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West Jackson County, Mississippi

Constructed Wetland Treatment System Case History

BACKGROUND

The West Jackson County Constructed Wetland Treatment System (CWTS) was built in two phases between 1990 and 1991 to provide additional effluent treatment and disposal capacity for the Mississippi Gulf Coast Regional Wastewater Authority's (MGCRWA) regional land treatment facility. Located north of Ocean Springs, Mississippi, the West Jackson County constructed wetlands consist of three parallel treatment systems that cover 56 acres.

The land treatment facility was originally designed to treat an annual average daily flow of 1.6 million gallons per day (mgd). Initially, this capacity was sufficient to treat the wastewater produced within the service area, which is primarily from household sources. However, following heavy rainfall events, hydraulic capacity of the land treatment facility was exceeded, and excess flow was bypassed directly into Costapia Bayou. Wetlands were constructed to increase the site's overall treatment capacity to 2.6 mgd and to eliminate this periodic bypass.

Spray irrigation is used for effluent treatment and disposal at West Jackson County during dry weather.

SYSTEM DESCRIPTION

As designed, the West Jackson County Natural Land Treatment System includes the following main components:

- a 75-acre lagoon/storage facility
- a 380-acre land application system
- three constructed wetland treatment systems, CWTS1, CWTS2, and CWTS3, with a combined area of 56 acres
- a 0.2-acre post-aeration pond

Wastewater is conveyed to the regional land treatment facility by a pressurized force main. Initial treatment is provided as the effluent moves through the three cells of the lagoon, which remove grit and settleable solids and reduce suspended and dissolved organic materials. The effluent flows by gravity to the distribution pump station where debris is removed by two traveling screens. The effluent is then pumped to the distribution system.

The partially treated effluent is applied to crops on two sites: a 245-acre southern site, located on Mississippi Sandhill Crane National Wildlife Refuge lands, and a 170-acre northern site, located on MGCRWA-owned land. Permanent big-gun sprinklers are used to apply the effluent. Underdrains on the land treatment fields transfer excess percolate to wetland ponds on the Refuge that provide nesting habitat for the endangered sandhill cranes. These birds have also benefited from this project through their use of the spray fields as feeding habitat.

Alternatively, the effluent can be pumped to the 22-acre CWTS1 or be gravity fed to the 34-acre CWTS2 and CWTS3 sites. CWTS1 consists of two cells that operate in series. Effluent from Cell 1A flows over eight adjustable weirs into Cell 1B. From there, Cell 1B effluent flows into an open collection ditch where it flows by gravity to the post-aeration pond north of CWTS2.

CWTS2 and CWTS3 are two separate, parallel treatment trains that operate in series. CWTS2 has three cells and CWTS3 has two cells. CWTS2 and CWTS3 are directly downgradient from the lagoon; therefore, influent flows by gravity at a constant rate up to 1.0 mgd. After being measured, the influent is split between the two treatment trains by a concrete flow splitter. Approximately 65 percent of the flow goes to CWTS2, and the rest to CWTS3, resulting in a uniform loading per acre to the treatment trains even though they are different sizes.

After treatment in the three CWTS, all wetland outflows are combined in the effluent collection ditch and conveyed to the post-aeration pond, which is equipped with two floating aerators. The post-aeration pond effluent passes through a Parshall flume for flow measurement, then through the outfall pipe where it is discharged into Costapia Bayou.

OPERATIONS AND MANAGEMENT

Cattails are the primary wetland species used for water quality treatment.

Constructed wetland systems can provide a high level of wastewater treatment with low operation and maintenance requirements and low energy costs. In the West Jackson County CWTS, wastewater is treated by the naturally occurring bacteria and fungi that colonize the sediments on the bottom of the cells as well as the stems and leaves of the vegetation below the water's surface. These microbes help transform and remove organic compounds and nutrients that might otherwise result in pollution of adjacent surface waters.

The bottoms of the CWTS cells are slightly sloped for easy draining during maintenance. Each wetland cell has three or more "deep zones," which are 5 feet deep and about 20 feet wide. The deep zones remain free of rooted marsh vegetation, allowing them to redistribute effluent through the system and provide atmospheric aeration. The deeper water in these zones furnishes year-round habitat for aquatic life, particularly mosquito fish and wetland-dependent birds such as waterfowl.

Operation of the West Jackson County CWTS is based on shallow, overland flow conditions in the first half of the wetland cells. Water depth increases to a maximum of about 1 foot at the downstream end of the cells. This operational strategy takes advantage of the fact that higher dissolved oxygen (DO) occurs in shallow, higher velocity areas of the wetland cells.

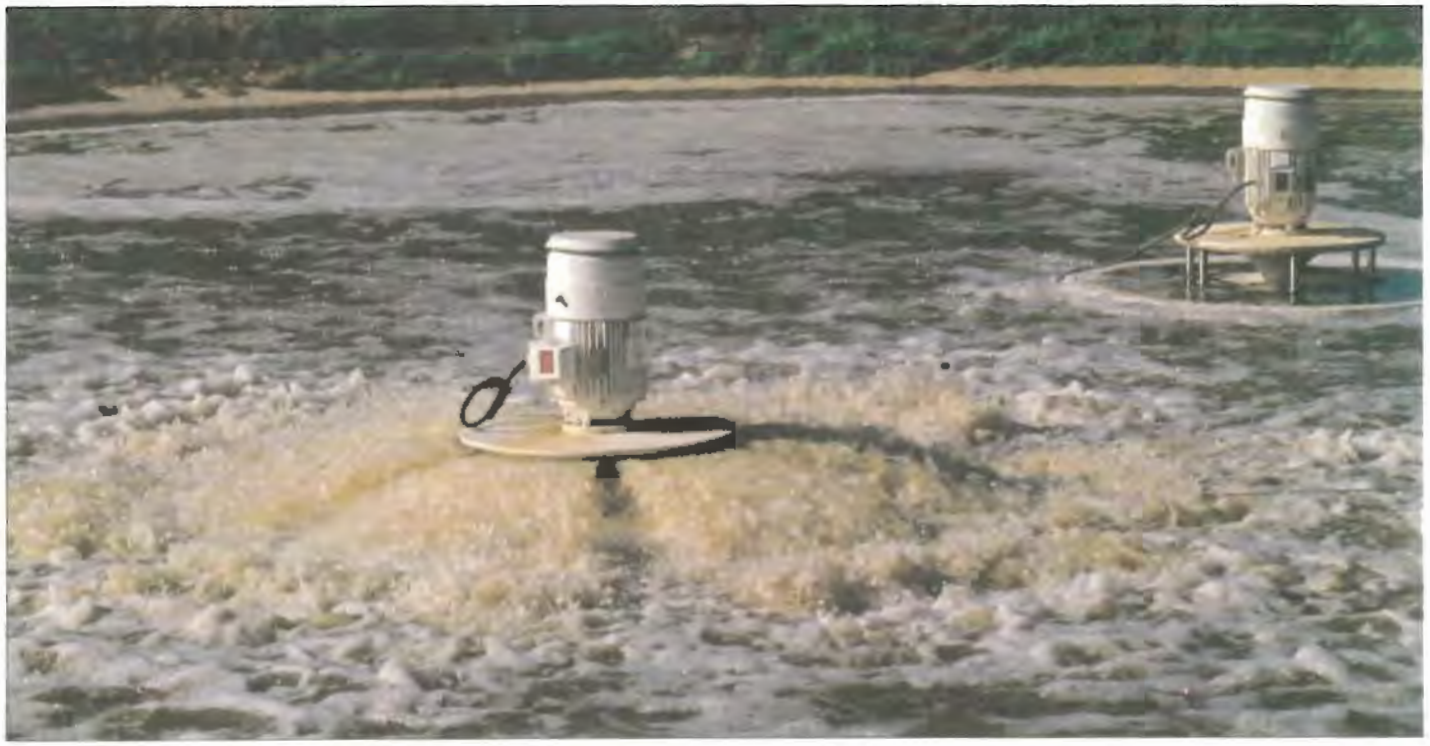
The West Jackson County CWTS was initially planted with cattail and bulrush

plants. The CWTS also has been naturally colonized by 43 other wetland plant species, providing a high level of biological diversity.

Influent from the pretreatment lagoon is distributed to the wetland cells by pipes with 2-inch holes drilled at 10-foot intervals. This method of distributing influent begins the flow through the treatment system and is critical for effective use of the CWTS for water quality treatment.

The effluent flows through the cells for up to 12 days to provide a high quality effluent. To account for seasonal changes in the reaction rate of microorganisms in the cells, the retention time is varied by changing water depths. Because the microorganisms react more quickly at higher temperatures, the retention time can be decreased during the summer and still provide the required contact time for effective treatment. Conversely, during the winter's colder temperatures, the reaction rate of the microorganisms is lower; therefore, the retention time is increased by raising water levels. Deep water zones provide effective redistribution of water flows along the length of the wetland cells. Stainless steel outflow weirs control cell water depth and promote the flow of effluent through the treatment system. After it is treated in the CWTS, effluent is conveyed to the post-aeration pond, where the flow rate and water quality are measured before final discharge.

Post-aeration is essential for consistent compliance with the dissolved oxygen permit limit of 6.0 mg/l.



PERFORMANCE

Construction of Phase I of the CWTS began in February 1990. The earthwork and planting were completed in July 1990, and startup and flows to this phase began in August 1990. Plant cover was fully established in Phase I by October 1990.

Construction of Phase II began in June 1990 and was completed about 8 months later. Influent flows to this phase began in October 1990 and planting was completed in April 1991. Plant cover was fully established in Phase II by June 1991.

Water quality measurements made since June 1991 following complete plant establishment indicate that the West Jackson County constructed wetlands will effectively reduce BOD5 and TSS concentrations to less than 8 mg/L. These reductions occur in spite of variable BOD5 and TSS inflow concentrations.

One of the key goals of the West Jackson County CWTS is ammonia nitrogen (NH3-N) reduction. Performance of the CWTS has been variable to date, with 3 out of 12 months having outflow NH3-N levels above the limit. High outflow NH3-N concentrations have been associated with either high TKN loadings (over 3 pounds per acre per day) or with high flows (over 2 mgd). Operational control of peak flows, TKN loading, and water level adjustment are currently being used to optimize this wetland system's nitrogen removal potential.

West Jackson County Constructed Wetland Design Criteria

Wetland Design Flow 1.6 mgd

Influent Quality

BOD5	45 mg/L
TN	12.5 mg/L (167 lb/d)

Effluent Criteria

BOD5	10 (13)a mg/L
TSS	30 mg/L
NH3-N	2 mg/L
pH	6-8.5 units
DO	6 mg/L
Fecal coliforms	2200 col/100 ml

Areas (acres)

CWTS 1	Cell A	12
	Cell B	10
CWTS 2	Cell A	9.7
	Cell B	7.8
	Cell C	4.0
CWTS 3	Cell A	9.2
	Cell B	3.3

a( ) December-April,
BOD5 = Five-day biochemical oxygen demand,
TN = Total nitrogen,
TSS = Total suspended solids,
NH3-N = Ammonia nitrogen,
DO = Dissolved oxygen

Water Quality Measurements

	Month	BOD5		TSS		Nitrogen	
		In	Out	In	Out	TN In	NH_3 Out
1991	June	28	9	40	15	7.3	1.2
	July	13	5	41	15	4.4	1.3
	August	23	4	49	10	15.2	1.0
	September	19	2.5	35	5	17.7	2.3
	October	27	4	35	4.5	14.5	3.5
	November	46	3	36	4	13.5	3.9
	December	39	4	29	7	6.9	1.3
1992	January	23	4	17	8	11.1	1.4
	February	19	5	12	4	14.5	1.6
	March	19	5	16	5	15.4	1.7
	April	28	4	18	4	12.2	1.2
	May	24	4.5	31	6.5	6.9	0.05

BOD5 outflow concentrations have remained below 5 mg/L since vegetation colonization was completed in June 1991. TSS outflow concentrations have settled to less than 8 mg since September 1991. NH3 outflow concentration is dependent on the mass loading of TN and has remained below 2 mg/L as long as TN loading is less than 167 lb/d (3 lb/ac/

ANCILLARY BENEFITS

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. This new wetland habitat provides food and cover for various types of wetland dependent vertebrate and invertebrate life. The aquatic invertebrate populations throughout the wetlands provide food for fish and birds.

The 45 wetland plant species identified to date, combined with open water zones and shallow edge areas, have resulted in a diversity of wildlife habitats and high populations of wildlife species. Sixty-two bird species were identified in or around the wetlands during 1991. About 37 of these species are considered to be wetland-dependent. Bird populations during the winter, spring, and fall seasons are dominated by ducks, sora rails, swamp sparrows, and wading birds. Summer bird population studies indicate the presence of at least 7 nesting bird species and a total of 30 species in and around the wetlands.

Winter bird populations include ducks, rails, sparrow coots, herons, egrets, and many other wetland species.

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