

NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD

**CONSTRUCTED WETLAND**

(No.)

**CODE 656**

**DEFINITION**

A constructed shallow water ecosystem designed to simulate natural wetlands.

historically was not a wetland, or was a wetland with a different hydrology, vegetation type, or functions that occurred naturally on site.

**PURPOSES**

To reduce the pollution potential of runoff and wastewater from agricultural lands to water resources

**CRITERIA**

**General Criteria Applicable to All Purposes**

**CONDITIONS WHERE PRACTICE APPLIES**

- Where a constructed wetland is a component of a planned conservation system or agricultural waste management system;
- Where wastewater or runoff originates from agricultural lands including livestock or aquaculture facilities;
- Where a constructed wetland can be constructed, operated and maintained without polluting air or water resources;

This practice does not apply to: wetland restoration (657) intended to rehabilitate a degraded wetland where the soils, hydrology, vegetative community, and biological habitat are returned to original conditions; wetland enhancement (659) intended to rehabilitate a degraded wetland where specific functions and/or values are enhanced beyond original conditions; or wetland creation (658) for creating a wetland on a site location which

**Laws and Regulations** - All federal, state, and local laws, rules and regulations governing the use of constructed wetlands must be followed. Constructed wetlands for waste treatment shall not be designed to discharge to waters of the state unless permitted by state laws and regulations, and appropriate permits have been obtained to do so. In addition, if discharge is permitted, the receiving surface water must have the capacity to assimilate the constructed wetland's effluent during low flow periods.

**Location** - Constructed wetlands shall be located outside the limits of wetlands of any classification

Constructed wetlands located within a floodplain shall be protected from inundation or damage from a 25-year flood event, or larger, if required by laws, rules, and regulations.

Constructed wetlands shall be located to provide sufficient separation distances from structures such as residences and

commercial buildings so prevailing winds and landscape elements such as building arrangement, landforms, and vegetation will minimize odors and protect aesthetic values. They shall be located with a separation distance that will minimize the potential for contamination of ground water resources. This distance shall be in accordance with laws, rules and regulations.

**Type** - Constructed wetlands shall be designed as surface flow systems consisting of adequate seepage control, a suitable plant medium, rooted emergent hydrophytic vegetation, and the structural components needed to contain and control the flow.

**Influent** - The influent to the constructed wetland shall be pretreated to reduce the concentrations of solids, organics, and nutrients to levels that will be tolerated by the wetland system and not cause excessive accretion within the wetland.

Where significant sediment and organic debris are expected in the wastewater or runoff to be treated, provisions for its removal before entry into the wetland must be provided.

**Water budget** - A water budget that evaluates runoff or wastewater volumes, precipitation, evaporation, and water use shall be used to determine the required hydraulic retention time in the wetland and storage requirements of the wetland pretreatment and post treatment facilities when included.

**Embankment** - The perimeter embankment shall have a minimum top width of 10 to 15 feet. Interior embankments shall have a minimum top width of 8 feet. If site conditions or owner preference result in a narrower top width, the Operation and Maintenance plan must reflect the additional effort required for vegetation maintenance and embankment repair. All embankment side slopes shall

be a minimum of a 2 horizontal to 1 vertical.

**Vegetation** - Vegetation selected for the constructed wetland shall be hydrophytic plants suitable for local climatic conditions and tolerant of the concentrations of nutrients, pesticides, and other constituents in the runoff or wastewater stream and selected for their treatment potential. Preference shall be given to native wetland plants with localized genetic material. Plant materials collected or grown from material collected within the same Major Land Resource Area (MLRA) are considered local.

**Planting medium** - The soil used for the planting medium shall have a cation exchange capacity, pH, electrical conductivity, soil organic matter, and textural class that is conducive to wetland plant growth and retention of contaminants.

**Seepage control** - The constructed wetland shall be located in soils with an acceptable permeability that meets all applicable regulations, or it shall be lined. Measures for controlling seepage shall be designed according to the procedures of NEH Part 651, Agricultural Waste Management Field Handbook, Appendix 10d, "Geotechnical Design and Construction Guidelines."

Livestock shall be excluded from the wetland.

#### **Additional Criteria for Wetlands Constructed for Waste Treatment**

**Topography** - Site topography shall accommodate the requirements for length to width ratios of the wetland and the wetland cells, and the requirement that the wetland cells be level side to side with grades of less than 0.05 ft/ft lengthwise.

**Inlet** - An inlet structure that will allow control of flow discharged to the wetland

and screening of influent to prevent debris from entering the wetland shall be provided. Design of the inlet structure shall assure its function throughout the life of the wetland considering accretion.

**Influent** - Constructed wetlands for wastewater treatment shall not allow for direct inclusion of contaminated and/or uncontaminated runoff.

Wastewater will be of sufficient volume and duration to keep the constructed wetland moist at all times or accommodations shall be made for the addition of supplemental water.

**Surface Area** - The surface area of the wetland shall be determined using a recognized design procedure (the presumptive method or the field-test method) in consideration of loading, temperatures, and the desired level of treatment.

The presumptive method is used when the pretreatment system has not yet been installed or for some other reason, the BOD5 of the wastewater cannot be determined. The field-test method is used when the BOD5 concentration can be adequately measured. If the field-test method is used, multiple tests must be taken over a considerable period to determine the extremes of the concentration of wastewater contaminants. If the wetland is being designed to remove ammonia, it would need a longer retention time since ammonia requires a longer residence time than BOD5 for removal.

**Configuration** - The constructed wetland shall have an overall length to width ratio of 1:1 to 4:1. Individual cells within the constructed wetland shall have a length-to-width ratio of 10:1 to 15:1. The wetland shall consist of at least two rows of parallel cells

**Flow depth** - The design depth shall be based on the most severe season of operation, the desired level of treatment, and the required littoral zone of the plant species being used. The design depth shall be a minimum of 0.33 ft. and a maximum of 1.5 ft.

**Embankments** - Height of the constructed wetland perimeter embankment shall be the sum of the following:

- Design depth
- Wetland accretion -- a minimum of 1 inch per year for the design life
- 25-year, 24-hour precipitation
- 12 inches of freeboard

The height of wetland's interior embankments shall be the minimum of the sum of the following:

- Normal design flow depth
- Wetland accretion -- minimum of 1 inch per year for the design life

**Overflow Device** - An ungated overflow device shall be provided to operate when the 25-year, 24-hour precipitation is exceeded. The overflow device shall operate without infringing on the wetland perimeter embankment's freeboard.

**Outlet** - Constructed wetlands will discharge to storage facilities to allow for land application or recycled through the waste management system unless federal, state and local regulation allow discharge to waters of the state.

An outlet structure shall be provided that allows maintenance of proper water level in the wetland and controls the flow from the wetland.

### **Additional Criteria for Wetlands Constructed for Runoff Treatment**

**Design Storm** - The constructed wetland system shall be designed to contain a 2-year storm runoff. Limited area sites handling only the “first flush” volume shall have a minimum capacity to store 0.5 inch of runoff volume from the entire drainage area. When less than full runoff is stored, bypass of the excess storm flow shall be provided.

**Detention time and surface area** - The detention time and surface area shall be calculated on the time required to achieve the required level of treatment based on the limiting contaminant present.

**Wetland Cells** - Length-to-width ratios are to be 4:1 to 10:1. Other dimensions and shapes that provide a more natural landscape appearance that meet treatment requirements can be used.

**Dikes** - The standard for Dike (356) shall be used as appropriate. Refer to the Engineering Field Handbook, Chapters 13, “Wetland Restoration, Enhancement, and Creation,” and 6, “Structures,” for design information. Existing drainage systems will be utilized, removed, or modified as needed to achieve the intended purpose.

**Depth** - Maximum water depth shall be 24 inches except in those instances where deep water areas are included as a special design.

**Outlet** - A water control structure to automatically regulate storage release in accordance with the design detention time shall be installed.

### **CONSIDERATIONS**

#### **Advantages**

1. Provides a high level of treatment - Properly designed, constructed, maintained and managed wetlands can provide very efficient treatment of animal wastewater. Test results show

that phosphorus, nitrate-nitrites, ammonia, BOD5 and suspended solids can be reduced to very acceptable levels.

2. Is inexpensive to operate - A constructed wetland requires little, if any, energy use and equipment needs are minimal. A well-designed wetland transfers water by gravity through the system. If topography limits the use of gravity, pumps will be necessary which increases the cost of operation. Once established, properly designed and constructed wetlands are largely self-maintaining.
3. Can be relatively inexpensive to construct - Each constructed wetland's design is site specific, taking into consideration such variables as topography, water supply, soil types, type of livestock operation, etc. Selection of a site with accommodating specifications keeps establishment costs low.
4. Reduces, if not completely eliminates, odor - Odor is a serious problem when handling and treating animal wastewater, especially if the farming operation is located in close proximity to residential housing.
5. Is able to handle variable wastewater loadings. Properly designed wetlands have shown great tolerance for varying amounts of wastewater loading. This is important because varying livestock production levels, changing climatic conditions, and modifications in management can alter loading rates significantly.
6. Reduces the land area needed for application of wastewater. Constructed wetlands reduce the concentration of

contaminants. Thus, the land area needed for application of water from a constructed wetland is less than the land area needed for direct application of wastewater.

7. Can be aesthetically pleasing. Depending upon design, location, and type of vegetation, constructed wetlands can enhance the landscape with color, texture, and variety in plant materials.

### **Limitations**

1. Requires a continuous supply of water. One of the most important factors in the success of a constructed wetland is the supply of water. In addition to the wastewater to be treated, supplemental water will have to be added if the wastewater supply is not sufficient to sustain plant populations during dry periods.
2. Can be relatively expensive to construct - just as a desirable topography and other natural factors such as soil type can make a constructed wetland inexpensive to build; undesirable land features increase construction costs. Changing the lay of the land, adding soil amendments, and/or liners, incorporating pumps, etc. increases the cost of building a wetland significantly.
3. Is affected by seasonal weather conditions, which may reduce treatment reliability - Seasonal weather conditions, such as cold and drought, reduce the efficacy of the system. Consider fluctuations in weather when designing and operating the wetland.

4. Supplemental clean water is required for the start-up phase of the wetland.
5. Wetlands do not necessarily become functional overnight and several years may elapse before performance reaches optimum levels.
6. Can be destroyed by an overload of solids or ammonia levels - A wetland can fill in with solids or flow patterns can be seriously disrupted when the design does not allow for the removal of solids before the wastewater enters the constructed wetland. High ammonia levels over time will destroy the plant life in the wetland.
7. Removes nutrients for use by crops - Nutrients removed by the wetland system are not available for land application and crop production.

### **Additional Considerations**

Locate constructed wetlands downgrade and as near the source of wastewater as practical.

Install measures to exclude or minimize attractiveness of the constructed wetland to wildlife that could be adversely affected by the constructed wetland. Take measures to exclude burrowing animals should they frequent the wetland. Consider the use of fences as an exclusion measure.

Recycle constructed wetland effluent back through the agricultural waste management system when practical.

In northern cold climates consideration should be given to storage of wastewater during winter months instead of wetland operation.

Add additional height to embankments to accommodate accumulated ice when

constructed wetlands are used in cold climates.

### **Cultural Resources Considerations**

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

### **Endangered Species Considerations**

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California

Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

### **Water Quantity**

1. Effects on the water budget, especially effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, on farm uses and ground water recharge.
2. Variability of effects often seasonal and weather variations.

### **Water Quality**

1. Effects of both growing and decaying vegetation or nutrients balance in the root zone.
2. Effects on erosion and the movement of sediment, pathogens, organic material, and soluble and sediment-attached substances carried by runoff.
3. Sediment-attached and construction-related effects on the quality of onsite downstream watercourses and impoundments.
4. Effects on wetlands and water related wildlife habitats.

### **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. Plans shall include construction sequence, vegetation establishment, and management and maintenance requirements.

## 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.

Operational requirements should 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;
- Surveillance of inlet and outlet.

Maintenance requirements should include:

- Repair of embankments;
- Control of vegetation;
- Repair of fences or other ancillary features
- Replacement of wetland plants;
- Repair of pipelines;
- Control of unwanted animals (varmints) or vectors (mosquitoes).

## REFERENCES

Davis, L. A Handbook of Constructed Wetlands: a guide to creating wetlands for: agricultural wastewater, domestic wastewater, coal mine drainage, stormwater in the Mid-Atlantic region, Volume 1: general considerations. USDA-NRCS, U.S. EPA--Region III, and PA. Dept. of Environmental Resources, <http://www.epa.gov/owow/wetland/pdf/hand/pdf>

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