NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

CONSTRUCTED WETLAND

(Ac.)

CODE 656

DEFINITION

An artificial ecosystem with hydrophytic vegetation for water treatment.

PURPOSE

For treatment of wastewater and contaminated runoff from agricultural processing, livestock, and aquaculture facilities; or

For improving the quality of storm water runoff or other water flows lacking specific water quality discharge criteria.

CONDITIONS WHERE PRACTICE APPLIES

- Constructed wetlands for the purpose of wastewater treatment apply where a constructed wetland is a component of an agricultural wastewater management system.
- Constructed wetlands for the purpose of water quality improvement apply where wetland effluent is not required to meet specific water quality discharge criteria.

This standard should not be used in lieu of NRCS Conservation Practice Standards (CPS) Wetland Restoration (657), Wetland Creation 658, or Wetland Enhancement (659), when the main purpose is to restore, create, or enhance, wetland functions other than wastewater treatment or water quality improvement.

CRITERIA

General Criteria Applicable to All Purposes

Locate the wetland to minimize the potential for contamination of ground water resources, and to protect aesthetic values.

Provide appropriate inlet control structures to prevent debris from entering the wetland, to control the rate of inflow during normal operations, and to control inflow as necessary for operation and maintenance.

Provide an outlet control structure capable of maintaining appropriate water depths to achieve the desired water treatment, and to meet the requirements of the hydrophytic vegetation.

The minimum height of interior embankments shall contain the design water depth and a sufficient depth for the accretion of settlable solids, decayed plant litter, and microbial biomass. In the absence of an accretion rate analysis, the minimum depth for accretion shall be one inch per year for either the design life of the practice or between scheduled debris and sediment removal maintenance operations.

Provide an auxiliary spillway or inlet bypass with sufficient capacity to pass the peak flow of the 25-year frequency, 24-hour duration storm and provide erosion protection for the perimeter embankment.

Unless otherwise specified, the spillway requirements, embankment configurations, excavated side slopes, protective cover on disturbed soils, and disposal of excavated material shall comply with the general criteria, criteria for embankment ponds, and criteria for excavated ponds as appropriate as contained in NRCS CPSPond (378).

Soils used in constructing the embankment shall be suitable for that purpose according to the Unified Soil Classification System.

Use a planting medium that has a cation exchange capacity, pH, electrical conductivity, organic matter, and textural class that is

conducive to wetland plant growth and retention of contaminants.

Select wetland plants that are suitable for local climatic conditions and tolerant of the concentrations of nutrients, pesticides, salts and other contaminants flowing into the wetland. Do not use invasive or non-native species that could be a problem in native habitats.

Provide supplemental water as necessary to establish and maintain plants in a condition suitable for the water treatment purpose.

Criteria Applicable to Wastewater Treatment

Locate outside the boundary area of natural wetlands of any classification.

Constructed Wetlands shall not be located within the 100-year floodplain unless the structure is protected from inundation and damage that may occur during the 100-year flood event. For a structure to be protected from inundation, the lowest part of the top of the storage structure shall be at least 1 foot above the water surface elevation of the 100-year flood.

The water surface elevation of the 100-year flood can be determined by using Federal Emergency Management Agency (FEMA) 100-year floods, U.S. Geological Survey (USGS) 100-year flood prone maps, and/or completing a hydrologic and hydraulic analysis. If no FEMA or USGS 100-year flood delineation is available for the location of the waste storage structure, the 100-year flood elevation must be determined by completing a hydrologic and hydraulic analysis.

To determine the 100-year flood elevation using a hydrologic and hydraulic analysis, a 100-year flow must first be estimated by using USGS published peak-flow 100-year frequency estimates, using USGS flow-frequency regression equations, or utilizing a rainfall runoff model. If using a rainfall runoff model, a 100-year frequency, 24-hour duration storm peak flow estimate shall be determined. Manning's equation or a step-backwater program such as Hec/Ras must then be used to determine the 100-year flood elevation corresponding to the 100-year flow estimate.

Pretreat water flowing to the wetland to reduce the concentrations of solids, organics, and nutrients to levels that will be tolerated by the wetland system and to prevent excessive accumulation of solids within the wetland.

Provide sufficient storage upstream of the wetland to contain the wastewater and runoff from a 25-year frequency, 24-hour duration storm. The outlet of this storage shall deliver the water to the wetland at a rate consistent with the treatment objectives of the wetland.

Design the wetland system with a minimum of two rows of functionally parallel cells.

Determine the surface area using design procedures in NRCS National Engineering Handbook (NEH), Part 637, Chapter 3, Constructed Wetlands, or alternative design procedures that are recognized by the regulatory and academic conservation partners in the state.

Construct wetland cells with a sufficient length-to-width ratio to assure uniform and predictable hydraulic retention times.

Control seepage as necessary for similar wastewater management facilities.

Exclude livestock from the wetland.

Criteria Applicable to Water Quality Improvement

When located in a floodplain or watercourse provide protection from damage from a 10-year frequency flood event.

When used to improve the water quality of surface water runoff, design the wetland so that it will return to design operating levels within 72 hours after a 10-year frequency, 24-hour duration storm event.

When used in populated areas install safety fences and warning signs forbidding access by unauthorized persons.

Provide an adequate access for cleanout and maintenance.

CONSIDERATIONS

Consider the impact a constructed wetland could have on existing wetlands or other significant features in the landscape ecosystem.

Consider bat boxes, mosquito fish, and other measures to control vectors and nuisance insects when locating the wetland near residences, commercial buildings, and public use areas.

Consider seasonal storage of contaminated water upstream of the wetland during cold, dry, or excessively wet climatic conditions when the function of the wetland may be compromised.

Effluent from the wetlands may be stored for land application, recycled through the wastewater management system, or otherwise used in the agricultural operation.

Measures for controlling seepage may be designed according to the procedures in NRCS NEH, Part 651, Agricultural Waste Management Field Handbook, Appendix 10d, "Geotechnical Design and Construction Guidelines."

Where wetland performance may be compromised by large, infrequent storm events, consider providing an inlet that captures the first flush of storm water runoff and allows excess flow to bypass the wetland.

Consider a sedimentation basin, and reaches of shallow and deep water within the wetland.

Provide inflow and outflow structures and cell geometries that promote cross-sectional mixing of water flowing through the wetland cell.

Consider the potential of pollutants entering the wetland that may cause environmental problems due to accumulation, biological uptake, or release during maintenance operations.

When selecting vegetative species, give priority to native wetland plants collected or grown from material within the Major Land Resource Area (MLRA) of the constructed wetland location, and consider the potential to transport chemical contamination from the wetland plant site to the constructed wetland.

Select plant materials that provide habitat requirements for desirable wildlife and pollinators. The addition of native forbs and legumes to grass mixes will increase the value of plantings for both wildlife and pollinators.

Fences or other measures may be needed to exclude or minimize access of humans or animals that could be adversely affected by the constructed wetland or that would inhibit its function.

Consider access for animals that might be attracted to the wetland, and egress for fish that could be entrained and trapped. Flatter side slopes generally provide better habitat for wildlife. If there is a desire to use the constructed wetland for wildlife habitat, consult NRCS CSs, Wetland Restoration (657), Wetland Enhancement (659), Wetland Creation (658), Wetland Wildlife Habitat Management (644), and Shallow Water Development and Management (646).

Consider providing embankment protection against burrowing animals.

Consider vegetative buffers (herbaceous and woody) around the perimeter of constructed wetland for additional filtering of pollutants entering and leaving wetland areas during precipitation events.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for each specific field site where a constructed wetland will be installed. Define the purpose, goals, and objectives of the practice and the soils, hydrology and vegetation criteria. Include information about the location, construction sequence, and vegetation establishment.

Specifications shall include:

- Dimensions of the constructed wetland;
- Species selection;
- Seeding rates, sprigging rates or planting density of containerized plants;
- Planting dates, care and handling of the seed to ensure that planted materials have an acceptable rate of survival;
- Site preparation such as stabilizing crop, mulching, or mechanical means of

stabilizing, fertilizer, and pH adjustment sufficient to establish and grow selected species.

OPERATION AND MAINTENANCE

- Develop an operation and maintenance plan that is consistent with the purposes and intended life of the practice. Include the requirements for safety, water management, cleanout of sediment, maintenance of structures, embankments, and vegetation, control measures for vectors and pests, and containment of potential pollutants during maintenance operations.

Operational requirements include:

- Maintenance of water level in wetland cells appropriate for vegetation;
- Control flow to wetland according to water budget;
- Monitoring of wetland performance;
- Sampling effluent for nutrients prior to utilization;
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- Surveillance of inlet and outlet.

Maintenance requirements should include:

- Repair of embankments;
- Control density of desirable vegetation;
- Removal of invasive and/or non-native species that could be a problem in native habitats;
- Repair of fences or other ancillary features;
- Replacement of wetland plants;
- Repair of pipelines and spillways;
- Control of unwanted animals (varmints) or vectors (mosquitoes).

REFERENCES

- USDA, NRCS. National Engineering Handbook, Part 637, Chapter 3. Constructed Wetlands.