Office of Water

Constructed Wetlands for Wastewater Treatment and Wildlife Habitat

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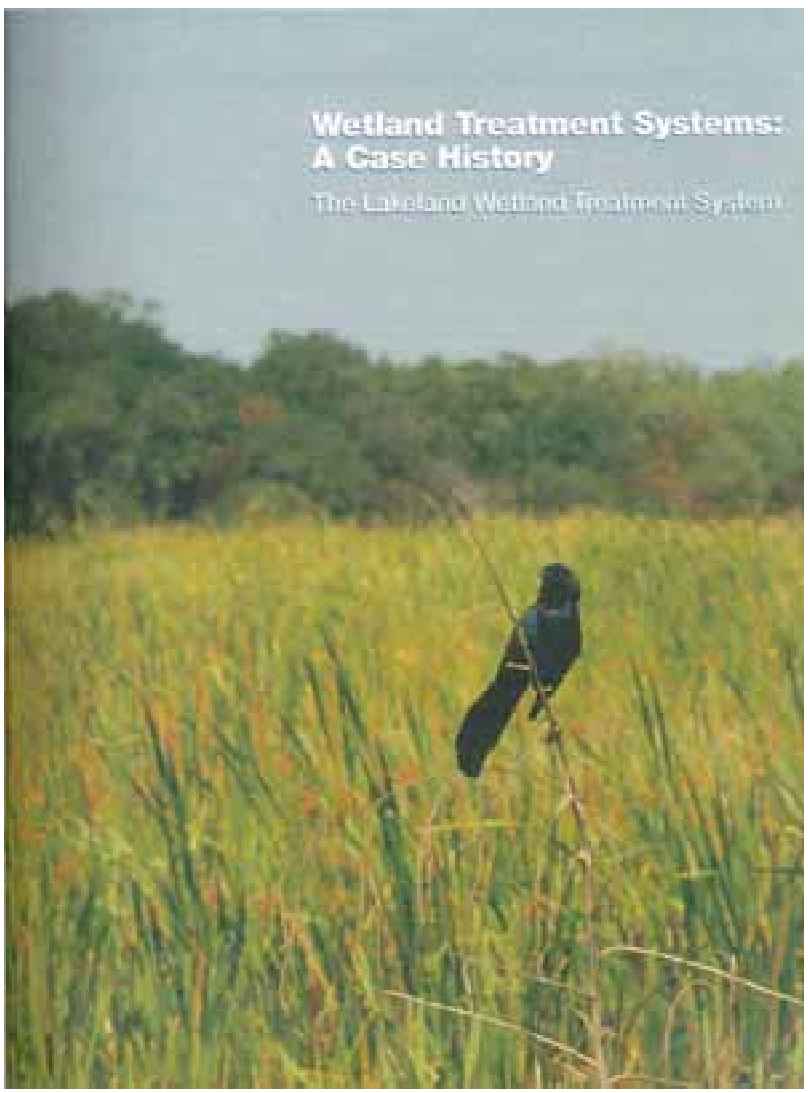
Lakeland, FL - Wetland Treatment Systems: A Case History - The Lakeland Wetland Treatment System



A Case History: Lakeland Wetland Treatment System

Introduction

The City of Lakeland (City) operates a 1,400 acre wetland treatment system located just |east of the town of Mulberry, Florida. The wetland system serves as the final treatment process for the City of Lakeland's 10.8 mgd Glendale Wastewater Treatment Plant and their 4.0 mgd Northside Wastewater Treatment Plant. These treatment plants serve a combined population of approximately 79,000 people within the city limits, as well as portions of the unincorporated areas of Polk County.

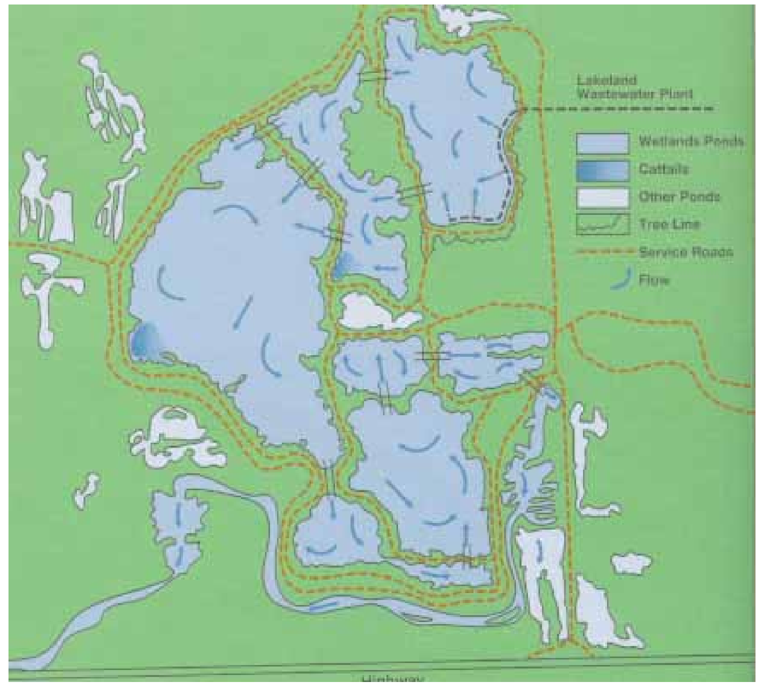


Figure 1
Plan view of the site showing the relative locations of the internal cells.
Click on picture for larger image.

Many of the natural upland and wetland communities within Polk County and the surrounding counties have been replaced by agricultural and industrial development. Citrus and phosphate mining industries have altered the landscape around Lakeland to a greater extent than any other development activity. The phosphate mines have provided the most dramatic changes to the lands in Polk County by not only eliminating the natural ecosystems, but also by significantly altering the topographic nature of these areas.

Restoration efforts within most of the abandoned mine sites have been limited in scope at best, since no real efforts generally are made to restore the original topography and vegetative communities. Instead, upland areas are normally replanted as monoculture pine forests, while most aquatic areas are comprised of lakes formed in unfilled mine pits. Most emergent wetland communities are restricted to the littoral zones of the lakes or are usually dominated by monoculture stands of cattails (Typha spp.) and/or Carolina willow (Salix caroliniana).

Project Background

Originally, the City began treating wastewater on the Glendale site in 1926 using a 2.5 mgd primary treatment plant. This plant began discharging effluent to Banana Lake via Stahl Canal, a practice that continued for more than 65 years. In 1939 the City upgraded the treatment plant with trickling filters to achieve secondary treatment. In the late 1950's and 1960's, the City rebuilt the trickling filters and expanded the facility to 10 mgd. The City began diverting up to 5.5 mgd of effluent from the Glendale treatment plant to the newly constructed C.D. McIntosh Jr. Power Plant for use as cooling water. In 1981 effluent pumped to the power plant was further treated on the power plant site and discharged (rapid infiltration) to the surficial aquifer adjacent to Lake Parker, thereby reducing the flows and loadings to Banana Lake. In 1988, the City expanded the wastewater treatment system to include its newly constructed 4.0 mgd Northside plant. When the Northside plant went on-line, it became the primary source of cooling water for the power plant.

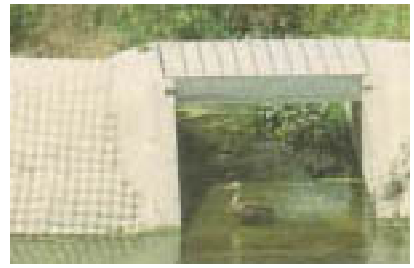
The sustained effluent discharge to Banana Lake, along with agricultural development in the Banana Lake watershed, severely degraded the water quality of the lake and down stream waterways. Early in 1983, the Florida Department of Environmental Protection (FDEP) indicated that the City's discharge permit to Banana Lake would not be renewed due to water quality problems in the lake. For this reason, both FDEP and the U.S. Environmental Protection Agency (USEPA) negotiated compliance schedules with the City to cease discharging effluent to Stahl Canal and Banana Lake.

One of the lakes located at the downstream end of the wetlands.

Faced with compliance schedules to cease discharging to Banana Lake, the City retained Post, Buckley, Schuh & Jernigan, Inc. (PBS&J) to develop and evaluate viable effluent disposal alternatives. Analysis of these alternatives indicated that disposal via an artificial wetland system would be the most cost effective method of effluent disposal for the existing Glendale plant. The Glendale facility has since been rerated to 10.8 MGD. The wetland site selected includes 1,600 acres that were formally used by W.R. Grace Inc. as a phosphate settling area. The site is characterized by a series of seven cells surrounded by levees. (See Figure 1.) Process waters from the previous mining operation were recycled through the cells to settle solids out of the water column. Overflow from the recycle system is discharged to the Alafia River. This process created a soil gradient across the cells where course-grained sands settled on the influent side of cells 1, 2, and 3, while fine clayey sediments settled on the effluent side of the cells. The settling process also created a significant topographic gradient in the first three cells that slope downward from the influent to effluent sides of the cell. The sediments in cells 4 through 7 are predominately nearly level fine clayey soils. A shallow lake still exists on the downstream side of Cell 5, while cells 6 and 7 remain as deep lakes.

Figure 2. *The influent structure aerates the water as it enters the wetland.*

Wetland Design



Weirs located along berms covered with grout-filled fabric revetments distribute flow into the cells 2 and 3.

Since 1987, approximately 1,400 acres of the project site have been used as part of the wetland treatment system. This area provides a permitted treatment capacity of 14 mgd of secondary effluent, although the current flows average approximately 8.0 mgd. Effluent is pumped from the Glendale plant polishing ponds through 6.4 miles of force main to the wetland system. In 1989, the influent to the wetland system was augmented by the inclusion of blow down waters from the Unit No. 3 cooling tower at the McIntosh Power Plant, along with periodic discharges from the ash ponds. Blow down waters from the power plant are mixed with effluent from the wastewater treatment plants at the Glendale plant and are then pumped to the wetland.

The H-flume outlet structure controls flows leaving the wetlands.

The introduction of the cooling waters and the ash pond effluent has significantly increased the total dissolved solids concentrations to the wetland. As an example, the average annual influent conductivity levels have increased.

The influent enters the wetland through a cascade inlet structure, as shown in Figure 2. The inlet structure is designed to aerate the influent waters through turbulent fall down the structure's 13 steps. The flow is split at the inlet structure between two Fabriform lined ditches that lie along the eastern boundary (influent side) of Cell 1. Water is discharged from the distribution ditches through weirs located every 100 feet along the ditch. Flow rates through individual weirs can be controlled by the addition or removal of flashboards. Once the water passes through the cell it is collected and discharged to Cell 2. This general pass through and collection system is repeated in cells 2 and 3. These three cells have the greatest change in topography. This system helps better distribute flow in these cells.. Cells 4 through 7 do not have distribution ditches. An H-flume outlet structure located at the south end of Cell 7 is used to monitor and control flows leaving the wetland site. A meteorological station provides data to assist in the preparation of annual water budgets for the wetland.

Site Conditions

In operation since 1987, the Lakeland Wetland Treatment System offers wildlife a natural habitat.

When the City assumed control of the wetland site, much of the interior of cells 1 through 4 were covered by cattails and Carolina willow. Upland islands within the cells generally were vegetated by undesirable grass/herbaceous species, and in some areas by pine (Pinus spp.) and live oak (Quercus virginiana) tree species. Vegetation in the upstream areas of Cell 5 was a mixture of cattails and Carolina willow, while the downstream half of the cell was a shallow lake system that was ringed by a dense population of water hyacinths (Eichhornia crassipes). Densities of algal populations in this lake often created a lime green color in the open water areas.

Although minimal disruption of the existing wetland vegetation within the treatment cells resulted from the construction activities, restoration grant monies received by the City from the Florida Department of Natural Resources were used to plant trees including black gum, red maple, sweet bay, swamp laurel oak, bald cypress, dahoon holly, and pop ash, within certain areas of cells 1 through 5. Secondly, the water hyacinths were removed from Cell 7 in response to concerns, voiced by the Polk County Environmental Services Division, that operation of the wetland system would increase mosquito production in areas covered by water hyacinths.

The areas along the eastern sides of cells 1 and 2 were originally barren sands or sparsely covered by upland grass species. These were the only areas planted with herbaceous wetland vegetation during construction. In both cells the pre-construction vegetation was cleared to allow the site to be graded. Initially, the highly permeable sandy soils made it difficult to establish wetland vegetation in these areas. However, after five years of operation both areas now support dense communities of wetland vegetation.

Operational Results

The original design objectives for the wetland treatment system were to improve the City's effluent quality beyond the secondary level (shown in Table 1 as Original Goals). Since start-up of the wetland system, state legislation was enacted that required the wetland to meet even more advanced wastewater treatment levels (also shown in Table1 as Existing Permit Conditions). Table 1 provides a summary of the influent BOD, TSS, TN & TP concentrations, water quality after passing through the first two cells (represented by station G3) that are primarily emergent wetlands, and the final effluent discharge structure. The average annual concentrations for the first four years of operation are presented, as well as the FDEP and USEPA permit limits. As shown, the wetland effluent quality has consistently met the permit limits, with the exception of TSS for 1990 and 1991. This can be at least partially attributed to increased algal populations in the last four cells within the wetland. Cell 7 previously was covered by water hyacinths, which served to limit the concentration of algae near the effluent structure. The removal of the water hyacinths in response to county concerns has allowed the algal concentrations to increase which appears to interfere with the wetlands ability to maintain TSS concentrations below permit limits. The City currently is working with FDEP, USEPA, and PBS&J to lower water levels in cells 3 through 6, and to increase the density and distribution of macrophytic vegetation in cells 4 through 7. Increased densities of macrophytic vegetation in the latter four cells should help limit the density of algae in these cells and, consequently, reduce their contribution to TSS in the effluent.

The wetland also has provided habitat for a

Table 1.

Water quality results for the first four years of operation

	Parameter			
	BOD (mg/L)	**TSS (mg/L)**	**TN (mg/L)**	**TP (mg/L)**
Influent	3.88	5.60	10.36	9.05
G3	1.14	1.74	2.79	6.54
Effluent	3.12	4.70	1.99	4.22
Original Goals	5.0	10.0	3.0	Exempt
Existing Permit Conditions	5.0	5.0	3.0	mpt

* Effluent phosphorus limits are exempted due to the high background phosphorus levels in the receiving stream.

Project Capital Costs

variety of wildlife species. Most notable are the large rookeries formed by wood

Wetland	$3,100,000
Pipeline	$2,800,000
Pump Station	$780,000
Total	$6,680,000

storks (*Mycteria americana*), white pelicans (*Pelecanus erythrorhynchos*), cormorants (*Phalacrocorax auritus*) anhingas (*Anhinga anhinga*), white ibis (*Eudocimus albus*), and several egret and heron species on the upland islands within cells 5, 6, and 7. In addition, there are several bobcat (*Felix rufus*) and otter (*Lutra canadensis*) families now living within the boundaries of the wetland.

The wide variety of wildlife inhabitint the wetlands includes anhinga and numerous other waterfowl.

Acknowledgements

Numerous individuals have contributed to the success of the Lakeland Wetland Treatment System. Listed below are some of the key groups and individuals.

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