
LAKE OKEECHOBEE WATERSHED RESTORATION OF FORMER DAIRIES

Mandate:

Lake Okeechobee Watershed Protection Program (LOWPP)

Candler Ranch**Project Overview:**

The remediation of Former Dairies project is one piece of a comprehensive program to reduce phosphorus (P) loads into Lake Okeechobee to meet the FDEP Total Maximum Daily Load (TMDL) limitation of 140 metric tons per year. The Candler Ranch is the site of former Rofra Dairy and is located in the S-191 (TC/NS) basin in Okeechobee County, Florida. This is a former dairy that participated in the SFWMD Buy-out Program: on April 24, 1991, a total of 910 lactating animals were removed from the property. Since the dairy closure, the entire property has been operated as a cow/calf beef operation. In 1993, the ranch made some changes and implemented some BMPs throughout the property however runoff water quality did not meet the 0.35 mg/L TP standard concentration. Further BMPs were suggested by the AgNMAs (Agricultural Nutrient Management Assessment Plans) that were developed for each of the former dairy properties that formed the basis of the SFWMD and FDACS remediation plans that implemented the BMPs.

Project Objectives:

1. Amend residual manure and pond water contained in the waste lagoons in the High Intensity Areas (HIA).
2. Retain surface water runoff from the former dairy High Intensity Areas (HIA).
3. Improve ditches, ponds, and culverts throughout the property to increase stormwater retention onsite.
4. Monitor water quality after post construction and remedial treatments in the property.
5. Amend the High Intensity Area with Ca/Mg base materials and Fe and Al salts.

Pre-Conditions of the Project:

1. In 2002, Soil and Water Engineering Technology (SWET) prepared a report outlining the phosphorus balance on the Candler Ranch property and its potential impact on surface water quality. A comprehensive soil survey showed that most of the P stored in the soil (top six

inches) was concentrated on an 85 acre area (HIA) located in the SW corner of the property, with soil P concentrations as high as 1854 mg/kg around the dairy barn.

2. On April 7, 2005, Ortho-P concentrations from the 2nd stage waste pond ranged from 5.7 to 6.8 mg/L. The volume of water to be treated was estimated to be 4 million gallons.
3. The volume of manure was estimated to be approximately 300 cubic yards (TP = 11 mg/kg) in the 1st stage waste pond and 3,000 cubic yards (TP = 83-150 mg P/kg) in the 2nd stage waste pond for a total of 3,300 cubic yards or about 5,404,838 lb of manure.

Project Features and Treatments:

1. Alum treatment and back filling of the 1st and 2nd dairy waste holding ponds.
2. Replanting areas of 1st and 2nd stage waste ponds with Bahia grass.
3. Improvement of High Intensity Area (HIA) surface water retention consisting of culvert installation and ditch and cooling ponds improvements.
4. Improvements of cattle crossings over Chandler Hammock Slough.
5. Monitoring of system performance after one year post construction and remedial treatments.

Status of the Project (June 2008):

1. Alum treatment and back filling of 1st and 2nd dairy waste holding ponds is complete. On January 13, 2006 Ortho-P concentrations post Alum treatment ranged from 0.025 to 0.37 mg/L. Approximately 4 million gallons of surface water was treated in the 2nd stage waste pond. Using a pre-treatment Ortho-P average concentration of 6.25 mg/L and a treated water average concentration of 0.13 mg/L, a 98% reduction was achieved.
2. Replanted areas from the 1st and 2nd stage waste ponds with Bahia grass are complete.
3. Expansion of the former HIA cooling ponds (1 and 2) and ditch improvements to retain additional runoff are complete.
4. Removal of existing culverts and replacement with new culverts with risers, which will provide a greater flow control, is complete.
5. Improvements of cattle crossing along Chandler Hammock Slough are complete. These improvements consisted in the replacement of existing culverts at different cattle crossings, with culverts with risers to increase runoff retention in the Chandler Hammock Slough.
6. Water sampling to evaluate the effectiveness of post construction of remedial treatments is ongoing because of the drought. Only 6 sampling events out of the original 15 sampling events

in the contract have been completed from July 2006 to April 2008. There is not enough water quality data at this point to properly evaluate the remedial treatments on the ranch.

7. Treatment of the HIA area with Ca/Mg base materials and Fe and Al salts was never performed, as all parties involved could not agree on the soil amendment that was safe and most effective for the project.

Lamb Island

Project Overview:

In 1994, the District acquired the Lamb Island Dairy site as part of the Kissimmee River Restoration Project to restore historic ecological functions to the Kissimmee River and floodplain. The property was purchased for establishment of floodplain conservation easement along Cypress Slough. However, as a former dairy site the property has accumulated high levels of phosphorus that are being discharged at excessive levels. In November 2000, District staff developed recommendations for the reduction of phosphorus discharge from the site.

A consultant was selected and the project was initiated in August 2002. The project consisted of three major tasks, 1) Detailed Design for Selected Alternatives, 2) Project Implementation and Performance Monitoring, 3) Project Performance Evaluation. Construction was completed by June 2005. Performance monitoring was conducted from November 2004 through November 2005.

Project Objective:

The objective of this project was to reduce, to the extent most practicable, the storm water TP load discharges from the Lamb Island Dairy property (Site). The SFWMD retained an engineering firm to implement one or more remedial alternatives as recommended by an Agricultural Nutrient Management Assessment (AgNMA) to minimize phosphorus (P) discharges from the Site. The implemented alternatives were aimed at reducing P discharges while taking into consideration cost effectiveness as well as the minimization of long-term operation and maintenance requirements.

Pre-Conditions of the Project:

The SFWMD purchased this property in 1994. Best management practices initiated in the early 1990s reduced phosphorus concentrations from this site from ~30 mg/L to ~5 mg/L. Since 1997, total phosphorus (TP) concentrations have averaged 3.1-3.7 mg/L on an annual basis, a concentration range 3-fold greater than the Surface Water Improvement Plan (SWIM) limit of 1.2 mg/L TP. Concentrations would need to decline to 0.35 mg/L TP to reach the SWIM limit for improved pasture.

Flow data are not measured except at inflow structures to the lake, so model simulations were used to estimate P load from the dairy. Based on this approach, the average annual edge-of-field

P load is approximately 1.5 metric tons with 0.5 tons estimated load to the Lake. Florida Department of Environmental Protection has mandated a TMDL of 140 metric tons/yr for Lake Okeechobee.

While this is a small load compared to the total P load reaching the Lake each year, the loading rate for this site is approximately 12.5 lbs/acre, which is a high loading rate. As defined by District staff, a priority site has a loading rate equal to or higher than 2.7 lbs/acre. Of 12 priority sites identified under the Works of the District program, only one of them had a loading rate higher than the Lamb Island Dairy site.

Project Features and Treatments:

The following design components were implemented:

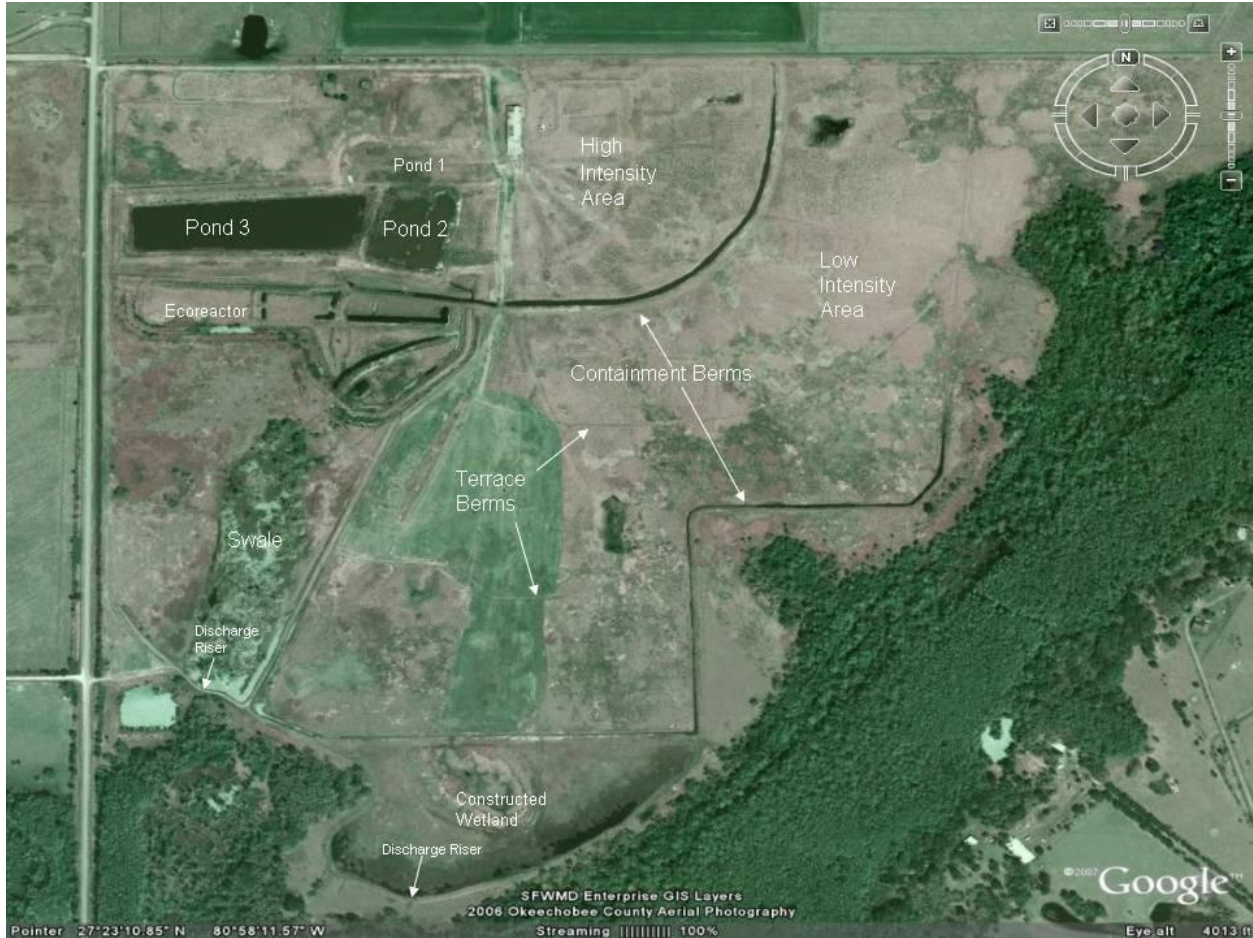
1. Construction of a surface water containment berm around the HIAs and high P soils to allow gravity flow of storm water runoff to the existing eco-reactor and swale for biological (wetland) treatment;
2. Construction of a containment berm at the edge of farm to collect and store a pre- determined amount of outer pasture runoff;
3. Construction of terrace berms in the pasture runoff containment area;
4. Construction of a wetland at the southern end of the pasture runoff containment area for biological (wetland) treatment;
5. Alum amendment of the dairy wastes (residual manure solids) contained in ponds 1 and 2 leaving inactivated material in-place;
6. Fill/grade pond 1;
7. Fill/grade pond 2 or suitable to maintain a crop;
8. Alum amendment of the impounded waters contained in the settling pond (Pond 3) and cooling pond to inactivate and precipitate water column phosphorus content;
9. Dewatering and backfilling the onsite perimeter ditch; and,
10. Hay cropping of all available land areas.

Status of the Project (June 2008):

The annual pre-condition load was estimated using the phosphorus loads calculated using Creams-WT. The rainfall reported for years 1993 (55.0 inches), 1994 (55.9 inches), and 1996 (56.6 inches), was similar to the monitoring period, and therefore, the average of the loads

calculated for these years was used to estimate the precondition load. Using this approach, the annual pre-condition load is 2,343 kg or 5,165 lb.

Post construction monitoring commenced on November 18, 2004, and sampling continued with a total of 16 sampling events completed through November 29, 2005. During this period there was zero discharge from the high intensity treatment system and a total of approximately 23 lbs of P discharged from the low intensity treatment system. Using the annual pre-condition P load estimate, 5,142 lbs of P were retained on the farm (99.5% retention). There was zero discharge from the farm during 2006 and 2007 due to drought conditions, therefore 100% load reduction.



Mattson Dairy

Project Overview:

The remediation of former dairies project is one piece of a comprehensive program to reduce phosphorus loads into Lake Okeechobee to meet the FDEP Total Maximum Daily Load (TMDL) limitation of 140 metric tons per year. The former Mattson and Pilgrim Dairies are located in the S-191 (TC/NS) basin in Okeechobee County, Florida. The Mattson and Pilgrim Dairies were closed in 1989 and 1991, respectively, as part of the SFWMD Dairy Buy-out Program. In May

1992, Mattson Dairy was issued a WOD permit, regulating P discharges concentrations no greater than 0.35 mg/L. The land use of the former Mattson Dairy property has been low-density beef cattle grazing since the dairy closure.

Project Objectives:

Based on the AgNMA recommendations, three main design features were developed in order to achieve the project objective of minimizing P discharges from the property:

1. Achieve a farm wide nutrient balance.
2. Reduction of P runoff by intercepting and binding high P soil runoff from the old HIA and crop fields.
3. Development of a stormwater management system to provide water quality detention of runoff.

Pre-Conditions of the Project:

1. These dairies were constructed in the 1950's, encompassing an area of 740 acres with drainage toward the southeast to Myrtle Slough. The Mattson property encompasses about 355 acres of pasture, mainly Bahia grass with 73 acres planted with Stargrass.
2. As part of the Buy-out program, the Pilgrim Dairy removed 253 lactating animals on June 21, 1989 and Mattson Dairy removed 405 lactating animals on July 3, 1991.
3. Various BMPs were implemented in the property over the years in an attempt to meet the regulated P discharge limit. While a reduction in P concentration from 7.0 mg/L to 2.5 mg/L was observed from 1989 to 2000, the P concentration was still one order of magnitude higher than the regulated limit of 0.35 mg/L.
4. The major P source on the property was identified to be the old HIA area, based on soil P measurements that ranged from 60 to 2570 mg/kg.
5. In order to further reduce P concentrations from the property, several AgNMA recommendations were suggested. Some of these recommendations consisted of: a) fencing off old dairy lagoons to restrict cattle access, b) additional BMPs such as a nutrient management plan to improve water quality, c) plant harvest crops in the HIA areas to mine excess soil P, and d) the use of soil aluminum and iron compounds to stabilize P in the soil.

Project Features and Treatments:

1. A farm wide nutrient balance will be achieved by:

a) Management of cow density through regional grazing such that P application do not exceed P uptake in pastures b) Through rotational grazing the time that the herd spend on a particular pasture will be reduced such that the pasture will be able to uptake the P deposited through manure deposition, and c) In addition, cows will be removed from fields with excessively high P concentrations and hay will be planted and harvested in order to promote the mining and/ or stabilization of P in these fields.

2. Reduction of high soil P runoff from the old HIA will be achieved by:

a) The installation of 35 ft buffer strips along the banks to intercept high P laden sediments from the old HIA area to adjacent water bodies, and b) No grazing, manure deposition or fertilizer application between the buffer strips.

3. Development of a stormwater management system by:

a) Constructing several water control structures downstream of previously impacted wetlands to store excess runoff, b) Construction of a stormwater pond of about 8.5 acres in size, c) Construction of a pump basin with a diesel powered 36 inch axial flow pump, d) Construction or cleaning of ditches to route stormwater to a single pump basin, e) Plugging the discharge from the southern cooling pond to the road side ditch and diverting it into the stormwater pond and f) Construction of a single overflow structure in the stormwater pond, allowing excess stormwater to flow into Myrtle Slough.

Status of the Project (June 2008):

1. Construction is 100% complete.
2. The first quarter of monitoring is underway.

McArthur Farms Dairy Barn #5

Project Overview:

The McArthur Farm Dairy Barn #5 project is a part of a comprehensive program to reduce phosphorus (P) loads into Lake Okeechobee to meet the FDEP Total Maximum Daily Loads (TMDL) limitation of 140 metric tons per year. McArthur Farms, Inc. former Dairy Barn #5 is located in the S-191 basin in Okeechobee County, Florida. The dairy operation was closed in 1991 as part of the SFWMD Dairy Buy-out program. The land use of the former McArthur Barn #5 property includes 100 acres of citrus groves, hay production and low-density beef cattle grazing. In 2003, Engineering and Water Resources, Inc. prepared an AgNMA report identifying alternatives for the remediation of former dairies. The goal of the AgNMA was to provide a basis for a management plan that would reduce P concentrations in surface waters from former dairies to 150 ppb. The AgNMA also provided an evaluation of the total P budget on the site and provided recommendations for possible BMPs to reduce P discharges from the site.

Project Objectives:

1. Reduce phosphorus runoff in stormwater from former dairy.
2. Redistribute high phosphorus soils from the former dairy lagoons onto hay production areas for offsite phosphorus export in the hay produced.
3. Reduce wet season discharges by storing water in wetlands and drainage canals.

Pre-Conditions of the Project:

1. In 2003, PSI was retained by the SFWMD to implement BMPs and agronomic practices to improve water quality from the property. The data provided in the AgNMA study together with additional data from PSI provided the basis for the development of the Phosphorus Remediation Plan (PRP) for McArthur Farms Dairy Barn #5.
2. The PRP was designed to maximize phosphorus loads reductions from upland sources and the treatment of surface water through the introduction of Best Management Practices (BMPs). The goal of the PRP was to provide a basis for the reduction of phosphorus content of surface water discharge from this property from an average of 790 ppb to 150 ppb.
3. During the development of the PRP, historic and existing land uses, farm management practices and soil conditions were examined to determine the most appropriate course of action to meet the objectives.

Project Features and Treatments:

1. Treatment of pasture and hayland areas with Pro-Sil (silica rich slag used in reducing water-extractable P in soils).
2. In situ treatment of organic solids in the holding ponds with Aluminum Sulfate (AlSO₄). PSI estimated that a total volume of 162,852 ft³ of organic solids with an estimated TP mass of 14,076 Lbs needed to be treated.
3. Renovation of the dairy barn area to hayland which includes:
 - 3a. Dairy barn renovation:
 - a) Herbicide treatment and mechanical clearing of trees and shrubs
 - b) Removal of concrete and other barn debris
 - c) Re-grade and disk the barn area
 - d) Broadcasting and deep disking (~ 12 inches) of Pro-Sil to maximize its P binding activity in the soil profile
 - e) Fencing the area to exclude cattle grazing
 - f) Fertilization and broadcast seeding the Dairy Barn area with mulatograss (hybrid of *Brachiaria* spp.).
 - 3b. Pastureland renovation:

a) Herbicide treatment and disking of area b) Broadcasting and disking of Pro-Sil. c) Fencing the area to exclude cattle grazing d) Fertilization and seeding with Sprigged Stargrass

4. Surface water retention/treatment and wetland rehydration, which includes:

a) The construction of weir-controlled ditch blocks. b) Improvement of existing surface water collection ditches through organics removal. c) Filling and rerouting of existing ditches to maximize rehydration and surface water contact time within the wetlands. d) Increase surface water storage by the addition of a-stage controlled grassed waterway. e) Improve agronomic land management practices by the addition of three cattle crossings, isolation of key retention system component from cattle through the repair and construction of fencing, the removal of organic solids from retention ditch segments and the restored pond that improved system hydraulics and maximized surface water storage capacity.

5. Monitoring of integrated Best Management Practices, which includes:

a) Surface water level measurements in the re-hydrated wetlands and restored ponds. b) Water quality sampling and analysis from re-hydrated wetlands and restored ponds (TP, SP, SRP, pH, Dissolved O₂, and Conductivity). c) Sediment sampling and analysis from restored ponds and selected ditch segments (Organic matter, Melich-P, Water soluble P, and TP). d) Surficial ground water measurements using wells (Soluble and reactive P). e) Soil sampling and analysis (Water soluble P and Mehlich-P). f) Vegetation sampling from transects of BMP-1 (stargrass), BMP-3a (mulatograss) and BMP-3b (stargrass).

Status of the Project (June 2008):

1. Pasture and hayland treatment with the P-immobilization product Pro-Sil was completed during the summer of 2006. Melich P concentrations from these areas decreased from 403.66 ppm in 2002 to 183.51 ppm in 2006 for a 55.7% P reduction. However, soil analysis from 2007 (210.63 ppm) and 2008 (255.61 ppm) indicates that both Mehlich-P and WSP concentrations from the 0-12 inches have increased from the 2006 Pro-Sil baseline condition.
2. Holding pond and conveyance ditch organic solids stabilization and treatment was completed in December of 2005. After the applications of AlSO₄ to each of the ponds, the organic solids were mixed and covered with fine sand from adjacent berms.
3. Renovation of the Dairy Barn area to hay land was completed in the summer of 2006. Mulatograss and stargrass from the high intensive area and southern portion of the BMP-3 area began thriving and covering the area during the wet season of 2007 and relatively wet winter of 2008. Mehlich P concentrations from these areas decreased from 479.51 ppm in 2002 to 183.91 ppm in 2006 for a 61.6% P reduction. However, soil analysis from 2007 (255.69 ppm) and 2008 (208.91 ppm) indicates that both Mehlich-P and WSP concentrations from the 0-12 inches have increased from the 2006 Pro-Sil baseline condition.

4. Surface water retention/treatment and wetland rehydration is complete. One year of water quality monitoring has been already completed.