

A Strategic Look at Constructed Wetlands in Urbanized Areas

by

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Abstract

The sounds of tranquility, coolness of the breeze from the water source, and recreational activities invite people to the park for a leisure day or a family outing. For this reason many developers are using parks as a marketing tool to attract buyers to housing developments in urban areas. Although available property with water features might be limited in these quickly developing areas, today's environmental engineers are exploring the opportunity to build developments that invite public enjoyment and benefit the environment.

Developers and design engineers are incorporating man-made bodies of water such as wetlands in site development plans. Constructed wetlands are used to control flooding and stormwater runoff, as well as, filter out contaminants from upstream waterways. Studies have shown that wetlands improve the quality of the downstream waterways. Additionally, wetlands provide environmental, aesthetic, and economic benefits to the area. Constructed wetlands are visually appealing to property owners and typically increase surrounding property values.

This project will explore the construction of wetlands in urban areas from an environmental engineer's perspective. Two case studies will be examined and presented as examples of how wetlands have been used to enhance the quality of downstream waterways. I plan to publish this project in the Undergraduate Annals of Honors Research to bring awareness to otherwise unknown creative solutions to complex civil engineering problems.

Honors Thesis Advisor: Dr. Kathleen Leonard, Professor

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Introduction

Constructed wetlands are becoming more prevalent in the world of civil engineering. Although society is becoming more urbanized, humanity still depends on nature for survival. Communities depend largely on ecosystems outside of city limits, but they also benefit greatly on internal ecologies. Not only can constructed wetlands provide a high level of wastewater treatment with low operation and maintenance requirements, but low energy costs make them an economic benefit to property owners and developers.

Definition

The term wetland can take on many connotations but it most accurately refers to land or areas (as marshes or swamps) that are covered, often intermittently, with shallow water or have soil saturated with moisture. A more specific definition as described by the U. S. Army Corp of Engineers (USACE) refers to wetlands as areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Hydrophytic vegetation, hydric soil, and evidence of water are three basic components in the definition that are required for the USACE to deem an area a wetland. Under the Clean Water Act and Rivers and Harbors Act, the USACE has regulatory jurisdiction of most streams, wetlands, and navigable waterways. The USACE requires developers, architects, and land owners to receive approval from them prior to disturbing known jurisdictional water bodies.

Constructed wetlands are special types of wetlands because they are designed and developed as opposed to occurring naturally in the ecosystem. Civil engineers use the naturally occurring hydrology to create wetlands that serve a purpose for their site or development.

Uses

Constructed wetlands are used to control flooding and stormwater runoff, as well as, filter out contaminants from upstream waterways. For that reason, many developers and design engineers are using constructed wetlands as a marketing tool to attract buyers to housing developments in urban areas.

The superfluous rainwater that does not infiltrate into the ground is known as stormwater runoff. Stormwater runoff is increased in urbanized areas due to the amount of impermeable surfaces, such as parking lots and roads, located within the community. Constructed wetlands are used to regulate the stormwater and filter out the contaminants that are picked up in the flow. Constructed wetlands improve the quality of water entering groundwater aquifers by acting as a filter system in which harmful bacteria and contaminants are converted to carbon dioxide and water.

Several phases of planning are required for constructed wetlands to operate successfully. It is best for civil engineers to use existing topography and water table levels to design the wetlands. For this reason, engineers must look at historical topographic imagery and aquifer records to determine optimal depths and slopes. This is specifically important when constructing wetlands for two of the more dominant uses of constructed wetlands: Municipal wastewater treatment and residential wastewater treatment.

Case Study One: Municipal Wastewater Treatment

The West Jackson County Constructed Wetland Treatment System (CWTS) was built in the early 1990s and provides effluent treatment for the Mississippi Gulf Coast Regional Wastewater Authority's regional land treatment facility. This facility was originally designed to treat 1.6 million gallons of flow per day. Wetlands were constructed to increase the site's overall treatment to capacity to 2.6 million gallons per day.

Water is transported to the treatment facility by a pressurized force main. Initial treatment of removing grit and settleable solids is provided as the effluent moves through three constructed wetland cells within the lagoon. The naturally occurring bacteria and fungi that attack the sediments on the bottom of the lagoon and floating debris help to remove the contamination as the effluent moves from cell to cell. The quality of the water increases as debris is removed and suspended solids are reduced. The effluent flows through the cells for up to 12 days to get to optimal quality and comply with discharge requirements administered by the state.

After the initial treatment in the three wetland cells, wetland discharges flow into an effluent collection ditch and continue to the post-aeration pond, where the flow rate and water quality are measured before the final discharge into the Costapia Bayou. Statistical data is showing that the quality of the water is improving prior to being discharged into the downstream waterway. The

construction of the three wetland cells has contributed to an increase in the overall capacity of the wastewater treatment facility. The EPA stated that “In addition to improving the quality of the effluent discharged to the receiving stream, the creation of the West Jackson County CWTS has resulted in significant wildlife benefits.” [United States Environmental Protection Agency, 152-153]

Case Study 2: Residential Wastewater Treatment

One of the major causes of water pollution is the poorly operating wastewater systems in urbanized areas, particularly at residential structures. A well-designed constructed wetland will take advantage of the naturally occurring hydrology improving the quality of the water entering the groundwater aquifers, while promoting a healthy ecological balance.

Single residences are typically designed for primary treatment with a septic tank where the solids are allowed to settle out. The effluent from the septic tank is transported to and even distributed over the constructed wetland where it is treated by microbes attached to the plant roots. The cell is planted with vegetation appropriate for atmospheric temperature and water depth. A study reported that “when the effluent leaves the septic tank it still contains organic compounds (BOD), as well as, bacteria and viruses which are potentially harmful to humans and animals. The constructed wetland is the secondary treatment that biologically transforms the organic constituents into CO₂ and water.” [Sauter and Leonard, 155]

Constructed wetlands developed for wastewater treatment of single residences have proven to be in compliance with discharge requirements for various parameters such as biochemical oxygen demand, ammonia, turbidity, and many others. Water samples have been taken at various constructed wetlands in northern Alabama and researchers have seen a reduction in the amount of these pollutants being discharge from the treatment systems.

Summary

Constructed wetlands are a benefit to the ecosystems in urbanized areas because they reduce pollutant loads that are carried by stormwater. The advantage of constructed wetlands relies on their ability filter out contaminants, improve water quality, provide additional habitat, and improve air quality. The creation of wetland habitat provides food and cover for different types of vertebrate and

invertebrate which provide food for fish and birds. Additionally, constructed wetlands provide environmental, aesthetic, and economic benefits to the area.

Constructed wetlands for wastewater treatment involve the use of engineered systems that are designed and constructed to utilize natural processes. They are designed to mimic natural wetland systems by utilizing wetland plants, soils, and microorganisms to remove contaminants from wastewater effluents. The salvage and recycle of wastewater and stormwater with constructed wetland systems provides the opportunity to effectively create or restore valuable wetland habitat for wildlife use and environmental enrichment.

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