Seepage Slope Wetlands Reclamation

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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 use of mined lands years before any phosphate is extracted. 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 ecosystem.

For more than 40 years, Mosaic and its predecessor companies have successfully reclaimed hundreds of 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 forested swamps and palmetto prairies.

Seepage slope wetlands occur where the gradual slope of the land from uplands down to wetlands or streams allows the flow of water through the soil to "break out" onto and flow over the land surface to wetlands or streams at the base of the slope.

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A Transitional Landscape

> The sustainability of transitional ecosystems is dependent on uplands absorbing and storing rainfall in the soil and slowly releasing stored water to downslope areas — a natural process that yields "base flow" to provide water to wetlands and streams during dry periods.

Seepage slope wetlands occur where the gradual slope of the land from uplands down to wetlands or streams allows the flow of water through the soil to "break out" onto and flow over the land surface to wetlands or streams at the base of the slope. When wetlands are found near the base of the slope, a stream channel outlet may also form to connect the seepage wetland to the regional riverine ecosystem. Often, these systems form near the uppermost segments in each of our major rivers, such as the Peace and Manatee rivers, and are known as headwater tributary wetlands.

Mosaic includes seepage slope wetlands in the reclaimed landscapes to support the regional hydrology. In nature, seepage slope wetlands frequently develop into bay wetlands, due to bay tree intolerance of deep standing water, along with their need for saturated soil conditions. Therefore, seepage slope wetlands are included in post reclamation designs. Application of hydrologic and ecological principles allows the development of land forms that permit the natural ground and surface water base flow process to occur, as well as results in diverse connections between wetland and upland habitats.

Alderman Creek and LMR8 (LMR is a reclamation abbreviation that stands for Little Manatee River), both located at Mosaic's Four Corners mine site in Hillsborough County, are reclaimed seepage slope wetlands that provide beneficial hydrologic and ecological functions as natural seepage slope wetlands.

Constructed in 1998, the Alderman Creek site used sand tailings to create a gradual slope from the upland portion down to the floodplain of Alderman Creek. The seepage slope provides the water needed to sustain an eight-acre bay wetland that drains over the land surface to Alderman Creek. In 2005, the Hillsborough County Environmental Protection Commission deemed Alderman Creek bay wetland as "trending toward success," with all success criteria having been met with the exception of those dependent on tree size (e.g., diameter at breast height and canopy cover.).

Prior to mining, the LMR8 site was improved pasture that was grazed and periodically harvested for sod, providing only marginal wildlife benefits. The reclamation was constructed in 2010 and includes a 16-acre seepage slope wetland that provides an ecological and hydrological connection between a reclaimed upland xeric habitat and an adjacent perennial stream. LMR8 is currently being maintained and monitored by Mosaic. <

Best Practices

> During the conceptual design of a reclaimed seepage slope wetland, Mosaic applies state-of-the-art scientific knowledge as well as continuous improvement practices to develop detailed design plans to allow creation of sustainable habitats.

Given the unique hydrological function of this type of wetland, a number of techniques and methods can be used to ensure the site will function as designed once constructed.

Reference sites, which are nearby seepage slope wetlands that provide hydrologic and ecological function, often provide a baseline for a site's design, as well as a benchmark to measure the reclaimed site's success. In locations like Alderman Creek, reference sites provide an indication of the ideal hydrology, elevation and vegetative components.

Some sites are designed through the use of adaptive management. At LMR8, Mosaic initially expected that the site would be needed for a clay settling area, which provides water storage for the mining operation. Through advances in clay storage management, Mosaic was able to eliminate the need for this use and instead create high-quality natural habitat that forms a complete micro ecosystem — from dry xeric uplands to headwater wetlands, with a stream system that connects to other preserved habitats off-site.

The design of the LMR8 seepage slope wetland applied state-of-the-art science and key learnings from Mosaic's Alderman Creek site. <

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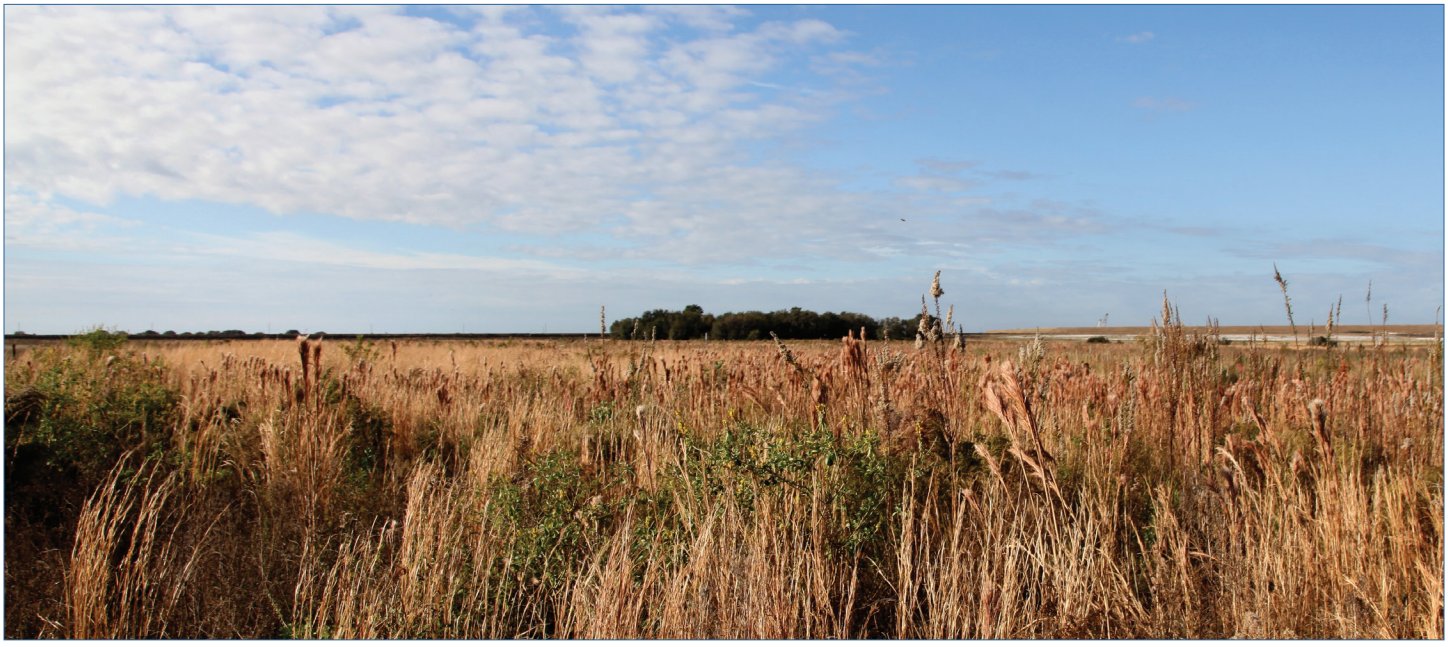
Seepage Slope Wetland Design At-a-glance

Key design aspects	Alderman Creek (1998-99)	LMR8 (2010)
Design reference site	• Mosaic's Hardee Lakes reclaimed seepage slope wetland was used as an analog site in the design of Alderman Creek.	• Mosaic's Alderman Creek reclaimed seepage slope wetland was used as an analog site in the design of LMR8.
Elevations	• The seepage slope was designed to allow for desired vegetation zones that would support a bay system.	• As with Alderman Creek, the seepage slope was designed to allow for desired vegetation zones that would support a bay system.
Hydrology	• The water source originates from a sand tailings hill upslope that allows ground water flow to break out at the wetland edge.	• The water source originates from a herbaceous wetland on an upslope sand tailings hill that allows ground water flow to break out at the wetland edge, as adapted from Alderman Creek.
Vegetative communities	• Bay swamp drained by wetland outlet swale/slough.	• Bay swamp drained by designed perennial stream.



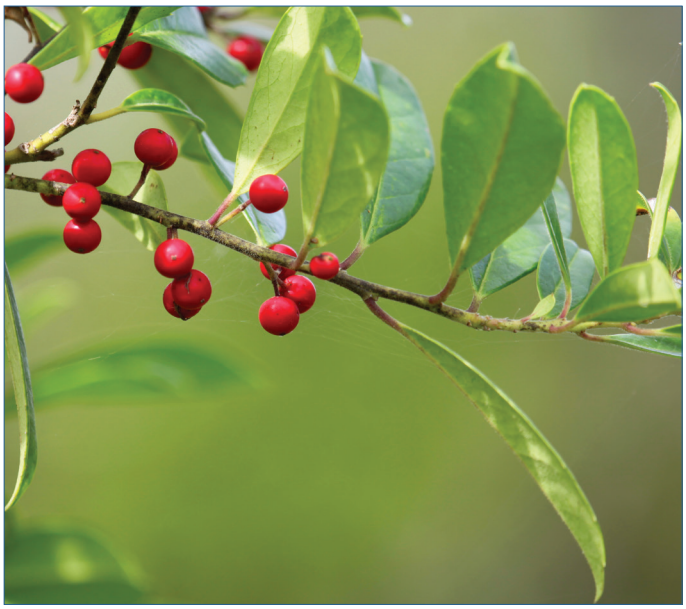
Mosaic applies state-of-the-art scientific knowledge as well as continuous improvement practices to develop detailed design plans.

Exact Science

> Putting a reclaimed seepage slope wetland in the ground as it was designed on paper is the key focus of the execution phase.

Mosaic knows that every detail counts when it comes to elevation tolerances and soil composition – the foundation of the system's success. On newer sites, Mosaic utilizes Global Positioning System technology to make sure the site is graded to exacting design specifications.

Although Alderman Creek and LMR8 were constructed more than 10 years apart, both sites utilized much of the same execution approach with a few key differences that include the use of muck and supplemental plantings <



A key factor for determining the success of a reclaimed seepage slope wetland is measuring how the site compares to natural, undisturbed habitats.

Qualitative and quantitative measures of success also include water levels in the upland soils, elevations where the water breaks out onto the land surface during wet summer months and dry winter months, and finally, the presence of desirable, naturally recruiting and reproducing species on the site.

Seepage Slope Wetland Execution At-a-glance

Key execution aspects	Alderman Creek (1998-99)	LMR8 (2010)
Establishing the site's elevations and hydrology	• Filled with sand tailings and contoured to grade. • A blanket of sand was placed outside the wetland at a higher elevation to create ground water seepage breakout points at the wetland edge. • Muck and tree stumps were directly transferred from an existing pre-mining wetland and spread in across the Alderman Creek wetland site. • As-built survey documents construction design criteria met.	• Utilized key learnings from hydrology performance at the Alderman Creek site • Pumped sand tailings created a seepage head. • Utilized the sand blanket seepage component to create seepage breakout conditions. • Contoured the ground, creating the seepage bank.
Re-vegetation	• Direct transfer of muck and tree stumps from a natural wetland approved for mining. • Planted containerized trees and transplanted herbaceous groundcover.	• Ground cover was planted on one-foot centers with species collected from other reclaimed wetlands. • Planted gallon stock trees at eight feet apart.
Monitoring	• Installed piezometer transects to document ground to surface water flow patterns.	• Piezometer network installed to measure ground water levels and seepage flow. Rainfall and flow is also measured in the perennial stream.
System maintenance	• Additional muck added to achieve design hydroperiod depth. • Nuisance species treated on an as-needed basis.	• No supplemental planting required to date. • Nuisance species treated on a regular basis.

Contributing Success

> There are several factors that indicate the success of a reclaimed seepage slope wetland. Key measurements of the site's performance illustrate how the site compares to natural, undisturbed habitats and also show that the site has performed as designed.

Qualitative and quantitative measures of the system also denote the success of a reclaimed seepage slope wetland. These measures include water levels in the upland soils, the elevations where the water breaks out onto the land surface during wet summer months and dry winter months, and most importantly, desirable species are naturally recruiting and reproducing at the site.

Wildlife utilization is another indication of a site's success in terms of broader support to the regional ecosystem. Because seepage slope wetlands are connected to upland habitat and adjacent wetlands, the system's ability to support both upland and wetland dependent wildlife is another indicator of success. <

Reclamation efforts provide balance and benefits to the region by restoring habitats that are characteristic of Florida's unique ecosystems.

Seepage Slope Wetland Success At-a-glance

Key success aspects	Alderman Creek (1998-99)	LMR8 (2010)
Connectivity	• Excess water from the wetland flows through a slough to connect to Alderman Creek.	• Connected to the LMR8 perennial stream and xeric site. • A reclaimed perennial stream connects the LMR8 seepage wetland to Howard's Prairie Preserve, which feeds into the Little Manatee River, a floodplain/habitat wildlife corridor protected by a conservation easement.
Drainage & Hydrology	• Upslope, at the top of the sand tailings hill is an herbaceous wetland, which serves as the origination of the water source for the seepage slope.	• Upslope, at the top of the sand tailings hill is a reclaimed dry xeric community; groundwater seepage below the xeric site provides the water source for the seepage slope.
Site Performance	• All of the permit success criteria have been met, with the exception of those dependent on tree size (e.g., DBH and canopy cover).	• UMAM assessment demonstrates preliminary success.

Progress Defined

> Successful sites like Alderman Creek and LMR8 demonstrate Mosaic's leadership in the reclamation of seepage slope wetlands. Mosaic's ability to adapt land uses and leverage best practices to create high-quality habitats continually progresses along with the success of reclamation efforts.

Ultimately, reclamation efforts provide balance and benefits to the region by restoring habitats that are characteristic of Florida's unique ecosystems. Reclamation also results in native habitat that is connected as compared to existing natural habitat that often consists of small, fragmented and isolated habitat patches. Much of the reclaimed native habitat is or will be protected from future disturbance by conservation easements.

Today, public funding is unable to fully support expensive conservation land acquisition programs. Mining, followed by reclamation of upland and wetland habitat, offers a unique opportunity to contribute both to the regional economy and ecosystem. <

Much of the reclaimed native habitat is or will be protected from future disturbance by conservation easements.

All photos were taken in reclaimed seepage slope wetlands in and around Mosaic's Four Corners mine site in Hillsborough County.