NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

WETLAND RESTORATION

(Ac.)
CODE 657

DEFINITION

The return of a wetland and its functions to a close approximation of its original condition as it existed prior to disturbance on a former or degraded wetland site.

PURPOSE

To restore wetland function, value, habitat, diversity, and capacity to a close approximation of the pre-disturbance conditions by restoring:

- Conditions conducive to hydric soil maintenance.
- Wetland hydrology (dominant water source, hydroperiod, and hydrodynamics).
- Native hydrophytic vegetation (including the removal of undesired species, and/or seeding or planting of desired species).
- Original fish and wildlife habitats.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies only to natural wetland sites with hydric soils which have been subject to the degradation of hydrology, vegetation, or soils.

This standard applies only to Class A (low hazard) structures with a fill height of 10 feet or less. Larger structures shall be designed using MN Practice Standard Pond (378), Grade Stabilization Structure (410), or TR-60 criteria.

This practice is applicable only where the natural hydrologic conditions can be approximated by actions such as modifying drainage, removing fill, restoring stream/floodplain connectivity, removing diversions, dikes, and levees, and/or by using a natural or artificial water source to provide conditions similar to the original, natural conditions.

This practice does not apply to:

- The treatment of point and non-point sources of water pollution (Constructed Wetland (656)).
- The rehabilitation of a degraded wetland, the reestablishment of a former wetland, or the modification of an existing wetland, where specific wetland functions are augmented beyond the original natural conditions; possibly at the expense of other functions (Wetland Enhancement (659)).
- The creation of a wetland on a site location which was historically non-wetland (Wetland Creation (658)).
- The management of fish and wildlife habitat on wetlands restored under this standard.

CRITERIA

General Criteria Applicable to All Purposes

The purpose, goals, and objectives of the restoration shall be clearly defined in the restoration plan, including soils, hydrology, vegetation, and fish and wildlife habitat criteria that are to be met and are appropriate for the site and the project objectives.

These planning steps shall be done with the use of a functional assessment-type procedure, or a state approved equivalent. The objectives will be determined by an analysis of current and historic site functions. They will be based on those functions which can reasonably be supported by current site constraints. Data from historic and recent aerial photography and/or other remotely sensed data, soil maps, topographic maps, stream gage data, intact reference wetlands, and historical records shall be gathered.

The soils, hydrology and vegetative conditions existing on the site, the adjacent landscape, and the contributing watershed shall be documented in the planning process.

The nutrient and pesticide tolerance of the plant and animal species likely to occur shall be evaluated where known nutrient and pesticide contamination exists. Sites suspected of containing hazardous material shall be tested to identify appropriate remedial measures. If remedial measures are not possible or practicable, the practice shall not be planned.

The availability of sufficient water rights should be reviewed prior to restoration.

Upon completion, the site shall meet soil, hydrology, vegetation and habitat conditions of the wetland that previously existed on the site to the extent practicable.

Where offsite hydrologic alterations or the presence of invasive species impact the site, the design shall compensate for these impacts to the extent practicable.

Invasive species, federal/state listed noxious plant species, and nuisance species (e.g., those whose presence or overpopulation jeopardize the practice) shall be controlled on the site as necessary to restore wetland functions. The establishment and/or use of non-native plant species shall be discouraged.

Criteria for Hydric Soil Restoration

Restoration sites will be located on soils that are hydric.

If the hydric soil is covered by fill, sediment, spoil, or other depositional material, the material covering the hydric soil shall be removed to the extent needed to restore the original soil functions.

Soil hydrodynamic and bio-geochemical properties such as permeability, porosity, pH, or soil organic carbon levels shall be restored to the extent needed to restore hydric soil functions.

Criteria for Hydrology Restoration

The hydroperiod, hydrodynamics, and dominant water source of the restored site shall approximate the conditions that existed before alteration. The restoration plan shall document the adequacy of available water sources based on groundwater investigation, stream gage data, water budgeting, or other appropriate means.

The work associated with the wetland shall not adversely affect adjacent properties or other water users unless the policy in NEM Part 510.1 is followed.

Timing and level setting of water control structures, if needed, will be based on the actions needed to maintain a close approximation of the original, natural hydrologic conditions.

The original natural water supply should be used to reestablish the site's hydrology to approximate the hydrologic conditions of the wetland type. If this is not possible, an alternate natural or artificial water supply can be used; however, these sources shall not be diverted from other wetland resources. If the alternate water source requires energy inputs, these shall be estimated and documented in the restoration plan.

To the extent technically feasible reestablish macrotopography and/or microtopography. Use reference sites within the local area to determine desired topographic relief. The location, size, and geometry of earthen structures, if needed, shall match that of the original macrotopographic features to the extent practicable.

Macrotopographic features, including ditch plugs installed in lieu of re-filling surface drainage ditches, shall meet the requirements of other practice standards to which they may apply due to purpose, size, water storage capacity, hazard class, or other parameters. If no other practice standard applies, they shall meet the requirements for Dike (356) unless there is no potential for damage to the feature or other areas on or off site due to erosion, breaching, or overtopping.

Excavations from within the wetland shall remove sediment to approximate the original topography or establish a water level that will compensate for the sediment that remains.

Water control structures that may impede the movement of desirable target aquatic species or species of concern shall meet the criteria in Aquatic Organism Passage (396).

Wetland restoration sites that exhibit soil oxidation and/or subsidence, resulting in a lower surface elevation compared to pre-disturbance, shall take into account the appropriate hydrologic regime needed to support the original wetland functions.

Criteria for Vegetative Restoration

Hydrophytic vegetation restoration shall be of species typical for the wetland type(s) being established and the varying hydrologic regimes and soil types within the wetland. Preference shall be given to native wetland plants with localized genetic material.

Where natural colonization of acceptable species can realistically be expected to occur within 5 years, sites may be left to revegetate naturally. If not, the appropriate species will be established by seeding or planting.

Adequate substrate material and site preparation necessary for proper establishment of the selected plant species shall be included in the plan.

Where planting and/or seeding is necessary, the minimum number of native species to be established shall be based on a reference wetland with the type of vegetative communities and species planned on the restoration site:

- Where the dominant vegetation will be herbaceous community types, a subset of the original vegetative community shall be established within 5 years, or a suitable precursor to the original community will be established within 5 years that creates conditions suitable for the establishment of the native community. Species richness shall be addressed in the planning of herbaceous communities. Seeding rates shall be based upon the percentage of pure live seed and labeled with a current seed tag from a registered seed laboratory identifying the germination rate, purity analysis, and other seed statistics.

- Where the dominant vegetation will be forest or woodland community types, vegetation establishment will include a mix of woody species (trees and/or shrubs) adequate to establish the reference wetland community.
- Forested wetland establishment will include a minimum of three species, where appropriate. Seedling preparation and planting will follow the criteria of MN Practice Standard Tree/Shrub Establishment (612).
- Establishment of non-woody vegetation shall follow the criteria in MN Practice Standard Critical Area Planting (342) or MN Practice Standard Vegetative Treatment Area (635).

DESIGN CRITERIA

Hydrology & Hydraulics.
The site shall be designed to handle the 10-year, 24-hour precipitation event by a combination of storage and spillway(s) capacity. Tables are provided in Engineering Field Handbook Chapter 13 (EFH 13) for quick and conservative design of this practice. A flood routing may be completed and the results used in place of the tables in EFH 13. Sites exceeding the criteria in the tables must use flood routing.

The minimum capacity of a natural or constructed emergency spillway shall be that required to pass the peak flow from the tables in EFH 13 or as determined by flood routing, less any reduction creditable to conduit discharge and detention storage. The tables assume an emergency spillway in good condition. A good spillway is one which will support vegetation (or is otherwise protected) and has exit slopes which lie within the ranges as defined in the EFH, Exhibit 11-2, Table 3. A poor emergency spillway is one that will likely sustain damage from an appreciable flow but will protect the principal spillway structure and embankment during the passage of a single design storm. Structures with a poor emergency spillway must increase the principal spillway design storm to a 25-year, 24-hour precipitation event.

The design storm must be safely controlled by the reservoir with a combination of storage and spillway capacity. In no case shall the difference in elevation between the principal and vegetated spillway be less than 0.5 foot. When flood routing is done, 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 from the 10-year, 24-hour design storm, whichever is higher. The 10 day drawdown shall be computed from the crest of the emergency spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower. Emergency spillways shall provide for passing the design flow at a safe velocity to a point downstream where the dam will not be endangered.

If base flow, which may include seepage, subsurface drainage or spring flow exists, a trickle tube or water control structure shall be provided.

Principal Spillway.
Pipe Spillways. The minimum pipe diameter shall not be less than 6 inches. If the pipe conduit diameter is 10 inches or greater, or 8 inches with an effective trash rack, its design discharge may be considered when calculating the peak outflow rate through the emergency spillway in a flood routing. The pipe may not be considered in the flood routing unless it has a free outlet.

Pipe conduits under or through the dam shall meet the following requirements:

1. Flexible pipe strength shall not be less than that necessary to support the design load with a maximum of 5 percent deflection.
2. The inlets and outlets shall be structurally sound and made of materials compatible with those of the pipe.

Acceptable pipe materials for fills less than ten feet in height are:

- PVC 1120 or 1220, conforming to ASTM D 1785 or ASTM D 2241 – Standard Dimension Ratio (SDR) 26 or Schedule 40.
- Corrugated steel pipe - minimum gage 16.
- Corrugated aluminum - minimum thickness 0.06 inch up to 24” diameter, and 0.075inch for 30” and 36” pipe.
- Reinforced concrete pipe.
- High density plastic dual wall.
- Other pipe material may be used if not under the fill.

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

1. The conduit is of smooth pipe larger than 8 inches in diameter and the pool depth is 3 feet or greater against the embankment.
2. The conduit is of corrugated pipe larger than 12 inches in diameter.

Seepage control is required on all structures with a permanent pool adjacent to the upstream slope of the fill that is more than 2 feet deep and exists for more than two days. Seepage control may not be needed where the water control structure outlets into a downstream tile line. Table 1 indicates required seepage control.

Table 1. Mandatory seepage control

Depth of water against fill, feet	Minimum Seepage Control Required
0-2 feet	None
2-5 feet	one anti seep collar
Greater than 5 feet	Follow criteria in Pond (378)

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

Non-Pipe Spillways. Spillways can be rock chutes, precast concrete block chutes, geosynthetic mat-lined chutes, sheet piling structures, aluminum toe wall structures, and built with other materials. For general design information see EFH 13, Wetland Restoration, Enhancement or Creation.

Vegetated Spillway.
The vegetated spillway shall be designed to safely control the flow from the storm as indicated in tables in EFH 13 Minnesota Supplement, or as determined by the flood routing procedure. Use of vegetated spillways in natural low areas without shaping is desirable since established vegetation is not disturbed. A natural or excavated spillway shall have a minimum 10 foot bottom width.

A vegetated spillway must be provided for each embankment, 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 emergency spillway: (1) a conduit with a cross-sectional area of 3 ft^2 or more, (2) an inlet that will not clog, and (3) an elbow designed to facilitate the passage of trash.

Spillways shall have a minimum length of level section upstream from the control section of 30 feet. The centerline of the approach channel upstream of the level section shall be tangent to the centerline of the level section. The shape of the level section shall have the same dimensions (side slope and bottom width) as the outlet section.

The designer shall be responsible for determining that the flow through a vegetated spillway is designed to be stable in as-built and aged conditions. Refer to EFH 11, Ponds and Reservoirs for design procedures.

Where the outlet has or will have seepage problems, appropriate measures shall be installed to maintain a stable outlet and promote good sod producing vegetation.

Embankment Structures and Dikes.
Foundation. A core trench should be considered under all embankment structures and dikes. A foundation investigation should be made in sufficient detail to determine if the site is suitable. A core trench is required if the fill height is greater than seven feet. A core trench should be considered under a dike to insure dike stability and to prevent excess seepage losses. This may include the entire dike length, short sections located in old drainageways, or areas near a water control structure. The core trench shall have a bottom width adequate for the necessary excavation, backfill, and compaction, but not less than 4 feet. Side slopes shall not be steeper than 1:1.

The centerline of the cutoff shall be located at or upstream from the centerline of the dam. The core trench shall be deep enough to extend into a relatively impervious soil layer. Core trenches will be excavated to a minimum depth of 2 feet below the existing ground level. The most impervious fill available shall be used as the backfill in the core trench.

Earthfill. Dikes shall have constructed side slopes of 3:1 upstream and 2:1 downstream or flatter. Flatter upstream side slopes shall be considered when potential exists for excessive wave action, ice action, erosion in organic soils on the face, or rodent action.

The embankment or dike may be homogeneous or have an impervious core. The minimum top width shall be 8 feet. Organic or highly permeable sandy soils should not be used in embankments. If they must be used for some reason, an analysis of seepage, stability, settlement, decomposition and potential rodent damage shall be documented to show that the structure will perform satisfactorily for the expected life span.

The height of the embankment needs to include sufficient allowances for the volume of storage required, the routing of the design storm(s), additional height for wave action, freeboard required, and a settlement allowance.

The design height of the dike shall be increased by a minimum 5 percent to allow for settlement.

The difference in elevation between the crest of the vegetated spillway and the top of the settled dike shall be the sum of the flow depth of the design storm through the vegetated spillway and at least the minimum freeboard allowance of 0.5 ft. The column labeled HP in the tables in EFH 13 MN Supplement provides information on the flow depth of the freeboard storm through the vegetated spillway.

When the water depth exceeds two feet against the embankment, the difference in elevation between the permanent pool elevation and the top of the settled dike shall be a minimum of 1.5 feet.

Flow Over Top. In special situations, it may be desirable to design an embankment with spillway flow over the top of the embankment. The use of this type of design is limited to shallow earthfill within a drainage ditch. All of the following conditions must be met for a flow-over embankment within a ditch (also called a ditch plug) to be allowed:

1. Damage likely to occur from the failure of the embankment is minimal,
2. Drainage area < 50 acres,
3. A trickle tube or principal spillway is optional by the design tables in the MN Supplement to EFH 13,
4. Fill height < 5 feet,
5. No baseflow is present,
6. Stable grade downstream, and
7. A good stand of vegetation can be established on the earthfill.

In these cases, use a minimum top width of 50 feet, 3:1 upstream slopes, and 20:1 or flatter downstream slopes. An upstream slope of 6:1 or flatter is preferable.

Floodplain Wetland Dikes. Dikes constructed in a floodplain with a principal spillway shall have an additional 1 foot of overfill added to the constructed height to protect the control structure from damage by the overflow water. This additional height shall be constructed for a distance of 50 feet on each side of the principal spillway or water control structure.

For dikes located in a floodplain, overtopping of the dike by flow from the floodway into the wetland is likely. In addition to the criteria already given, vegetative spillways associated with dikes located in a floodplain may be located on level natural ground, in excavation, or on compacted fill. Vegetated spillways shall be at least 100 feet wide and have a crest length of at least 30 feet.

Borrow Area. If a borrow area is located upstream or downstream from an embankment, it will be located so that the minimum distance between the toe of the embankment and the edge of an excavated borrow area will be at least 50 feet.

Wave Action. The design of all earthen embankments shall consider the impacts of wave action. Appropriate measures to protect against wave damage may include:

1. A flatter upstream embankment slope.
2. A berm with a minimum 10 foot radius may be provided around a 24” diameter or larger water control structure to minimize vegetative plugging.
3. Riprap or other erosion control material.
4. Additional fill height.

Stabilization. A vegetative stabilization plan shall be prepared according to the criteria in Critical Area Planting (342).

Subsurface Drainage Alteration.
In areas where subsurface drains are used to alter hydrology of the site, the existing drainage system shall be modified to the extent possible to restore the hydrologic conditions of the wetland. Such modifications are not subject to the requirements outlined in the Hydrology & Hydraulics section above, provided the restoration does not impact adjacent property owners, and no dikes, levees, or embankments are used to restore the wetland. Review of drainage records, interviews, and site investigations may be needed to determine the extent of the existing drainage system.

In some cases, existing subsurface drains may be blocked or controlled to restore wetland conditions to previously drained lands. Blocks and control structures shall be adequate to meet all hydraulic, structural, and other functional requirements.

Where the drain lines serve as outlets from other areas where drainage is still desired, appropriate measures shall be included in the design to keep the upstream drainage system(s) maintained at its current capacity.

The effects of the subsurface drainage system may be modified or eliminated by one or a combination of the following:

1. Removing or rendering inoperable a portion of the drain at the downstream edge of the site.
2. Modifying the drain with a water control device.
3. Outletting the drain above the wetland area.

4. Routing the drain around, away from, or through the wetland area.

When removing a portion of the drain downstream of the site, the length removed shall be sufficient so that the drain does not alter the hydrology of the wetland. Use lateral effect information to determine the break location.

The minimum length of drain that should be removed or rendered inoperable at each tile break is the shorter of what is necessary to make a tile have negligible impact on hydrology of the wetland within the lateral effect zone, or 100 feet (see EFH 13 MN Supplement). The measurement for tile broken is to begin outside the edge of the wetland. Sites with multiple tile breaks may use shorter distances as long as the overall impact is that the remaining tile is outside the lateral effect zone and thus has a minimal hydrologic impact on the wetland. A 100 foot break must be used at the outlet end for the overall site. The minimum for any break length is 40 feet.

Where dikes or embankments are to be constructed over existing drains, the entire length of the drain under the earthfill shall be removed. In addition, a minimum length of 25’ of tile shall be removed upstream from the upstream toe of the earthfill, and 50 feet shall be removed downstream of the downstream toe of the earthfill.

All envelope, filter material or flow enhancing material shall be removed within the length specified for tile removal. This includes tile fragments and debris. Where tile is removed, each exposed end of the remaining tile shall be plugged or capped to prevent water from entering or exiting the tile. The trench from tile removal shall be filled with similar soil and compacted to achieve the density equivalent to adjacent existing material. If the drain is routed around the wetland and perforated drain tubing or sectioned tile is used, the drain shall be located so that it has no hydrologic effect on the wetland area. This minimum offset distance from the wetland should be determined by scope and effect equations; see EFH Chapter 19, Hydrology Tools for Wetland Determination.

In general, routing non-perforated drainage tile through a wetland should be avoided. If it is necessary, the design shall consider flotation of the tile.

CONSIDERATIONS

Soil Considerations

Consider making changes to physical soil properties, including:

- Increasing or decreasing saturated hydraulic conductivity by mechanical compaction or tillage, as appropriate.
- Incorporating soil amendments.
- The effect of construction equipment on soil density, infiltration, and structure.

Consider changes in soil bio-geochemical properties, including:

- Increasing soil organic carbon by incorporating compost.
- Increasing or decreasing soil pH with lime, gypsum, or other compounds.

Hydrology Considerations

Consider the general hydrologic effects of the restoration, including: Impacts on downstream stream hydrographs, volumes of surface runoff, and groundwater resources due to changes of water use and movement created by the restoration.

Consider the impacts of water level management, including:

- Increased predation due to concentrating aquatic organisms, including herptivores, in small pool areas during draw downs.
- Increased predation of amphibians due to high water levels that can sustain predators.
- Decreased ability of aquatic organisms to move within the wetland and from the wetland area to adjacent habitats, including fish and amphibians as water levels are decreased.
- Increases in water temperature on-site, and in off-site receiving waters.
- Changes in the quantity and direction of movement of subsurface flows due to increases or decreases in water depth.
- The effect changes in hydrologic regime have on soil bio-geochemical properties, including: oxidation/reduction; maintenance of organic soils; and salinity increase or decrease on site and on adjacent areas.
- Increase the design storm frequency if circumstances merit or to build in a higher factor of safety.
- When designing dikes and embankments plan the top width and side slopes accordingly, considering potential access and forces such as wave action, ice action, erosion, and rodent action.
- When a vegetative spillway is used as a principal spillway and where base flows or undesired durations of storm runoff will exist, trickle tubes or drains shall be considered in combination with the vegetated spillway.

Vegetation Considerations

Consider:

- The relative effects of planting density on fish and wildlife habitat versus production rates in woody plantings.
- The potential for vegetative buffers to increase function by trapping sediment, cycling nutrients, and removing pesticides.
- The selection of vegetation for the protection of structural measures that is appropriate for wetland function.
- The potential for invasive or noxious plant species to establish on bare soils after construction and before the planned plant community is established.
- The use of prescribed burning to restore wetland and adjacent upland plant communities.

Fish and Wildlife Habitat Considerations

Consider:

- The addition of coarse woody debris on sites to be restored to woody plant communities for an initial carbon source and fish and wildlife cover.
- The potential to restore habitat capable of supporting fish and wildlife with the ability to control disease vectors such as mosquitoes.
- The potential to establish fish and wildlife corridors to link the site to adjacent landscapes, streams, and water bodies and to increase the sites colonization by native flora.
- The need to provide barriers to passage for unwanted or predatory species.

PLANS AND SPECIFICATIONS

Plans and specifications for this practice shall be prepared for each site. Plans and specifications shall be developed using approved specifications sheets, job sheets, or other documentation. The plans and specifications for structural features will include, at a minimum, a plan view, quantities, and sufficient profiles and cross-sections to define the location, line, and grade for stakeout and checkout. Plans and specifications shall be reviewed and approved by staff with appropriate job approval authority.

OPERATION AND MAINTENANCE

A separate Operation and Maintenance Plan will be prepared for sites that have structural features. The plan will include specific actions for the normal and repetitive operation of installed structural items, especially water control structures, if included in the project. The plan will also include the maintenance actions necessary to assure that constructed items are maintained for the life of the project. It will include the inspection schedule, a list of items to inspect, a checklist of potential damages to look for, recommended repairs, and procedures for documentation.

Management and monitoring activities needed to ensure the continued success of the wetland functions may be included in the above plan, or in a separate Management and Monitoring Plan. In addition to the monitoring schedule, this plan may include the following:

- The timing and methods for the use of fertilizers, pesticides, prescribed burning, or mechanical treatments.
- Circumstances when the use of biological control of undesirable plant species and pests (e.g. using predator or parasitic species) is appropriate, and the approved methods.
- Actions which specifically address any expected problems from invasive or noxious species.
- The circumstances which require the removal of accumulated sediment.
- Conditions which indicate the need to use haying or grazing as a management tool, including timing and methods.

REFERENCES:

USDA-NRCS, 2003. ECS 190-15 Wetland Restoration, Enhancement, Management & Monitoring. 425 pp.

wre&m.pdf (50 MG)

USDA-NRCS. National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 13, “Wetland Restoration, Enhancement, or Creation.”

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https://www.nwo.usace.army.mil/html/od-rwy/hydricsoils.pdf