Constructed Wetland

Conservation Practice Fact Sheet 656

Definition

A constructed wetland is a strip or area of herbaceous vegetation that removes contaminants from overland flow.

Figure 1. Cattails in a nearly mature wetland established by transplanting of rhizomes

Purpose

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

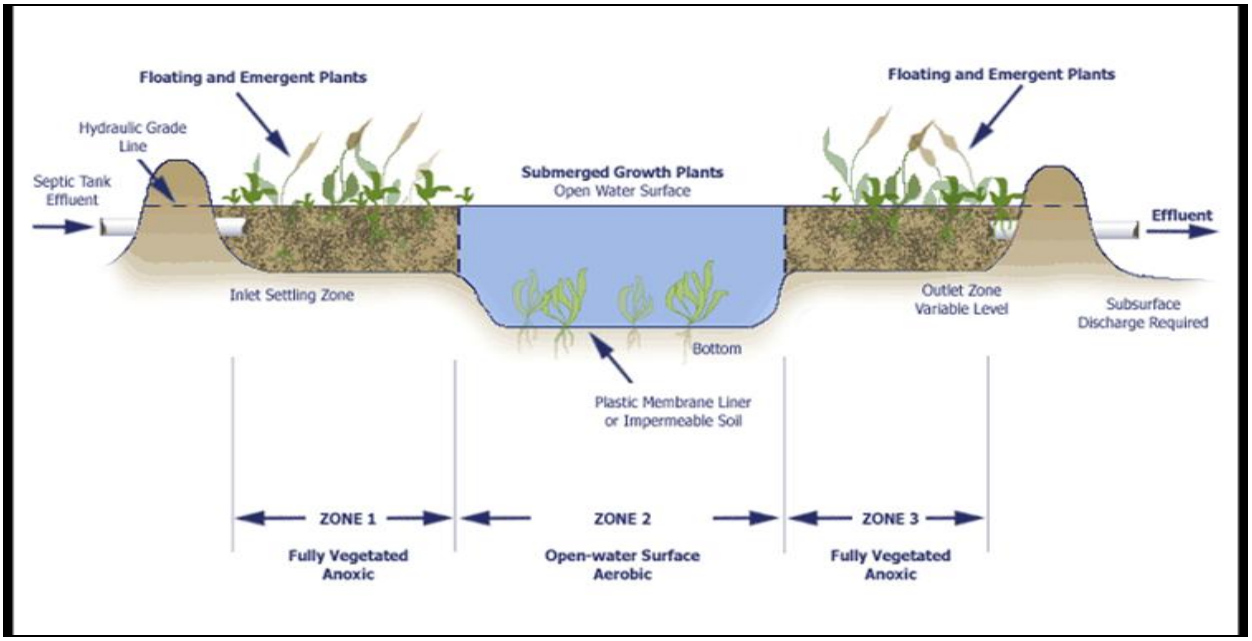
For improving the quality of storm water runoff or other water flows lacking specific water quality discharge criteria.

Condition where practice applies:

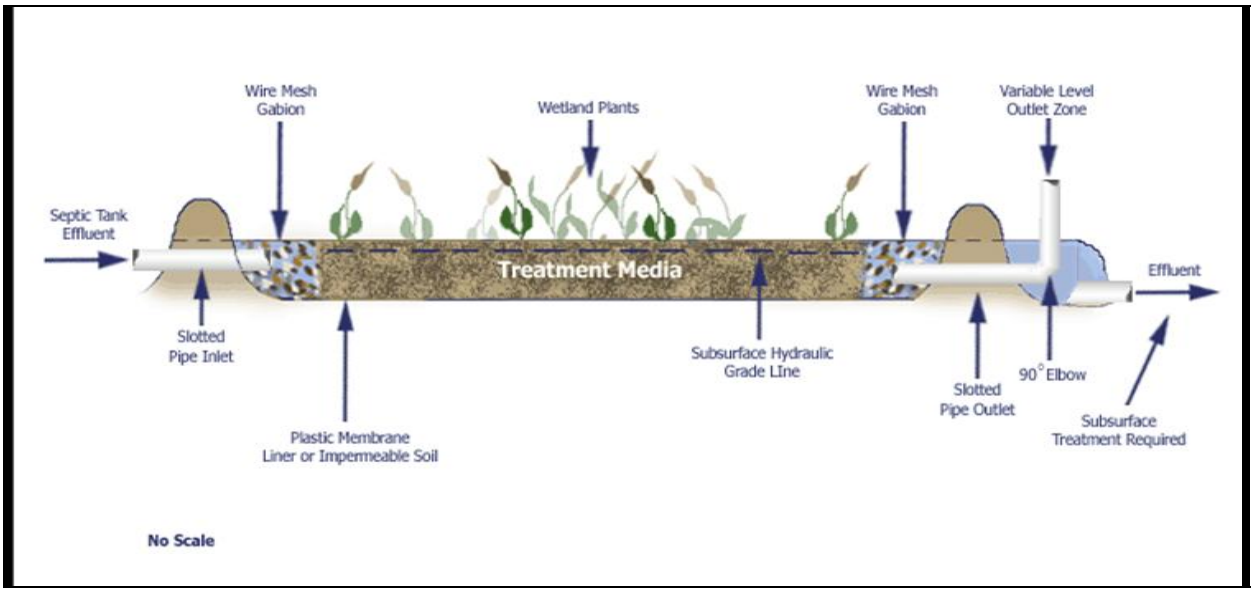
- Constructed wetlands for the purpose of wastewater treatment apply where a constructed wetland is a component of an agricultural wastewater management system. (i.e. Figure 2)

Typically two cells are constructed. Wastewater flows through a pipe from a collection basin into the constructed wetlands. Wastewater is distributed evenly across the width of the wetland cell and flows through a gravel medium. A waterproof liner is used in the first cell to contain the wastewater and assure adequate water levels for the wetland plants. The first cell is planted with wetland plants. From the first cell, wastewater enters a second cell that acts as a disposal area.

As wastewater flows through the system, suspended solids and trace metals settle and are filtered. Plants and organic materials also absorb nutrients and trace metals. Microbes and other organisms accumulate on the gravel surfaces, stems, and roots of the wetland plants and use the organic materials and nutrients from the wastewater as food. Plants provide much of the oxygen needed by the organisms to live and grow.



Free Water Surface constructed wetlands (FWS)



Vegetated Submerged Bed constructed wetlands (VSB)

Figure 2. Constructed lined wetland cell for the treatment of wastewater

- Constructed wetlands for the purpose of water quality improvement apply where wetland effluent is not required to meet specific water quality discharge criteria. (i.e. Figure 3)

To function, the wetland must be designed to create a shallow basin of soil, plants, water and detritus that collectively remove several types of pollutants through physical, chemical and biological processes. These processes all occur naturally and are only enhanced by design. Sedimentation is the dominant removal process for particulate pollutants operating within a storm-water treatment wetland. Sheet flow conditions across the wetland reduce runoff velocities. In addition, hydraulic resistance and physical filtration are supplied by the vegetation, which enhances sediment removal. The root network of the plants helps secure sediments, reducing the potential for resuspension. A second removal process is the adsorption of pollutants to the surfaces of bottom sediments, wetland vegetation and organic detritus. Adsorption is a key removal process for phosphorus, trace metals and certain hydrocarbons.

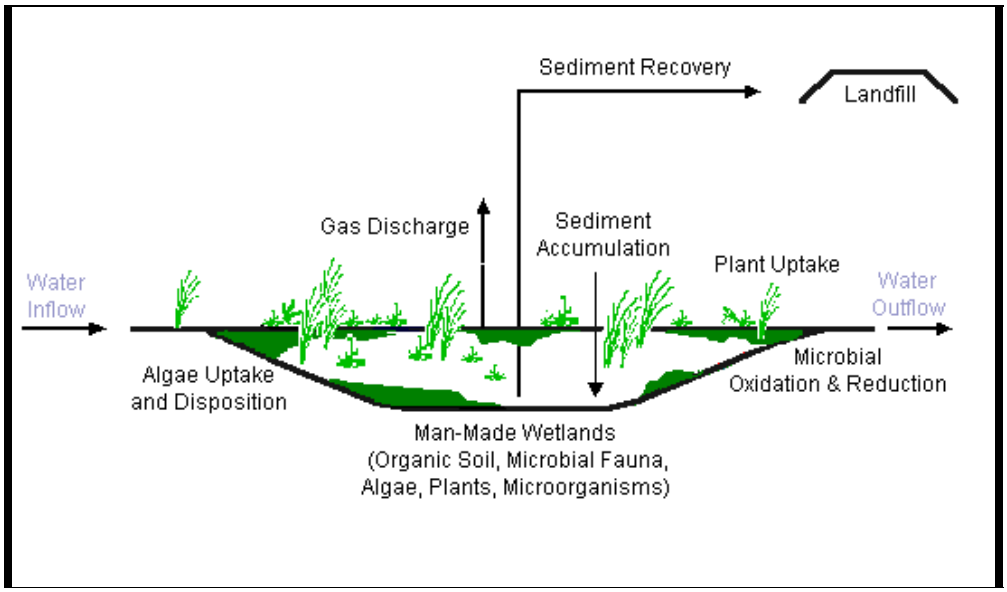


Figure 3. Constructed wetlands for water quality improvement

General Criteria

The wetland shall be located to minimize the potential for contamination of ground water resources, and to protect aesthetic values.

Appropriate control structures must be used 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.

An outlet control structure capable of maintaining appropriate water depths shall be used to achieve the desired water treatment, and to meet the requirements of the hydrophytic vegetation.

The 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. The minimum depth for accretion shall be 1 inch per year for either the design life of the practice or between scheduled debris and sediment removal maintenance operations.

A planting medium shall be used that has a cation exchange capacity, pH, electrical conductivity, organic matter, and textural class that are conducive to wetland plant growth and retention of contaminants.

Wetland plants shall be selected 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.

Considerations

- Consider the impact a constructed wetland could have on existing wetlands or other significant features in the landscape ecosystem.
- Install bat boxes, mosquito fish, and other measures to control vectors and nuisance insects.
- Consider a sedimentation basin, and reaches of shallow and deep water within the wetland.
- Select inflow and outflow structures and cell geometries that promote cross-sectional mixing of water flowing through the wetland cell.
- 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.
- 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 structural features for animals and wildlife that might be attracted to the wetland, and egress for fish that could be entrained and trapped.
- Consider providing embankment protection against burrowing animals.
- Consider vegetative buffers (herbaceous and woody) around the perimeter of the constructed wetland for additional filtering of pollutants entering and leaving wetland areas during precipitation events.

Plans and Specifications

Plans and specifications will be prepared for each specific field site where a constructed wetland will be installed.

Vegetative specifications will include:

- 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

<u>Operational requirements include</u>:

a. Maintenance of water level in wetland cells appropriate for vegetation

b. Control flow to wetland according to water budget

c. Monitoring of wetland performance

d. Sampling effluent for nutrients prior to utilization

e. Surveillance of inlet and outlet operations

<u>Maintenance requirements should include</u>:

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

REFERENCES:

"Special Constructed Wetlands Project in South Carolina", Surrency, D. 1999, USDA-NRCS Georgia Plant Materials Specialist, Athens, GA

"Constructed Wetlands for Urban Stormwater Management", Donald Surrency, Plant Materials Specialist USDA-NRCS, Athens, GA

"Treatment of Agricultural Waste by use of Constructed Reed-bed Wetlands", 2003 Department of Chemistry, Univ. of GA

"Using Constructed Wetlands for Removing Contaminants from Livestock Wastewater", Kenneth D. Simeral, Associate Professor, Ohio State University

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