NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

WETLAND RESTORATION

(Acre)

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 practice is applicable only where the natural hydrologic conditions can be approximated by actions such as modifying drainage, 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

All necessary local, state, and federal permits shall be obtained by the landowner (or representative) prior to the restoration.

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.

This practice may adversely affect cultural resources. Planning, installation and maintenance must comply with GM 420, Part 401, *Cultural Resources (Archeology and Historic Properties).*

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.

When the anticipated disturbance will be greater than or equal to one (1) acre, an erosion control permit must be obtained from the Vermont Agency of Natural Resources, Department of Environmental Conservation, Water Quality Division. The permit will require the development of an Erosion and Sediment Control Plan which must be followed throughout construction.

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

Domestic livestock will be excluded from the wetland, wetland buffer and erosion control areas.

Invasive species, federal/state listed noxious plant species, Vermont Invasive Plant Watch List, 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 agreed to by signed written letter, easement or permit.

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 and historic aerial photography 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.

The acceptable methods of restoring the hydrology of a site are: low embankments, depressions, ditch plugs and tile breaks.

Low embankment structures, depressions, ditch plugs and tile breaks shall be designed in accordance to this standard.

Criteria for Low Embankment Structures

Structures are considered low embankment if all the following apply:

1. The embankment does not cross a perennial stream.
2. The maximum height of fill, measured from the lowest point at the downslope toe of embankment to the top surface of the fill along the centerline of the embankment does not exceed six (6) feet.
3. Failure of the embankment will not result in: loss of life; damage to homes, commercial or industrial buildings, main highways, or railroads; or interruption of the use or service of public utilities.

General Criteria for low embankments structures shall be as follows:

1. The embankment top width will be a minimum of six (6) feet.
2. All drains shall be plugged according to the distances listed in Table 1. The plug shall be installed from downslope edge of the core trench if one is required or the centerline of the embankment extending upslope.
3. A core trench shall be provided under the embankment if more than two (2) feet of water is impounded.
4. Install anti-vortex devices, trash guards and beaver protection on water control structures as appropriate.
5. All vegetation and topsoil will be removed from the “foot print” of the embankment. The design height of the embankment shall be increased by the amount needed to insure that after settlement, the actual height of the embankment equals or exceeds the design height. The increase shall be not less than 5 percent.
6. Seeding of embankment shall be in accordance to Practice Standard 342 – Critical Area Planting.

Table 1 – Minimum Length of Drain to be Removed

Permeability (in/hr)	Soil Texture	Minimum Distance (feet)
> 2.0	Sand and Organics	75

0.6 to 2.0	Loam	50
<0.5	Clay	25

Additional Criteria for low embankment structures (see Table 2) where the contributing watershed is less than 50 acres and the drainage area average slope is less than 10 percent shall be:

1. The structure must safely pass a 10 year – 24 hour storm frequency. The earth embankment crest may serve as a service spillway where flows are infrequent enough to establish and maintain vegetation on the embankment. When frequent flows are anticipated, a water control structure or erosion resistant spillway shall be installed to help maintain and establish vegetation on the embankment.

Table 2. Embankment slopes and minimum auxiliary spillway capacity

Watershed			Min. design storm[1]	
Drainage Area (Acres)	Average Slope (%)	Embankment Slopes	Frequency (Years)	Minimum Duration (Hours)
≤ 50	< 10	5:1 or flatter	10	24
> 50	≥ 10	3:1 or flatter	25	24

1. Select rain distribution based on climatological region.

Additional Criteria for low embankment structures where the contributing watershed is equal to or greater than 50 acres and/or the drainage area average slope is equal to or greater than 10 percent shall be:

1. A spillway system shall be provided that includes a principal spillway and an auxiliary spillway. The principal spillway and the auxiliary spillway can be combined into a single erosion resistant spillway capable of handling the full design discharge. The combined spillway shall be designed to discharge the runoff from a 25 year – 24 hour storm event. For drainage areas less than 100 acres, the minimum pipe diameter will be 8 inches. For drainage areas equal to or greater than 100 acres, the minimum pipe size shall be 12 inches. A drainage diaphragm shall be used on all pipes larger than 12 inches in diameter. The drainage diaphragm shall be installed in accordance to Practice Standard 378 – Pond. Animal guards will be installed on all pipes less than 12 inches in diameter.
2. When the principal and auxiliary spillways are separate, the auxiliary spillway crest will be set 0.5 feet above the crest of the principal spillway. No freeboard is required between the elevation of the peak discharge in the auxiliary spillway and the embankment crest if the downstream embankment slope is 5 horizontal to 1 vertical or flatter. Otherwise, a freeboard of 0.5 feet is required between the elevation of the peak discharge and the crest of the top of embankment. The auxiliary spillway shall be designed to be stable.

For sites with favorable storage conditions, the 25 year peak discharge may be flood routed to reduce the size of the auxiliary spillway.

When the spillway is vegetated it will be located in natural, undisturbed soil. Rock lined spillways will have geotextile installed prior to placing riprap.

The standards and specification for Dike (356), Structure for Water Control (587), Pond (378), and Wetland Wildlife Habitat Management (644) will be used as appropriate. Refer to Engineering Field Handbook, Chapter 13, “Wetland Restoration, Enhancement, and Creation”, and Chapter 6, “Structures” for additional design information.

Water control structures that may impede the movement of target aquatic species or species of concern shall meet the criteria in Fish Passage, Code 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 Depressions

Undisturbed wetland systems typically consist of complexes that contain a diversity of topographic

relief with wet depressions and upland islands. When wetlands are drained or altered, they normally lose most of their micro and macro topographic relief through land leveling or other agricultural activities. The following criteria will be used to establish wet depressions within the wetland restoration project area. Refer to *Using Micro and Macrotopography in Wetland Restoration*, Indiana NRCS Biology Technical Note 1 for additional information.

1. If original conditions cannot be determined from historical aerial photography or other sources, depression size, depth, shape and density should be based upon conditions existing in reference wetlands. This may include oxbows and other depressional areas typical of floodplain forests. Unless original conditions indicate otherwise, depressions will have varying depth with a maximum of 4 feet of excavation. A minimum of 2/3 of the surface area of the constructed depression will have varying depths from 6 inches to no more than 18 inches.
2. Depression side slopes will be gentle with a minimum of 50% of side slope area being graded to 6:1 (6 horizontal to 1 vertical) or flatter. The remaining side slope area will have to be 3:1 or flatter.
3. Depressions will be irregular in shape to maximize edge effect and provide additional cover for waterfowl, amphibians, reptiles and other wetland dependent species utilizing the site.
4. Surface drainage into the depression will be maintained.
5. When depressions are connected by meander channels; the channels shall have:
    - minimum excavated depth of 1 foot,
    - maximum depth that is 1 foot less than that of the pothole,
    - side slopes not steeper than 3:1.

Criteria for Subsurface Drain Removal or Destruction

In areas where subsurface drains were installed to remove surface and/or subsurface water, the existing system will be modified to restore the wetland hydrologic condition.
Review of design records, interviews, and site investigations will be needed to determine the extent of the existing system.

The effect of a subsurface drainage system will be eliminated by the following:

1. remove and render inoperable a portion of the drain at the downstream edge of the site.
2. modify the drain with a water control device; or
3. replace the drain with non-perforated pipe through the wetland site.

The minimum length of drain to be removed or rendered inoperable shall be as shown in Table 1.

If needed, the ends of the disturbed drain shall be capped and buried to keep sediment and rodents from entering the drain.

Provisions shall be made to maintain drainage system integrity both upstream and downstream of the wetland as necessary.

Bedding, filtering and/or flow enhancing material will be removed if necessary. The resulting trench shall be filled with compacted earth to a density of the adjacent soil.

Criteria for Surface Drain Removal (Ditch Plug)

Where surface drains were constructed to drain wetlands, the drain can be plugged with earth to restore the wetland hydrology. A water control structure may be used to manipulate water levels for vegetation management.

The installation of a plug shall not cause accelerated erosion or flooding. Flow water shall be diverted around the ditch plug on vegetated undisturbed soil, or flow over the ditch plug in areas reinforced with geotextile and stone, or through an erosion resistant water control structure.

All fill shall be earth compacted to the approximate density of the adjacent soil material.

The height of the plug shall be at least 1 foot higher than the low bank of the ditch. The maximum

plug height from ditch bottom shall be 6 feet.

The width of the plug shall be at least two times the channel top width, measured perpendicular to the flow.

The length of the plug shall be at least 20 feet measured parallel to the ditch flow direction.

All slopes shall be 5 to 1 or flatter.

Increase fill height to compensate for settling. A minimum of 5 percent for mineral soils and 33 percent for organic soils shall be used.

When appropriate, the ditch can be filled along the entire extent, or along some portion of its extent. Ditch filling should always commence from the upslope end and then downstream from that point.

The ditch plug and all disturbed areas shall be seeded according to Practice Standard 342 – Critical Area Planting.

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. Refer to *Wetland, Woodland, Wildland – A Guide to the Natural Communities of Vermont* and comparison soils guide to determine likely plant composition of the wetland to be restored. Document natural communities and plant composition in nearby natural wetlands in similar landscape position to further support the vegetation restoration plan. Species and habitats of concern should be considered when developing vegetation restoration plans.

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. Tree and/or shrub planting (by seed, shoot, or seedling) and site preparation will follow Practice Standard 612 – Tree/Shrub Establishment. It is expected that for wildlife purposes, planting density and stocking rates will generally be lower than for production purposes, and that the selection of species will generally be different than species for production purposes.

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.
- When drawdowns or impounding are most beneficial for a given focus plant or animal species.

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.
- Biological control of undesired plant species and pests (eg. using predators or parasites species) shall be implemented where available and feasible.

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

All projects will have a Wetland Restoration Plan developed that uses the approved Vermont template. This template includes goals and objectives, current site conditions, historic site conditions, species and habitats of special concern, targeted natural communities, planned practices, management considerations, and monitoring requirements. Plans and specifications for this practice shall be prepared for each site. Plans and specifications shall be recorded 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.
- Water control structures will be managed to benefit target plants and animal species.

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