

Activity: Constructed Wetlands	STP-04
<p>Design and Sizing Considerations</p> <ul style="list-style-type: none"> ➤ These systems should be designed by a licensed professional civil engineer. ➤ Suitable soils for wetland vegetation. <ul style="list-style-type: none"> ➤ Surface area equal to at least 1% and preferably 2% of the tributary watershed. Surface area greater than about 1 or 2% of the tributary watershed is not justified, given the uncertainty of any improvement in performance with the increase in size. ➤ A Forebay, baffle box, or other stormwater quality inlets are often required to remove floatable debris and coarse sediments. ➤ The simplest form of a constructed wetland includes a basin with a forebay and wetland vegetation area. The deeper forebay (3 to 6 feet) traps floatables and the larger settleable solids, facilitating maintenance as well as protecting the wetland vegetation. Alternatively, a detention pond may be placed before the wetland, to remove settleable solids and to protect the wetland from extreme increases in water elevation. The wetland vegetation is placed in a shallow pool that extends laterally across the basin. Construction of low flow channels through emergent vegetation can cause stormwater to short circuit through channels rather than through the wetland vegetation. ➤ Placing rooted wetland species through the majority of the facility adds to the cost, in comparison to a wet pond. However, it is believed by many practitioners that the vegetation improves performance. Placing the vegetation across the facility improves settling of particulates and uptake of dissolved contaminants. As the constructed wetland is shallower than a wet pond, there may be better contact between the water and soil which may be the primary remover of dissolved phosphorus and metals. ➤ The vegetation reduces the effect of wind which can cause significant short-circuiting in a wet pond. Water loss in a wetland may not be greater and possibly less than a wet pond. Evapo-transpiration from the plants will be greater in a wetland but evaporation from the water surface may be less because the dense vegetation eliminates the effect of the wind. The net result may be a slower rate of water loss. Conceivably a constructed wetland could be made smaller than a wet pond, given the benefits of the vegetation. ➤ Relying on volunteer plants to cover the vegetated area will delay complete coverage for several years and may allow the invasion of undesirable species or dominance by one or two species such as cattails which tend to flourish in disturbed conditions. Complexity is promoted by varying water depth through the vegetated area rather than keeping the depth uniform. ➤ Using gravel as the substrate may be a suitable approach in small facilities. Because the gravel is lacking in nutrients certain emergent species will take their nutrients from the water (Thut, 1988). See Reddy and Smith (1988). Harvesting may also be more practical with this approach. 	

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Design and Sizing Considerations (Continued)

- Of particular concern in many areas will be mosquitoes. Thick stands of emergent vegetation provide an ideal breeding habitat. If *Gambusia* (mosquito fish) are introduced into the facility the design must include a deep pool area where the fish can reside during the dry season. The forebay can serve this function.
- The facility can be sized using the same procedure outlined for Wet Detention Ponds, STP-02. However, inasmuch as a wetland is shallower than a wet pond, sizing the wetland for the same V_b/V_r as a wet pond requires considerably more surface area. Given the likely advantages of a constructed wetland over a wet pond, some may consider this to be an unreasonable penalty. It is therefore recommended that the surface area of the constructed wetland not exceed that which would be determined for a wet pond.
- Additional design considerations include:
 - Have 25% to 50% (forebay and afterbay) 3 to 6 ft. deep, and remaining area 6 in. to 24 in. deep or as appropriate for the wetland species selected. This geometry should provide satisfactory conditions for wetland wildlife (Adams et al., 1983).
 - Side slopes of at least 4:1 (H: V) to a water depth of 2 ft. except on very small facilities where retaining walls may be used to conserve space. If retaining walls are used, the area must be fenced for safety.
 - Access for maintenance vehicles to the forebay, the outlet, and around the perimeter.
 - Freeboard of at least 2 feet.
 - With earthen contained facilities, install an antiseep collar on the outlet pipe.
 - The soils must be suitable for wetland vegetation. If necessary, organic soils (18 to 24 in.) must be imported to the site.
 - The soil must have an affinity for phosphorus. Soils with aluminum and iron are best. Soils saturated with phosphorus or a metal specie may cause the concentrations of these contaminants to increase in the overlying water.
 - Minimize short-circuiting by placing energy dissipaters at the inlet, and by having a high length to width ratio.
- Short-circuiting must be minimized by using a generally rectangular or irregular shaped configuration with a length to width ratio of at least 3:1 to 7:1 and by placing the inlet and outlet at opposite ends. The inlet and outlet can be placed at the same end if baffling (islands) is installed to direct the water to the opposite end before returning to the outlet. If topography or aesthetics requires the wetland to have an irregular shape, the wetland area and volume should be increased to compensate for the dead spaces. Energy dissipaters and entrance baffles will spread the water laterally across the facility.
- Minimize water loss by infiltration through the wetland bottom.
- Supplemental water may be needed to avoid loss of rooted vegetation during the dry period.

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Design and Sizing Considerations (Continued)	<ul style="list-style-type: none"> ➤ To maintain the wet pool to the maximum extent possible excessive losses by infiltration through the bottom must be avoided. Depending on the soils, this can be accomplished by compaction, incorporating clay into the soil, or an artificial liner. Wetland vegetation species have evolved to handle the stress of seasonal variations in water availability. However, during the dry season there must be sufficient water to avoid complete desiccation of plant roots. Consequently, constructed wetlands are infeasible in areas where there is a lack of either a base flow or near-surface ground water during the dry season. Supplemental water such as pumped ground water and treated process wastewater may have to be used. ➤ Constructed wetlands may not need antivortex and trash rack devices on their outlets like a wet pond because of the rooted vegetation. See STP-02, Wet Detention Ponds regarding inlet design. Design concepts for outlet devices are discussed in STP-02 and 3, Detention Ponds. See Josselyn (1982) regarding wetland plant considerations. Establishing wetland vegetation initially may be difficult and require multiple plantings. ➤ Another consideration is the regulatory implications of removing accumulated material from constructed wetlands. Some actions will require a 404 or other permit. At present, constructed wetlands are excluded from this requirement (Ritchie, 1992).
Maintenance	<ul style="list-style-type: none"> ➤ Remove foreign debris and sediment build-up. ➤ Areas of bank erosion should be repaired. ➤ Remove nuisance species. ➤ Check at least annually and after each extreme storm event. ➤ Clean deposits from the forebay when a loss of capacity is significant, probably every 3 to 5 years depending on the land use, or when the concentrations of toxicants in the sediments are reaching a level of concern. If baffle boxes are used instead of a forebay, it will require annual inspection. If a stormwater quality inlet(s) is used, then it will require inspections every 6 months. <p><i>Sediment Removal</i></p> <ul style="list-style-type: none"> ➤ A primary function of STPs is to collect sediments. The sediment accumulation rate is dependant on a number of factors including watershed size, facility sizing, construction upstream, industrial or commercial activities upstream, etc. The sediment contents should be identified before it is removed and disposed. ➤ Some sediment may contain contaminants of which the Indiana Department of Environmental Management (IDEM) requires special disposal procedures. If there is any uncertainty about what the sediment contains or it is known to contain contaminants, then IDEM should be consulted and their disposal recommendations followed. Generally, special attention or sampling should be given to sediments accumulated in facilities serving industrial, manufacturing or heavy commercial sites, fueling centers or automotive maintenance areas, large parking areas, or other areas where pollutants (other than "clean" soil) are suspected to accumulate and be conveyed via storm runoff.

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Maintenance (Continued)	<ul style="list-style-type: none"> ➤ Some sediment collected may be innocuous (free of pollutants other than “clean” soil) and can be used as fill material, cover or land spreading. It is important that this material not be placed in a way that will promote or allow resuspension in storm runoff. The sediment should not be placed within the high water level area of the STP, other BMP, creek, waterway, buffer, runoff conveyance device, or other infrastructure. Some demolition or sanitary landfill operators will allow the sediment to be disposed at their facility for use as cover. This generally requires that the sediment be tested to ensure that it is innocuous. ➤ There is some question as to whether annual harvesting of rooted vegetation is either practical or effective at reducing seasonal losses of nutrients and prolonging the life of the facility (USEPA, 1988). The benefits of harvesting may depend upon the wetland specie (Suzuki, T. et al., 1991). Placing rooted vegetation in gravel beds rather than soil may make harvesting practical. If harvesting is to be done, it should occur twice per season, in the early summer when nutrient content in the plant material is at its peak, and in the fall before plant dormancy. Given the significant role of the bottom soil in removing metals and phosphorus its replacement may be required, although, probably not more frequently than once every few decades. Cleaning the forebay more frequently is important as noted above.
Inspection Checklist	<ul style="list-style-type: none"> ➤ Concern for mosquitoes. ➤ Cannot be placed on steep unstable slopes. ➤ Need base flow to maintain water level. ➤ Not feasible in densely developed areas. ➤ Nutrient release may occur during winter. ➤ Overgrowth can lead to reduced hydraulic capacity. ➤ Regulatory agencies may limit water quality to natural wetlands. ➤ Establishing wetland vegetation may be difficult. ➤ Wetlands are generally shallower than wet ponds and result in larger area requirements. ➤ Costs for providing supplemental water may be prohibitive.