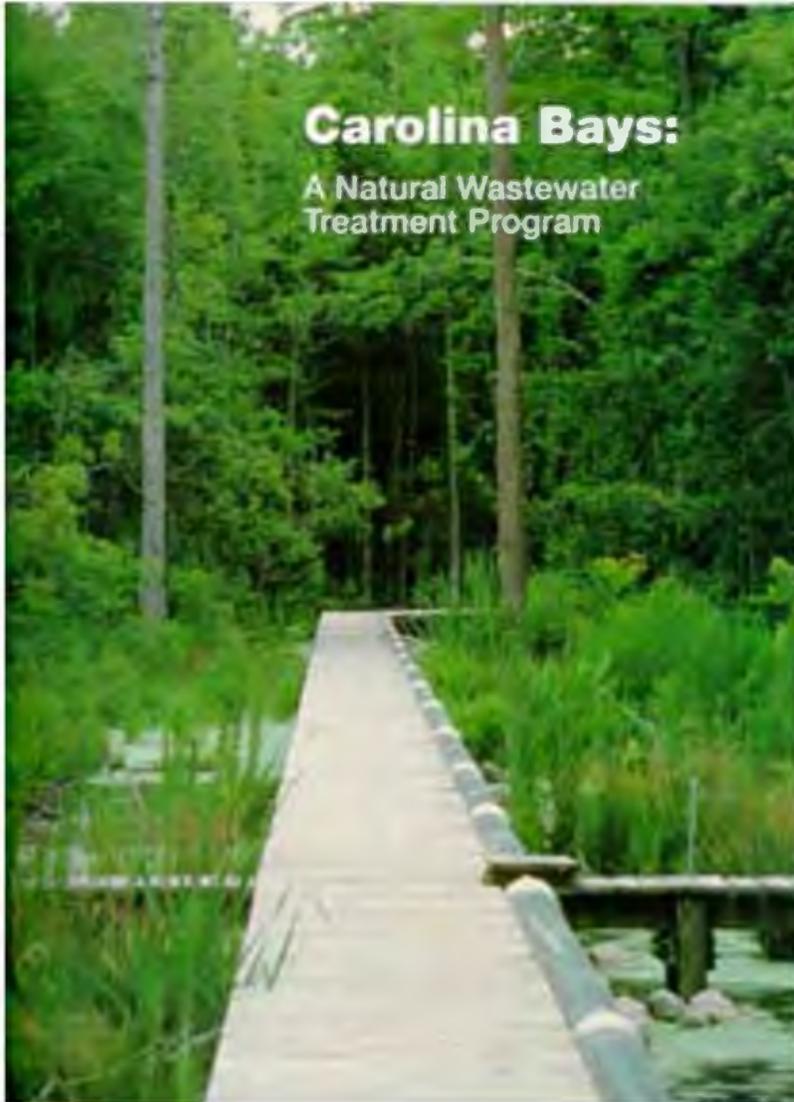


Carolina Bays: A Natural Wastewater Treatment Program



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Background

Carolina bays are mysterious land features often filled with bay trees and other wetland vegetation. Because of their oval shape and consistent orientation, they are considered by some authorities to be the result of a vast meteor shower that occurred thousands of years ago. Others think the natural forces of wind and artesian water flow caused the formation of lakes, which later filled with vegetation.

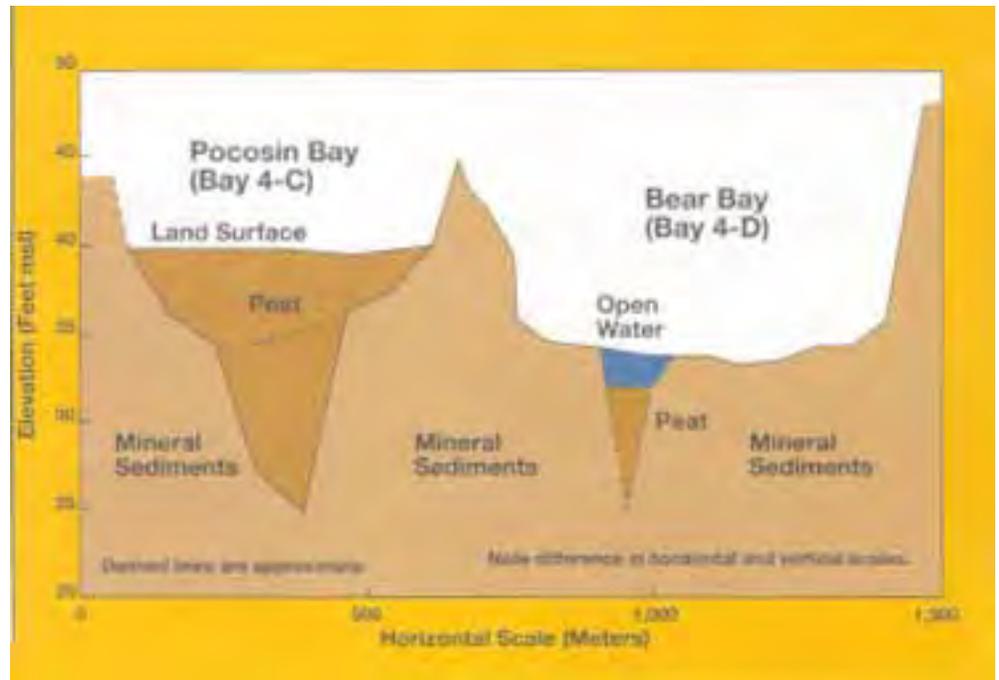
Whatever their origin, over 500,000 of these shallow basins dot the coastal plain from Georgia to Delaware. Many of them occur in the Carolinas, which accounts for their name. Most Carolina bays are swampy or wet areas, and most of the hundreds present in coastal Horry County, South Carolina, are nearly impenetrable jungles of vines and shrubs. Because of population growth and increased tourism in Horry County, expansion of essential utility operations was required. The regional water utility, the Grand Strand Water & Sewer Authority (GSWSA), retained CH2M HILL in the late 1970s to evaluate wastewater treatment and disposal options.

Locations to dispose of additional effluent were extremely limited because of sensitive environmental and recreational concerns. The slow-moving Waccamaw River and Intracoastal Waterway, into which existing facilities discharged, could not assimilate additional loading without adverse effects on water quality and resulting impacts on tourism and recreational activities.

On the basis of extensive research and pilot studies, CH2M HILL recommended discharging effluent from a new 2.5 million gallon per day (mgd) wastewater treatment plant to four nearby Carolina bays.

The U.S. Environmental Protection Agency (EPA) considers the use of wetlands to be an emerging alternative to conventional treatment processes. As a result, EPA Region IV and the South Carolina Department of Health and Environmental Control awarded an Innovative /Alternative Technologies funding grant for the Carolina bays treatment project, enabling GSWSA to provide expanded collection, treatment, and disposal services at affordable costs.

This grant was used for planning, pilot testing, design, and construction of the full-scale Carolina Bay Natural Land Treatment Program.



In cross section, Carolina bays are shallow, bowl-shaped depressions, often filled with peat and surrounded by sandy ruins.

Site Description

After 5 years of intensive study to evaluate viable treatment and disposal alternatives, four Carolina bays were selected as treatment sites. Site selection criteria focused on three primary factors: 1) distance from the wastewater source, 2) available treatment area, and 3) environmental sensitivity. The bays chosen for the GSWSA treatment complex had been previously affected by man and were the least environmentally sensitive of the bays considered.



Four bays covering 700 acres make up the Carolina Bay Natural Land Treatment System. Plant succession in these bays is naturally controlled by fire as seen in Bay 4B (second from left).

Carolina Bays 4-A and 4-B are joined along a portion of their margins and encompass about 390 acres of dense, shrubby plant communities with scattered pine trees. This plant association is called "pocosin" after an Indian word describing a bog on a hill. A powerline right-of-way bisects Bay 4-A and also cuts through the southern end of Bay 4-B.

The 240-acre Pocosin Bay (Bay 4-C) is also dominated by pocosin vegetation and is filled with up to 15 feet of highly organic peat soils. This bay had received the least amount of prior disturbance and is being used only as a contingency discharge area. Bear Bay (Bay 4-D) covers 170 acres and is dissimilar from the other bays because it is densely forested by pine and hardwood tree species. A large portion of this Carolina bay was cleared for forestry purposes in the mid-1970s but has since been revegetated with a mixture of upland and wetland plant species.

Carolina Bay Project Summary

George R. Vereen WWTP

Design flow = 2.5 mgd

Pretreatment by aerated lagoons in parallel trains, one completely suspended lagoon and three partially suspended lagoons per train

Lagoon total area = 4.4 acres

Total aeration = 192 hp

Disinfection by contact chlorination

Carolina Bays

Average hydraulic loading rate = 1 in./week Effluent distribution system

7,000 feet of 10-inch aluminum piping 30,000 feet of elevated boardwalks

Final effluent permit limits

BOD5 monthly average 12 mg/l
TSS monthly average 30 mg/l
NH3 summer (Mar-Oct) 1.2 mg/l
NH3 winter (Nov-Feb) 5.0 mg/l
UOD summer (Mar-Oct) 481 lb/day
UOD winter (Nov-Feb) 844 lb/day

Total treatment area = 702 acres

Bay 4A
 combined = 390 acres
Bay 4B
Bay 4C (Pocosin Bay) = 142 acres
Bay 4D (Bear Bay) = 170 acres

Biological criteria (allowable % change)

	Bay			
	4A	4B	4C	4D
Canopy cover	15	15	0	50
Canopy density	15	15	0	50
Subcanopy cover	15	15	0	50
Plant diversity	15	15	0	50

Project Cost Summary

Pilot system	\$411,000
Vereen WWTP	3,587,000
Effluent distribution system (including land)	2,490,000
Engineering (pilot and full scale) and monitoring	1,332,000
<hr/>	
Total cost	\$7,820,000

Operations and Management

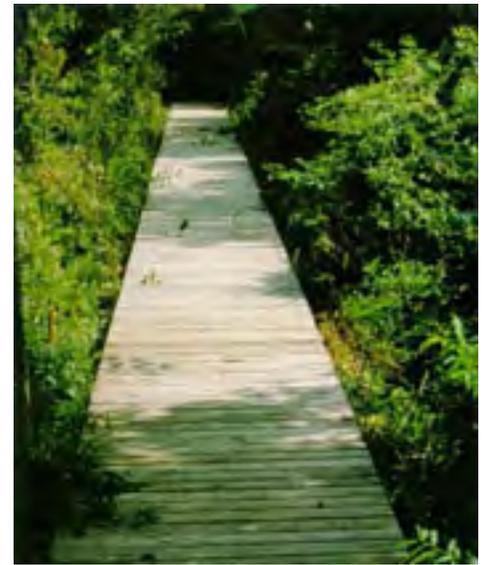
The carefully planned and monitored use of Carolina bays for tertiary wastewater treatment facilitates surface water quality management while maintaining the natural character of the bays.



Aluminum pipes distribute the treated effluent.

After undergoing conventional primary and secondary treatment processes at the George R. Vereen Wastewater Treatment Plant, the wastewater is slowly released into a Carolina bay for tertiary treatment, rather than directly to recreational surface waters of the area.

The plants found in the Carolina bays are naturally adapted to wet conditions, so the addition of a small amount of treated water increases their productivity and, in the process, provides final purification of the wastewater.

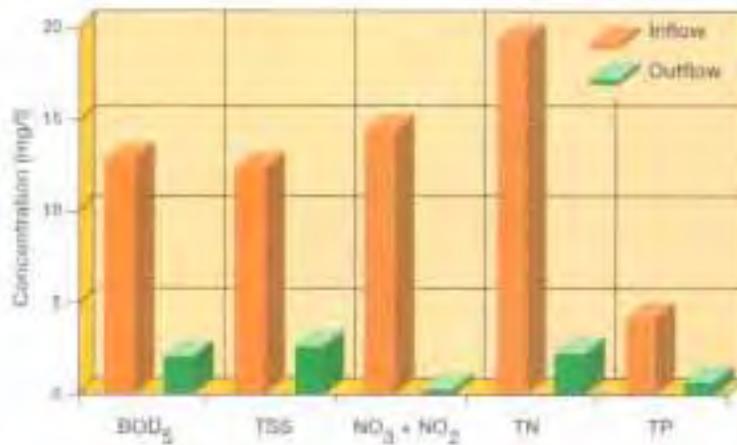


High-nutrient water in the bays increases plant productivity.

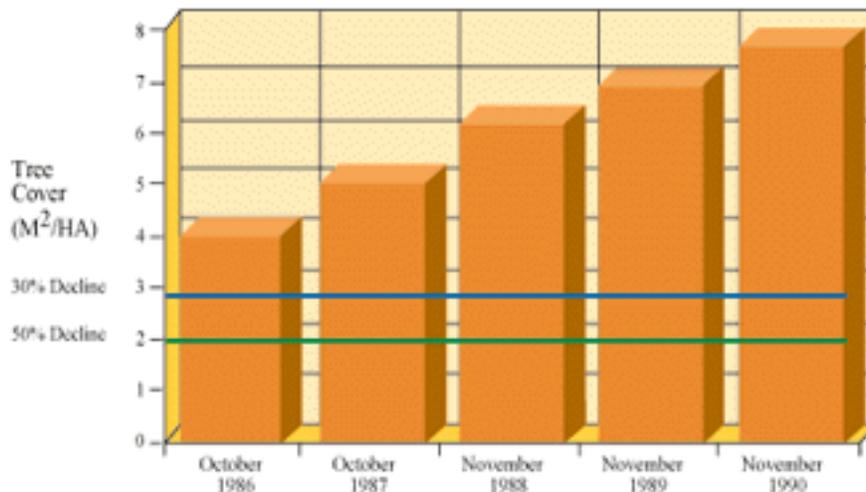
The treated effluent can be distributed to 700 acres within the four selected Carolina bays through a series of gated aluminum pipes supported on wooden boardwalks. Wastewater flow is alternated among the bays, depending on effluent flow rate and biological conditions in the bays.

Water levels and outflow rates can be partially controlled in Bear Bay through the use of an adjustable weir gate. Natural surface outlets in the other three bays were not altered by construction of the project.

Performance



Compliance with biological criteria protects the Carolina Bay plant communities from undesirable changes.



Operational water quality since 1987 indicates significant assimilation of residual pollutants is occurring in Bear Bay.

In 1985, after site selection was completed and before wastewater distribution began, baseline studies were conducted on the hydrology, surface water, and groundwater quality and flora and fauna of Bear Bay. Treated effluent was first discharged to the bay in January 1987, and monitoring was continued to measure variations in the water quality and biological communities. By March 1988, the pilot study had been successfully completed and the Carolina Bay Natural Land Treatment Program was approved for full-scale implementation by EPA and South Carolina regulatory agencies.

In October 1990, the Carolina Bay Natural Land Treatment System was dedicated as the Peter Horry Wildlife Preserve and began serving the wastewater treatment and disposal needs of up to 30,000 people.

Ongoing monitoring indicates that significant assimilation is occurring in Bear Bay before the fully

treated effluent recharges local groundwater or flows into downstream surface waters. Biological changes have been carefully monitored, with the main observed effect being increased growth of native wetland plant species.



Variations in the water quality of Bear Bay are closely monitored.

Ancillary Benefits

The Carolina Bay Natural Land Treatment Program not only serves wastewater management needs but also plays an important role in protecting the environment. Although the Carolina bays have been recognized as unique, 98 percent of the bays in South Carolina have been disturbed by agricultural activities and ditching. The four bays in the treatment program will be maintained in a natural ecological condition. These 700 acres of Carolina bays represent one of the largest public holdings of bays in South Carolina.

The use of wetlands for treatment can significantly lower the cost of wastewater treatment because the systems rely on plant and animal growth instead of the addition of power or chemicals. Also, the plant communities present in the wetlands naturally adjust to changing water levels and water quality conditions by shifting dominance to those species best adapted to growing under the new conditions.



Wetland plant communities easily adjust to changing conditions



Pitcher plants occur naturally in the Carolina bays.

Carolina bays provide a critical refuge for rare plants and animals. Amazingly, black bears still roam the bays' shrub thickets and forested bottom lands just a few miles from the thousands of tourists on South Carolina's beaches. Venus flytraps and pitcher plants, fascinating carnivorous plants that trap trespassing insects, occur naturally in the Carolina bays. In addition, the bays are home to hundreds of other interesting plant and animal species.

The Carolina Bay Nature Park, to be managed by GSWSA, is currently being planned. The focal point of the park will be an interpretive visitor center open to the public. This simple structure will be designed and built in harmony with its

surroundings on a sand ridge overlooking two Carolina bays. The center will feature displays about black bears and Venus flytraps as well as theories on the origin of the Carolina bays, their native plant associations, including the associated sandhill plant communities, and their use for natural land treatment.

The visitor center will be the hub for three hiking trails, including a 5-minute walk through an adjacent cypress wetland; a 45-minute trail through Pocosin Bay and associated titi shrub swamp and long-leaf pine uplands; and a one-hour walk through a heavily forested Carolina bay and its adjacent sandhill plant communities.



Combined with the interpretive nature center, the hiking trails and boardwalks will provide public access, scientific research, and educational opportunities that were previously unavailable.

The designation of the Peter Horry Wildlife Preserve in October 1990 was the first step in establishing this park.



An interpretive visitor center is planned as the focal point of the Carolina Bay Nature Park.

Awards

In 1991, the Carolina Bay Natural Land Treatment Program won the Engineering Excellence Award, Best of Show, from the Consulting Engineers of South Carolina.

The American Consulting Engineers Council (ACEC) Grand Conceptor Award, considered the highest national honor in the consulting engineering field, was awarded to CH2M HILL in 1991 for its implementation of the Carolina bays project. ACEC selected the project from a field of 127 national finalist entries, each of which had earlier won in state or regional engineering excellence competitions.



Acknowledgements

Numerous individuals and organizations have shared the vision necessary to implement the Carolina Bay Natural Land Treatment Program. Some of the key organizations and individuals include the following:

Grand Strand Water and Sewer Authority

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Sidney F. Thompson, Chairman
Douglas P. Wendel, Executive Director
Fred Richardson, Engineering Manager
Larry Schwartz, Environmental Planner

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