

Mixed Forested Wetlands Reclamation

November 2013



As Mosaic prepares to mine wetland systems, our reclamation crews often harvest and store the muck layer from the wetland's surface. This material, which contains a valuable seed bank of native vegetation, begins to sprout wetland vegetation shortly after it is distributed.

About Mosaic Reclamation

> In carrying out its mission to help the world grow the food it needs, Mosaic couples recovery of phosphate resources with respect of the phosphate-rich land that fuels thriving communities, economies, and American and global food production. While mining is a temporary use of the land, reclamation offers habitat and recreational benefits for generations to come. Land reclamation is the process of turning mined lands back into productive use and has been required by law in Florida since 1975. In respecting this important balance, Mosaic continuously improves its reclamation practices to create natural habitats blended with other land uses across the reclaimed landscapes.

Mosaic's dedicated team of reclamation scientists, engineers, ecologists and biologists develop detailed reclamation plans for the productive future use of mined lands years before any phosphate is extracted from the

ground. With Mosaic reclaiming any lands it disturbs, the reclamation plans for critical habitats focus on connecting preserved and reclaimed lands to create a diverse and sustainable habitat network that is integrated into the larger regional ecosystems of Central Florida.

The Science of Persistence

For more than 40 years, Mosaic and its predecessor companies have successfully reclaimed thousands of acres of mined land. Reclaimed habitats at Mosaic's mines include streams and their associated floodplains, as well as connected and isolated wetland, and upland natural environments, such as xeric oak and palmetto prairies. <



The anaerobic, or oxygen-deficient, environment of the muck is capable of maintaining viable seeds in the soil for long periods of time.



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Dedication and Integration

> Habitat diversity across reclamation efforts is imperative to the sustainability of the broader ecosystem. Supporting this relationship, the wetlands in Florida's unique ecosystems serve as valuable habitats for wildlife, provide critical rainfall storage capacity and assist with water purification.

Two examples of Mosaic's reclaimed wetland forests where tree species like pines, cypress and other hardwoods provide the canopy (also known as mixed forested wetlands) are Little Payne Creek 7 Wetland No. 3 (LPC7 Wetland No. 3), located in Hardee County, and Peace River No. 7 (PR7), located in Polk County.



Sustainability of the broader ecosystem is dependent on habitat diversity.



Mosaic's wetlands reclamation process involves planting a variety of vegetation on reclaimed phosphate mine land.

As a more mature site, LPC7 Wetland No. 3 was mined in 1995 and reclamation planting started in 2000. Before the site was mined, the surrounding landscape was made up of several small stream channels that flowed through pastures following storm events. The reclaimed system includes an 11-acre depressional wetland, a wetland primarily surrounded by uplands, and surrounding forested upland habitat. LPC7 Wetland No. 3 was deemed self-sustaining and "released" by the U.S. Army Corps of Engineers in 2006 and by the Florida Department of Environmental Protection in 2010. The most recent release of reclaimed land related to LPC7 Wetland No. 3 was granted by the FDEP in 2013.

PR7 is a newer site also located on formerly mined land. The site was mined in 2004 and reclaimed in 2007. The pre-mining land use was orange groves, upland mixed hardwoods and pasture, while the reclaimed site is composed of a 15-acre wetland and a 38-acre upland forest and pasture. Mosaic continues to monitor the progress of PR7. <

Details of Design

> Over the past 15 years, techniques used to develop conceptual designs for reclaimed wetlands have improved with the development of sophisticated hydrology simulation models. Comparing the methods used to design LPC7 Wetland No. 3 and PR7 demonstrates how more detailed design on the front end of a project provides additional insight into how the wetland is going to function after it's established.

LPC7 Wetland No. 3 was designed before today's more advanced hydrology modeling technology was available.

However, at PR7, newer modeling techniques confirmed the adjacent uplands would provide proper hydrology needed to sustain the wetland.

Regardless of design methods, Mosaic takes a progressive approach to all land reclamation. On newer sites like PR7, Mosaic is able to leverage best practices and key learnings from older projects. While older sites like LPC7 Wetland No. 3 pose challenges, they are continuously managed in a way that leads to thriving reclamation sites. <

Mixed Forested Wetland Design At-a-Glance

Key Design Aspects	LPC7 Wetland No. 3 (2000)	PR7 (2007)
Hydrology	<ul style="list-style-type: none">• Design focus limited to the development of surface water flow.	<ul style="list-style-type: none">• Hydrology modeling defined the needs of this specific wetland habitat and the ability of the drainage area to meet those needs.
Elevations	<ul style="list-style-type: none">• Without input from surface water runoff and groundwater flow or a connected stream, the design outlined an isolated depressional wetland.	<ul style="list-style-type: none">• An outlet swale was included in the wetland design to ensure appropriate water depths that support vigorous forest growth.
Tree components	<ul style="list-style-type: none">• Hardwoods and conifers were used to create a dense, shady tree component for the wetland system.	<ul style="list-style-type: none">• The planting plan reflected tree species naturally occurring within the Peace River floodplain.
Plant density	<ul style="list-style-type: none">• Used six inches of muck to develop dense understory of herbaceous plants.• Supplemental planting of trees on 10-foot centers was completed to obtain permitting success criteria of 400 trees per acre.	<ul style="list-style-type: none">• Trees and shrubs were planted at a density with the intent to ultimately obtain permit success criteria.• Groundcover planting density significantly exceeded permit requirements (10,000 plants per acre) to accelerate establishment of desirable vegetation and exclude unwanted vegetation.
Species diversity	<ul style="list-style-type: none">• More than seven types of typical forest wetland trees were used.• No more than 30 percent of any one species was planted.	<ul style="list-style-type: none">• Mimicked the species diversity of the adjacent floodplain.

Levels of Alignment

> Mosaic takes great care to make sure the appropriate reclamation approaches are used to develop and monitor the progress of a site’s plant community.

During the implementation of a reclaimed mixed forested wetland, one key focus area includes establishing the proper

topography and elevation. This ensures that water levels and variations are supportive of the needs of the forested system as water levels and fluctuation are vital for all wetland systems, both natural and reclaimed. <



Establishing the proper topography and elevation of a reclaimed wetland ensures it will have the water it needs to develop.



An important part of Mosaic’s reclamation efforts include monitoring the progress of a site’s plant community.

Mixed Forested Wetland Design At-a-Glance

Key Execution Aspects	LPC7 Wetland No. 3 (2000)	PR7 (2007)
Hydrology	<ul style="list-style-type: none"> Developed by grading overburden to establish the site foundation. 	<ul style="list-style-type: none"> Developed using sand tailings reclamation media and overburden cap to provide required drainage area to support the wetland and soils to establish upland vegetation.
Revegetation	<ul style="list-style-type: none"> Initially planted in 2000 with maples, water hickory, ash, tupelo, water oak and cypress. 	<ul style="list-style-type: none"> Initially planted with red maple, sweet gums, bald cypress and bay tree assortments, and native shrubs.
Monitoring	<ul style="list-style-type: none"> FDEP site reviews helped to identify areas needing improvement. Annual mitigation wetland vegetative surveys are performed by outside consultants as required by permit. Hydrology showed to support a highly functioning marsh, but was not as supportive to the forested canopy. Remedial work focused on developing the canopy while preserving the favorable attributes on the ground. 	<ul style="list-style-type: none"> Quarterly FDEP site reviews. Annual mitigation wetland vegetative surveys are performed by outside consultants as required by permit. Wetland water levels are monitored regularly with a staff gauge.
System Maintenance	<ul style="list-style-type: none"> Plantings were completed to supplement the density and diversity throughout the entire project. Acclimatization was accomplished using three- and seven-gallon trees (to get the tree's rootball used to high flood water conditions, potted trees are submerged in the wetland water pockets. At the end of the wet season the trees are removed from the pots and planted in the inundated portions of the wetland where trees had not previously survived.). The presence of desirable understory eliminated the need for nuisance management. 	<ul style="list-style-type: none"> Supplemental plantings occurred in response to vegetative survey results and consisted of trees, shrubs and groundcover needed to meet permit success criteria. Spraying specifically targeted, unwanted vegetation—or weeds—with herbicide at least on an annual basis.
Wetland Functionality Prior to Release	<ul style="list-style-type: none"> Ecotones between the wetlands and the uplands were beneficial to wildlife. 	<ul style="list-style-type: none"> Wetland is utilized by common gallinule, great egret, little blue heron, green heron, glossy ibis, common yellowthroat, and red-winged blackbird based on 2012 monitoring. Wetland is trending to success based on 2012 vegetative monitoring.

Well-Rounded Success

➤ In assessing the overall success of a reclaimed wetland forest, it's important to evaluate how the system functions as a whole, in addition to specific quantitative criteria that the site is measured against.

Mosaic evaluates the success of a mixed forested wetland through quantitative measures, such as tree canopy development, proper undergrowth shrubs and groundcover, and whether invasive weedy nuisance species are present. These indicators, outlined by various regulatory agencies, specify if the reclaimed site is able to provide the beneficial functions found in similar natural habitats. Also, the measurements provide assurance that the site will continue to mature into productive wetland

habitat without the need for any additional upkeep. In meeting these criteria, Mosaic develops sites that are of the same – if not better – quality than pre-mining sites.

The impact of reclamation efforts on land-use within the region is also an indication of a site's success. Mosaic looks to balance the post-mining landscape with uses that will serve both the environment and community. For example, wetlands are placed within the overall landscape in a manner that could allow for future development in other reclaimed areas without compromising the function of the wetlands, and most wildlife corridors are placed in permanent protection through conservation easements. <



Success factors for a mixed forested wetland include proper tree canopy development and the presence of undergrowth shrubs and groundcover.

Mixed Forested Wetland Success At-a-Glance

Key Success Aspects	LPC7 Wetland No. 3 (2000)	PR7 (2007)
Connectivity	<ul style="list-style-type: none"> • Forms the basis for an integrated habitat network based on where it sits in the landscape and the transition to the upland through the buffer. • A swale connects the wetland lobe to Little Payne Creek, where during rainy/wet season wetland waters drain. 	<ul style="list-style-type: none"> • Water drains into wetlands from adjacent uplands, then discharges into the Peace River floodplain via designed outlets to maintain proper hydrology. • Protective ditch and berm system that surrounded the project during mining and reclamation was removed with FDEP approval when water quality monitoring demonstrated the project met state water quality standards. • Constructed upland buffer was connected to the adjacent Peace River floodplain when ditch and berm system was removed.
Drainage/Hydrology	<ul style="list-style-type: none"> • The site currently provides significant functional value as a mixed forested wetland. • Stores flood waters, balances water table, keeping surrounding roads and public spaces less vulnerable to flooding and erosion. 	<ul style="list-style-type: none"> • Vegetative and hydrology monitoring indicates the wetland is performing as designed and trending to success.
Site Performance	<ul style="list-style-type: none"> • As the trees mature through successional stages the forest understory will self-align to adapt to the canopy cover. • Wildlife inhabitants include bald eagles, the endangered woodstork, herons, frogs, fish, alligators, snakes, deer, rabbits and raccoons. • Adjacency to the Little Payne Creek integrated habitat network corridor makes it less likely to be impacted in the future. • By locating the system contiguous to Payne Creek, as compared to an isolated location elsewhere, the wildlife habitat value is optimized, based on research conducted by the University of South Florida. 	<ul style="list-style-type: none"> • Project wetlands and uplands met FDEP reclamation standards and was released in 2012. • Vegetative monitoring results indicate tree and shrub density is 442 trees and 117 shrubs per acre relative to wetland mitigation success criteria of 400 and 100 per acre respectively. • Maintenance herbicide treatments and supplemental plantings will continue until dredge and fill permit criteria are met in order to obtain subsequent releases from other regulatory agencies.

> Successful reclamation projects like LPC7 Wetland No. 3 and PR7 demonstrate Mosaic's leadership in the reclamation of mixed forested wetlands and illustrate its dedication in creating viable reclaimed habitat. This determination, along with the advancement of science-based reclamation technology, allows Mosaic to ensure the long-term sustainable success of a reclaimed site.

Ultimately, reclamation efforts provide balance and benefits to the region by restoring habitats essential to Florida's unique ecosystems. Reclamation also connects native habitats as compared to the existing natural habitat that is often fragmented and isolated. To minimize future disturbance, much of the reclaimed native habitat is or will be protected by conservation easements.

Today, public funding is unable to fully support expensive land conservation land programs. Phosphate mining, followed by science-based reclamation of upland and wetland habitat offers a unique opportunity to favorably contribute to the regional economy and protection and conservation of important ecosystems. <



Mosaic continually monitors and measures the sites it reclaims to ensure they will mature into productive wetland habitat without the need for any additional upkeep.



Mosaic's reclamation efforts provide balance and benefits to the region by restoring habitats essential to Florida's unique ecosystems.