife, manage the buffer to favor food, shelter, and nesting cover that will satisfy the habitat requirements of the desired wildlife species. Refer to Maryland Wildlife Biology and Management Handbook for more information.

For purposes of reducing excess pollutants in surface runoff and shallow groundwater, or providing habitat and corridors for wildlife, manage the dominant canopy to maintain maximum vigor of overstory and understory species.

Nuisance Plants and Animals

Describe the extent to which plant and animal pest species, including noxious weeds, will need to be controlled.

Weeds should be controlled for 2 - 3 years after planting. Any use of fertilizers, mechanical treatments, prescribed burning, pesticides, and other chemicals to assure buffer function shall not compromise the intended purpose. **Trees should not be fertilized in the first year, because the trees will develop too much top growth compared to the roots.** Biological control of undesirable plant species and pests (e.g., using predator or parasitic species) shall be implemented where available and feasible.

Acceptable Uses

Describe the acceptable uses (e.g., grazing, hunting, nature preserve, etc.) and time of year/frequency of use restrictions, if any.

Limit disturbance within the first 15 feet (Zone 1) to occasional removal of some tree and shrub products such as high value trees if the intended purpose is not compromised by the loss of vegetation or harvesting disturbance. Regular removal of tree and shrub products such as timber, nuts, and fruit may be permitted outside of Zone 1, as long as the intended purpose is not compromised. Any removals of tree and shrub products shall be conducted in a manner that maintains the intended purpose and is consistent with state and local law.

Additional operation and maintenance requirements shall be developed on a site-specific basis to assure performance of the practice as intended.

Note the requirements of specific cost-share programs or other funding sources that may impose management limitations in addition to, or more restrictive than, those specified above.

SUPPORTING DATA AND DOCUMENTATION

The following is a list of the minimum data and documentation to be recorded in the case file:

1. Purpose of riparian forest buffer.
2. Field location and plan view.
3. Size of planting.
   - Width of floodplain (ft)
   - Width of planting (ft)
   - Length of stream (ft)
   - Acres of riparian forest buffer
4. Planting details.
   - Date planted
   - Species planted
   - Spacing of planting
5. Operation and maintenance plan.

REFERENCES

1. Brown, R.G., Brown, M.L., 1972. Woody Plants of Maryland. Baltimore, MD

2. Delaware Natural Heritage Program, DNREC, McAvoy, W.A. and K.A. Bennett, 2001. The Flora of Delaware, an Annotated Checklist.

3. Keller, Cheny M.E., et al., 1993. Avian Communities in Riparian Forest of Different Widths in Maryland and Delaware. Wetlands V.13(2):137-144.

4. Martin, A.C., H.S. Zim and A.L. Nelson, 1961. American Wildlife & Plants: A Guide to Wildlife Food Habitats. New York, NY. Dover Publications.

5. Natural Resources Conservation Service, Conservation Practice Standard for Riparian Herbaceous Cover, Code 390.

6. Natural Resources Conservation Service, Conservation Practice Standard for Conservation Cover, Code 327.

7. Natural Resources Conservation Service, Conservation Practice Standard for Streambank and Shoreline Protection, Code 580.

8. Natural Resources Conservation Service, Conservation Practice Standard for Fence, Code 382.

9. Natural Resources Conservation Service, Conservation Practice Standard for Stream Crossing, Code 232.

10. Natural Resources Conservation Service, Maryland Wildlife Biology and Management Handbook.

11. Natural Resources Conservation Service, Stream Corridor Restoration: Principles, Processes, and Practices. National Engineering Handbook, Part 653.

12. Natural Resources Conservation Service, Streambank and Shoreline Protection, Engineering Field Handbook, Chapter 16.

13. Natural Resources Conservation Service, Soil Bioengineering for Upland Slope Protection and Erosion Reduction, Engineering Field Handbook, Chapter 18.

14. Nutrient Subcommittee of Chesapeake Bay Program, 1995. Water Quality Functions of Riparian Buffer Systems in the Chesapeake Bay Watershed. EPA 903-R-95-004.

15. Schultz, R.C., J.P. Colletti, T.M. Isenhart, W.W. Simpkings, C.W. Mize, and M.L. Thompson, 1995. Design and Placement of a Multi-species Riparian Buffer Strip. Agroforestry Systems 29:201-225.

16. U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry, 1991. Riparian Forest Buffers -- Function and Design for Protection and Enhancement of Water Resources. NA-PR-07-91. Prepared by. David J. Welsch Atlanta, GA.

17. U.S. Department of Agriculture, Forest Service, Southern Region, 1992. Stream Habitat Improvement Handbook. Tech. Publ. R8-TP 16. Prepared by: :Monte E Seehorn Radnor, PA.

18. U.S. Fish and Wildlife Service, Chesapeake Bay Field Office with the Natural Science Center and Adkins Arboretum, 1995. Native Plants for Wildlife Habitat. Annapolis, MD.

USDA
NATURAL RESOURCES
CONSERVATION SERVICE

DELAWARE CONSERVATION
PRACTICE STANDARD

FILTER STRIP

CODE 393
(Reported by Acre)

DEFINITION

A strip or area of herbaceous vegetation situated between cropland, grazing land, or disturbed land (including forestland), and environmentally sensitive areas.

PURPOSES

This practice may be applied for one or more of the following purposes:

- To reduce sediment, particulate organic matter, sediment-adsorbed pollutants, and soluble pollutants in surface runoff;
- To intercept nutrients in shallow groundwater;
- To restore, create, or enhance wildlife habitat.

CONDITIONS WHERE PRACTICE APPLIES

This practice may be applied in the following locations:

- On the lower edges of cropland, grazing land, or disturbed areas where pollutants may move offsite into environmentally sensitive areas;
- Up slope of conservation practices, such as ponds, diversions, and terraces, to reduce the amount of sediment or other contaminants moving into the practice area;
- On land adjacent to watercourses, water bodies, and wetlands to provide riparian herbaceous buffers and in areas where permanent vegetative establishment is needed to enhance wildlife habitat.

This practice does not apply to treatment of wastewater from milking parlors, silos, waste treatment lagoons, waste storage facilities, composting facilities, or below concentrated livestock holding areas. (Refer to the Delaware conservation practice standard for Wastewater Treatment Strip, Code 635.)

CONSIDERATIONS

Consider the long-term land use objectives of the client and how the implementation and maintenance of this practice will affect those objectives. Consider adjusting the size of the filter strip to accommodate harvesting and maintenance equipment.

Identify and evaluate any constraints such as management options, economic feasibility, access, state and federal regulations, or cost-share program requirements.

Assess site conditions, including surrounding land uses, types and quantity of pollutants, slopes and soils, residual herbicides (to the extent known), available moisture during the growing season, and existing vegetation on the site and in adjacent areas, including any noxious weeds that may be present.

Consider the potential for erosion where the filter strip will outlet into streams or channels.

Consider using this practice to protect areas with significant archaeological or cultural properties from potential damage from contaminants.

CRITERIA

Criteria Applicable to All Purposes

The filter strip shall consist of a perennial herbaceous planting that is not part of a cropland or pasture rotation. The location, layout, and density of the filter strip shall reflect the intended purpose of the practice, conditions of the site, and the objectives of the land user.

Site preparation and planting to establish the filter strip shall be done at a time and manner to insure survival and growth of the selected species. A conservation tillage method should be used for establishment, especially if erosion is a concern.

Select plant species that are native, or are introduced and are non-invasive (i.e., not likely to spread beyond the planted area and displace native species). Only viable high quality and regionally adapted seed should be used. Selection of native species shall be a priority when feasible.

The filter strip shall be protected from uncontrolled livestock access and frequent vehicular traffic. Noxious weeds shall be controlled as required by state law.

Note: Specific cost-sharing programs or other funding sources may impose criteria in addition to, or more restrictive than, those specified in this standard.

Additional Criteria to Reduce Sediment, Particulate Organic Matter, and/or Soluble Pollutants in Surface Runoff and Shallow Groundwater

These criteria apply to filter strips on the lower edges of cropland, grazing land, or disturbed areas where pollutants may move offsite via surface and/or subsurface flow into adjacent water courses, water bodies, wetlands, or other environmentally sensitive areas. These criteria also apply to filter strips installed up slope of conservation practices such as terraces or diversions.

Filter Strip Width (Flow Length). In fields with slopes of 6 percent or less, the minimum filter strip width shall be 24 feet.

Table 1. Minimum filter strip widths by percent slope.

Percent Slope	Minimum Strip Width (ft)
≤ 6	24
7	28
8	32
9	36
10	40

In fields with greater than 6 percent slopes, the minimum strip width shall be increased 4 feet for each one percent increase in slope perpendicular to the strip. Generally, the maximum effective length of flow is 100 feet for removal of sediment.

Sediment and Particulate Retention. Where the primary purpose of the filter strip is to trap sediment and other particulates in surface runoff, the slope of the land immediately above the filter strip shall be greater than 1% but less 10%. The filter strip shall be designed to convey surface water through vigorous dense vegetation. Overland flow entering the filter strip shall be primarily sheet flow. Concentrated flow shall be dispersed using level spreaders. The leading edge of the filter strip shall be approximately on the contour.

Contributing land shall be treated so that the average annual sheet and rill erosion rate above the filter strip is less than 10 tons per acre per year. If the erosion rate is equal to or more than 10 tons per acre per year, or the slope of the land is steeper than 10%, consider using the conservation practice standard for Critical Area Planting, Code 342, to vegetate the slope.

The ratio of drainage area to the filter strip area shall be less than 50:1.

Additional Criteria to Restore, Create, or Enhance Wildlife Habitat

When the filter strip is primarily intended to provide herbaceous buffer habitat between intensively used lands and riparian areas or other

environmentally sensitive areas, the minimum width of the filter strip shall be 35 feet. Beyond this minimum, the width of the filter strip shall be based on the needs of the desired wildlife species for food, cover, and travel corridors. A diverse mixture of grasses, forbs, and/or legumes shall be selected and planted to benefit wildlife.

When wildlife habitat will be provided in combination with one or more other purposes, then the minimum criteria for the other purposes (e.g., sediment retention and nutrient uptake) must also be met. If the filter strip width required by the other purpose(s) is less than 35 feet, then additional width shall be added to achieve a minimum total width of 35 feet. Plantings shall be selected to provide wildlife benefits, provided that they do not detract from the filter strip's other functions.

When the primary purpose of the filter strip is to trap sediment and other particulates in surface runoff, any addition to the filter strip width specifically for wildlife habitat shall be added to the downhill edge of the filter strip where less sediment deposition is expected to occur.

Once established, the filter strip shall not be mowed during the nesting season of the desired wildlife species. For Delaware, the primary nesting season is generally from April 15 through August 15. Livestock and vehicular traffic shall likewise be excluded during the primary nesting season.

SPECIFICATIONS

All trees, stumps, rocks, or similar materials that will interfere with installing the grass filter strip shall be removed and disposed of properly.

Plans and specifications for filter strips shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. The completed work shall be checked and documented to verify that this practice was completed according to the drawings, standard, and specification. Documentation shall be in accordance with the section "Supporting Data and Documentation."

Selection of Plant Species and Rates. When severe site conditions are present or anticipated and significant erosion control and sediment retention is needed. seeding mixes and rates shall be specified in accordance with the conservation practice standard for Critical Area Planting, Code 342.

When site conditions are not severe and optimum wildlife habitat is desired, the conservation practice standard for Conservation Cover, Code 327, shall be used to specify the appropriate seeding mix and rate.

Proper Treatment of Plant Materials. All plant materials must be correctly handled before planting. In general, plants shall be planted as soon as possible after receiving them from the supplier. Seed shall be kept cool and dry until planted.

Recommended Planting Dates. Refer to the conservation practice standards for Critical Area Planting, Code 342, or Conservation Cover, Code 327, as appropriate, to determine the recommended planting dates for the different types of plant materials.

Establishment of Plant Materials. Follow the establishment recommendations provided in the Delaware Job Sheets for warm season grass plantings and cool season grass plantings. The completed Job Sheet(s) can serve as the planting plan and specifications for the practice.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall be prepared for each filter strip. Appropriate Job Sheet(s) may be used to serve as the management plan, as well as supporting documentation, and shall be provided to the land user. At a minimum, the following components shall be addressed in the O&M plan, as applicable:

Vegetation in the Filter Strip. Vegetation must be maintained in a vigorous condition. For optimum sediment retention and other water quality benefits, mow two to three times annually to a height of 3 to 5 inches and remove top growth if possible. Removal of top growth from the site can significantly reduce the amount of nitrate-nitrogen in the soil and can reduce the movement of nitrate-nitrogen below the root zone. If phosphorus is a concern, periodically test the soil to monitor phosphorus build-up.

Where wildlife habitat is a concern, mow only the minimum area necessary to filter sediment (see Table 1 for minimum widths), and do not mow during the primary nesting season (April 15 to August 15).

When tilling adjacent fields, care must be taken to not plow into the filter strip and decrease the width or to create furrows adjacent and parallel to the filter strip that can turn into gullies.

Maintain fencing as needed to protect the filter strip from uncontrolled access.

Control undesirable plants by pulling, mowing, or spraying with a selective herbicide. Control noxious weeds as required by state law.

Inspect for insects and diseases, and if an incidence threatens stand survival, take corrective action to bring the pest under control.

Sheet Flow. Maintain sheet flow entering the filter strip. Repair all rills and small channels within the filter strip. Needed repairs must be made immediately to reestablish sheet flow onto and through the filter strip.

Sediment Accumulation. Sediment that accumulates along the upper part and within the filter strip shall be removed before it accumulates to a height of 6 inches and begins to divert runoff water around the filter strip as concentrated flow. Removal and redistribution can be accomplished with tillage equipment or other machinery. The area disturbed by this removal shall be regraded and replanted if necessary.

Acceptable Uses. Describe the acceptable uses (e.g., flash grazing, haying, etc.) and time of year/frequency of use restrictions, if any. Pay particular attention to cost-sharing program requirements as they relate to acceptable vs. restricted uses, and other management restrictions.

Frequency of Inspection. Inspect the filter strip at least once per year.

SUPPORTING DATA AND DOCUMENTATION

1. Extent of planting in acres, field number where the practice located, and the location of the practice marked on the conservation plan map.

2. Assistant notes.

2. Completed copy of the appropriate Job Sheet(s) or other specifications and management plans, including species, seeding/planting rates, and planting dates.

3. Design slope, if applicable, width, and length of the filter strip.

REFERENCES

1. USDA, Natural Resources Conservation Service. Conservation Practice Standard for Conservation Cover, Code 327. Delaware Field Office Technical Guide.

2. USDA, Natural Resources Conservation Service. Conservation Practice Standard for Critical Area Planting, Code 342. Delaware Field Office Technical Guide.

3. USDA, Natural Resources Conservation Service. Conservation Practice Standard for Riparian Forest Buffer, Code 391. Delaware Field Office Technical Guide.

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5. USDA, Soil Conservation Service, 1991. A Procedure for the Design of Vegetative Filter Strips, Final Report.

USDA
NATURAL RESOURCES
CONSERVATION SERVICE
DELAWARE
CONSERVATION PRACTICE
STANDARD

GRASSED WATERWAY

CODE 412
(Reported by Acre)

DEFINITION

A natural or constructed channel that is shaped or graded to required dimensions and established with suitable vegetation.

PURPOSES

This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- To convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding
- To reduce gully erosion
- To protect/improve water quality

CONDITIONS WHERE PRACTICE APPLIES

In areas where added water conveyance capacity and vegetative protection are needed to control erosion resulting from concentrated runoff and where such control can be achieved by using this practice alone or combined with other conservation practices.

CONSIDERATIONS

Consider the time of year for installation of this practice. Avoid periods of high runoff volumes, or temporarily divert runoff from the planted area. This will allow the vegetation to become well established before it is subjected to storm flows. Use irrigation, if available, to promote germination and vegetative establishment.

If wildlife is a concern, select plant species that provide wildlife benefits, provided that they do not distract from the grassed waterway's other functions. Do not mow or graze the waterway during peak nesting season. Consider leaving the waterway unmowed through the winter to provide good winter cover.

Consider establishing filter strips on each side of the waterway to improve water quality and wildlife habitat.

Provide livestock and vehicular crossings as necessary to prevent damage to the waterway and its vegetation.

Consider the potential to affect National Register listed or eligible cultural resources.

CRITERIA

Grassed waterways shall be planned, designed, and constructed to comply with all federal, state, and local laws and regulations.

Capacity. The minimum capacity shall be that required to convey the peak runoff expected from a storm of 10-year frequency, 24-hour duration. When the waterway slope is less than 1 percent, out-of-bank flow may be permitted if such flow will not cause excessive erosion. The minimum in such cases shall be the capacity required to remove the water before crops are damaged.

Velocity. Design velocities shall not exceed those obtained by using the procedures, "n" values, and recommendations in the NRCS Engineering Field Handbook (EFH) Part 650, Chapter 7, or Agricultural Research Service (ARS) Agricultural Handbook 667, Stability Design of Grass-lined Open Channels.

Width. The bottom width of trapezoidal waterways shall not exceed 100 feet unless multiple or divided waterways or other means are provided to control meandering of low flows.

Side Slopes. Side slopes shall not be steeper than a ratio of two horizontal to one vertical. They shall be designed to accommodate the equipment anticipated to be used for maintenance and tillage/harvesting equipment that will cross the waterway.

Depth. The minimum depth of a waterway that receives water from terraces, diversions, or other tributary channels shall be that required to keep the design water surface elevation at, or below the design water surface elevation in the tributary channel, at their junction when both are flowing at design depth.

Freeboard above the designed depth shall be provided when flow must be contained to prevent damage. Freeboard shall be provided above the designed depth when the vegetation has the maximum expected retardance.

Drainage. Designs for sites having prolonged flows, a high water table, or seepage problems shall include Subsurface Drains (NRCS Practice Code 606); Underground Outlets (NRCS Practice Code 620), Stone Center Waterways, or other suitable measures to avoid saturated conditions.

Outlets. All grassed waterways shall have a stable outlet with adequate capacity to prevent ponding or flooding damages. The outlet can be another vegetated channel, an earthen ditch, a grade-stabilization structure, filter strip, or other suitable outlet.

Vegetative Establishment. Grassed waterways shall be vegetated according to NRCS Conservation Practice Standard Critical Area Planting, Code 342.

Seedbed preparation, time of seeding, mixture rate, stabilizing crop, mulching, or mechanical means of stabilizing, fertilizer, and lime requirements shall be specified for each applicable area.

Establish vegetation as soon as conditions permit. Use mulch anchoring, nurse crop, rock, straw or hay bale dikes, filter fences, or runoff diversion to protect the vegetation until it is established.

PLANS AND SPECIFICATIONS

Plans and specifications for grassed waterways shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose(s).

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be provided to and reviewed with the landowner. The plan shall include the following items and others as appropriate.

A maintenance program shall be established to maintain waterway capacity, vegetative cover, and outlet stability. Vegetation damaged by machinery, herbicides, or erosion must be repaired promptly.

Seeding shall be protected from concentrated flow and grazing until vegetation is established.

Minimize damage to vegetation by excluding livestock whenever possible, especially during wet periods.

Inspect grassed waterways regularly, especially following heavy rains. Damaged areas will be filled, compacted, and seeded immediately. Remove sediment deposits to maintain capacity of grassed waterway.

Avoid using waterways as turn-rows during tillage and cultivation operations.

Mow or periodically graze vegetation to maintain capacity and reduce sediment deposition.

Control noxious weeds.

Do not use as a field road. Avoid crossing with heavy equipment when wet.

SUPPORTING DATA FOR DOCUMENTATION

Field Data and Survey Notes.

The following is a list of the minimum data needed:

a. Plan view sketch.

b. Slope of each design reach (hand level survey permitted when slope is steeper than 2 percent)

c. Cross-section (minimum of one per reach not to exceed 300 feet.)

d. Lengths of each reach and total length.

e. Profile and cross-section of outlet and, special precautions if needed.

Design Data

Record on appropriate engineering paper. For guidance on the preparation of engineering plans see Chapter 5 of the EFH, Part 650. The following is a list of the minimum required design data

a. Locate the practice on the farm plan map in the case file.

b. Determine soil type and any special restrictions.

c. Determine peak runoff from the contributing drainage area for the required design storm in accordance with Chapter 2, EFH Part 650 or by other approved method.

d. Design each reach in accordance with Chapter 7, EFH, Part 650, or other source.

e. Show job class on the plan.

f. Plan view sketch, profile of waterway when required and cross-sections of each design reach to be shown on plans.

g. Quantities estimate.

h. Details of outlet protection or other structural components needed.

i. Planting plan. This must meet the criteria, specifications and documentation requirements of the conservation standard for Critical Area Planting (Code 342). Show on the plans.

j. Written Operation and Maintenance plan.

Construction Check Data/As-Built Plans

Record on survey notepaper, SCS-ENG-28, or other appropriate engineering paper. Survey data will be plotted in red. The following is a list of minimum data needed for As-built documentation:

a. Documentation of site visits on CPA-6. The documentation shall include the date, who performed the inspection, specifics as to what was inspected, all alternatives discussed and decisions made and by whom.

b. Check notes recorded during or after completion of construction showing grade and cross section of constructed reaches and outlets including length, width, and depth.

c. Calculate acreage.

d. Statement on seeding and fencing.

e. Final quantities and documentation for quantity changes. Materials certifications as appropriate.

f. Sign and date check-notes and plans by someone with appropriate approval authority. Include statement that practice meets or exceeds plans and NRSC practice standards.

USDA
NATURAL RESOURCES
CONSERVATION SERVICE

DELAWARE CONSERVATION
PRACTICE STANDARD

ROOF RUNOFF STRUCTURE

CODE 558
(Reported by No.)

DEFINITION

Structures that collect, control, and transport precipitation from roofs.

PURPOSES

This practice may be applied for one or more of the following purposes:

- Improve water quality.
- Reduce soil erosion.
- Increase infiltration.
- Protect structures.
- Increase water quantity.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Roof runoff structures are a component of an overall resource management system.
- Roof runoff needs to be diverted away from structures or contaminated areas.
- There is a need to collect, control, and transport runoff from roofs to a stable outlet.
- Roof runoff is collected and used for other purposes.

CONSIDERATIONS

Avoid discharging outlets near wells or into structures that discharge directly into surface waters.

This practice has the potential to affect National Register listed cultural resources or eligible (significant) cultural resources. These may include archeological, historic, or traditional cultural properties. Care should be taken to avoid adverse impacts to these resources. Follow NRCS state policy for considering cultural resources during planning.

CRITERIA

Criteria Applicable to All Purposes.

Design Capacity. At minimum, a 10-year frequency, 5-minute rainfall precipitation event shall be used to design roof runoff structures, except where excluding roof runoff from manure management systems. In that case, a 25-year frequency, 5-minute precipitation event shall be used to design roof runoff structures (Refer to Agricultural Waste Management Field Handbook, National Engineering Handbook - Part 651, Appendix 10B). When gutters are used, the capacity of the downspout(s) must equal or exceed the gutter flow rate.

Outlets. Runoff may empty into surface or underground outlets or onto the ground surface. Surface and underground outlets shall be sized to ensure adequate design capacity and shall provide for clean-out as appropriate. When runoff from roofs empties onto the ground surface, a stable outlet shall be provided. When runoff is conveyed through a gutter and downspout system, an elbow and energy dissipation device shall be placed at the end of the downspout to provide a stable outlet and direct water away from the building.

Surface or ground outlets such as rock pads, rock filled trenches with subsurface drains, concrete and other erosion-resistant pads, or preformed channels may be used, particularly where snow and ice are a significant load component on roofs.

Vegetation. Disturbed areas that are not to be cultivated shall be seeded as soon as practicable after construction. Planting shall be specified in accordance with NRCS Practice Standard 342, Critical Area Planting, for seeding.

Supports. Where snow and ice will accumulate on roofs, guards and sufficient supports to withstand the anticipated design load shall be included.

Materials. Roof runoff structures shall be made of durable materials with a minimum design life of ten years. Roof gutters and downspouts may be made of aluminum, galvanized steel, wood, or plastic. Aluminum gutters and downspouts shall have a nominal thickness of 0.027 inches and 0.020 inches, respectively. Galvanized steel gutters and downspouts shall be at least 28 gauge. Wood shall be clear and free of knots. Wood may be redwood, cedar, or cypress. Plastics shall contain ultraviolet stabilizers. Dissimilar metals shall not be in contact with each other.

Rock-filled trenches and pads shall consist of poorly graded rock (all rock fragments approximately the same size) and be free of appreciable amounts of sand and/or soil particles. Crushed limestone shall not be used for backfill material unless it has been washed. Subsurface drains or outlets shall meet the material requirements of the applicable NRCS conservation practice standard.

Concrete appurtenances used shall meet the requirements of NRCS Construction Specification 32, Concrete for Minor Structures.

Protection. Roof runoff structures shall be protected from damage by livestock and equipment.

Additional Criteria to Increase Infiltration

Runoff shall be routed onto pervious landscaped areas (e.g., lawns, mass planting areas, infiltration trenches, and natural areas) to increase infiltration of runoff. These areas shall be capable of infiltrating the runoff in such a way that replenishes soil moisture without adversely affecting the desired plant species.

Additional Criteria to Protect Structures

Runoff shall be directed away from structure foundations to avoid wetness and hydraulic loading on the foundation.

On expansive soils or bedrock, downspout extensions shall be used to discharge runoff a minimum of five (5) feet from the structure.

The discharge area for runoff must slope away from the protected structure.

Additional Criteria to Increase Water Quantity

Structures needed to collect and store water from roofs for potable and non-potable purposes shall be designed and installed in accordance with sound engineering principles. Storage structures for non-potable purposes, such as irrigation water, should be designed in accordance with NRCS conservation practice standards, as appropriate.

Potable water storage structures should be constructed of materials and in a manner that will not increase the contamination of the stored water. Roof runoff collected and stored for potable uses must be treated prior to consumption and should be tested periodically to assure that adequate quality is maintained for human consumption.

PLANS AND SPECIFICATIONS

Plans and specifications for this practice shall be prepared in accordance with the previously listed criteria. Plans and specifications shall contain sufficient detail concerning site preparation and establishment to ensure successful management of the practice. Appropriate conservation practice standards shall be used for designing and installing structural and vegetative measures. Documentation shall be in accordance with the section "Supporting Data and Documentation" in this standard.

OPERATION AND MAINTENANCE

An Operation & Maintenance Plan shall be developed that is consistent with the purposes of the practice, intended life, safety requirements,

and the criteria for the design. The plan shall contain, but not be limited to, the following provisions:

1. Keep roof runoff structures clean and free of obstructions that reduce flow.

2. Make regular inspections and perform repair maintenance as needed to ensure proper functioning of the roof runoff structures.

SUPPORTING DATA FOR DOCUMENTATION

The following is a list of the minimum data and documentation to be recorded in the case file:

1. The location of the practice marked on the conservation plan map.

2. Assistance notes.

3. Completed copy of the appropriate Job Sheet(s) or other specifications for seeding. See NRCS Practice Standard 342, Critical Area Planting.

4. Operation and Maintenance Plan.

Field Data and Survey Notes

Record on survey notepaper, SCS-ENG-28, or other appropriate format. The following is a list of the minimum data needed:

1. Plan view sketch showing the location and dimensions of the roofs.

2. Profile of existing ground along the proposed roof runoff outlet structures.

3. Locations and elevations of the proposed outlets for the roof runoff.

Design Data

Record on appropriate engineering paper. For guidance on the preparation of engineering plans see Chapter 5 of the Engineering Field Handbook, Part 650. The following is a list of the minimum required design data:

1. Determine soil type and any special restrictions.

2. Determine peak runoff from the contributing roof area for the required design storm in accordance with Agricultural Waste Management Field Handbook, National Engineering Handbook - Part 651, Appendix 10B, or by other approved method.

3. Determine the required gutter size and size and number of downspouts needed.

4. Show the engineering job class on the plans. Show the location description and elevation of temporary benchmarks utilized in the design survey. Provide a location map, which indicates the job site.

5. Show the location, spacing, size, and grade of all gutters and downspouts and the type and quality of material to be used.

6. Details of underground outlets (if utilized) including the alignment, size and grade. Provide a profile of each line and outlet details.

7. Details of rock filled trenches (if used) including the location, length, typical cross section, and rock gradation requirements.

8. Details of energy dissipation devices (if used) including the location, dimensions and material requirements.

9. Show on the plans the planting plan for disturbed areas.

10. Estimated quantities and cost estimate.

Construction Check Data/As-Built Plans

Record on survey notepaper, SCS-ENG-28, or other appropriate format. Survey data will be plotted on the as-built plans in red. The following is a list of minimum data needed for as-built documentation:

1. Documentation of site visits. The documentation shall include the date, who performed the inspection, specifics as to what

was inspected, all alternatives discussed and decisions made and by whom.

2. Check notes recorded during or after completion of construction showing the location and size of the installed gutters and downspouts. During installation, check and record the size and grade of underground outlets (if specified) and/or the length, dimensions, and the rock gradation of the rock filled trenches (if specified) as well as the measurements and materials of the energy dissipation devices (if specified).

3. Statement regarding the final grading and seeding.

4. Final quantities and documentation for quantity changes. Material certifications as appropriate.

5. Signature and date on check-notes and plans of someone with the appropriate engineering job approval authority. Include a signed statement that constructed practice meets or exceeds the construction plans and NRCS practice standards.

USDA
NATURAL RESOURCES
CONSERVATION SERVICE

DELAWARE CONSERVATION
PRACTICE STANDARD

HEAVY USE AREA PROTECTION

CODE 561
(Reported by Acre)

DEFINITION

The stabilization of areas frequently and intensively used by people, animals or vehicles by establishing vegetative cover, by surfacing with suitable materials, and/or by installing needed structures.

PURPOSES

This practice may be used as a part of a conservation management system to support one or more of the following purposes.

- Reduce soil erosion
- Improve water quantity and quality
- Improve air quality
- Improve aesthetics
- Improve livestock health

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to urban, agricultural, recreational or other frequently and intensively used areas requiring treatment to address one or more resource concerns.

CONSIDERATIONS

When stabilizing heavily used areas consider adjoining land uses and the proximity to residences, utilities, cultural resource areas, wetlands or other environmentally sensitive areas, and areas of special scenic value.

For heavy use areas conducive to protection by vegetation, consideration must be given to the effect(s) of treading and/or miring. The vegetative species selected should tolerate and persist under heavy use conditions. If practicable, consider increasing the size of the area and/or establishing a rest/non-use period to allow plant recovery and increase vigor.

Heavy use area protection effects on the water budget, especially on volumes and rates of runoff, infiltration, and transpiration due to the installation of less pervious surfaces should be considered in the selection of surfacing materials.

The transport of sediments, nutrients, bacteria, organic matter from animal manures, oils and chemicals associated with vehicular traffic, and soluble and sediment-attached substances carried by runoff should be considered in selection of companion conservation practices.

If the purpose of the heavy use area protection is improvement of water quality, the heavy use area should be (re)located as far away from the waterbody or watercourse as possible. Any work in and/or discharges near streams, wetlands or waterbodies may require a permit from the US Army Corps of Engineers, state water quality (permitting) authority, or local authority.

The size of heavy use areas utilized by livestock is dependent on the landowner's operation including type and number of animal, confinement periods, and/or the intended use. The size of treatment areas can range from 30 square feet per animal in partial-confinement to 400 square feet per animal in total confinement to 4000 or more square feet for animal exercise areas. Heavy use protection areas should be

kept as small as practicable.

When surface treatments such as bark mulch, wood-fiber or other non-durable materials are used for short-term livestock containment areas, consideration should be given to vegetation of the affected area with a cover crop.

For areas with aggregate surfaces that will be frequently scraped, consideration should be given to the use of concrete or cementitious materials to lessen the recurring cost of aggregate replacement.

This practice has the potential to affect National Register listed cultural resources or eligible (significant) cultural resources. These may include archeological, historic, or traditional cultural properties. Care should be taken to avoid adverse impacts to these resources. Follow NRCS state policy for considering cultural resources during planning.

CRITERIA

General Criteria Applicable to All Purposes

All planned work shall comply with Federal, state, and local laws and regulations.

Safety of the users shall be incorporated into the design of the heavy use area protection.

Design Load. The design load will be based on the type of traffic, (vehicular, animal, or human) anticipated on the heavy use area. The minimum design load for areas that support vehicular traffic will be a wheel load of 4000 lbs.

Foundation. All site foundations shall be evaluated for soil moisture, permeability, texture and bearing strength in combination with the design load and anticipated frequency of use.

A base course of gravel, crushed stone, other suitable material and/or geotextile shall be provided on all sites with a need for increased load bearing strength, drainage, separation of material and soil reinforcement. Natural Resources Conservation Service (NRCS), National Engineering Handbook (NEH), Parts 642 and 643 (formerly, NEH, Section 20) and AASHTO M-288 (latest edition) provide guidance in quality specification and geotextile selection.

An impervious barrier shall be provided on sites with a porous foundation (high permeability rate), where there is a need to protect ground water from contamination.

Foundation preparation shall consist of removal and disposal of soil and other material that are not adequate to support the design loads.

Surface treatment. The surface treatment shall meet the following criteria:

Bituminous Pavement. The thickness of the pavement course, the kind and size of aggregate, the type of proportioning of bituminous materials, and the mixing and placing of these materials shall be in accordance with Department of Transportation criteria for the expected loading.

Concrete. The quality and thickness of concrete and the spacing and size of reinforcing steel shall be appropriate for the expected loading.

Other Cementitious Materials. Soil cement, roller compacted concrete, and coal combustion by-products (flue gas desulfurization sludge and fly ash) may be used as surface material if designed and installed to withstand the anticipated loads and surface abrasion.

Aggregate. A fine or coarse aggregate surface shall be a minimum 2-inches thick.

Other. Surfacing materials, such as cinders, tanbark, bark mulch, brick chips, shredded rubber and/or sawdust, shall have a minimum layer thickness of 2 inches.

Structures. All structures shall be designed according to appropriate NRCS standards and specifications or Engineering Handbook recommendations.

Sprays and artificial mulches. When utilizing sprays of asphalt, oil, plastic, manufactured mulches, and similar materials, the manufacturer's recommendations for application shall be incorporated into the design.

Drainage and erosion control. Provision shall be made for surface and subsurface drainage, as needed, and for disposal of runoff without causing erosion or water quality impairment. Provision shall be made to exclude unpolluted run-on water from the treatment area. All treatment areas shall be shaped to prevent ponding of water.

Vegetative Measures. Liming, fertilizing, soil preparation, seeding, mulching, sodding and vegetation management shall be according to the planned use and appropriate conservation practice standard in the local technical guide. If vegetation is not appropriate, other measures shall be used to accomplish the intended purpose.

Additional Criteria for Areas Utilized by Livestock

The treated area shall extend an appropriate distance from facilities such as portable hay rings, water troughs, feeding troughs, mineral boxes and other facilities where livestock concentrations cause resource concerns.

NRCS conservation practice standards Critical Area Planting, Code 342; Fencing, Code 382; Prescribed Grazing, Code 528A; Filter Strip, Code 393; or Use Exclusion, Code 472 shall be used as companion practices, when needed, to meet the intended purpose of the heavy use area protection.

Provisions shall be made to collect, store, utilize and/or treat manure accumulations and contaminated runoff in accordance with NRCS conservation practice standard, Waste Management System, Code 312.

Additional Criteria for Areas Utilized for Recreation

The treated area shall be conducive to the overall recreation area and aesthetically blend with the general landscape and surroundings.

Plants, landscaping timbers, traffic control measures, wooden walkways, etc. shall be evaluated for effectiveness, aesthetics and accessibility as covered by the Americans with Disabilities Act.

PLANS AND SPECIFICATIONS

Plans and specifications for heavy use area protection shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. Plans and specifications shall include construction plans, drawings, job sheets or other similar documents. These documents shall specify the requirements for installing the practice, including the kind, amount and quality of materials to be used.

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) plan shall be prepared for and reviewed with the landowner or operator. The plan shall specify that the treated areas and associated practices are inspected annually and after significant storm events to identify repair and maintenance needs.

The O&M plan shall detail the level of repairs needed to maintain the effectiveness and useful life of the practice.

For livestock operations, the O&M plan for heavy use areas may be included as a part of the overall waste management plan. Periodic removal and management of manure accumulations will be addressed in the O&M plan.

SUPPORTING DATA FOR DOCUMENTATION

The following is a list of the minimum data and documentation to be recorded in the case file:

Planning Information, Field Data and Survey Notes

1. Location and extent of the heavy use area protection. Also note the location and extent of the practice on the conservation map.

2. Description of the objectives of the practice, including the desired functions which the heavy use area protection is expected to provide.

3. Soils investigation logs and notes, as appropriate for site conditions and the proposed design.

4. Topographic survey of the site, as appropriate for site conditions and the proposed design.

Design Data

1. Location map with the site identified.

2. Soil survey map with the site identified.

3. A plan view showing the extent of the area treated.

4. Grading and drainage plan for the site where appropriate.

5. Plans and specifications for the foundation and surface treatment.

Construction Check Data/As Built Plans

1. Check notes recorded during and after completion of construction showing the as-built elevations of the practice and the type and extent of the surface treatment.

2. Red line the construction plans to indicate the construction's conformance to the design.

3. Sign and date check-notes and plans by someone with appropriate approval authority. Include statement that practice meets or exceeds plans and NRSC practice standards.

USDA
NATURAL RESOURCES
CONSERVATION SERVICE

DELAWARE CONSERVATION
PRACTICE STANDARD

TERRACE

CODE 600
(Reported by Ft.)

DEFINITION

An earth embankment, or a combination ridge and channel, constructed across the field slope.

PURPOSES

This practice may be applied as part of a resource management system to support one or both of the following:

- Reduce soil erosion.
- Retain runoff for moisture conservation.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Soil erosion by water is a problem.
- There is a need to conserve water.
- The soils and topography are such that terraces can be constructed and farmed with reasonable effort.
- A suitable outlet can be provided.
- Excess runoff is a problem.

CONSIDERATIONS

Consider adjusting the spacing to allow an even number of trips with the equipment.

Consider aligning terraces and/or installing subsurface drainage to correct seepage problems.

This practice has the potential to affect National Register listed cultural resources or eligible (significant) cultural resources. These may include archeological, historic, or traditional cultural properties. Care should be taken to avoid adverse impacts to these resources. Follow NRCS state policy for considering cultural resources during planning.

CRITERIA

Criteria Applicable to All Purposes

Terraces shall be planned, designed and constructed to comply with applicable federal, state and local laws and regulations.

Spacing. The maximum spacing for terraces for erosion control shall be determined by use of one of the following methods:

1. V.I. = xs + y or H.I. = (xs + y) (100/s)

Where:

V.I. = vertical interval in feet (m)

H.I. = horizontal interval in feet (m)
(See figure 2 and 3)

x = a variable with values from 0.4
to 0.8 (0.12 to 0.24)

s = land slope in percent

y = a variable with values from 1.0 to 4.0
(0.3 to 1.2)

Values of *x* for different geographical zones are shown in Figure 1. Values of *y* are influenced by soil erodibility, cropping system and crop management practices. A value of 1.0 (0.3) shall be selected for erodible soils with tillage systems that provide little or no cover during periods of intense rainfall. A value of 4.0 (1.2) shall be

used for erosion-resistant soils with tillage systems that leave a large amount of cover (1.5 tons of straw equivalent per acre or 3.4 metric tons per hectare) on the surface. A value of 2.5 (0.75) shall be used if one of the factors indicated is favorable and the other unfavorable. Other values between 1.0 (0.3) and 4.0 (1.2) may be used according to the estimated quality of the factors. The horizontal spacing does not have to be less than 90 feet.

2. Revised Universal Soil Loss Equation (RUSLE). The spacing shall not exceed the critical slope length as determined using RUSLE. When tables are used to calculate critical slope, refer to Table 1 of this standard for terrace P factor. Soil loss in the inter-terrace interval must be less than or equal to the allowable soil loss.

In no case shall the maximum horizontal spacing exceed that shown in Table 2 for the condition shown. The maximum limits may not be exceeded when making adjustments indicated below.

Spacing may be increased as much as 10 percent to provide better location or alignment, to adjust for farm machinery, or to reach a satisfactory outlet.

The likelihood of benching of steep slopes by tillage, land forming, and erosion shall be considered when determining the terrace interval. For example, use the proposed as-built slope and length in RUSLE calculations.

For level terraces used for erosion control and water conservation, the spacing shall be determined as previously described, but in no case shall the maximum horizontal spacing exceed 600-ft. (180 m). An *x* value of 0.8 (0.24) may be used for all level terraces used primarily to impound water. When using the V.I. or H.I. spacing method, Figures 2 and 3 show the horizontal interval or erosion length to be used in calculating terrace spacing (Figure 4).

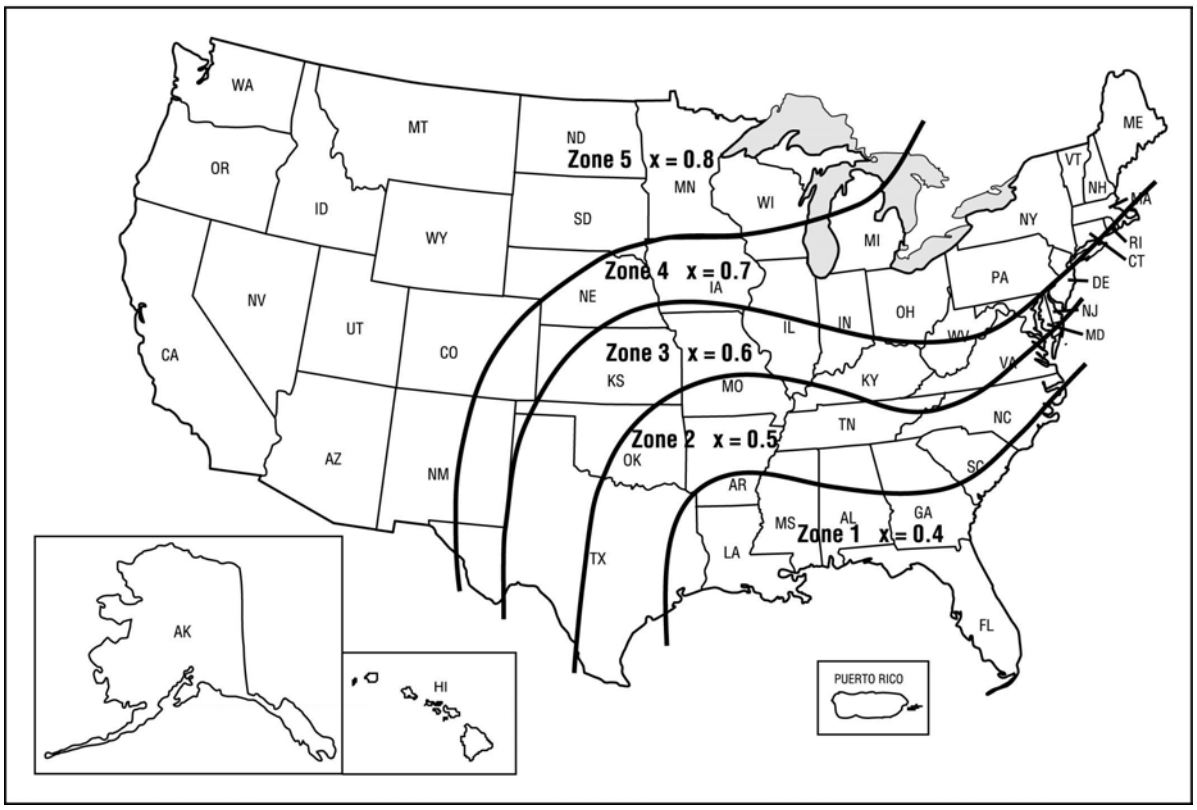

Figure 1. Values of x in equation V.I. = xs + y or H.I. = (xs + y) (100/s)

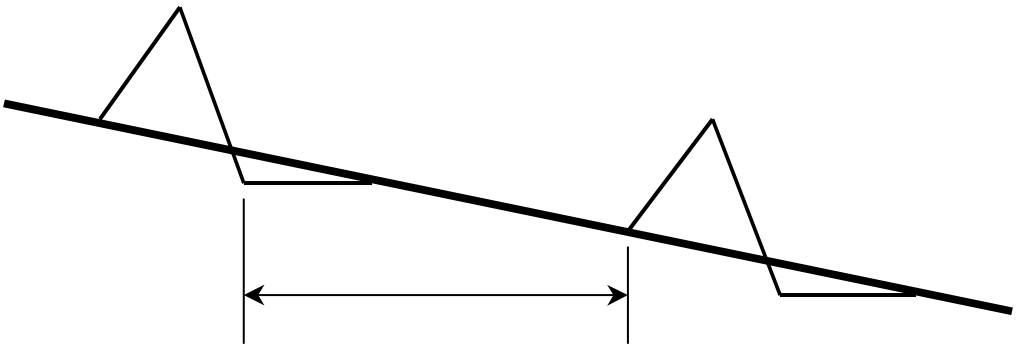

Figure 2. Horizontal Interval for Steep Back-slope Terraces

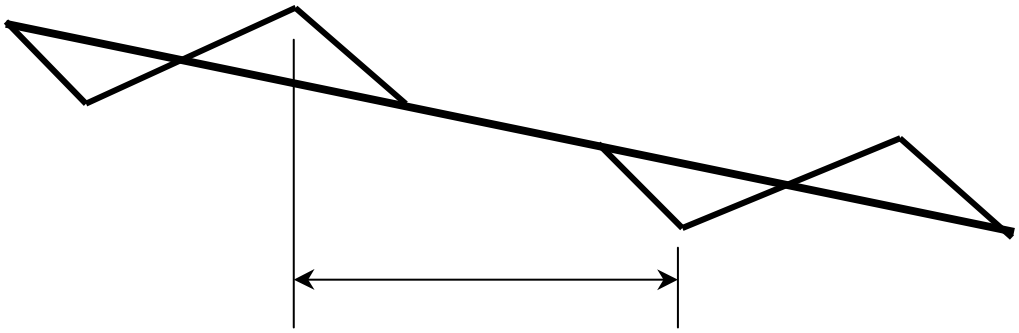

Figure 3. Horizontal Interval for Broad-Based Terraces

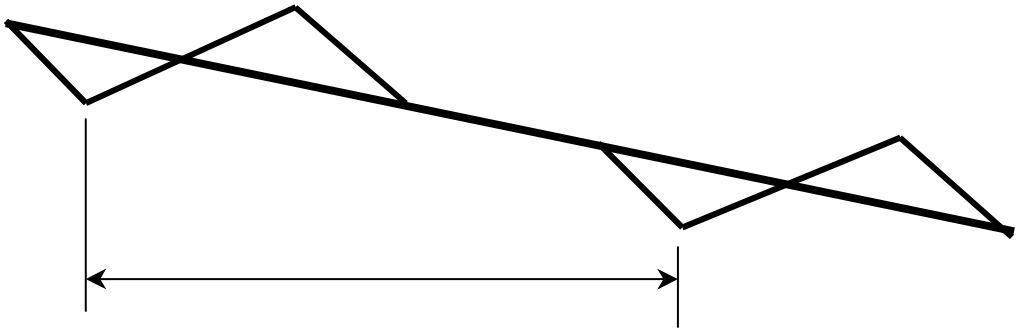

Figure 4. Terrace Spacing

Table 1. Terrace P factors [1]

Horizontal Interval		Closed Outlets [2]	Open outlets with percent grade of: [3]		
(ft)	(m)		0.1 - 0.3	0.4 - 0.7	0.8
Less than 110	Less than 33	0.5	0.6	0.7	1.0
110-140	33-42	0.6	0.7	0.8	1.0
140-180	43-54	0.7	0.8	0.9	1.0
180-225	55-68	0.8	0.8	0.9	1.0
225-300	68-90	0.9	0.9	1.0	1.0
More than 300	More than 90	1.0	1.0	1.0	1.0

NOTE: If contouring or stripcropping P factors are appropriate, they can be multiplied by the terrace P factor for the composite P factor.

1 These figures are not appropriate for sediment yield estimates.
2 "P" factors for closed outlet terraces also apply to terraces with underground outlets and to level terraces with open outlets.
3 The channel grade is measured on the 300 ft. of terrace or the one-third of total terrace length closest to the outlet, whichever distance is less

Table 2. Maximum horizontal spacing for terraces

	RUSLE R Factor of > 175		With Contour Stripcropping		For Concentrated Flow Control	
Percent Slope	Ft	M	Ft	M	Ft	M
0-2	450	130	600	180	700	210
2-4	300	90	600	180	700	210
4-6	200	60	600	180	600	180
6-9	150	45	400	120	500	150
9-12	150	45	250	75	500	150
12-18	150	45	150	45	400	120
> 18	150	45	150	45	300	90
Minimum spacing required, all slopes	90	27	90	27	200	60

Alignment. Cropland terraces shall be parallel if feasible and as parallel as practicable. Curves shall be long and gentle to accommodate farm machinery.

Capacity. The terrace shall have enough capacity to control the runoff from a 10-year frequency, 24-hour storm without overtopping. For terraces with underground outlets, the capacity shall be increased by the estimated 10-year sediment accumulation, unless sediment is removed through maintenance. Terrace systems designed to provide flood protection or to function with other structures shall have the appropriate design capacity. When the capacity is determined by the formula Q = AV and the V is calculated using Manning's formula, a minimum *n* value of 0.035 shall be used for bare channels. Agricultural Handbook Number 667,

Stability Design of Grass-lined Open Channels, or equivalent shall be used for vegetated channels.

Cross section. The terrace cross section shall be proportioned to fit the land slope, the crops grown, and the farm machinery used. Additional height shall be added if necessary to provide for settlement, channel sediment deposits, ridge erosion, the effect of normal tillage operations, and safety. The ridge shall have a minimum width of 3 ft. (1 m) at the design elevation. The steepest slope of a vegetated front or back ridge slope is 2 horizontal:1 vertical. Terrace ridges, especially those with steep back slopes, can be very hazardous. All cropped terrace slopes that are to be farmed shall be no steeper than those on which farm equipment can operate safely. Potential hazards must be brought to the attention of the responsible person. The opening at the outlet end of gradient and open-end level terraces shall have a cross section equal to that specified for the terrace channel.

End closures. Level terraces may have open ends, partial end closures, or complete end closures. Partial and complete end closures shall be used only on soils and slopes where the stored water will be absorbed by the soil without appreciable crop damage or where underground outlets are provided.

If terraces with closed or partly closed ends are specified, the end closures must be installed before the terraces are completed. The end closures shall be designed so that the water flows over the end closure before overtopping the terrace ridge.

Partial end closures shall not be more than half the effective height of the terrace ridge. Complete end closures are more than half the height of the ridge. The cross section of the closures may be less than the terrace cross section.

Channel grade. Channel grade shall be determined by one of the following methods:

1. Maximum channel velocities for permanently vegetated channels shall not exceed those used for grassed waterways.
2. Maximum channel velocity for cultivated channels shall be nonerosive for the soil and planned treatment. Maximum velocity for erosion-resistant soils is 2.5 ft/s (0.75 m/s); for average soils, 2.0 ft/s (0.6 m/s); and for easily erodible soils, 1.5 ft/s (0.45 m/s). Velocity shall be computed by Manning's formula, using a maximum *n* value of 0.035.

For short distances and in upper reaches, channel grades or velocities may be increased to improve alignment. If terraces have an underground outlet, water and sediment will pond in the lower reaches of the channel, thus reducing the velocity in those reaches and allowing steeper channel grades within the impoundment area. Minimum grades shall be such that ponding in the channel caused by minor irregularities will not cause serious damage to crops or delay field operations.

Terrace length. The volume of water stored in level terraces is proportional to the length. Therefore, it is necessary that the length be held within reason so that damage in case of a break is minimized. Level terrace length shall not exceed 3,500 ft. (1,000 m) unless the channel is blocked at intervals not exceeding 3,500 ft. (1,000 m). Normally, the capacity and the nonerosive velocity requirements will control the gradient terrace length.

Outlets. All terraces must have adequate outlets.

Vegetated outlets may be used for gradient or open-end level terraces. Such an outlet may be a grassed waterway or other vegetated area. The outlet must convey runoff water to a point where the outflow will not cause damage. Outlets shall be installed and vegetation established before the terrace is constructed to provide a stable outlet. The water surface in the terrace shall not be lower than the water surface in the outlet at their junction when both are operating at design flow.

Underground outlets may be used on gradient or level terraces. The outlet consists of an intake and an underground conduit. An orifice place, increase in conduit size, or other features shall be installed as needed to control the release rate and prevent excessive pressure in the conduit. Terraces shall be designed to control a 10-year frequency, 24-hour storm without overtopping. The release time shall not exceed the inundation tolerance of the planned crops. If sediment retention is desired, adjust release rate according to particle size.

The underground conduit shall meet the requirements specified for Underground Outlets (620) or Subsurface Drains (606). Conduits must be installed deep enough to prevent damage

from tillage equipment. The inlet shall consist of a vertical perforated pipe or other structure suitable for the intended purpose. The inlet shall be located uphill of the front slope of the terrace ridge, if farmed, to permit passage of farm machinery and, if necessary, provide for the anticipated accumulation of sediment. The outlet of the conduit shall have adequate capacity for the design flow without causing erosion. Blind inlets may be used where they are effective.

Soil infiltration may be used as the outlet for level terraces. Soil infiltration must permit drainage of the design storm from the terrace channel within a reasonable period so standing water does not significantly damage crops.

Combinations of different types of outlets may be used on the same system to maximum water conservation, to affect water quality, and to provide for economical installation of a more farmable system.

Vegetation. All areas to be vegetated shall be established as soon as practicable after construction.

Drainage. Install subsurface drainage to stabilize terrace where needed. It shall be designed taking into consideration the effect of snowcatch and melt on water budget components.

Additional Criteria Applicable to Retaining Runoff for Moisture Control

Terrace capacity shall be designed in accordance with a water budget analysis.

SPECIFICATIONS

Plans and specifications for establishment of this practice shall be prepared in accordance with the previously listed criteria. Plans and specifications shall contain sufficient detail to ensure success of the practice. Documentation shall be in accordance with the section "Supporting Data and Documentation" in this standard.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall be prepared for each management unit. The plan shall provide specific instructions for operating and maintaining the system to insure that it functions properly. Appropriate job sheet(s), fact sheets, or other information sheets may be used to serve as the management plan as well as supporting documentation and shall be provided to the client. These sheets shall be referenced in the conservation plan narrative.

The minimum requirements to be addressed in the operation and maintenance plan are:

1. Provide periodic inspections, especially immediately following runoff events.

2. Promptly repair or replace damaged components as necessary.

3. Maintain terrace ridge height and outlet elevations.

4. Remove sediment that has accumulated in the terrace to maintain capacity, a positive channel grade, and to maintain capacity where soil infiltration serves as the outlet.

5. Each inlet for underground outlets must be kept clean and sediment buildup redistributed so that the inlet is in the lowest place. Inlets damaged or cut off by farm machinery must be replaced or repaired immediately.

6. Vegetation, where specified, shall be maintained and trees and brush controlled by chemical or mechanical means.

7. Vegetated outlets should be established before construction when feasible.

8. Keep machinery away from steep back sloped terraces. Keep equipment operators informed of all potential hazards.

SUPPORTING DATA AND DOCUMENTATION

The following is a list of the minimum data and documentation to be recorded in the case file:

1. Extent of planting in acres, field number, and the location of the practice marked on the conservation plan map;

2. Assistance notes shall include dates of site visits, name or initials of the person who

made the visit, specifics as to alternatives discussed, decisions made, and by whom;

3. Completed copy of the appropriate job sheet(s) or other specifications and operation and management plan.

Field Data and Survey Notes

The following is a list of the minimum data needed:

1. Plan view sketch.

2. Establish and describe a temporary benchmark.

3. Topographic survey of the area of the proposed terraces.

4. Special control or field features that must be considered in the design.

5. Cross-sections and profile of the proposed outlet for the proposed terraces, as appropriate.

6. Location and elevation of soil borings.

Design Data

Record on appropriate engineering paper. For guidance on the preparation of engineering plans see Chapter 5 of the Engineering Field Handbook - Part 650. The following is a list of the minimum required design data:

1. Locate the practice on the farm plan map in the case file.

2. Determine soil type and any special restrictions.

3. Determine the required storage capacity.

4. Design the terraces to meet the criteria of this practice standard.

5. Determine peak runoff from the contributing drainage area for the required design storm in accordance with Chapter 2, EFH, Part 650, or by other approved method.

6. Size the terraces and outlets in accordance with Chapter 8, EFH, Part 650, or other source.

7. Design notes or design sheet must show cuts and fills, riser location (if underground outlet), required cross section, channel grades, orifice size, embankment elevation or grade rod, utility notification, construction notes, and other pertinent information.

8. Provide for the safe outlet of discharge from the terraces. Show details of outlet protection or other structural components needed.

9. Provide for the control of erosion during and following construction.

10. Show job class on the plan.

11. Estimated Quantities.

12. Planting plan. Give seeding, lime, fertilizer and mulching requirements.

Construction Check Data/As-Built Plans

Record on survey notepaper, NRCS-ENG-28, or other appropriate engineering paper. Survey data will be plotted in red on the as-built plans. The following is a list of minimum data needed for As-built documentation:

1. Documentation of site visits on CPA-6. The documentation shall include the date, who performed the inspection, specifics as to what was inspected, all alternatives discussed, and decisions made and by whom.

2. Record check notes during or after completion of construction showing grades and cross section of constructed components and outlets including length, width (or diameter) and depth.

3. Statement as to the condition or adequacy of vegetation on the seeding areas, and other disturbed areas.

4. Final quantities and documentations for quantity changes. Materials certifications as appropriate.

5. Sign and date check-notes and plans by someone with appropriate approval authority. Include statement that practice meets or exceeds plans and NRCS practice standards.

USDA
NATURAL RESOURCES
CONSERVATION SERVICE

DELAWARE CONSERVATION
PRACTICE STANDARD

WATER AND SEDIMENT CONTROL BASIN

CODE 638
(Reported by No.)

DEFINITION

An earth embankment or a combination ridge and channel generally constructed across the slope and minor watercourses to form a sediment trap and water detention basin.

PURPOSES

A water and sediment control basin may be established to:

- Improve farmability of sloping land.
- Reduce watercourse and gully erosion.
- Trap sediment.
- Reduce and manage onsite and downstream runoff.
- Improve downstream water quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to sites where:

- The topography is generally irregular.
- Watercourse or gully erosion is a problem.
- Sheet and ril erosion is controlled by other conservation practices.
- Runoff and sediment damage land and improvements.
- Soil and site conditions are suitable.
- Adequate outlets can be provided.

Water and sediment control basins shall not be used in place of terraces. Where a ridge and/or channel extend beyond the detention basin or level embankment, standards for Terrace (600) or Diversion (362) must be applied as appropriate.

CONSIDERATIONS

Water and sediment control basins should be part of a resource management plan including such practices as terraces, grassed waterways, contouring, a conservation cropping system, conservation tillage, and crop residue management.

Where possible, the basin should be configured to enhance sediment deposition. This can be accomplished by using flow deflectors, inlet and outlet selection, and by adjusting the length to width ratio.

For cropped fields, embankment orientation and crop row direction should be approximately perpendicular to the land slope to support contour farming. The design should support farmability by limiting short point rows or sharp curves. Field boundaries and row lengths should also be considered in planning basin location and row direction.

Effects on streams and wetlands must be considered. Mitigation may be required where water is diverted or degraded for downstream uses.

This practice can be used to develop/enhance seasonally ponded areas for migratory waterfowl.

Where possible, the design should enhance habitat for native and endangered species.

Effects on downstream water quality and temperature may be critical for some species.

This practice has the potential to affect National Register listed cultural resources or eligible (significant) cultural resources. These may include archeological, historic, or traditional cultural properties. Care should be taken to avoid adverse impacts to these resources. Follow NRCS state policy for considering cultural resources during planning.

Operation safety of vehicle and farming equipment should be considered when selecting cut and fill slopes, especially where cropping or haying is planned.

CRITERIA

Criteria Applicable to All Purposes

The resource management system must reduce soil loss in the interval above and below the basin to prevent excessive maintenance and operation problems.

Where land ownership or physical conditions preclude treatment of the upper portion of a slope, a water and sediment control basin may be used to separate this area from, and permit treatment of the lower slope.

The design must limit inundation, infiltration, and seepage to prevent crop damage and/or other problems.

This practice must conform to all federal, state, and local laws and regulations. Laws and regulations of particular concern include those involving water rights, dam construction, land use, pollution control, property easements, and wetlands,including DNREC, Delaware Sediment and Stormwater Regulations.

Spacing. Water and sediment control basins must generally be spaced at terrace intervals (see standard for Terrace (600)). Adjust spacing or include other measures needed to prevent erosion in the watercourse between basins.

The system of basins and row arrangements must be parallel and spaced to accommodate farm machinery where needed to fit row crop spacing.

Spacing design must consider embankment slope lengths, top width, and outlet location.

Cross Section. For portions of the basin controlling only flowing water 3 feet or less deep, embankment slopes must be two horizontal to one vertical, or flatter. For all other portions of the basin, the sum of the upstream and downstream slopes must be 5:1 or flatter with a maximum 2:1 in either slope. Slopes may be vegetated or flattened to permit cropping.

Earth Embankment. Minimum effective top widths are given in Table 1. Constructed embankment height must be at least 5% greater than design height to allow for settlement. The maximum settled height of the embankment must be 15 feet or less measured from natural ground at centerline of the embankment.

Table 1

Minimum Top Width of Embankments

Fill Height (Feet)	Effective Top Width (Feet)
0-5	3
5-10	6
10-15	8

Foundation Cutoff and Seepage Control. Portions of basin ridges designed to impound more than a 3-foot depth of water must include foundation cutoff and seepage control as required by the standard for Pond (378).

Capacity. Basins must have capacity to prevent overtopping by runoff from a 10-year frequency, 24-hour duration storm. Larger design storms may be used where needed for flood control or other purposes.

In addition to the above storage, basins must have capacity to store at least the anticipated 10-year sediment accumulation, or periodic sediment removal must be provided to maintain the required capacity.

Basin ends must be closed to an elevation that will contain design capacity. Freeboard may be added to design height to provide for safe operation of auxiliary spillways. Auxiliary spillways must not contribute runoff to a lower basin (or pond) except where the lower basin (or pond) is designed to control the flow.

Outlets. Water and sediment control basins must have spillways, underground outlets or soil infiltration outlets that conform to standards for Pond (378), Grassed Waterway (412), Diversion (362) or Underground Outlet (620) as appropriate.

Topsoil. Where necessary to restore or maintain productivity, topsoil must be stockpiled and spread over disturbed areas.

Vegetation. Disturbed areas that are not cropped must be established to appropriate vegetation or otherwise protected from erosion using organic or gravel mulch or other measures.

Selection of vegetation species must consider environmental quantity and quality, endangered species needs, and wildlife food and habitat needs. Seedbed preparation, fertilizing, seeding, and mulching must be in accordance with standards for Critical Area Planting (342) and Mulching (484).

PLANS AND SPECIFICATIONS

Plans and specifications for establishment of this practice shall be prepared in accordance with the previously listed criteria. Plans and specifications shall contain sufficient detail to ensure success of the practice. Documentation shall be in accordance with the section "Supporting Data and Documentation" in this standard.

OPERATION AND MAINTENANCE

A site specific Operation and Maintenance (O&M) plan shall be prepared for and reviewed with the landowner or operator. The plan shall contain guidance to maintain the embankment, design capacity, vegetative cover and outlet.

All plans shall include a provision that after each large storm, basins must be inspected and needed maintenance performed. When sediment storage is full, accumulated sediment must be removed or the basin must be redesigned and modified to restore capacity.

Where designs include underground outlets, O&M plans should include checking for clogging and/or pipe damage.

SUPPORTING DATA FOR DOCUMENTATION

The following is a list of the minimum data and documentation to be recorded in the case file:

1. Extent of planting in acres, field number where the practice located, and the location of the practice marked on the conservation plan map.

2. Assistance notes.

Field Data and Survey Notes

The following is a list of the minimum data needed:

1. Plan view sketch.

2. Establish and describe a temporary benchmark.

3. Topographic survey of the area of the proposed water and sediment control basin.

4. Location and description of trees and other obstacles that may need to be removed.

5. Location and elevation of soil borings.

6. Cross sections and profile of the proposed outlet for the proposed water and sediment control basin.

Design Data

Record on appropriate engineering paper. For guidance on the preparation of engineering plans see Chapter 5 of the Engineering Field Handbook - Part 650. The following is a list of the minimum required design data:

1. Locate the practice on the farm plan map in the case file.

2. Determine soil type and any special restrictions.

3. Design the water and sediment control basin to meet the criteria of this practice standard.

4. Determine peak runoff from the contributing drainage area for the required design storm in accordance with Chapter 2 of the Engineering Field Handbook - Part 650, or by other approved method.

5. Size the principal spillway in accordance with Chapter 3 of the Engineering Field Handbook - Part 650, or other source.

6. Size the emergency spillway in accordance with Chapter 11 of the Engineering Field Handbook - Part 650, or other source.

7. Provide for the safe outlet of discharge from the water and sediment control basin.

8. Provide for the control of erosion during and following construction.

9. Show the engineering job class on the plans.

10. Estimated quantities.

11. Planting plan. This must meet the criteria, specifications, and documentation requirements of the conservation practice standard. Show on the plans.

12. Written Operation and Maintenance Plan.

Construction Check Data/As-Built Plans

Record on survey notepaper, NRCS-ENG-28, or other appropriate engineering paper. Survey data will be plotted in red on the as-built plans. The following is a list of minimum data needed for as-built documentation:

1. Documentation of site visits on CPA-6. The documentation shall include the date, who performed the inspection, specifics as to what was inspected, all alternatives discussed and decisions made and by whom.

2. Profile notes along centerline of top of completed embankment.

3. Cross section notes at one or more locations on the completed embankment.

4. Profile notes along centerline of earth spillway.

5. Cross section notes of emergency spillways as needed to determine whether planned grade and dimensions have been met.

6. Location, size, type, grade, and/or pertinent elevations of the principal spillway.

7. Statement as to the condition or adequacy of vegetation on the embankment, spillway, and other disturbed areas.

8. Type and location of fencing and safety features where appropriate.

9. Final quantities and documentation for quantity changes. Material certifications as appropriate.

10. Signature and date on the check-notes and plans of someone with appropriate engineering job approval authority. Include a written statement that the constructed practice meets or exceeds the construction plans and NRCS practice standards.

USDA
NATURAL RESOURCES
CONSERVATION SERVICE
DELAWARE
INTERIM
CONSERVATION
PRACTICE STANDARD

INCINERATOR

CODE 769
(Reported by Each)

DEFINITION

An incinerator used to dispose of mortalities from poultry operations.

PURPOSE

The purpose of this practice is to provide a suitable disposal method of dead poultry to prevent pollution and improve environmental quality.

This standard covers the planning, sizing, and installation of a manufactured incinerator for the disposal of poultry mortalities.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where current disposal practices of dead poultry are unsatisfactory and where there is a need to improve sanitation, reduce pollution, or enhance the visual resource.

The incinerators are sized for normal mortalities and are not intended for disposal of the large quantities of dead birds that can result from a catastrophic event.

All federal, state, and local laws, rules, and regulations governing waste management, pollution abatement, and health and safety shall be strictly adhered to. The owner or operator shall be responsible for securing all required permits, approvals, and registration and for the operation of the unit in accordance with appropriate laws, rules, and regulations. (See Appendix A). Delaware Department of Natural Resources and Environmental Control (DNREC) currently requires incinerators to have two chambers. Dual chamber incinerators installed for dead animal disposal must be registered with DNREC prior to construction and operation. DNREC will require stack testing for single chamber units not previously tested and approved. Owners or operators should contact DNREC before making financial commitments for a particular unit to determine if that unit has been approved. Stack testing is expensive compared to the cost of the incinerator.

DESIGN CRITERIA

The required minimum incinerator capacity will be determined using the following table or formula methods:

Type Animal	Daily Loss Factor (lb/day/animal)
Chickens:	
Broilers (4.2 lbs)	0.0050
Laying Hens (4.5 lbs)	0.0014
Roasters (6.5 lbs)	0.0080
Breeding Hens (7.5 lbs)	0.0019
Breeder, Male (11 lbs)	0.0082

If detailed records are available, the following formula can be used to determine the Daily Loss Factor for a specific operation:

$$\frac{MW \times AM}{L} = \text{Daily Loss Factor}$$

Where:
MW = Mature weight of the animal (i.e. - 4.2 lbs)
AM = Average mortality for the life of the animals, as a decimal (i.e. - 0.05)
L = Life of the animals in days (i.e. - 42 Days)

Example 1 (Using Formula):

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Given: 36,000 roasters
6.5 lb market weight
8% average mortality
65 day flock life

Daily Loss Factor = $\frac{6.5 \times 0.08}{65}$ = 0.008 lb/day/bird

Average daily weight of dead birds:
36,000 x 0.008 = 288 lbs/day

Incinerator capacity:
Minimum 288 lbs per loading capacity

Example 2 (Using Table Value):

Number of broilers = 42,000

Average daily weight of dead broilers:
42,000 x 0.005 = 210 lbs/day

Incinerator capacity:
Minimum 210 lbs per loading capacity

The recommended incinerator size will be the smallest size available that will handle the required minimum capacity. More than one incinerator may be required for larger operations. Heavy mortalities at the end of a cycle may require loading the incinerator more than once a day.

Any operation using incineration for disposal of dead poultry will have a plan for collecting and disposing of the ash material remaining after incineration. This plan will be contained in the Nutrient Management Plan established for the operation. The plan will require the use of an ash collection box or bucket and disposal of the ash on the land or through a community trash disposal system.

Under present DNREC policy, only double chamber incinerators with a burner in each chamber are approved for use. Single burner units will be required to pass a stack test (which demonstrates compliance with the regulation) before DNREC will approve their use in Delaware. DNREC will maintain a list of approved units.

Electrical hook-up to be installed as per standard industry practices but in no case less than the minimum requirements of the most recent edition of the National Electrical Code. Installation must be certified by a qualified licensed electrician. All electrical wiring shall be in conduit at the incinerator. Wherever installation could be classified as a hazardous location, specific conformance to Article 500 of the National Electrical Code will be met.

Gas hook-up must be certified in writing by a qualified state licensed Liquified Petroleum Contractor to meet National Fire Protection Association (NFPA) Code 54 & 58; all other state, national, and local codes; and in accordance with the manufacturer's recommendations. Other fuel sources must meet all state and local codes for transmission of flammable or volatile fuels. For diesel-fired incinerators, a Spill Prevention, Control, and Countermeasures (SPCC) Plan shall be prepared by a registered professional engineer for any individual fuel storage tank in excess of 660 gallons, or cumulative storage capacity of multiple tanks in excess of 1,320 gallons.

Location of Incinerators

Locate the incinerator according to the following requirements:

- at least 20 feet from any building to prevent spontaneous combustion
- at least 50 feet from any surface water source
- at least 100 feet from any well or subsurface water source
- at least 500 feet from any residence located off the property of the owner/operator

- on a concrete slab

CONSIDERATIONS

Consideration should be given to providing roof protection for the incinerator to extend the life of the unit. Metal roof purlins and covering should be used to prevent spontaneous combustion from the stack.

Consideration should be given to the use of an afterburner to reduce any objectionable odors, fumes and particulate fallout to acceptable levels.

SPECIFICATIONS

Scope

This item shall consist of the clearing, excavation, backfill, concrete, reinforcing steel, and other appurtenances required for the installation of an incinerator and the disposal of all cleared and excavated materials. Construction shall be carried out in such a manner that erosion, water, air, and noise pollution will be minimized and held within legal limits as established by State regulations.

Clearing and Grubbing

All trees, brush, and stumps shall be removed from the site and spoil areas before excavation is performed. All material cleared from the area shall be disposed of by burning or burying
on-site or hauling to an appropriate landfill. All burning shall conform to regulations and laws of Delaware.

Excavation

Soils containing excessive organic material will be removed from the foundation area. The completed excavation and placement of spoil material shall conform as nearly to lines, dimensions, grades, and slopes shown on the plans or staked on the site as skillful operation of the excavating equipment will permit.

Concrete

This work shall consist of furnishing, forming, placing, finishing, and curing Portland cement concrete. The concrete mixture shall be no less than a five (5) bag per yard mix. The water content shall not exceed 6 gallons per bag of cement. The concrete will be thoroughly rodded or vibrated and spaded to remove air voids and produce dense, watertight concrete. Concrete shall contain a standard known brand of Portland cement with washed sand and gravel. Clean water shall be used in the mix. [Suggested ratio of aggregates in mix:
94 lbs. cement (1 bag), 6 gallons water,
170 lbs. clean dry sand, 315 lbs. dry gravel.
Smaller batches: 1 part cement, 2 parts sand, and 3 parts gravel; add water at the rate of 1 gallon per 16 lbs of cement.]

Installation of Incinerator

Incinerators will be installed according to all national, state, and local laws, regulations, and codes, and the manufacturer's instructions. It shall be installed on a concrete pad. It may be protected by a house structure or by a roof structure with metal purlins and roofing material.

Vegetation

Vegetation shall be applied to all disturbed areas as critical area planting and will include liming, fertilizing, seedbed preparation, seeding, and mulching. If farm animals will have access to the area, the area around the incinerator will be fenced, if appropriate.

Approval

A complete copy of the design will be filed by the district conservationist.

OPERATIONS AND MAINTENANCE

The manufacturer's instructions regarding the operation and maintenance will be followed.

It is the responsibility of the operator of the incinerator to operate the unit in a manner such as is necessary to prevent the emission of objectionable odors, fumes and particulate fallout to the extent that they are not a nuisance to neighbors and others living downwind.

SUPPORTING DATA AND DOCUMENTATION

The following is a list of the minimum data and documentation to be recorded in the case file:

Planning Information, Field Data, and Survey Notes

1. Field location of the incinerator and assistance. Also note the location of the incinerator on the conservation plan map.
2. Description of the objectives of the practice, including the desired functions which the incinerator is expected to provide.
3. Soil investigation logs and notes, as appropriate for the site conditions.
4. Topographic survey of the site, as appropriate for site conditions and the proposed design.

Design Data

1. Computations establishing the design capacity of the incinerator, the manufacturer and model number of the selected incinerator along with its rated capacity.
2. Location map with site identified.
3. Soil map with site identified.
4. Standard drawings of the concrete base.
5. Details of incinerator attachment to the concrete base (provided by the manufacturer).
6. Details of the roof (if any) attachment to the concrete base (provided by the manufacturer).
7. Operation and maintenance plans or completed copy of the appropriate job sheet(s) if used, with DNREC Guidance for Poultry Incineration (Appendix A) attached.

Construction Check Data/As Built

1. Check notes recorded during or after completion of construction showing as-built conditions of the practice.
2. Sign and date construction check notes to include statement that practice meets or exceeds plans and specifications.

REFERENCES

National Electric Code
National Fire Protection Association Code
DNREC Guidance for Poultry Incineration (Appendix A)