Corkscrew Watershed Initiative

Deliverable 6.1: Final CWI Short- and Long-Term Restoration Projects Technical Memorandum

Prepared for

South Florida Water Management District

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Prepared by

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Abbreviations and Acronyms

1-D	one-dimensional
AMP	Airport Mitigation Park
BCB	Big Cypress Basin
CREW	Corkscrew Regional Ecosystem Watershed
CWI	Corkscrew Watershed Initiative
CWI Project	Corkscrew Watershed Initiative Project
ERP	Environmental Resource Permit
LiDAR	light detection and ranging
NAVD	North American Vertical Datum of 1988
O&M	operation and maintenance
PDT	Project Delivery Team
SFWMD	South Florida Water Management District
TWG	Technical Working Group

1.0 Background/Introduction

1.1 Project Purpose

The objective of the Corkscrew Watershed Initiative (CWI) Project is to develop a comprehensive strategy to achieve ecological restoration of the Corkscrew Watershed by improving wetland hydroperiods and natural flows, while reducing flood risk in nearby flood-prone areas without adversely impacting the water supply and water management needs of the Corkscrew Watershed. The objective will be accomplished through a public planning process that engages and involves key partners, stakeholders, and the public. The project will identify viable short-term and long-term strategies to achieve the CWI Project goals. The proposed restoration alternatives will be cost-effective, feasible, and resilient. The CWI Project will consider population growth, land development, and climate change including sea level rise and future rainfall. This project aligns with the mission of the South Florida Water Management District's (SFWMD) Big Cypress Basin (BCB) 2023–2028 Strategic Plan and will contribute to the resiliency of the Big Cypress Watershed.

1.2 Project Background and Scope of Work

The CWI Project boundary encompasses southern Hendry County, northern Collier County, and southern Lee County as shown in Figure 1-1. The CWI Project area is comprised of rivers (Imperial and Estero), creeks (Halfway and Spring), and wetland sloughs/swamps (Flint Pen Strand and Upper Corkscrew Swamp) within the Estero Bay Basin Watershed in southern Lee County and the Cocohatchee Canal/River Basin and Golden Gate/Naples Bay Watershed in northern Collier County. The initial project planning area was broadened beyond what may be considered an effective area to ensure thorough consideration of vulnerable communities and ecosystems.

Previous studies and monitoring have documented reduced hydroperiods and increased water level recession rates in Audubon's Corkscrew Swamp Sanctuary (owned and managed by National Audubon Society), a critically important ecosystem, within the past 60 years. This 3-year planning CWI Project (2024–2027) is funded by the BCB and builds on previous efforts to determine potential causes of the shortened hydroperiod documented at the Corkscrew Swamp Sanctuary. The Technical Working Group (TWG) is serving as the project planning team and is comprised of SFWMD staff, representatives of local governments in the region, and others with responsibility for the management of the Corkscrew Watershed. TWG participants are those with expertise in the Corkscrew Watershed and the ability to fund and implement projects in the CWI Project area. Collectively, representatives of the City of Bonita Springs, Collier County, Corkscrew Swamp Sanctuary, Corkscrew Regional Ecosystem Watershed (CREW) Land and Water Trust, Lee County, SFWMD, and Village of Estero make up the TWG. The TWG is providing guidance to the SFWMD Project Manager responsible for administering the contract and acting as the liaison between the TWG, the CWI Project Consultant (J-Tech), and the SFWMD Project Development Team.

The CWI Project work plan was finalized on July 1, 2024, and includes a detailed history of work on the project that has been completed to date by the SFWMD and TWG member organizations.

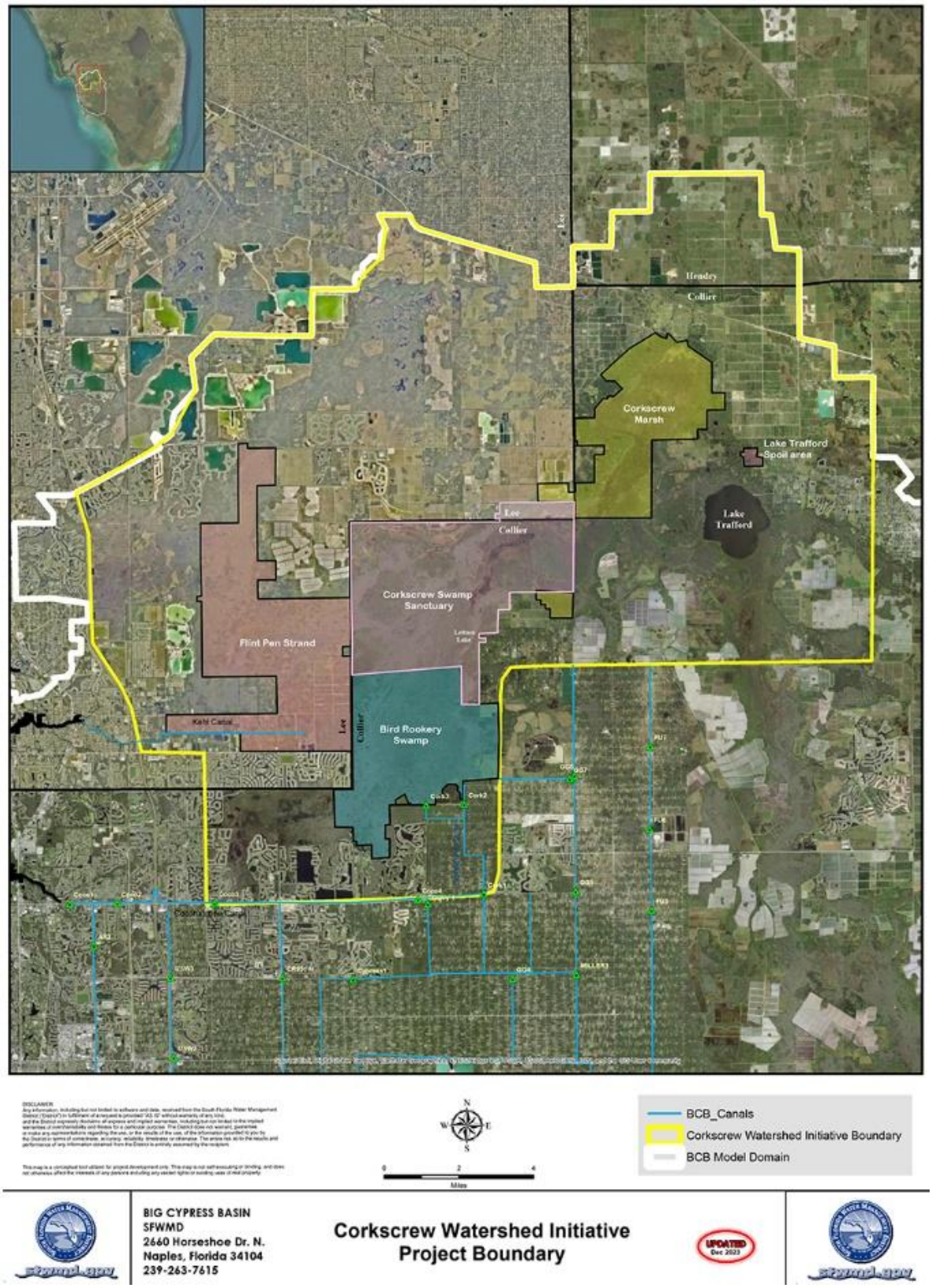


Figure 1-1. Corkscrew Watershed Initiative Project Area

The work plan also identifies the various tasks and deliverables that will be completed as part of the CWI Project. In summary, the CWI Project tasks include the following:

- Task 1 – Project Coordination (ongoing)
- Task 2 – Information Collection and Review and Site Reconnaissance (completed)
- Task 3 – Develop Performance Measures and Metrics (completed)
- Task 4 – Refine Project Area (completed)
- Task 5 – BCB Model Refinement (completed) and Existing Conditions Simulation (in progress)
- Task 6 – Develop Initial List of Potential Ecologic and Hydrologic Restoration Projects (in progress)
- Task 7 – Future Baseline and Alternative Conditions Models Development/Evaluation
- Task 8 – Develop Final Project Matrix Including Project Goals, Cost and Regulatory Requirements
- Task 9 – CWI Public Planning Project Report, Conceptual Plan(s), and Funding Summary Memo

The previously submitted Performance Measures and Metrics (Task 3) defined more specific objectives of the project and how proposed restoration alternatives would be evaluated. Over the past several months, J-Tech has been working with the SFWMD Project Manager, TWG, and SFWMD Project Delivery Team (PDT) to develop conceptual projects to achieve these objectives. In general, projects were developed to address a specific issue within a specific area. An initial screening was conducted based on available information regarding the effectiveness of the project concepts. Those projects passing the initial screening will be combined with others to formulate overall comprehensive CWI alternatives for further examination. This memorandum summarizes the list of proposed conceptual restoration projects developed and an initial formulation of project alternatives for further consideration.

For purposes of this memorandum, the proposed conceptual restoration projects (or projects) refers to the projects developed for consideration with input from the TWG and PDT. The conceptual restoration projects refers to the projects that passed the initial screening for inclusion in the alternatives development. Restoration alternatives include groups of projects which together provide an overall approach to achieving CWI goals. The projects are combined into five restoration alternatives that will be further screened and to select three for more detailed modeling and analysis.

The proposed conceptual restoration projects were developed in coordination with the TWG and PDT and have been identified prior to completion of the hydraulic and hydrologic existing conditions model. Therefore, the short- and long- term restoration projects outlined below have been identified without the benefit of modeling results.

1.3 Document Structure

This CWI Short- and Long-Term Restoration Projects Technical Memorandum meets the requirements of Deliverable 6.1 (CWI Short- and Long-Term Restoration Projects Technical Memorandum). Section 2.0 of this memorandum summarizes the project goals. Section 3.0 presents the performance measures and metrics previously developed to provide a basis for evaluating proposed conceptual restoration projects. Section 1.0 summarizes additional background information collected to support the development and screening of proposed conceptual restoration projects. This includes a high-level summary of existing

conditions and conceptual model as well as project objectives and challenges to achieving the objectives. Following this background information, 11 concept level proposed conceptual restoration projects are reviewed in Section 5.4.6. Each summary provides a description and objective; specific challenges; related performance measurements; elements to be included in each project; initial approach to modeling the benefits and impacts of project implementation; and initial assessments of accessibility, maintenance, constructability, project risk, and permitting considerations. In Section 6.0, these individual projects are combined into an initial list of restoration alternatives proposed for more detailed evaluation.

2.0 Project Goals

The CWI Project goals include ecological restoration of wetland hydrology and habitats, providing flood protection, and maintaining and possibly enhancing water supply while ensuring the CWI Project components are cost-effective, have stakeholder support, and can be implemented. These goals provide the framework for the performance measures and metrics that will be used to evaluate the components of the CWI Project. Additional details about each goal are included in the sections below.

2.1 Hydrologic Restoration of Wetlands

The wetlands in the CWI Project area have been impacted by changes in hydrology due to modifications in water flows from development, regional drainage infrastructure and increased groundwater pumping. To restore wetland hydrology, several measures could be evaluated including creating more natural sheet flow patterns, modifying water depths to more closely match historical depths, establishing hydroperiods that are more similar to historical conditions, improving water recession rates for wetland communities, and evaluating potential impacts for saltwater intrusion.

2.2 Habitat Restoration

The CWI Project area includes habitat for multiple species, including those that are threatened or endangered. Measures to improve and restore habitat in the CWI Project area include removing undesirable vegetation and replanting with native species, restoring habitat in key locations for wildlife use especially for threatened and endangered species, improving connectivity of habitats for wildlife use, and modifying the fire ecology to promote native upland and wetland vegetation species.

2.3 Flood Protection

In recent years, there has been an increase in development near the CWI Project area and additional development is planned. Therefore, it is important that the CWI Project elements not negatively affect the flood protection level of service for that development. In addition, sea level rise conditions affect the downstream and Imperial River portions of the CWI Project area and must be evaluated in selecting Project components to design for those conditions.

2.4 Water Supply

The urban developments and agricultural properties near the CWI Project area are considered existing legal users of water. Therefore, it is important that the CWI project elements not negatively affect the water supply level of service for these permitted users. The CWI Project components focused on storage should help to increase aquifer recharge and thereby improve water supplies. The SFWMD Lower West Coast Water Supply Plan has additional information regarding water supply planning in this area.

2.5 Project Implementation

When selecting components for the CWI Project, the cost effectiveness, operation and maintenance (O&M) costs, available grant funding, implementation timeline, ease of implementation, and stakeholder support provide important decision points in the success of the project. In addition, the CWI Project components may be temporary or permanent depending on the solution type needed.

3.0 Performance Measures and Metrics

To evaluate the ability of the CWI Project to meet the goals described in Section 2.0, performance measures and metrics will be assessed. These parameters must be relatively easy to measure and informative to multiple aspects of the CWI Project, and some should also be capable of being modeled. This section summarizes the proposed performance measures and metrics.

3.1 Performance Measures and Metrics by Goal

For each goal, J-Tech identified performance measures and metrics based on input from the SFWMD Project Delivery Team and TWG members. Table 3-1 summarizes the performances and metrics that will be evaluated to determine whether CWI Project components meet the established goals.

Table 3-1. Performance Measures and Metrics by CWI Project Goal

Goals	Performance Measures	Metrics
Hydrologic Restoration of Wetlands	Saltwater Intrusion	The proposed approach cannot have significant potential for adverse impacts to salinity levels in areas at risk to high salinity
	Sheet Flow	Remove manmade features that cause a reduction in sheet flow
	Water Depth Targets	Establish more historic water depths
	Dry Season Water Level	Improve dry season (November 1 – May 31) water levels/establish dry season water levels to more historic conditions
	Hydroperiods	Establish more historic hydroperiods
Habitat Restoration	Vegetative Community	Attain more appropriate mix of desirable vegetation for various vegetative communities
	Wildlife Use	Key representative species
	Threatened and Endangered Species	Protected species (snail kite, Florida Bonneted Bat, caracara, gopher tortoise, Eastern indigo snake, panthers, burrowing owl, etc.)
	Connectivity	Develop wildlife and hydrologic corridors
Flood Protection	Flood Reduction - Future Conditions	Level of flood reduction with future conditions (development, sea level rise, and storm events)
Water Supply	Water Supply/Aquifer Recharge	Maintain water supply
Implementation	Cost Effective	Cost-benefit analysis
	O&M Costs	Evaluation of O&M needs
	Grant Funding Available	Total grant funding for the project
	Short- Versus Long-Term Implementation	Implementation timeframe
	Stakeholder Support	Level of support
	Ease of Implementation	Level of effort

4.0 Restoration Project Development

4.1 Existing Conditions and Issues

Figure 4-1 depicts the generalized flow patterns within the CWI Project area. For purposes of this discussion, the CWI Project area refers to the natural areas of Corkscrew Marsh, Corkscrew Swamp, Bird Rookery Swamp, and Flint Pen Strand, which are the focus of the proposed conceptual restoration projects. As suggested by Figure 4-1, there are two major flow paths: the eastern flow way and western flow way. The western flow way originates in the Airport Mitigation Park (AMP). This system is primarily rainfall driven; however, there are also discharges from adjacent agricultural fields and mine sites. The water flows beneath Corkscrew Road into Flint Pen Strand, then either to the west toward culverts beneath Interstate 75 or south to Kehl Canal. The proportion of water flowing west or south depends on stages and time of year. The eastern flow way originates from two sources: (1) Corkscrew Marsh to the northeast, and (2) the area around Lake Trafford to the east. After passing beneath Washout Road, water continues south through the Bird Rookery Swamp to discharge along Shady Hollow Boulevard to the west and Immokalee Road to the east. Depending on stages, some water may flow west over the naturally higher topography in the center of the CWI Project area, toward Flint Pen Strand.

Also presented on Figure 4-1 are areas designated as too wet and too dry. These areas were defined with the assistance of the TWG based on their collective experience working in the area. Based on discussions with AMP personnel, the AMP is too wet during the wet season, which impedes access for habitat maintenance activities. Notably, in some cases conditions are too wet to the north and too dry to the south. In addition, conditions vary seasonally. For instance, the area characterized as too wet in Corkscrew Marsh is too wet all year long. However, the area to the south in the Corkscrew Swamp Sanctuary is too dry during the dry season and also has shortened hydroperiods. The area characterized as too wet in the northwest corner of the Corkscrew Swamp Sanctuary is too wet only in the wet season. Manmade features between these two areas may be limiting flow to the south. Achieving a more historical seasonal balance of available water is the objective of several proposed conceptual restoration projects discussed in Section 5.0.

Similar to the AMP, much of the CWI Project area (with the exception of Corkscrew Marsh) is described as being too dry during the dry season with large variations in stages from wet to dry season. This likely is the result of development of adjacent areas and channelization of flows for flood protection, which has left the hydrology of the CWI Project area to be primarily rainfall driven without sufficient dry weather inflows. This, combined with the naturally permeable soils in the region and dry season water withdrawals, may contribute to the large variations in water levels. In essence, water is moving through the watershed more quickly than in historical conditions.

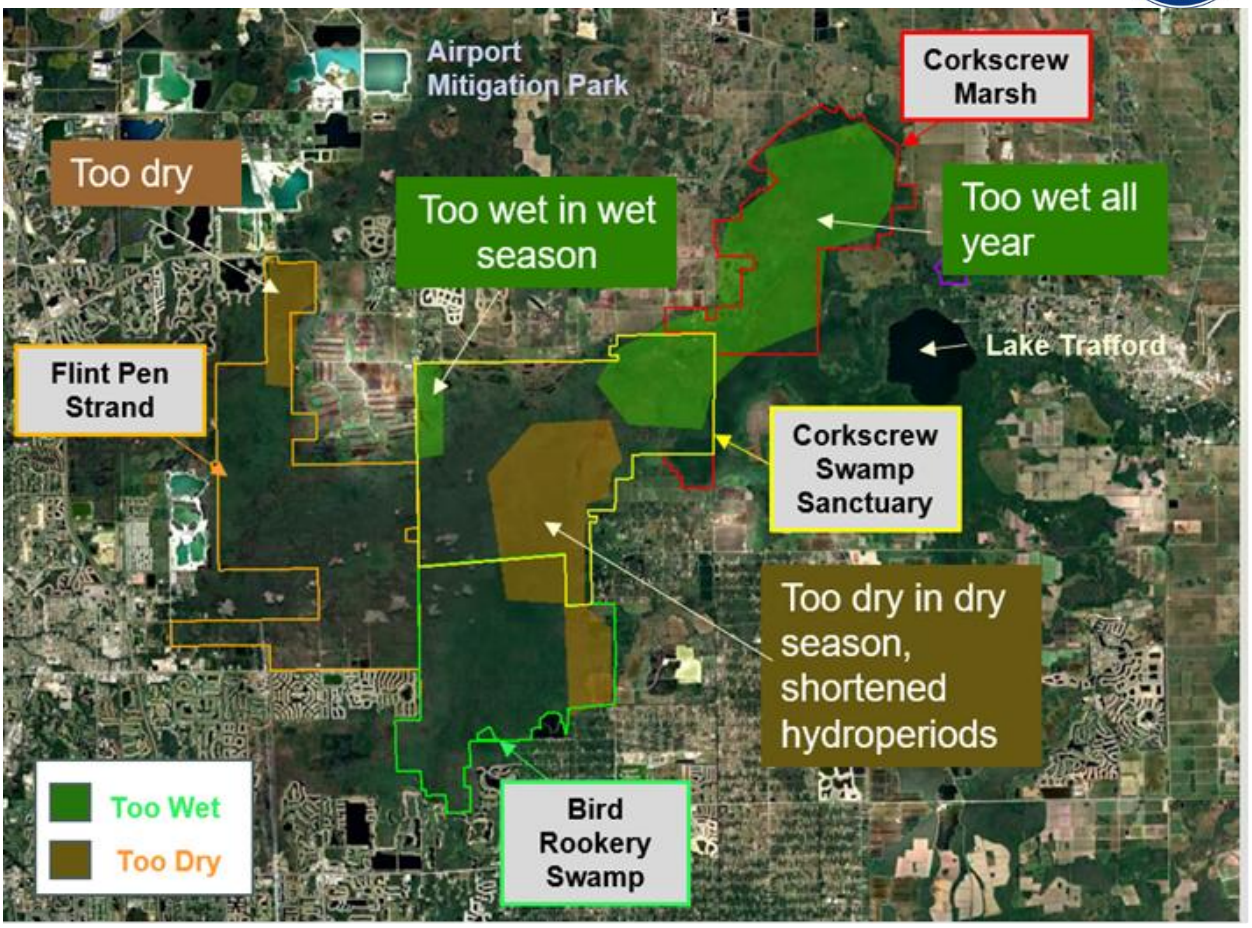


Figure 4-1. Corkscrew System Generalized Flow Patterns

4.2 Project Objectives

Based on the general conceptualization for the system presented above, the following objectives have been defined for the purpose of identifying potential proposed conceptual restoration projects to achieve the overall project goals.

Extend wetland hydroperiods and increase stages where needed in the wet season versus dry season. There is a need to extend wetland hydroperiods to more closely match historical conditions, improve dry season water levels, and improve wet season water depths for the wetland habitats within the system.

Improve internal flow and distribution. There are manmade features that limit the internal distribution of flow within the system (i.e., Washout and Corkscrew roads). Other features, such as the manmade berms at the former fish farm, also impede the distribution of flow. Removal of these restrictions would result in a more natural flow distribution.

Decrease over-drainage. Over-drainage at outfalls could allow water to leave the CWI Project area that would otherwise be retained in storage within the project area. Several breaches in berms located along Shady Hollow Boulevard and Kehl Canal could be exacerbating this issue. Repair of these breaches and better control of the discharge would help mitigate over-drainage.

Move more water to the CWI Project area. The system hydrology is primarily rainfall driven. Additional flow diverted to the system could be used to augment rainfall in increasing stages.

Reduce flood risk. Several adjacent areas currently experience flooding. Ideally, mitigation of the hydroperiods would retain a greater percentage of storm flows, thereby reducing flood risks in downstream areas.

Maintain water supply. Placing more water in storage will help recharge the underlying aquifer used for water supply.

4.3 Project Challenges

There are several challenges to implementing solutions for enhancing the hydroperiods within the Corkscrew system, which need to be considered in plan formulation and evaluation. These challenges are summarized below.

Avoiding offsite impacts. Avoiding offsite impact is the highest priority. This may include higher stages during storm events and longer-term impacts to groundwater. Redistribution of water within the CWI Project area may impact nearby supply wells. Several public water supply wellfields are also in the vicinity of the CWI project area. Wells within or adjacent to areas characterized as too wet may not receive the same recharge if this water were to be redistributed to other areas to improve hydroperiods. In addition, raising and lowering groundwater will not be limited to the CWI Project area; changes to groundwater levels will extend to adjacent properties. Due to the low elevation of the adjacent properties, this may result in these areas becoming too wet or too dry for their current use.

Permeable Soils/Transmissivity of the Surficial Aquifer System. TWG members have indicated that raising gates during the dry season to reduce surface discharges has not resulted in significant changes in hydroperiods, suggesting that groundwater flows play a key role in the system hydrology. The groundwater level variations in the region have been documented in the Lower West Coast Water Supply Plan. Therefore, approaches addressing management of surface water may not be sufficient to effect the needed change and subsurface solutions may also be required.

Habitat impacts. Over time, habitats have changed in response to reduced water availability. Wood stork nesting has dramatically declined, and the succession of plant communities has been altered, reducing habitat value for wildlife and posing additional challenges for habitat stewardship. There is reduced freshwater storage and an increased risk of catastrophic fire. Water redistribution may impact these habitats. The proposed project needs to provide a net benefit considering both impact and benefits to the ecosystem. Furthermore, surveys will be needed prior to advancing projects to avoid or minimize impacts to threatened and endangered species.

Area development. The vicinity of the Corkscrew system is developing at a rapid rate. Areas formerly used as agricultural fields or mine sites are rapidly being converted into residential areas, which will alter the system hydrology by changing surface water drainage, irrigation water demand, and distribution as well as evapotranspiration. To the extent possible, known development projects can be incorporated into the alternative evaluation. However, future development projects and their impact on system hydrology cannot be known at this time.

Variability of hydrologic issues and balancing objectives. As identified above, different portions of the CWI Project area have different hydrologic concerns. Restoring hydrology to meet the needs of the various parts of the natural system while also balancing the overall project objectives will be a challenge.

Implementable solutions. The proposed solutions need to be implemented within a reasonable timeframe. Although the actual technologies expected to be employed are relatively straightforward (i.e., adding a weir gate to an existing culvert to control water levels) and well developed, there are other challenges to developing implementable solutions:

- **Long-term O&M (active versus passive structures) –** In general, the more complicated the structure, the more O&M is required. A simple open culvert requires occasional cleaning, whereas a culvert with an adjustable gate requires more frequent visits and adjustment, especially for flood control. Furthermore, an entity needs to take ownership of the structure and commit the resources necessary to maintain the structure.
- **Land acquisition/easements –** Land acquisition is often problematic but may be required if changes in hydrology will impact property. Some private landowners may be resistant, which may limit the ability to fully implement a project in an area in need of mitigation.
- **Funding –** Consideration of the funding required to implement a proposed project compared to the net benefit provided needs to be considered.

4.4 Information Gathering

Over the course of this study, several meetings were held with stakeholders to collect information and input on proposed conceptual projects. Those contributing significantly to this process included:

- **TWG** – Quarterly meeting have been held with the TWG, during which projects have been proposed and refined based on input from the TWG members.
- **Lee County** – A meeting was held with staff to discuss projects Lee County has been implementing within the vicinity of the Corkscrew System, in particular the Kiker Preserve project discussed below. Also discussed were measures taken by Lee County within the area of development, such as the inclusion of flow ways in redevelopment plans to maintain and restore the natural flows to the CWI Project area.
- **AMP** – A meeting was held with staff from the AMP. During the meeting, hydrologic conditions in the AMP were discussed.
- **Other stakeholders** – Other meetings have been held with Collier County staff and Conservation Collier, as well as landowners in the region adjacent to the project area.

4.5 Related Projects

4.5.1 Kiker Preserve

The Kiker Preserve project was originally developed as a flood control project in the Southern Lee County Flood Mitigation Plan in 2020. The project aimed to use the Flint Pen Strand area of the Corkscrew System for flood storage by constructing a shallow berm along the west and southwestern perimeter of Flint Pen Strand. Gates constructed along the berm would retain stormwater during large storm events for later release. The project has since been modified to include habitat restoration aspects.

The general concept of the project is shown in Figure 4-2. The berm has been divided into three segments. The first phase of the project has been funded and is currently in the design phase. Based on discussions with Lee County, the berm will be approximately 4 to 5 feet high (approximate crest at 20 feet North American Vertical Datum of 1988 [NAVD]) with control gates to release water following a storm event. The gates will also be used to manage water levels in Flint Pen Strand for habitat enhancement. Another habitat enhancement aspect of the project includes a relatively large restoration area where existing access roads will be used to control water flow within the Flint Pen area.

This project will have significant impact on the hydrology of the CWI Project area, providing the ability to manage water levels in the western portion of the CWI Project area. However, since the project will be operated to provide flood control, this will be a priority in system operation and may involve maintaining water levels to provide flood storage. The operations schedule will be more fully developed as the design progresses. This project is being implemented by Lee County separately but parallel with the CWI Project.

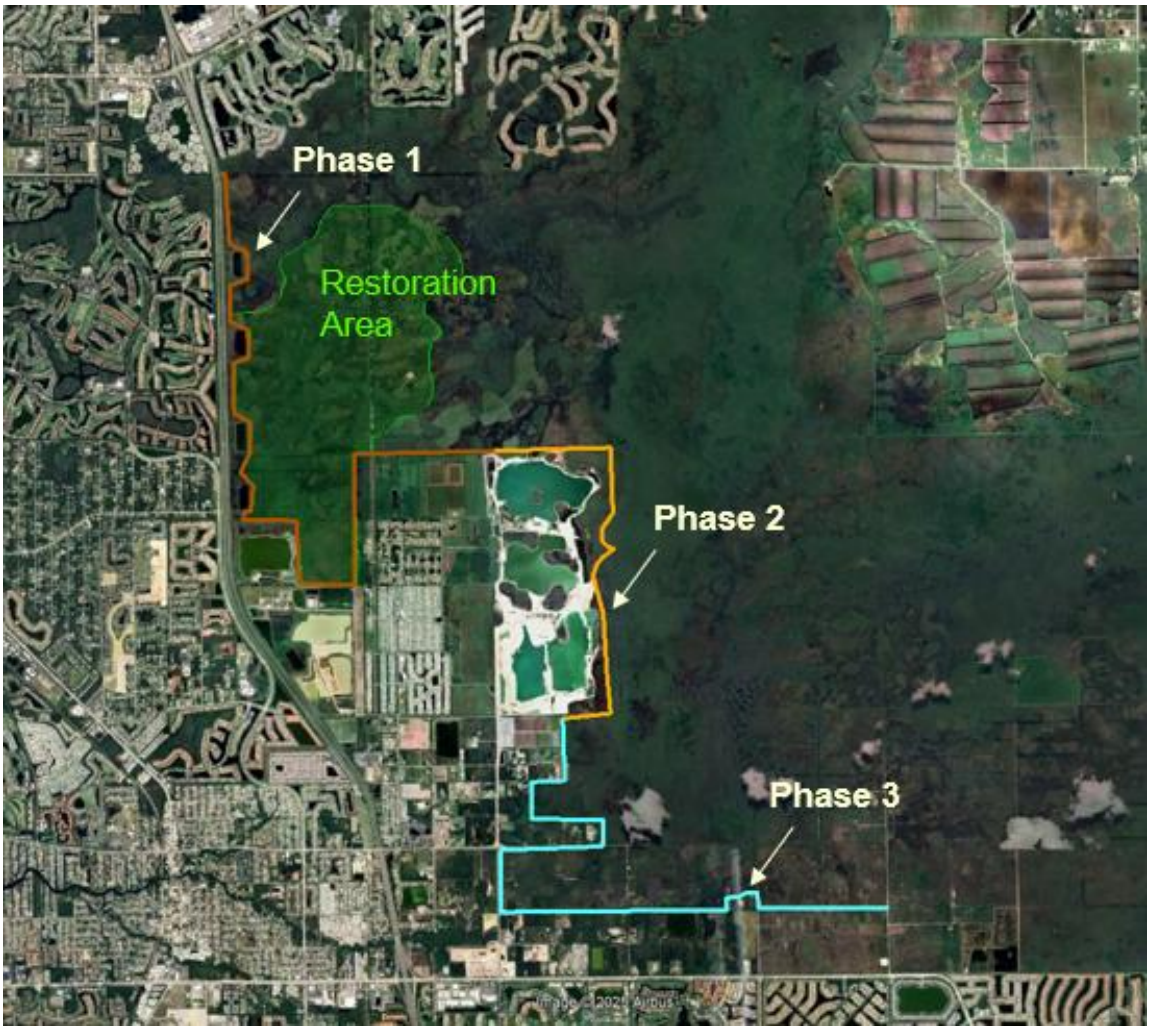


Figure 4-2. Kiker Preserve Project

4.5.2 Bird Rookery Swamp Culvert Replacement

Within Bird Rookery Swamp, SFWMD has been replacing culverts along the trail (Figure 4-3). Of the 22 culverts, 16 have been replaced in the last 2 years and the remaining six will be replaced in 2025.

These culverts were previously in poor condition and may have been impeding flow through Bird Rookery Swamp. The replacement of these culverts could allow water to drain more freely to the south. The potential impacts of this change have not been assessed; however, it may lead to increased over-drainage of Bird Rookery Swamp. A project has been proposed to provide better management of the flows by retrofitting these culverts with weir structures.

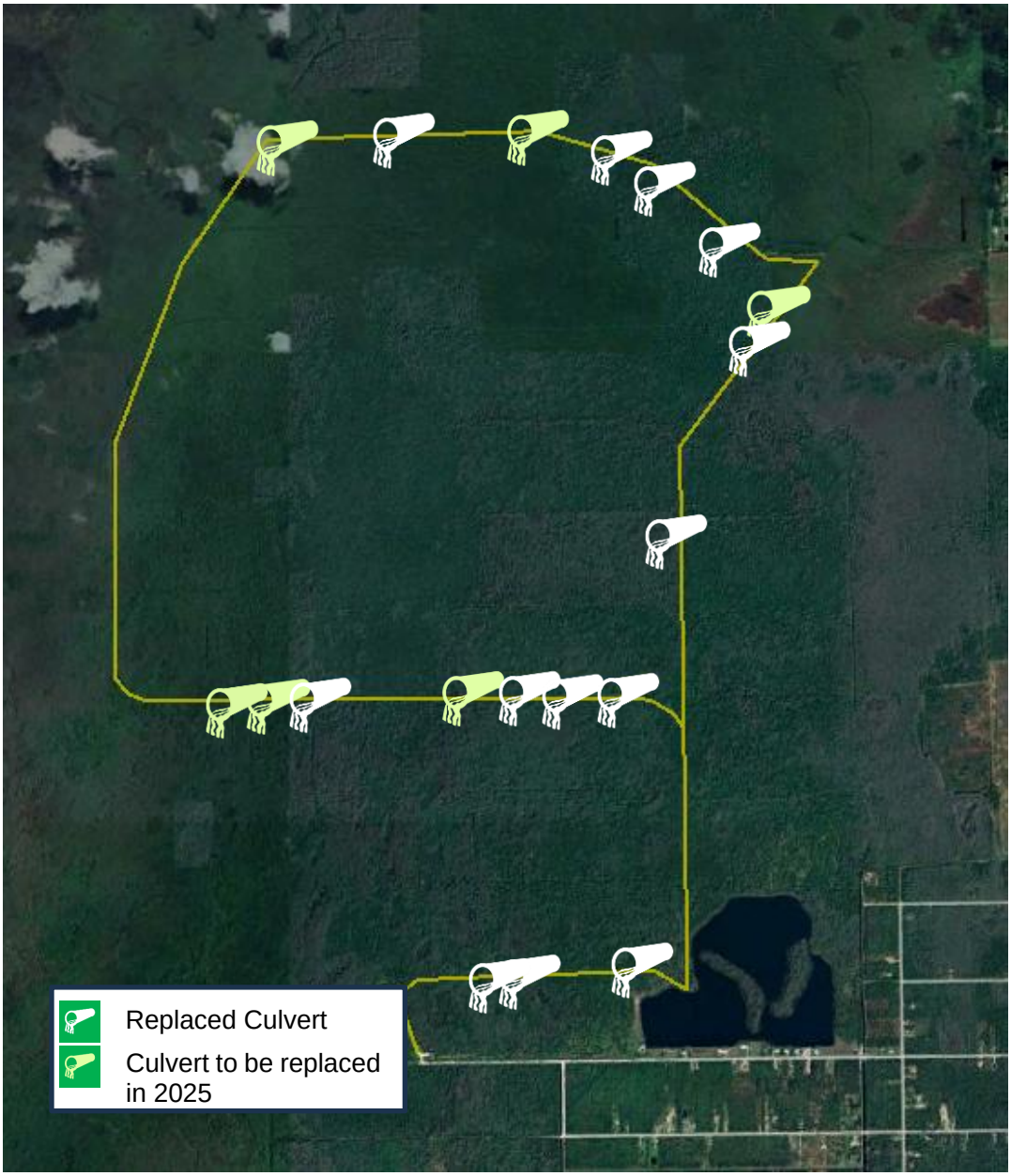


Figure 4-3. Bird Rookery Swamp Culvert Replacement

4.5.3 Development Projects

Much of the adjacent lands previously used for agriculture and mining are being developed into residential and mixed-use communities. Based on a review of available permit information and discussions with the TWG, a list of relevant development projects was identified as shown on Figure 4-4 and summarized in Table 4-1. These projects will have some impact on the Corkscrew System hydrology. The land use change will increase runoff with more impervious surfaces, resulting in higher peak flows. There may be a reduction of groundwater extraction for irrigation. Operation schedules and requirements identified in Environmental Resource Permits (ERPs) should make discharges from these areas more predictable. The development projects include a significant amount of environmental preservation in lands bordering the Corkscrew System, including some restoration of natural flow ways. However, the water quality of runoff may be reduced if appropriate controls are not maintained. This development may also provide an additional constraint on the operation of the water levels within the Corkscrew System. Protection of these homes during flooding events is a priority of the CWI Project.

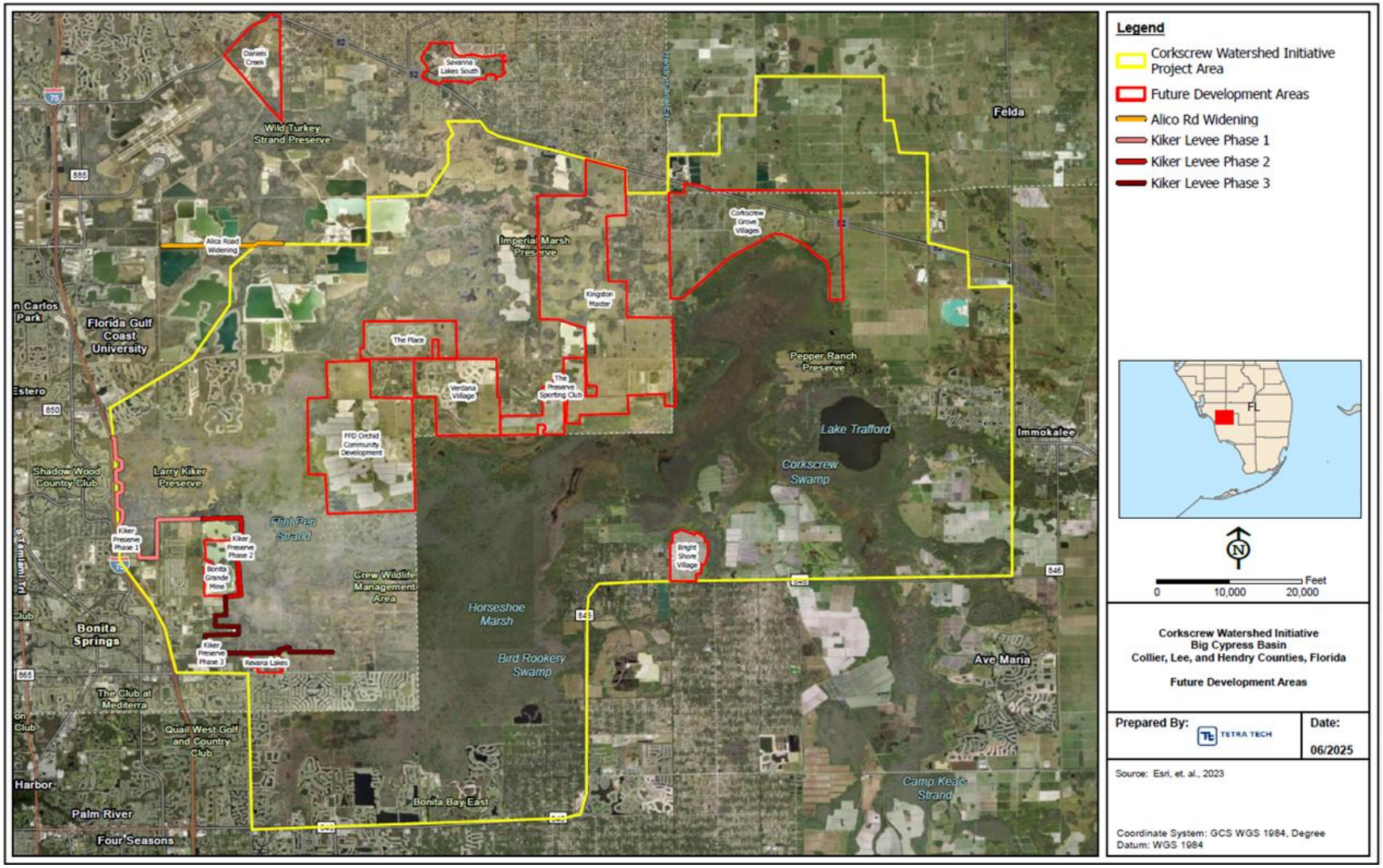


Figure 4-4. Areas of Future Development

Table 4-1. Summary of Known Future Development Projects

Project	Description	Potential Impact in CWI Project Area	Status
Kiker Preserve Phase 1	6.7-mile berm, along I-75 and 3-square-mile restoration area	Increased stages in western portion of project area	In Design
Kiker Preserve Phase 2	3.4-mile berm, around Bonita Grande Mine site	Increased stages in western portion of project area	Permitted, Construction Soon
Kiker Preserve Phase 3	6.2-acre berm along Kehl Canal	Increased stages in western portion of project area	Pending Land Acquisition
Alico Road Widening	3 miles of road widening, 88-acre drainage area	Possible alteration of northern flow path	ERP Approved
Corkscrew Grove Villages	1,500-acre mixed use and 6,000 acres of conservation land	Land use change directly north of CREW Marsh	In Permitting (ERP Conceptual)
Verdana Village	959.9 acres residential, 1,178.4 acres preserve	Land use change north of Corkscrew Swamp, includes flow way	Completed
Bright Shore Village	676.08 acres residential and commercial development	Land use change south of Corkscrew Marsh	Conceptual Permit Approved
Bonita Grande Mine	285 acres residential, 59.21 acres preserve and 314 acres lakes	Land use change west of Flint Pen Strand	Permitted; Under Construction
Orchid Community Development District	2,291-acre mixed use and 2,917-acre preserve flow way	Land use change adjacent to Flint Pen Strand, incorporates flow ways	Conceptual Permit Approved
Kingston Master	3,444-acre mixed use and 3,032-acre preserve flow way	Land use change north of Corkscrew Swamp, incorporates flow ways	Conceptual Permit Approved
The Place	6,785-acre residential development	Land use change adjacent to AMP	Built
Revana Lakes	160.3-acre residential and commercial development, 43.98 acre preserve	Land use change south of Kehl Canal	ERP Approved

4.6 Engineering Approaches to Hydrologic Restoration

Conceptual restoration projects proposed to achieve the CWI objectives of hydrologic restoration fall generally into three categories.

1) Projects aimed at providing better control of water flow into areas targeted for hydrologic improvement, including removal of manmade impediments and the ability to vary flow seasonally. These projects may allow for water storage during the wet season for slow release into the dry season.

2) Projects aimed at slowing down water moving through an area including filling ditches that may be causing short circuiting as well installation of water control structures. These projects may provide the ability to raise stages, increase storage, and extend hydroperiods within the targeted habitat areas for improvement.

3) Projects aimed at decreasing over drainage of targeted habitat areas. These projects may be effective in reducing the amount of water leaving the areas targeted for hydrologic restoration.

4.6.1 Surface Water Controls

The proposed projects include surface water controls such as shallow berms, culverts, weirs, and variable gates. Whereas culverts may be used to enhance flow through a berm, the discharge is relatively uncontrolled and subject to the culvert sizing. Weirs and gates control flow through a berm. Used together, a series of berms with weirs (either variable or not) could be used to create a series of shallow pools, placing water into storage, increasing stages and extending hydroperiods (Figure 4-5). The use of variable weirs allows management of water levels in the pools seasonally.

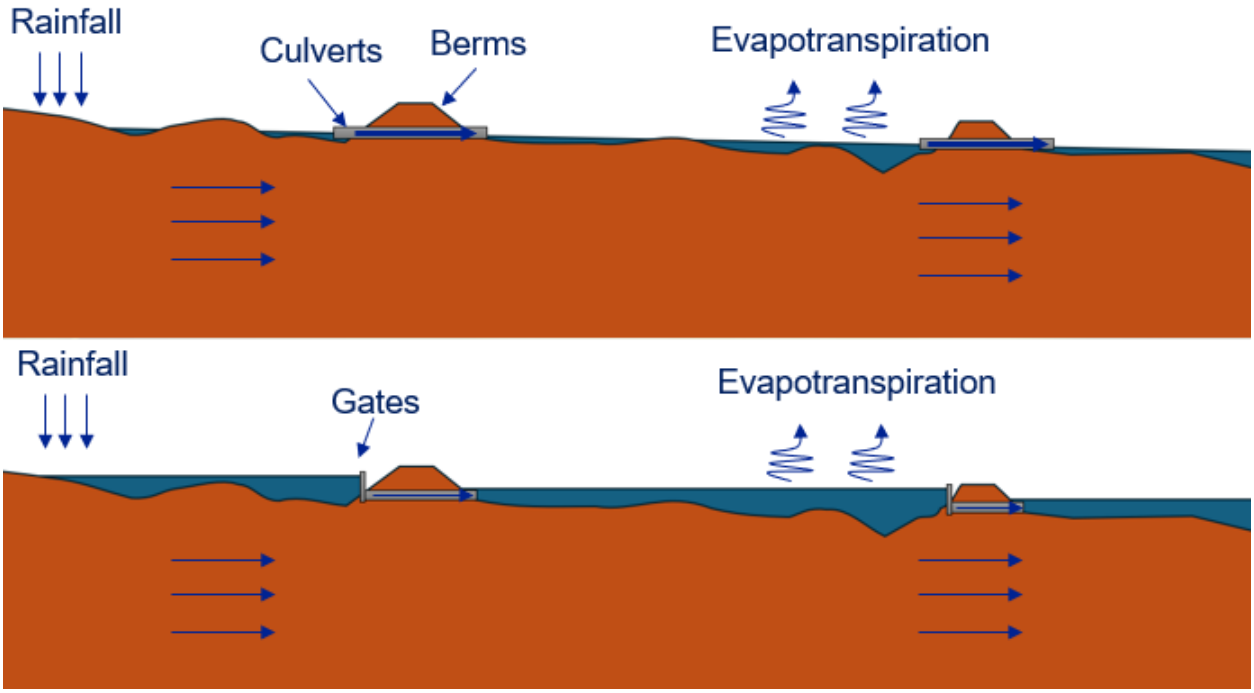


Figure 4-5. Conceptualization of Surface Water Controls

4.6.2 Active and Passive Structures

Each of the structures require some level of maintenance; however, passive structures generally require less and are therefore preferred. Active structures, such as variable weirs and gates, require more frequent routine visits to ensure the gate is operational, maintain mechanical equipment, and adjust seasonally. Where a structure requires adjustment to provide flood protection, a more robust design is needed with redundancy to ensure the gate remains operational during extreme weather events. In general, structures requiring adjustment for flood protection were avoided.

4.6.3 Surface Water and Groundwater Controls

The above conceptualization assumes that surface water is the primary flow path. However, it has been reported that at a location downstream of Bird Rookery Swamp, leaving structures Cork2 and Cork3 closed resulted in minimally increased stages. Groundwater recession was reported to be slowed, but the low groundwater level was about the same. In addition, the downstream canal network for flood control purposes is maintained at lower elevations than occur naturally in the wetland systems to the north, and the existence of the canal system may possibly create a gradient effect during the dry season.

The subsurface conditions may play a more significant role in moving water through the system (Figure 4-6). Limiting surface water flow through a raised weir may temporarily increase water levels behind the berm; however, in response to the higher water levels, groundwater seepage is increased and the surface water placed in storage drains relatively quickly. The subsurface barriers would limit water movement through the subsurface layer. The primary flow path through the system in this case is through the culverts where flow could be managed through weir adjustments.

The use of subsurface barriers may be necessary to achieve project objectives. However, there is a greater project risk and cost when implementing a subsurface barrier. Studies and detailed modeling would be required to properly design the barrier system. Once completed, the barrier is relatively permanent and mitigating unintentional impacts of the barrier would be difficult. As such, subsurface barriers should be used with caution, only in a case where the possible benefits outweigh the cost and project risks involved.

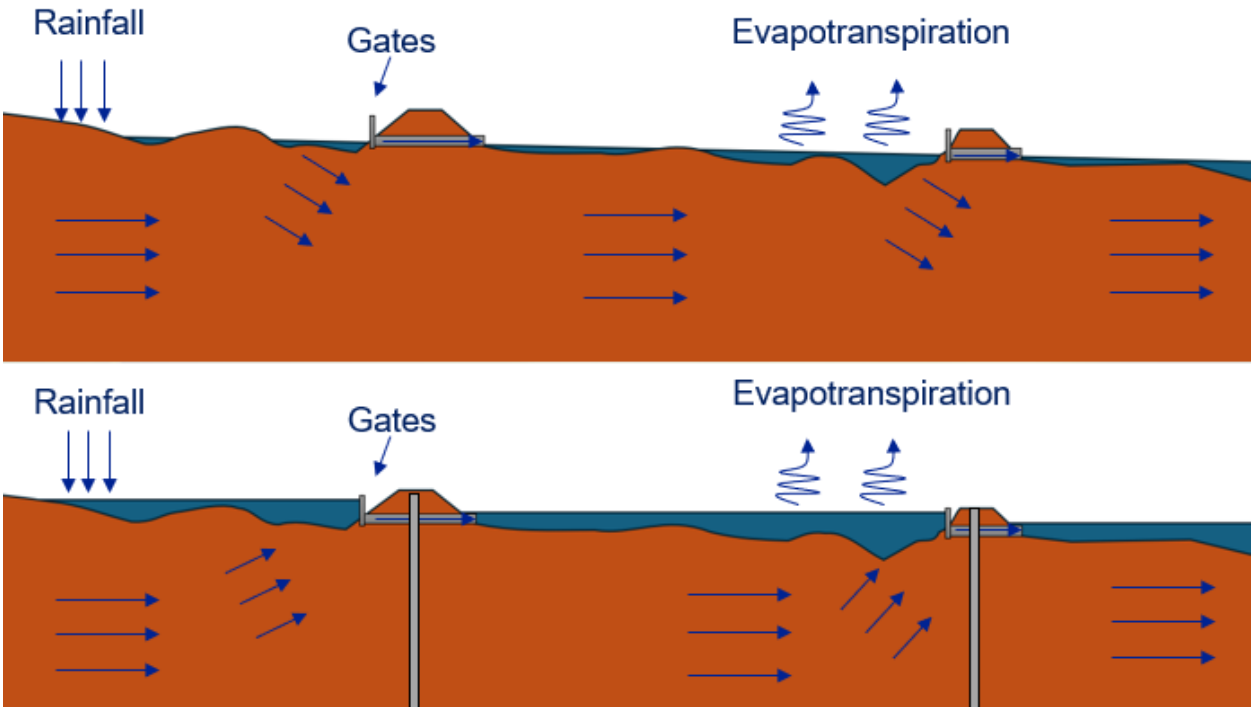


Figure 4-6. Conceptualization of Groundwater Controls

5.0 Preliminary Restoration Concepts

This section presents 11 proposed conceptual restoration projects (or projects) for consideration for further evaluation. It is important to recognize that not all of these projects will be implemented; rather, the benefits and impacts of each will be evaluated to inform the development of the restoration alternatives. In Section 6.0, individual conceptual restoration projects are combined to develop restoration alternatives to achieve the CWI objectives. These conceptual restoration projects have been organized by general area (Figure 5-1) and are summarized below:

Restoration of Northeast-Southwest Flow Ways: These projects aim to remove the suspected impediment and provide better control of surface water flow from Corkscrew Marsh to Corkscrew Swamp and include:

- Project 1: Washout Road Culvert Improvements
- Project 2: Restoration of Former Fish Farm

Bird Rookery Swamp Hydrologic Improvements: These projects aim to provide a more natural surface and groundwater flow distribution and increase hydroperiods within Bird Rookery Swamp and include:

- Project 3: Culvert Improvements along Bird Rookery Trail

Hydrologic Improvements along Shady Hollow Blvd: These projects aim to reduce over-drainage to the south and focus on the area of Shady Hollow Boulevard. These projects include:

- Project 4: Shady Hollow Boulevard Berm Repair and Gate Installation
- Project 5: Corkscrew Canal Gate and Berm
- Project 6: Former Agricultural Area Restoration
- Project 7: Red Maple Swamp Restoration
- Project 8: GG Main Branch Canal Connection at Immokalee Road

Western Flow Way Improvements: These projects focus on the western flow way with the intent of augmenting the effectiveness of the Kiker Preserve project. These projects include:

- Project 9: Kehl Canal Berm Repair and Gate Installation
- Project 10: Corkscrew Road Culvert Improvements

System Wide Projects: One project is proposed that may bring benefits to the entire project area. This project includes:

- Project 11: Kiker Preserve Berm Extension

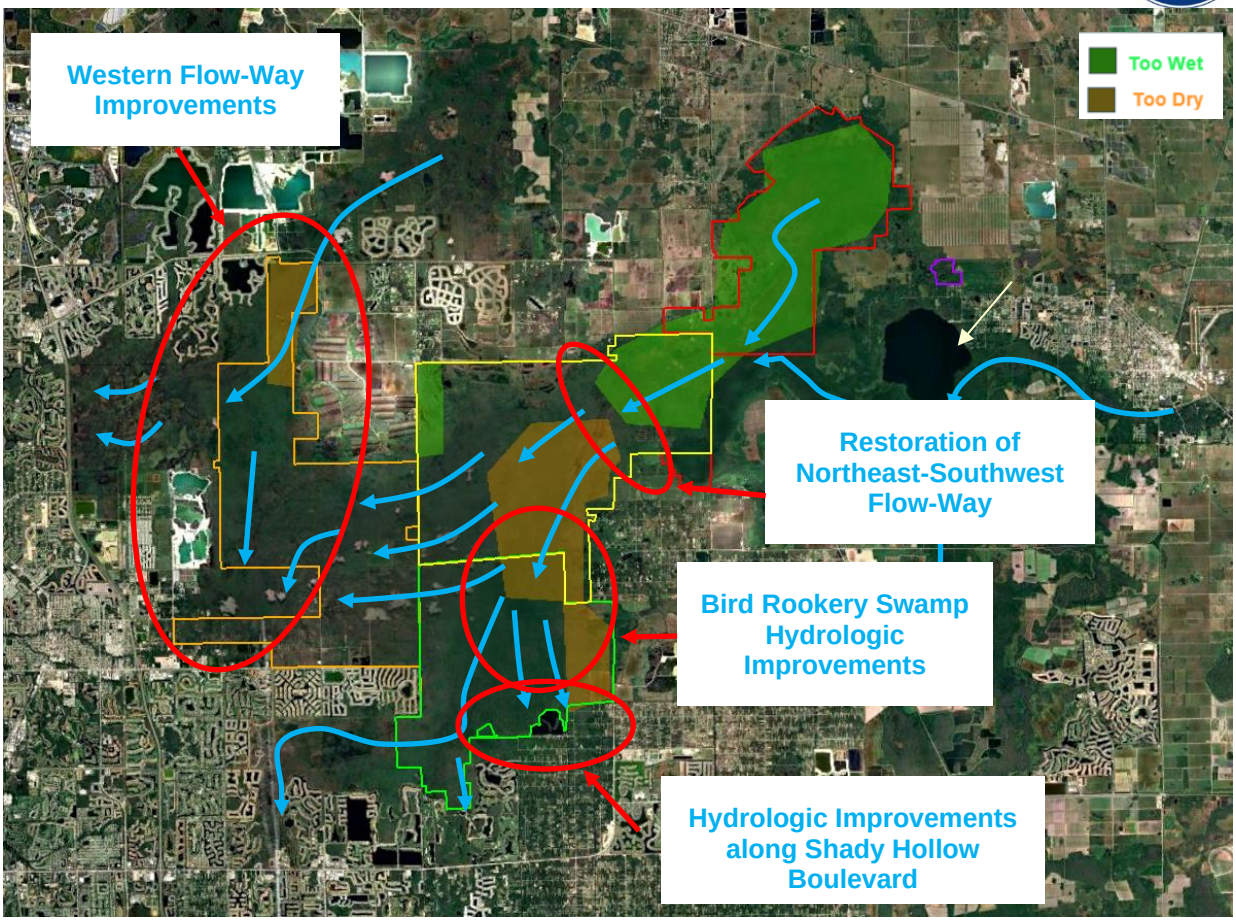
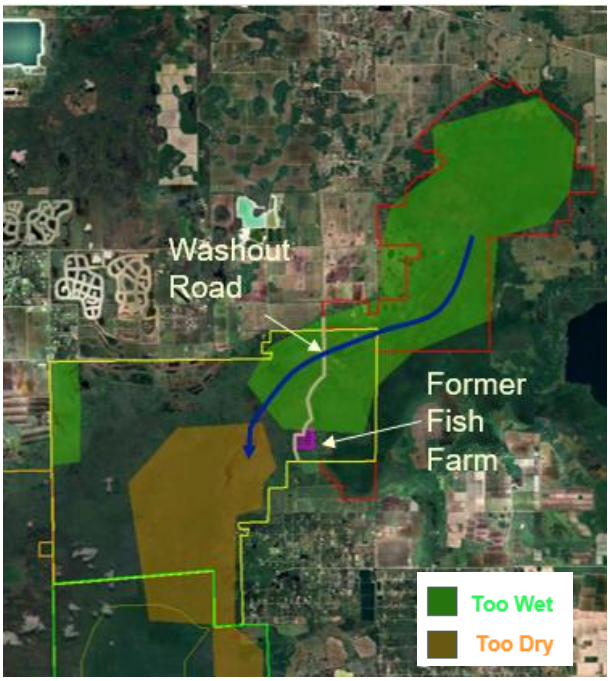


Figure 5-1. Proposed Conceptual Restoration Concepts

5.1 Restoration of Northeast-Southwest Flow Ways

Two projects have been included for consideration to address the restoration of the northeast-southwest flow ways. Based on discussions with the TWG, conditions within Corkscrew Marsh are considered too wet. Conditions to the southwest within Corkscrew Swamp are considered too dry. Separating these two areas is Washout Road and an area previously used for aquaculture (Fish Farm), both of which appear to be restricting flow. The intent of these two projects is to restore the flow path from Corkscrew Marsh to the Corkscrew Swamp for better distribution of water within the CWI Project area. A review of light detection and ranging (LiDAR) data suggests two primary flow paths through the area separated by Little Corkscrew Island (Figure 5-2). A northern flow path that crosses Washout Road and the southern flow path that traverses the site previously used for aquaculture. The two projects discussed below address both flow paths.



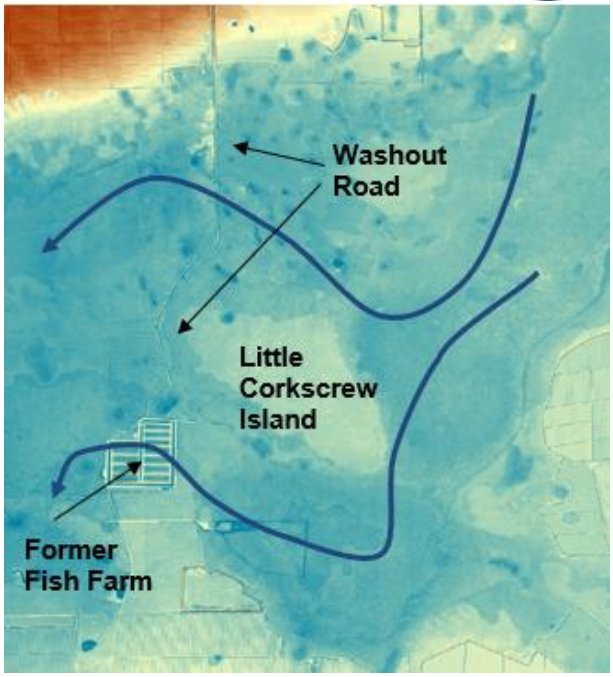


Figure 5-2. Northeast-Southwest Flow Way

5.1.1 Project 1: Washout Road Culvert Improvements

Project Description and Objective

Culverts beneath Washout Road are reported in poor condition. This project includes replacement of these culverts and, if beneficial, improvement through upsizing. In addition, weir gates will be installed for better water level management. Providing greater hydraulic conveyance beneath Washout Road will allow for drainage of areas considered too wet and bring more water to areas considered too dry. The addition of weir gates will provide the ability to manage flows to prevent over-draining of Corkscrew Marsh.

Project Challenges

The proposed project is internal to the CWI Project area and readily implementable from a technical perspective. A significant challenge, however, is over-drainage of areas in Corkscrew Marsh altering hydroperiods to a point that is detrimental to the existing habitat. In addition, groundwater recharge in Corkscrew Marsh is supplying permitted wells. Over-drainage could result in reduced groundwater recharge and limit the ability for permitted users to access this water. South of Washout Road, stages cannot be raised to a point that results in flooding of adjacent private properties. Notably, several properties to the east of Bird Rookery Swamp have surface elevations similar to those in Bird Rookery Swamp. Raising water levels and improving hydroperiods without causing impacts on these properties is a significant challenge common to several proposed conceptual projects.

To provide better control of the amount of water allowed to pass from Corkscrew Marsh to Corkscrew Swamp, the project will include manually adjustable weir gates on upgraded culverts. The structures may operate on a schedule such that Corkscrew Marsh is used for storage to be released slowly during dry months to improve conditions in Corkscrew Swamp and the Bird Rookery area.

Related Performance Metrics

Performance metrics related to this project include the following:

Hydrologic Restoration of Wetlands

- **Sheet Flow**: Water level control options from project implementation should provide enhanced sheet flow. Weir setting may be varied to promote water distribution among the culverts.
- **Water Depth Targets:** Control options provided by project implementation should result in the ability to better manage available water levels. Achieving an appropriate balance of water retained in Corkscrew Marsh versus Corkscrew Swamp through weir adjustments could be further examined through modeling and in the field after project implementation through adaptive management.
- **Hydroperiods:** Water level control options provided by project implementation should result in the system being better able to meet hydroperiod targets. Weirs may be used to control the gradual release of water over the dry season to maintain beneficial hydrology.
- **Dry Season Water Level:** Water level control options provided by project implementation should result in reducing the rate of groundwater recession. Weirs may be used to control the gradual release of water over the dry season to maintain beneficial hydrology. Corkscrew Marsh has been identified by the TWG as being too wet during both the wet and dry seasons.

Habitat Restoration

- **Vegetative Community**: Control options provided by project implementation should provide land management staff with the ability to manage water levels to promote more appropriate vegetative communities. For example, this may assist with enhanced ability to remove the excess Carolina willow that has overgrown the historical sawgrass marsh in this area.
- **Wildlife Use:** Control options provided by project implementation should provide land management staff with the ability to control water levels to promote wildlife use, such as enhanced use of prescribed fire to maintain appropriate marsh habitat for wildlife.
- **Threatened and Endangered Species:** Improved hydrology should result in improved habitat for threatened and endangered species. No potential impacts to threatened and endangered species have been identified.
- **Connectivity:** Although the proposed project will allow greater flow through Washout Road, the road will remain in place; therefore, connectivity will not be significantly improved. Connectivity is not diminished for species that use the road as a corridor.

Flood Protection

- It is not expected that the proposed project will play a role in flood protection. However, the amount of flow released needs to be controlled so as not to create flood impacts downstream.

Water Supply

- Permitted wells within the vicinity of Corkscrew Marsh rely on local recharge to maintain groundwater levels for water supply. The extent to which lowering surface water levels within Corkscrew Marsh will reduce this recharge will be further evaluated through modeling. Although

likely insignificant, the project would need to be operated to avoid significant impacts to these water supplies.

Project Elements

Seven existing culvert locations have been identified along Washout Road (Figure 5-3). A review of LiDAR suggests a lower ground surface in the area north of Little Corkscrew Island. This area is expected to be the primary flow path. Two of the seven culverts are located in this area. Additional culverts or the use of spreader ditches on the downstream side may be beneficial to promote a more uniform distribution of discharge. In addition, raising a portion of the road so that it does not overtop may be considered. This will also increase operational flexibility of the weir gates, allowing higher stages in Corkscrew Marsh for storage.

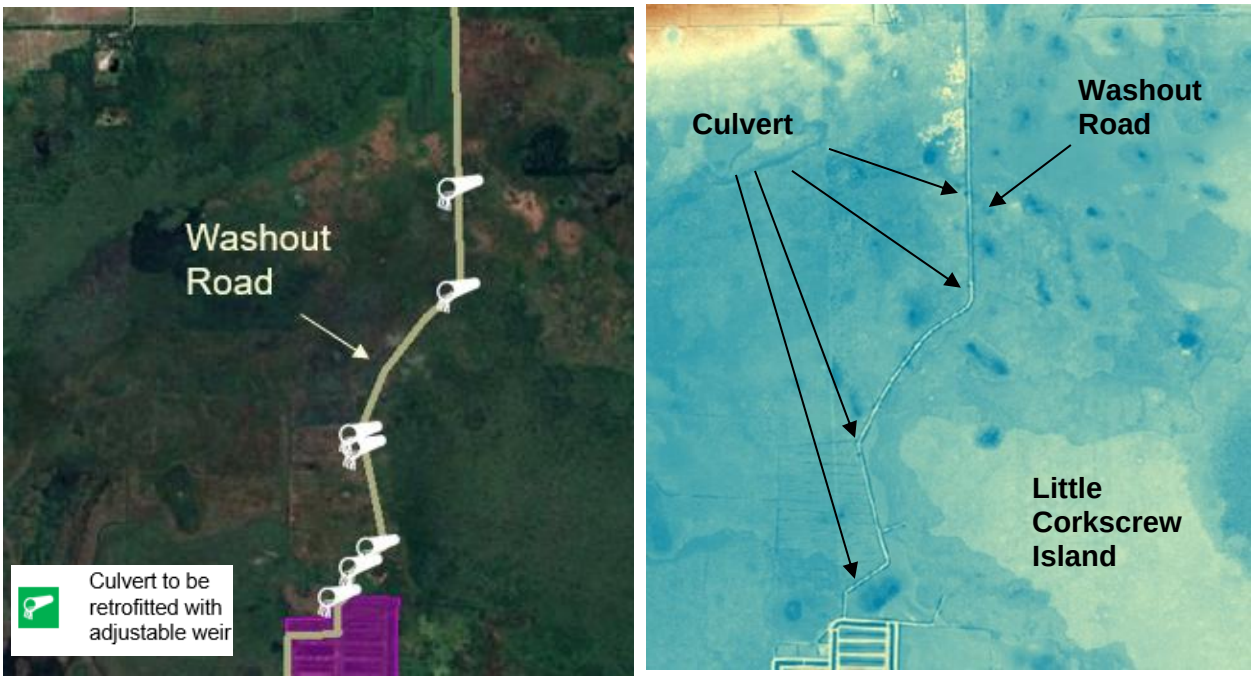


Figure 5-3. Washout Road Culvert Locations and LiDAR Surface Elevations

Project elements include culvert replacement, installation of adjustable weirs, and potential improvement of Washout Road. Replacement culverts are expected to be standard corrugated metal, installed by simple excavation, and backfill. Adjustable weirs would involve constructing a chamber on the upstream side of the culvert, typically sheet pile or cast concrete (refer to **Error! Reference source not found.**). An adjustable slide gate would be mounted to the upstream side chamber and grating would be placed at the top of the chamber to allow access for gate adjustment. The general concept can be used for new culvert installation as well as a retrofit to an existing culvert.

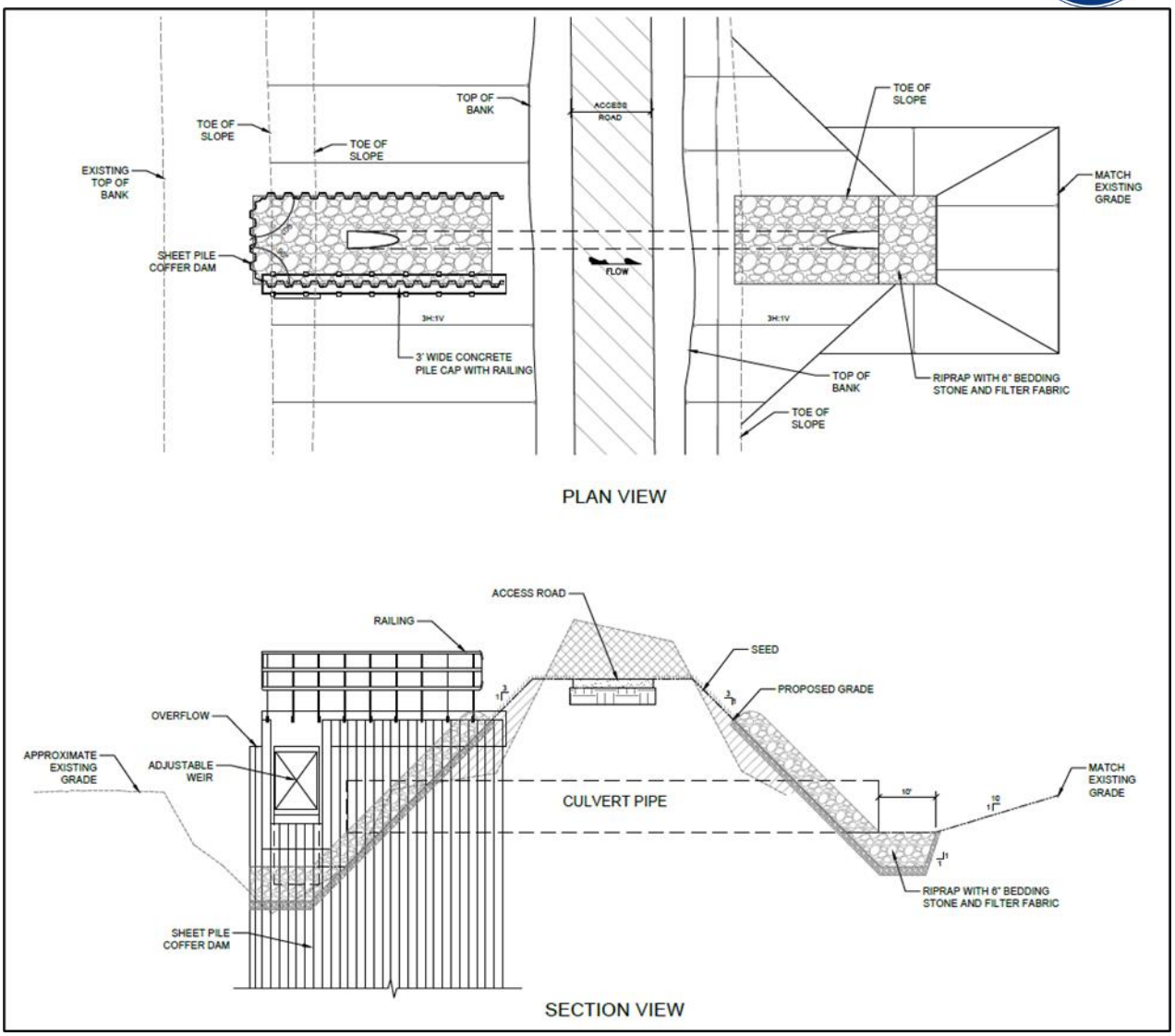


Figure 5-4. Typical Adjustable Weir Plan and Section

If a defined channel is not present upstream of the weir gates, collection ditches should be considered, depending on local topography, to help provide an even collection of sheet flow and avoid concentrating flow to a specific location that would be prone to erosion. Similarly, discharge from the culverts should be via a vegetated level spreader ditch if a defined channel is not present. Level spreader ditches are typically designed to provide an even distribution of discharge, promote sheet flow, and maintain a non-erosive velocity. Typically, the length of the spreader ditch is calculated as 10 times the discharge in cubic feet per second for a 10-year, 24-hour storm event. A bypass is often included for larger flows. The collection/spreader ditches will have a 5-foot-wide bottom width, 3-to-1 side slopes, and an invert to maintain about 3 feet of standing water to discourage vegetation growth blocking the ditch.

Modeling Approach

Within the refined CWI model, flow in the Washout Road area has been conceptualized to include a groundwater component, surface sheet flow component, and one-dimensional (1-D) channel

component. To capture the flow impediment of Washout Road, blockages were added to the overland flow component by defining areas upstream and downstream of Washout Road as separate flow areas. These areas are connected via culverts with weirs to simulate suspected culvert blockage (Figure 5-5).

To simulate the proposed project condition, modeled culverts may be lowered and/or upsized and weir structures may be varied to simulate the gate adjustment. Weirs may be adjusted seasonally to store water in Corkscrew Marsh with gradual release over the dry season. A spreader canal may also be added to simulate the change in flow distribution along the downstream (western) side of the road.

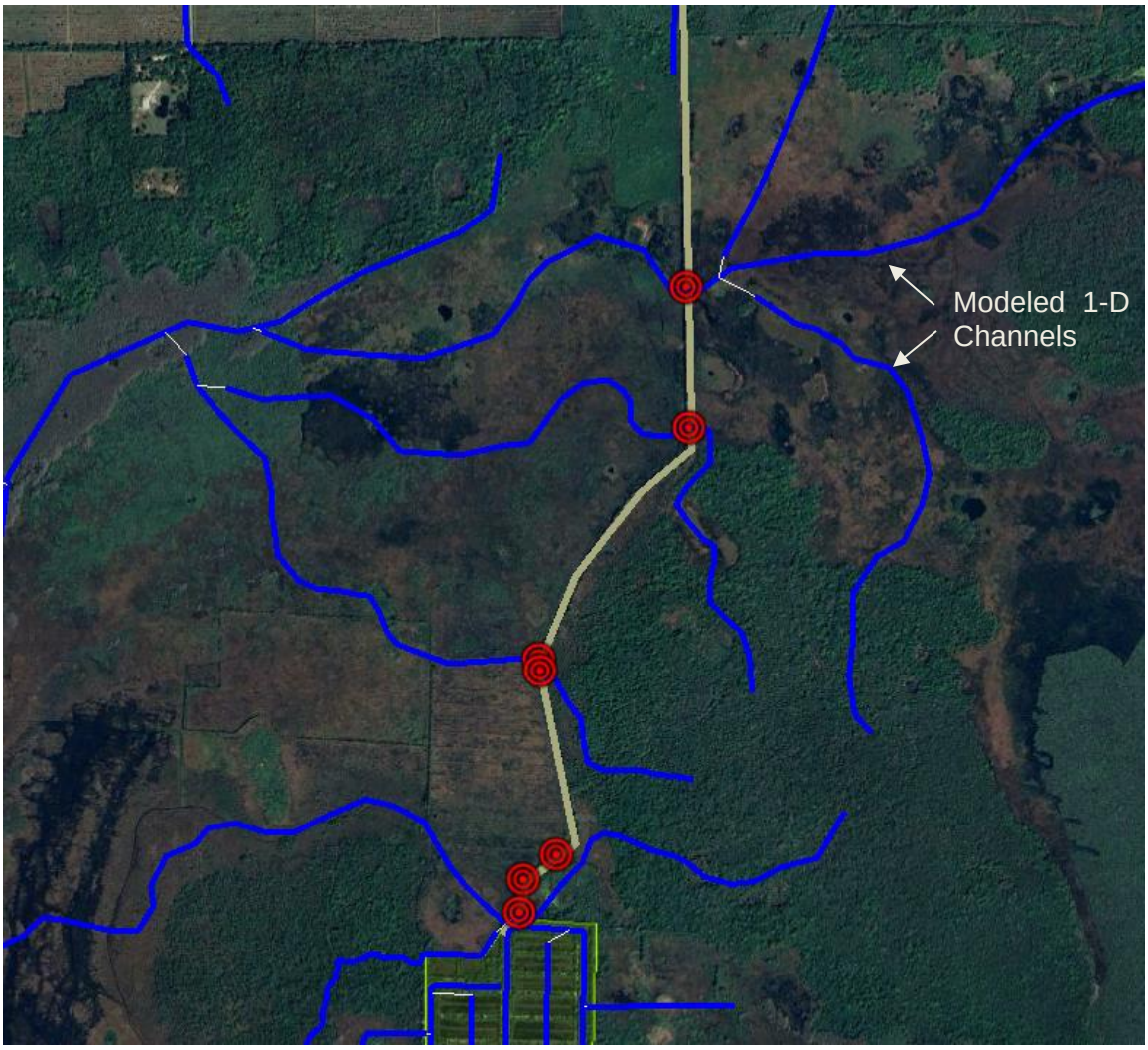


Figure 5-5. CWI Refined Model 1-D Channels at Washout Road

Accessibility and Maintenance

Access during construction would be via Washout Road, resulting in minimal damage to natural areas. Following construction, routine maintenance of the structures would be required including adjustment of gates, exercising of mechanical equipment, and mowing. Regular road grading should also be conducted to avoid rutting.

Constructability and Project Risk

Overall, the project is considered readily implementable with commonly employed technologies. The addition of variable weirs minimizes risks since the amount of flow can be adjusted to seasonal conditions as needed. At present, it is not expected that the structures would be used in a flood control capacity requiring adjustment during a storm event and posing a risk in the event of failure.

Permitting Considerations

Culvert repair and replacement is considered a maintenance activity and should qualify for state regulatory exemptions and/or federal nationwide permits. Local permits may also be needed for work within areas outside SFWMD's ownership. Additional culverts, raising the road elevation, installation of collection/spreader ditches, or the addition of adjustable weirs on existing culverts may require individual permits and associated operational schedules.

Initial Screening Results

Based on the analysis presented above, this project is retained for inclusion within the restoration alternatives formulation. The benefits could be significant, and the challenges are reasonable and could be overcome. The project is readily implementable with standard technologies and provides minimal disturbance of natural areas. The inclusion of adjustable weirs reduces project risk.

5.1.2 Project 2: Restoration of Former Fish Farm

Project Description and Objective

Infrastructure remaining from the former fish farm operation within Corkscrew Swamp Sanctuary includes 11 shallow ponds and a perimeter canal system. This area was historically used to raise fish for wood stork foraging but has been abandoned for many years. Berms also remain, separating these features and obstructing sheet flow. This project would include reestablishing flow through this area through degrading berms and use of adjustable weirs. In addition, certain areas could be re-graded within the fish farm to allow for both shallow and deep-water habitats to enhance wading bird foraging habitat.

Project Challenges

The proposed project is internal to the CWI Project area and readily implementable from a technical perspective. Similar to Project 1 above, a significant challenge is over-drainage of areas in Corkscrew Marsh, altering hydroperiods to a point that is detrimental to the existing high value habitat. In addition, recharge in this area is supplying permitted wells. Over-drainage could result in reduced groundwater recharge and limit the ability of permitted users to access this water. South of the former fish farm, stages cannot be raised to a point that results in flooding of adjacent private properties.

To provide a better level of control for the amount of water allowed to pass from Corkscrew Marsh to Corkscrew Swamp, the project will include manually adjustable weir gates on upgraded culverts. The structures, when operated under a schedule could use the Corkscrew Marsh for storage and release slowly during dry months to improve conditions in Corkscrew Swamp and Bird Rookery Swamp.

Related Performance Metrics

Performance metrics related to this project include the following:

Hydrologic Restoration of Wetlands

- **Sheet Flow**: Water level control options from project implementation should provide enhanced sheet flow. Weir settings may be varied to promote water distribution among the culverts. Inflow collection ditches and discharge spreader ditches could be included where a channel does not already exist to promote sheet flow and avoid channelization caused by the project implementation.
- **Water Depth Targets:** Water level control options provided by project implementation should result in the ability to better manage water. Achieving an appropriate balance of water retained in Corkscrew Marsh versus Corkscrew Swamp through adjustment of weir settings could be further examined through modeling and in the field after project implementation through adaptive management.
- **Hydroperiods:** Water level control options provided by project implementation should result in the system being better able to meet hydroperiod targets. Weirs may be used to control the gradual release of water over the dry season to maintain beneficial hydrology.
- **Dry Season Water Level:** Water level control options provided by project implementation should result in reducing the groundwater recession rate and improving dry season water levels. Weirs may be used to control the gradual release of water over the dry season to maintain beneficial hydrology.

Habitat Restoration

- **Vegetative Community**: Control options from project implementation should provide land management staff with the ability to control water levels to promote more appropriate vegetative communities.
- **Wildlife Use:** Water level control options from project implementation should provide land management staff with the ability to control water levels to promote more wildlife use.
- **Threatened and Endangered Species:** Improved hydrology should result in improved habitat for threatened and endangered species. No potential impacts to threatened and endangered species have been identified.
- **Connectivity:** Although the proposed project will allow greater flow through the former fish farm area, the berms will remain in place; therefore, connectivity will not be significantly improved. Connectivity is not diminished for species that use the berm as a corridor.

Flood Protection

- It is not expected that the proposed project will play a role in flood protection and require adjustment in the event of a storm event. However, the amount of flow released needs to be controlled so as not to create flood impacts downstream.

Water Supply

- Permitted wells near Corkscrew Marsh rely on local recharge to maintain groundwater levels for water supply. The extent to which lowering surface water levels within Corkscrew Marsh will reduce this recharge may be further evaluated through modeling. Although likely insignificant,

the future project would need to be operated to avoid significant impacts to these water supplies.

Project Elements

The former fish farm was constructed with 11 shallow ponds with separating berms/access roads and a perimeter canal (Figure 5-6). It is expected that the western berm will remain in place as this is currently the southern portion of Washout Road. Three culverts equipped with adjustable weirs will be constructed at a low point along the western berm to allow water flow and level management similar to Washout Road. Restoration activities to the east will be determined based on preferred habitat to be created. Deep zones may be left to provide diversity. However, a sufficient number of berm breaches should be included to allow a smooth flow of water with minimal head loss and to prevent the formation of stagnant zones.

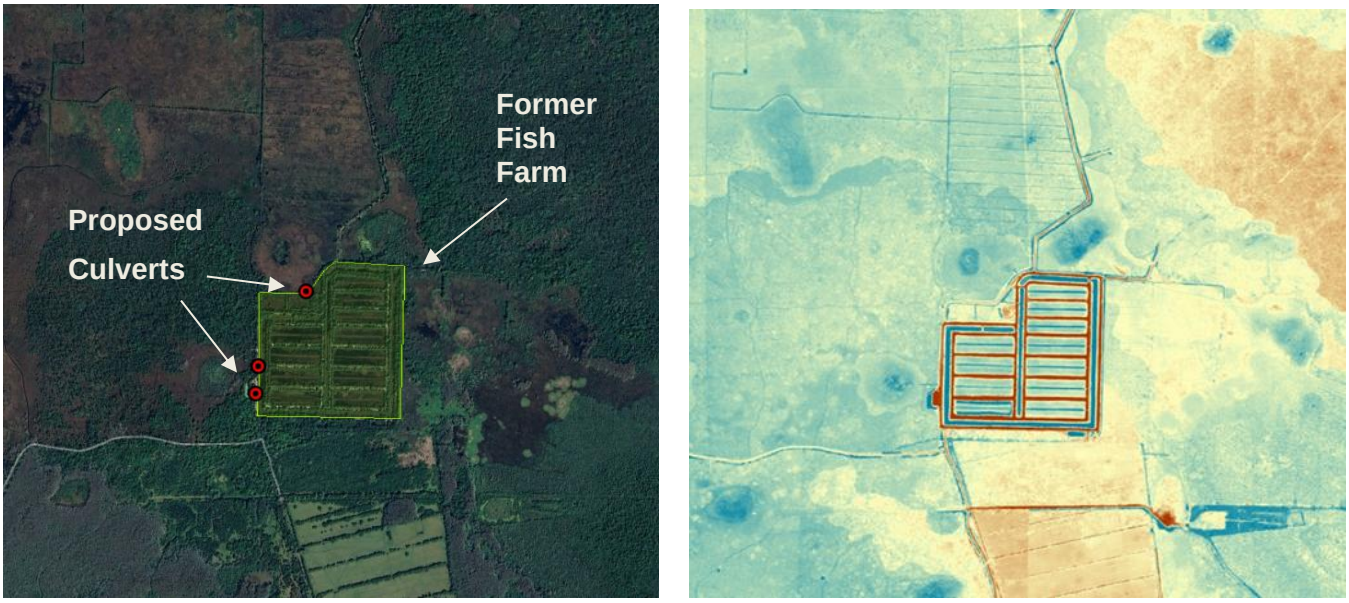


Figure 5-6 Former Fish Farm Culvert Locations and LiDAR Imagery

Modeling Approach

Within the refined CWI model, flow near the former fish farm has been conceptualized to include a groundwater component, a surface sheet flow component, and a 1-D channel component. To capture the flow impediment of the former fish farm, blockages were added to the overland flow component by defining areas upstream and downstream of the former fish farm as separate flow areas. These areas are connected via culverts and weirs to simulate the farm road and fish farm berm blockages. Storage features are also included to represent the pond storage and perimeter canals in order to account for potential seepage from the adjacent wetlands (Figure 5-7).

To simulate the proposed project condition, the proposed culverts will be added with weir structures varied to simulate the gate adjustment. Weir may be adjusted seasonally to store water in Corkscrew Marsh with gradual release during the dry season. Storage features in the former fish farm will be eliminated, and the topography modified to restore an average ground surface elevation consistent with the adjacent areas.

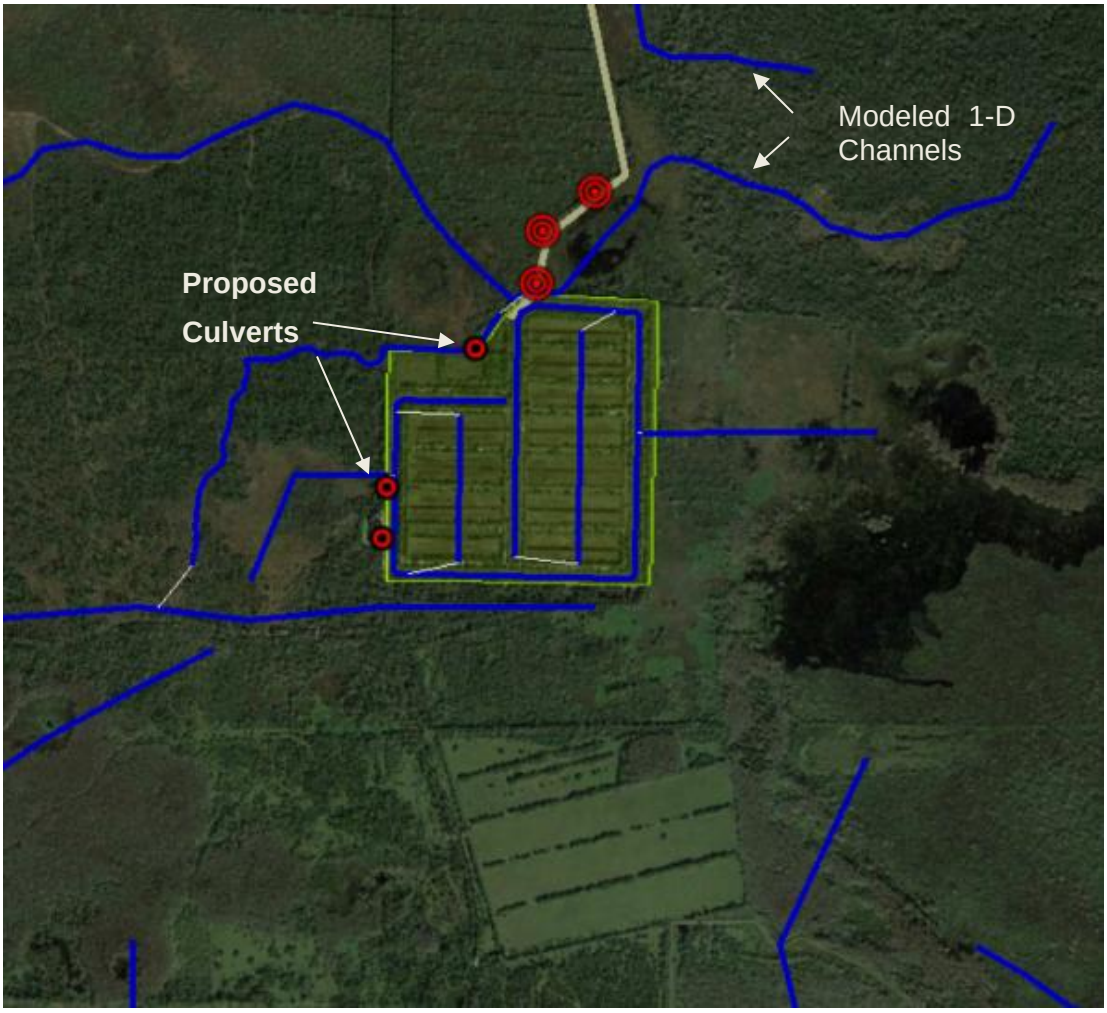


Figure 5-7. CWI Refined Model 1-D channels at the Former Fish Farm

Accessibility and Maintenance

Access during construction would be via the existing Washout Road and access roads resulting in minimal damage to natural areas. Following construction, routine maintenance of the structures would be required including adjustment of gates, regular exercising of mechanical equipment, and mowing.

Constructability and Project Risk

Overall, the project is considered readily implementable with commonly employed technologies. The addition of variable weirs minimizes risks since the amount of flow can be adjusted to project conditions as needed. It is not expected that the structures would be used in a flood control capacity, posing a risk in the event of failure.

Permitting Considerations

Environmental restoration projects of this size and scope generally qualify for state general permits and federal nationwide permits. Local permits may also be needed for work within areas outside SFWMD's ownership.

Initial Screening Results

Based on the analysis presented above, this project is retained for inclusion within the restoration alternatives formulation. The benefits could be significant, and challenges are reasonable and could be overcome. The project is readily implementable with standard technologies and provides minimal disturbance of natural areas. The inclusion of adjustable weirs reduces project risk.

5.2 Bird Rookery Swamp Hydrologic Improvements

Based on discussions with the TWG, conditions in the southern half of Corkscrew Swamp Sanctuary and the northeastern portions of Bird Rookery Swamp were characterized as too dry. One project is proposed to address these conditions with the intent of slowing down water flow through the area, allowing for higher groundwater and surface water stages and storage, increasing hydroperiods, and improving dry season water levels.

After passing beneath Washout Road, described above, water from Corkscrew Marsh flows generally southwest through Corkscrew Swamp and then into Bird Rookery Swamp. Depending on stages, some water may also continue to the west. Within Bird Rookery Swamp, a series of access roads have been constructed, originally for purposes of logging. The perimeter trail shown in Figure 5-8 is the current Bird Rookery Trail. These roads are slightly elevated, forming a berm. Flow passes beneath these roads through a series of recently replaced culverts discussed in Section 4.5.2.

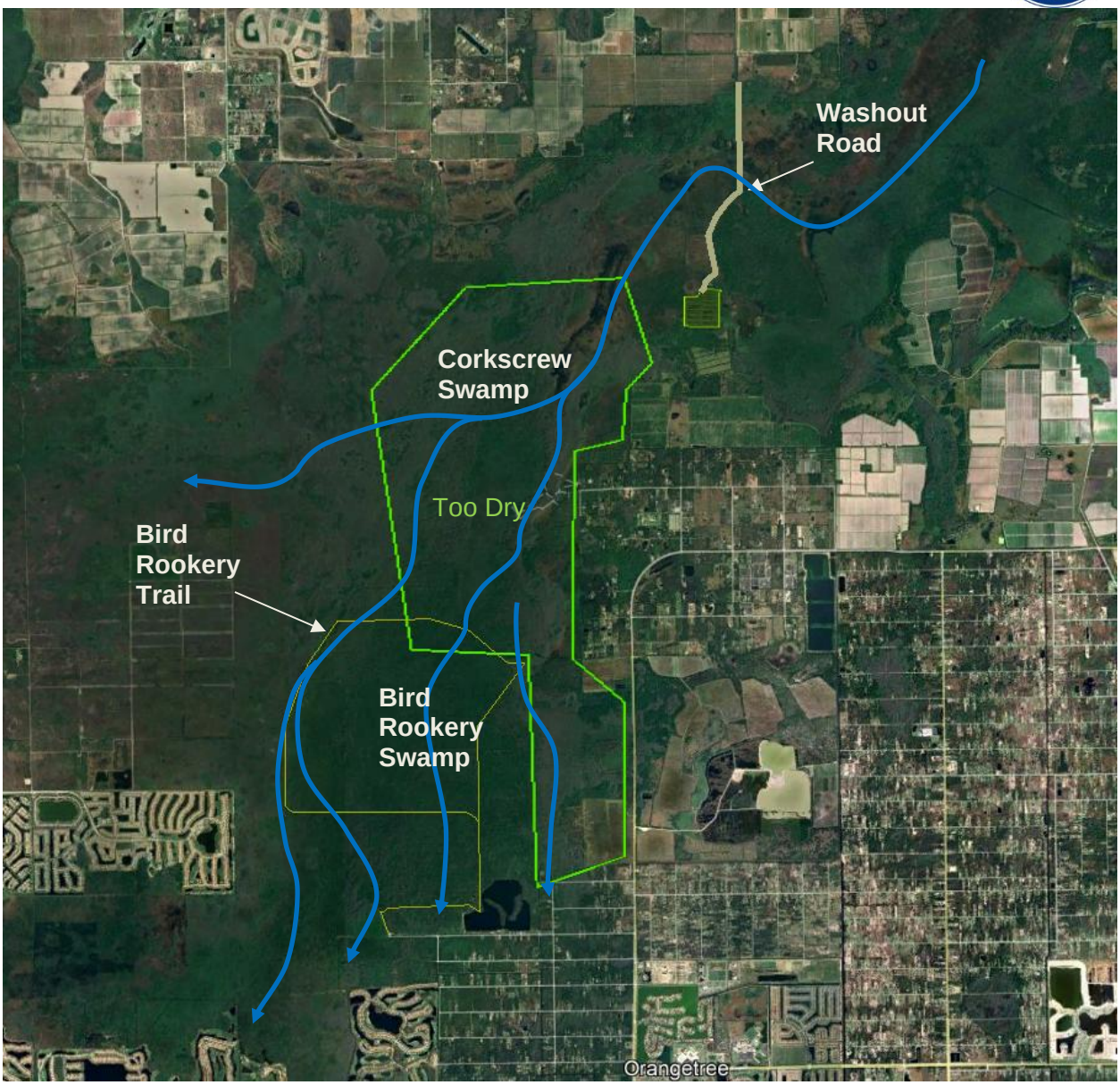


Figure 5-8. Bird Rookery Swamp Generalized Flow Patterns

Figure 5-9 presents LiDAR imagery as well as some general elevations. The topographic data suggest grades from about 16 feet NAVD west of Washout Road to less than 14 feet NAVD in the vicinity of Shady Hollow Boulevard. A low point occurs at the north end of Corkscrew Canal, north of Cork 2 at an elevation of about 13 feet NAVD. To the west is a rise with slightly higher elevations by about 2 feet. Private properties to the east are at higher elevations. A berm to the east of the point at the north end of Corkscrew Canal has a low point of about 16 feet NAVD. At low stages, surface flow would be confined to a relatively narrow north south flow-way along the eastern flow-ways. As stages increase the flow-way would expand, eventually overtopping the rise at the low point allowing water to flow to the west.

Of significant importance to the system hydrology is the elevation of adjacent properties to the east. Notably, these properties are only slightly higher than the primary flow-way. Although it appears

structures have been constructed on elevated ground, the elevation of privately owned land significantly limits the ability to raise stages within the area.

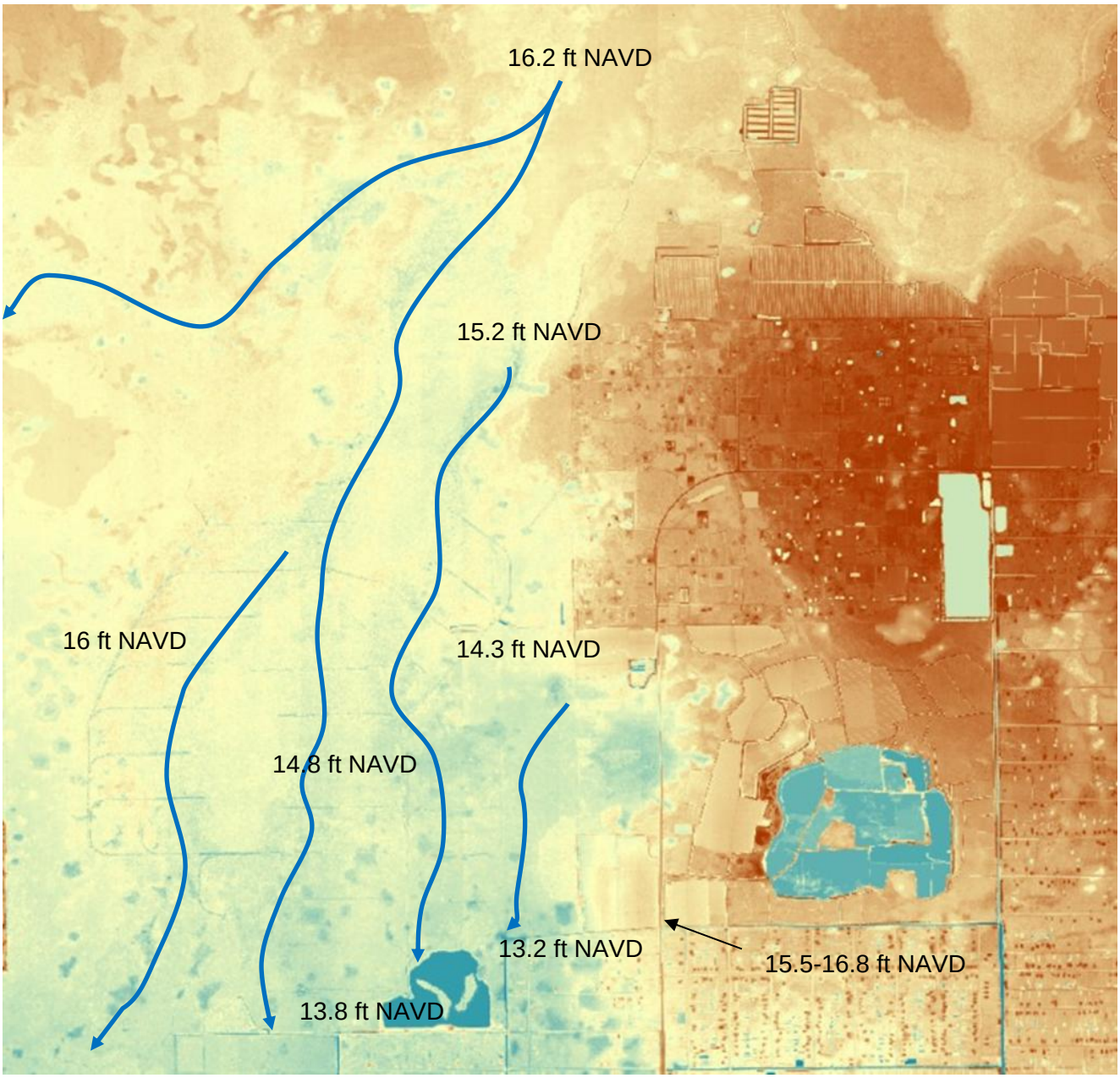


Figure 5-9 Bird Rookery Swamp LiDAR Elevations

5.2.1 Project 3: Culvert Improvements Along Bird Rookery Trail

Project Description and Objective

There are 22 culverts beneath Bird Rookery trail (refer to Figure 5-10), which have been or will be replaced. This project would include the addition of adjustable weir gates for improved water level management. One additional culvert is proposed within the low point of the flow path to the east, also

equipped with an adjustable weir gate. Once in place, the optimal balance of weir gate operation schedules can be evaluated through adaptive management to obtain the appropriate levels.

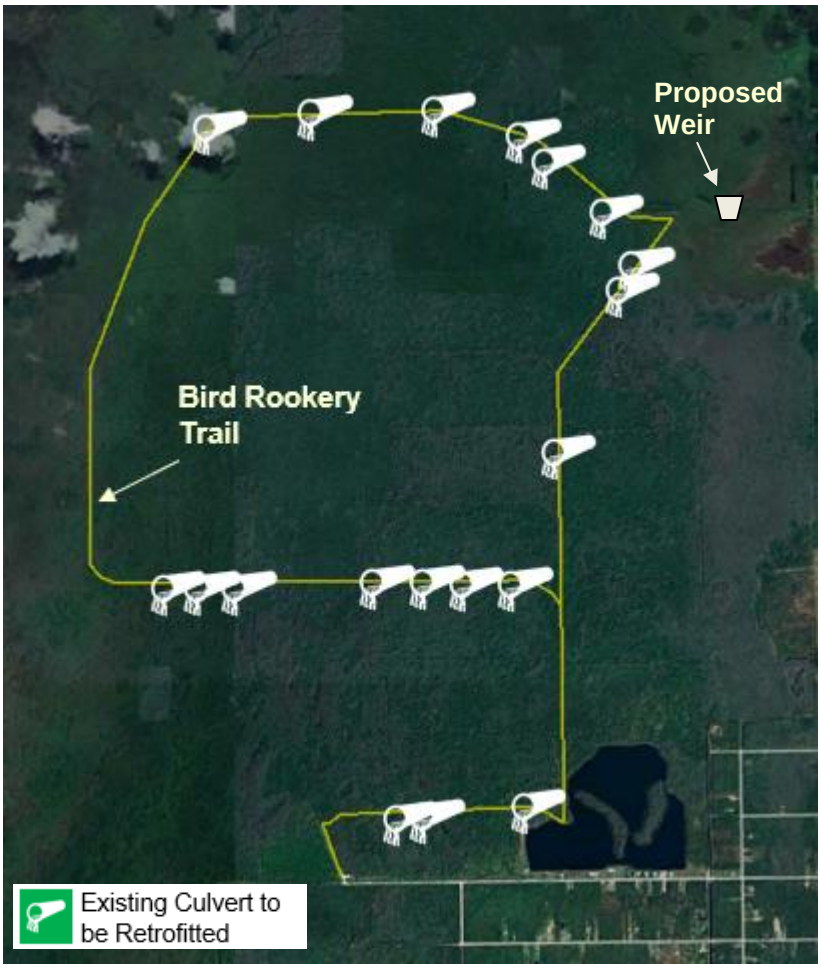


Figure 5-10. Project 3 Weir Structures

Project Challenges

The proposed project is internal to the CWI Project area and readily implementable from a technical perspective. A significant challenge is not raising stages to a point that may impact adjacent privately owned property. As discussed, adjacent properties have elevation only slightly above that within the primary flow-way. More detailed evaluation of LiDAR data in conjunction with model results will be required to ensure the proposed project does not result in offsite impacts. In addition to flooding during large storms, longer term impacts associated with elevated groundwater levels will also require further investigation. The more these properties can be hydraulically isolated from Bird Rookery Swamp, the more operational flexibility and the more stages and hydroperiods can be increased. Another concern is flow to the south beyond the CWI Project area. Currently, this water discharges to the BCB canal system to the south. The proposed project would reduce the amount of water reaching the BCB system, which needs to be further evaluated through modeling. Although improvement of Corkscrew Swamp and Bird Rookery Swamp may be achieved, it should not result in significant impacts to BCB or substantially increase the potential for saltwater intrusion.

Related Performance Metrics

Performance metrics related to this project include the following:

Hydrologic Restoration of Wetlands

- **Saltwater Intrusion**: Water level control options provided by project implementation cannot have significant potential for adverse impacts to salinity levels in areas at risk to high salinity. Dry season groundwater levels will be assessed in areas at risk, as well as flows at key downstream outfall structures (such as Coco1, GG1, Imperial River, Kehl Canal, etc.).
- **Sheet Flow**: Water level control options provided by project implementation should provide enhanced sheet flow. Weir settings may be varied to promote water distribution among the culverts.
- **Water Depth Targets:** Water level control options provided by project implementation should result in the system being better able to meet water depth targets. Achieving an appropriate schedule of weir setting could be further examined through modeling and refined in the field after project implementation through adaptive management.
- **Hydroperiods:** Water level control options provided by project implementation should result in the system being better able to meet hydroperiod targets. Weirs may be used to control the gradual release of water over the dry season to maintain beneficial hydrology. Achieving an appropriate schedule of weir setting could be further examined through modeling and refined in the field after project implementation through adaptive management.
- **Dry Season Water Level:** Water level control options provided by project implementation should result in reducing the groundwater recession rate and improving dry season water levels. Weirs may be used to control the gradual release of water over the dry season to maintain beneficial hydrology.

Habitat Restoration

- **Vegetative Community**: Water level control options provided by project implementation should provide land management staff with the ability to better control water levels to promote more appropriate vegetative communities.
- **Wildlife Use:** Control options from project implementation should provide land management staff with better control of water levels to promote wildlife use.
- **Threatened and Endangered Species:** Improved hydrology should result in improved habitat for threatened and endangered species. No potential impacts to threatened and endangered species have been identified.
- **Connectivity:** By increasing water stages in wetland areas, wetland footprint should increase and improve the overall connectivity between habitats. However, the access roads would not be removed as part of this project.

Flood Protection

- It is not expected that the proposed project will play a role in flood protection requiring adjustment in the event of a storm event. However, the amount of flow released needs to be managed so as not to create a flooding issue.

Water Supply

- Increased groundwater recharge should benefit local permitted water supply wells.

Project Elements

As described above, there are 22 culverts along Bird Rookery trail, which will be retrofitted to include adjustable weir gates. These may be retrofitted in a manner similar to the procedure described above and shown in **Error! Reference source not found.**. In addition to the 22 culvert retrofits, an additional adjustable weir culvert will be added to the east. Actual sizing of the proposed culvert will be further examined through modeling. In addition, based on modeling results, the benefits of improving Bird Rookery trail (i.e., raising) will be determined.

Modeling Approach

Within the refined CWI model, flow in Bird Rookery Swamp has been conceptualized to include a groundwater component, a surface sheet flow component, and a 1-D channel component. To capture the flow impediment caused by the Bird Rookery trail and culverts, which until recently have been in poor condition, blockages were added to the overland flow component by defining areas upstream and downstream as separated flow areas. These areas are connected via culverts with weirs to capture to simulate suspected culvert blockage (Figure 5-11).

To simulate the proposed project condition, modeled culverts may be lowered and/or upsized and weir structures varied to simulate the gate adjustment. Weirs may be adjusted seasonally to store water for gradual release over the dry season.

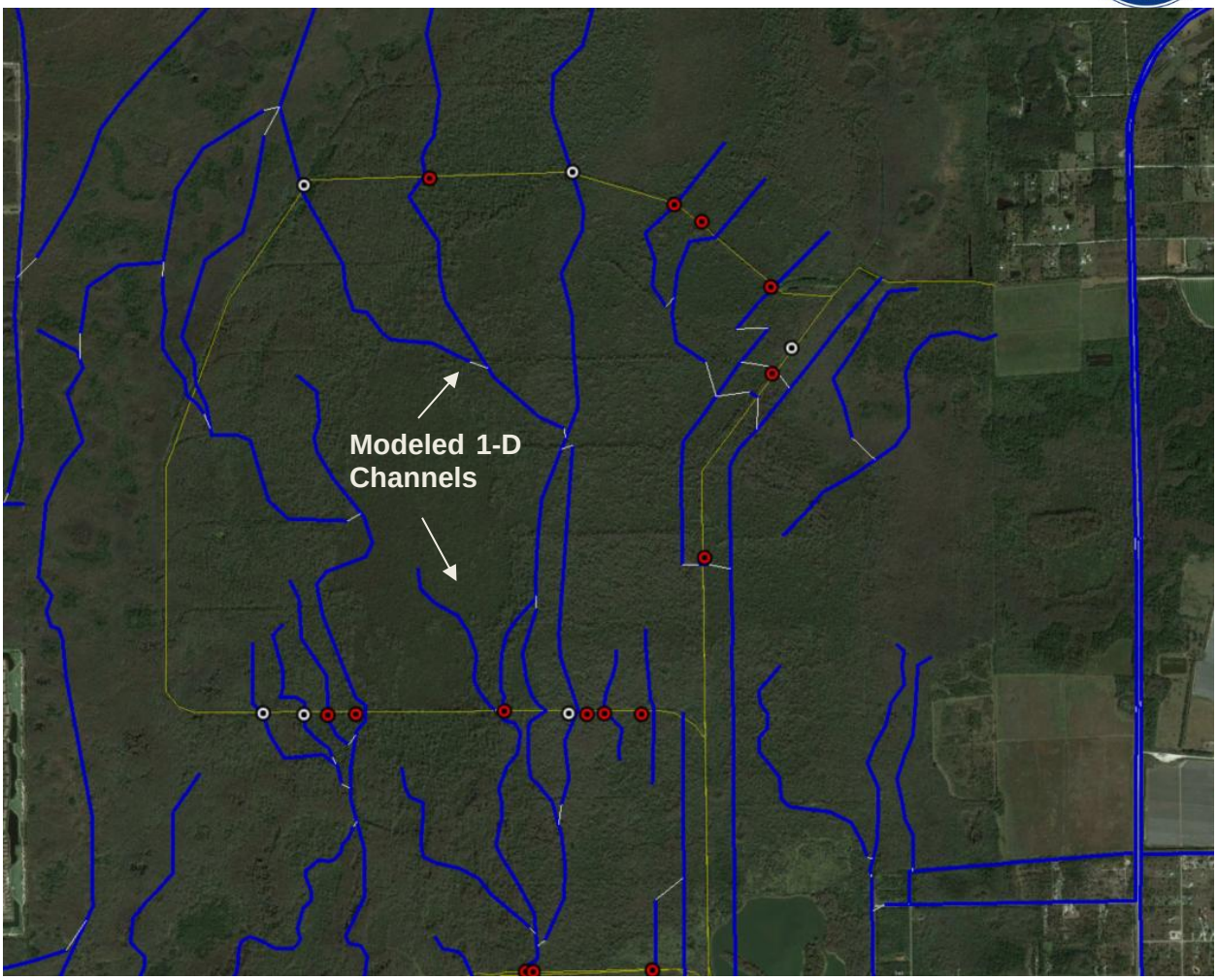


Figure 5-11. CWI Refined Model 1-D Channels in Bird Rookery Swamp

Accessibility and Maintenance

Access during construction would be via the existing Bird Rookery trail resulting in minimal damage to natural areas. Following construction, routine maintenance of the structures would be required including adjustment of gates, exercising of mechanical equipment, and mowing.

Constructability and Project Risk

Overall, the project is considered readily implementable with commonly employed technologies. The addition of variable weirs minimizes risks because the amount of flow can be adjusted to site conditions as needed. It is not expected that the structures would be used in a flood control capacity, posing a flood risk in the event of failure.

Permitting Considerations

Culvert repair and replacement is considered a maintenance activity and should qualify for state regulatory exemptions and/or federal nationwide permits. Installation of adjustable weir gates and new weirs may require a higher level of permitting depending on the size and scope of the proposed infrastructure. Local permits may also be needed for work within areas outside SFWMD's ownership.

Initial Screening Results

Based on the analysis presented above, this project is retained for inclusion within the restoration alternatives formulation. The benefits could be significant, and challenges are reasonable and could be overcome. The project is readily implementable with standard technologies and provides minimal disturbance of natural areas. The inclusion of adjustable weirs reduces project risk.

5.3 Hydrologic Improvements Along Shady Hollow Boulevard

As described above, the primary flow paths through Bird Rookery extend south. This water is discharged along Shady Hollow Boulevard. Projects described above aim to increase incoming flow from Corkscrew Marsh and redistribute flows within Bird Rookery Swamp. The projects described in this section aim to reduce over-drainage at Shady Hollow.

Generalized flow paths toward Shady Hollow Boulevard are shown on Figure 5-12. LiDAR data are shown on Figure 5-13. Based on a review of LiDAR data, flow through the eastern flow path likely discharges at the low point at the north end of the Corkscrew Canal. Flow in the canal is controlled downstream at the Cork2 Structure. Flow paths to the west discharge either to the pond in the Saddlebrook Lakes residential area or to the ditch on the north side of Shady Hollow Boulevard. The pond appears to have an access road on the north and west sides, which may limit the amount of discharge. Discharge to the ditch on the north side of Shady Hollow Boulevard is limited by the presence of a berm. Based on LiDAR imagery and site reconnaissance in August 2024, four areas of potential breach are noted (see Figure 5-13), the most significant of which is at the west end. Water in the ditch on the north side of Shady Hollow Boulevard flows either to Cork3, to Red Maple Swamp Preserve via culverts under Shady Hollow Boulevard or to Cork2 via a stormwater pipe.

Red Maple Swamp Preserve is located to the south of Shady Hollow Boulevard. The approximately 300-acre area (including approximately 60 acres of privately owned lands) is relatively undeveloped; however, LiDAR data suggest the presence of remnant ditches indicating a portion of the area has been graded due to historical farming operations. The area is ringed by ditches that tie into the Corkscrew Canal to the east. Forty-first Street bisects the area in the east-west direction. This road is relatively low lying and prone to flooding. Ditches on either side of the road covey water to the east to discharge to Corkscrew Canal. Drainage from the area is to the southeast corner where it discharges to the Corkscrew Canal south of Cork3 via an open connection. The area is ringed by ditches that tie into the ditch on the south side.

Along Immokalee Road, runoff west of the road is conveyed to Cork2. Water east of Immokalee Road appears to be conveyed to the east toward GG7. A culvert beneath Immokalee Road may convey more water to Bird Rookery Swamp from areas to the east of Immokalee Road. Finally, in the western portion of Shady Hollow Boulevard is an area previously used for agricultural purposes. The perimeter channel and berm around this area may result in short circuiting of flow, reducing sheet flow. In addition, due to lack of management, the area is reportedly dominated by undesirable vegetation.

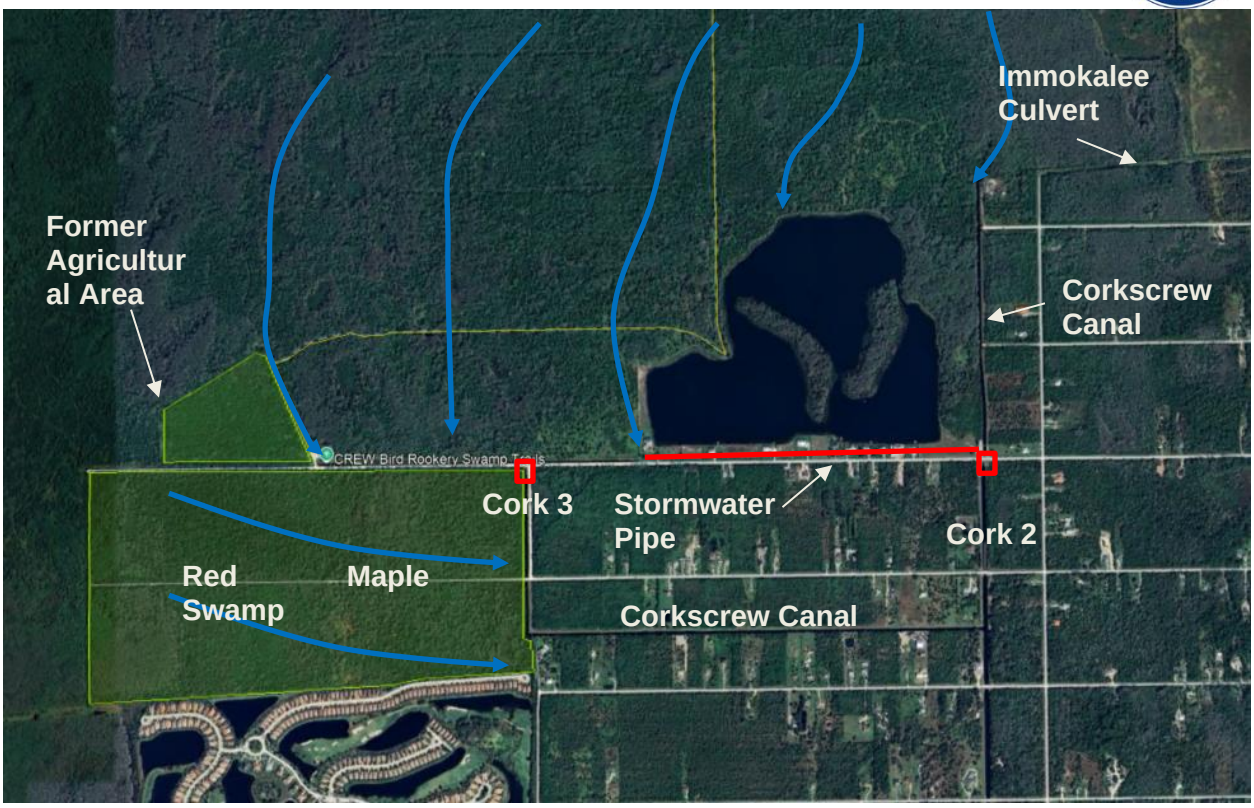


Figure 5-12. Hydrologic Features in the Vicinity of Shady Hollow Boulevard

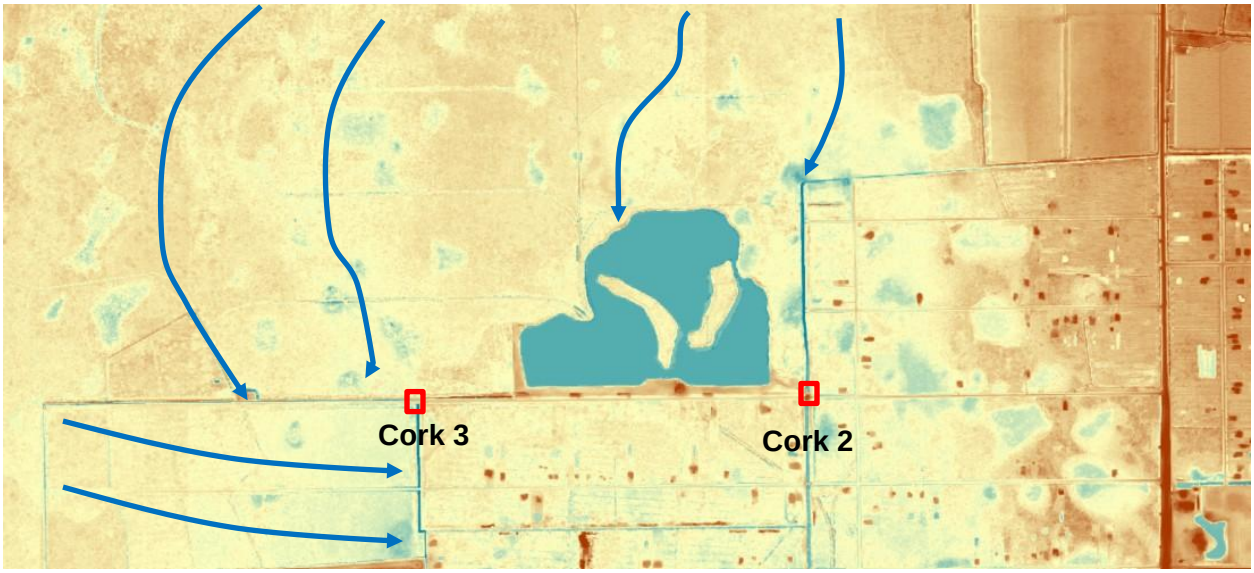


Figure 5-13. LiDAR Elevations in the Vicinity of Shady Hollow Boulevard

Four projects are proposed for consideration to reduce over-drainage along Shady Hollow Boulevard or otherwise benefit the CWI Project area. The first includes repairing the berm on the north side of Shady Hollow Boulevard and installation of adjustable weir gates at key discharge locations. The second builds on the first with the introduction of a limited berm at the point of discharge of the eastern flow path to allow for greater operational flexibility of water levels and flows. The third and fourth projects involve restoration of the former agricultural area and Red Maple Swamp to reduce short circuiting and

encourage sheet flow. The fifth project also involves installing a culvert under Immokalee Road to allow water conveyance from the east to Bird Rookery Swamp.

5.3.1 Project 4: Shady Hollow Blvd Berm Repair and Gate Installation

Project Description and Objective

Based on a review of LiDAR data, at least six breach locations have been identified (see Figure 5-14). The largest breach appears to be just upstream of the Shady Hollow stormwater culvert. To the east of Cork3, top of berm elevations are about 20 feet NAVD. The breach just west of the Shady Hollow stormwater pipe has an elevation of about 15 feet NAVD. To the west of Cork3, the berm is in poorer condition with crest elevation between about 17 feet NAVD and 15 feet NAVD. The proposed project would improve the berm to a uniform 20 feet NAVD. A collection ditch will be excavated just north of the berm to provide a source of fill for berm construction and promote sheet flow from the north. Two adjustable weir structures would connect the collection ditch with the existing stormwater ditch on the north side of Shady Hollow Boulevard. The weir structure would enable better management of water levels north of Shady Hollow Boulevard. The project would also include an assessment of the berm integrity over its entire length and reinforcement or reconstruction where the berm is determined to be vulnerable through geotechnical investigation.

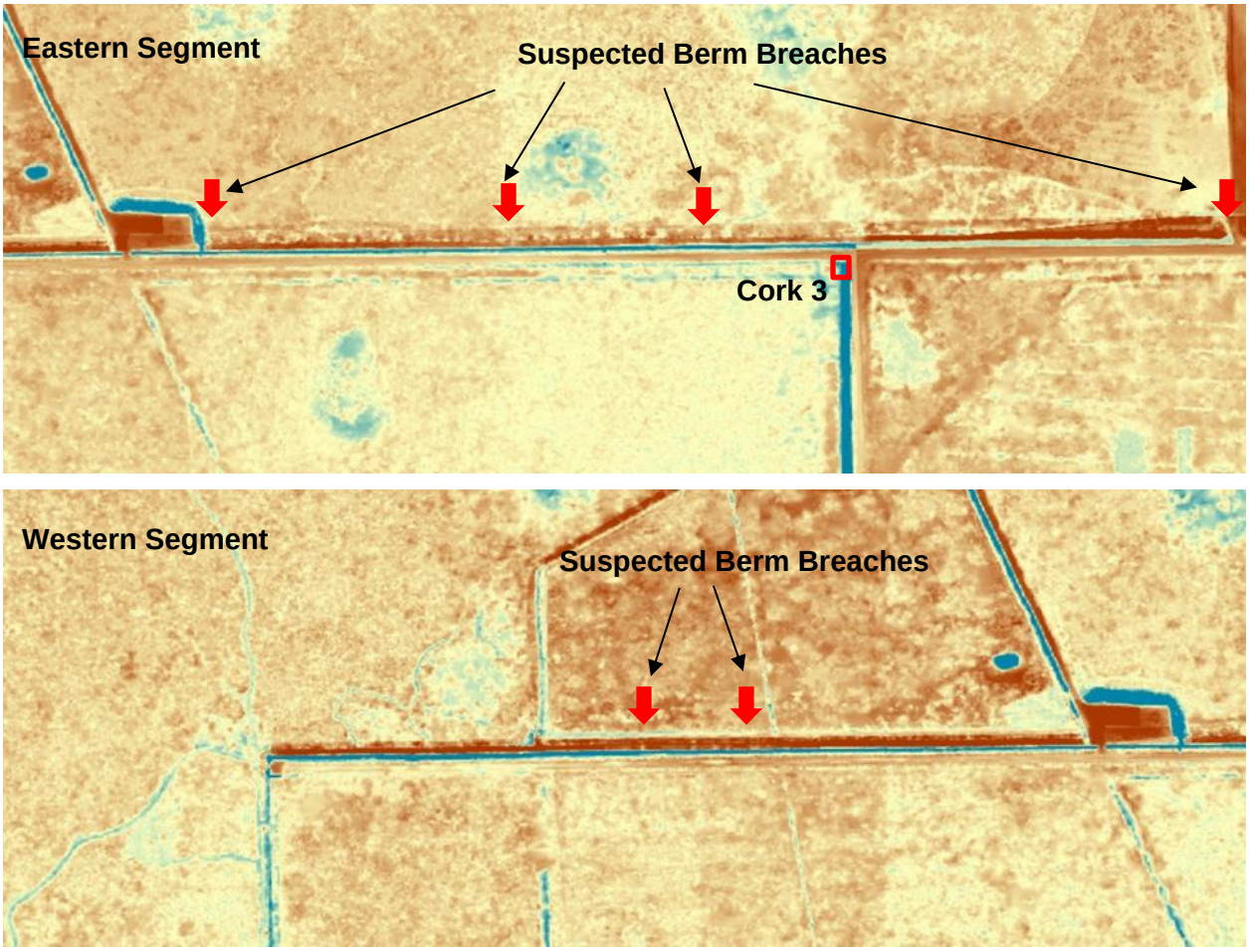


Figure 5-14. Location of Suspected Berm Breaches Along Shady Hollow Boulevard North Berm

Project Challenges

The proposed project is readily implementable from a technical perspective. A significant challenge, however, is avoiding impacts to the adjacent privately owned properties. Although the gate structure could be used to raise surface and groundwater stages, extending hydroperiods to the north, this increase in stage may extend to the east, resulting in a similar rise in water levels in the pond on private property and adjacent to residences. It is likely that the structures will need to be operated following a seasonal schedule of raising and lowering the weir structure. However, the structures should not require adjustment for a large storm event and thus would serve in a flood protection capacity to eliminate risk associated with failure of the gate operation. In addition, similar to Project 3, the proposed project should not deprive the BCB of a significant amount of water resulting in impacts.

Related Performance Metrics

Performance metrics related to this project include the following:

Hydrologic Restoration of Wetlands

- **Saltwater Intrusion**: Water level control options provided by project implementation cannot have significant potential for adverse impacts to salinity levels in areas at risk to high salinity. Dry season groundwater levels will be assessed in areas at risk, as well as flows at key downstream outfall structures (such as Coco1, GG1, Imperial River, Kehl Canal, etc.).
- **Sheet Flow**: Water level control options provided by project implementation should provide enhanced sheet flow. A collection ditch excavated on the north side of the berm should result in an even collection of sheet flow without the risk of channelization.
- **Water Depth Targets:** Water level control options provided by project implementation should result in the system being better able to meet water depth targets north of Shady Hollow Boulevard. Achieving an appropriate schedule of weir settings could be further examined through modeling and in the field after project implementation through adaptive management.
- **Hydroperiods:** Water level control options provided by project implementation should result in the system being better able to meet hydroperiod targets. Weirs may be adjusted to provide storage during the wet season and prevent over-drainage during the dry season. Achieving an appropriate schedule of weir settings without impacting adjacent properties could be further examined through modeling.
- **Dry Season Water Level:** Water level control options provided by the project should result in reducing the groundwater recession rate and improving dry season water levels. Achieving an appropriate schedule of weir settings could be further examined through modeling.

Habitat Restoration

- **Vegetative Community**: Options provided by the project should provide land management staff with better control of water levels to promote more appropriate vegetative communities.
- **Wildlife Use:** Control options provided by project implementation should provide land management staff with the ability to better control water levels to promote more wildlife use.
- **Threatened and Endangered Species:** Improved hydrology should result in improved habitat for threatened and endangered species. No potential impacts have been identified.

- **Connectivity:** Shady Hollow Boulevard will remain in place and connectivity will not be improved. However, higher stages to the north should result in greater areas of wetland connected to other habitats.

Flood Protection

- It is not expected the proposed project structures would need to be designed and managed to maintain flood protection. However, water levels need to be maintained such that a flood risk is not created.

Water Supply

- Increased groundwater recharge should benefit local permitted water supply wells.

Project Elements

As described above, the portion of the Shady Hollow berm east of Cork3 appears to have been better maintained with a crest elevation of about 20 feet NAVD. This project would involve berm improvement for the 6,500 feet west of the Saddlebrook Lakes development (Figure 5-15). Preliminarily, the berm would have a crest elevation of 20 feet NAVD, although this may be refined through modeling. To the north, two collection ditches would be excavated. These ditches would promote unform collection of natural sheet flow from areas to the north without concentrating the flow at specific discharge locations and may be operated with different weir settings. The collection ditch will have a 5-foot-wide bottom width, 3-to-1 side slopes, and an invert of about 12 feet NAVD. The intent is to maintain a minimum of 3 feet of standing water in the collection ditch to discourage vegetation growth that blocks the ditch. Fill necessary to build up the berm may be gathered on site through the excavation of collection ditches. At the east end of the collection ditch, a variable weir structure will be installed to discharge water to the existing stormwater gate on the north side of Shady Hollow Boulevard (Figure 5-14 above). The weir structure will be appropriately sized through modeling to convey 100-year peak design flows while maintaining stages below a maximum of 18 feet NAVD to provide a minimum 2 feet of freeboard. Erosion protection would be provided at structure discharges.

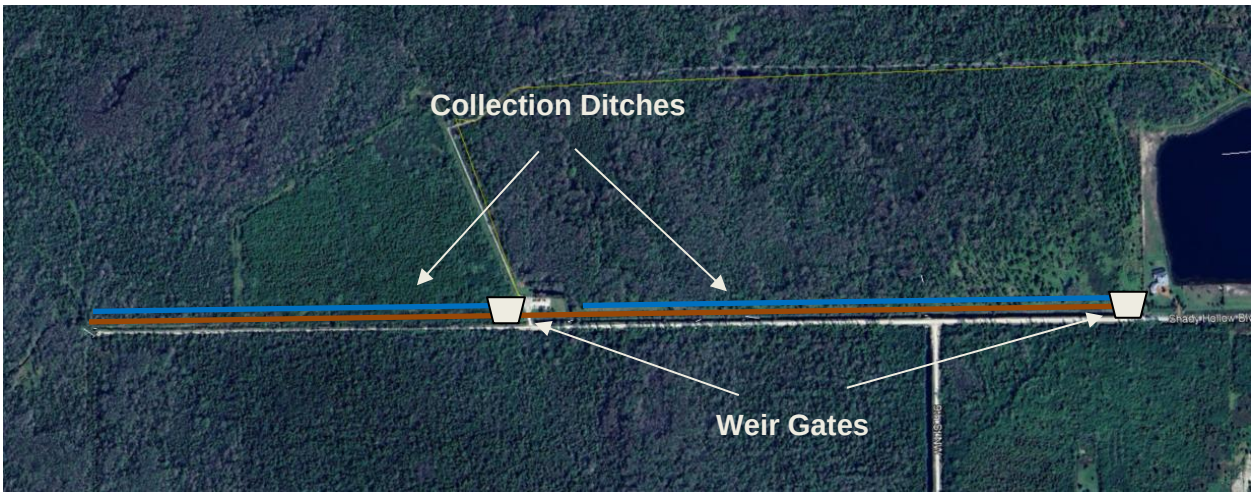


Figure 5-15. Shady Hollow Berm Repair Project Elements

Modeling Approach

Within the refined CWI model, flow in the vicinity of Shady Hollow Boulevard has been conceptualized to include a groundwater component, a surface sheet flow component, and a 1-D channel component (Figure 5-16). To simulate the connection between flow paths within the natural area to the north and the stormwater ditch on the north side of Shady Hollow Boulevard, the ditches north and south of the road are simulated in the 1D channel component. These ditches are connected at three locations where there are pipes under the road via culverts and weirs. The north ditch is connected to the headwater of the Cork3 structure, whereas the south ditch is connected to the tailwater side of Cork3, creating a flow bypass south of the control structure.

To simulate the proposed project condition areas north and south of the proposed berm, the cross sections of the north ditch will be adjusted to include the elevation of the berm on the north side of the channel. This prevents overland flow below the elevation of the berm to enter the channel. The collection ditches will be added north of the berm and adjustable weirs and culverts will be added and linked to the ditch north of Shady Hollow. Weirs may be adjusted seasonally to store water in the wet season for gradual release over the dry season.

Accessibility and Maintenance

Access during construction would be via Shady Hollow Boulevard, resulting in minimal damage to natural areas. Following construction, routine maintenance of the structures would be required including adjustment of gates, regular exercising of mechanical equipment, and mowing.

Constructability and Project Risk

Overall, the project is considered readily implementable with commonly employed technologies. The addition of variable weirs minimizes risks since the amount of flow can be adjusted to project conditions if needed. It is not expected that the structures would be used in a flood control capacity, posing a risk in the event of gate failure.

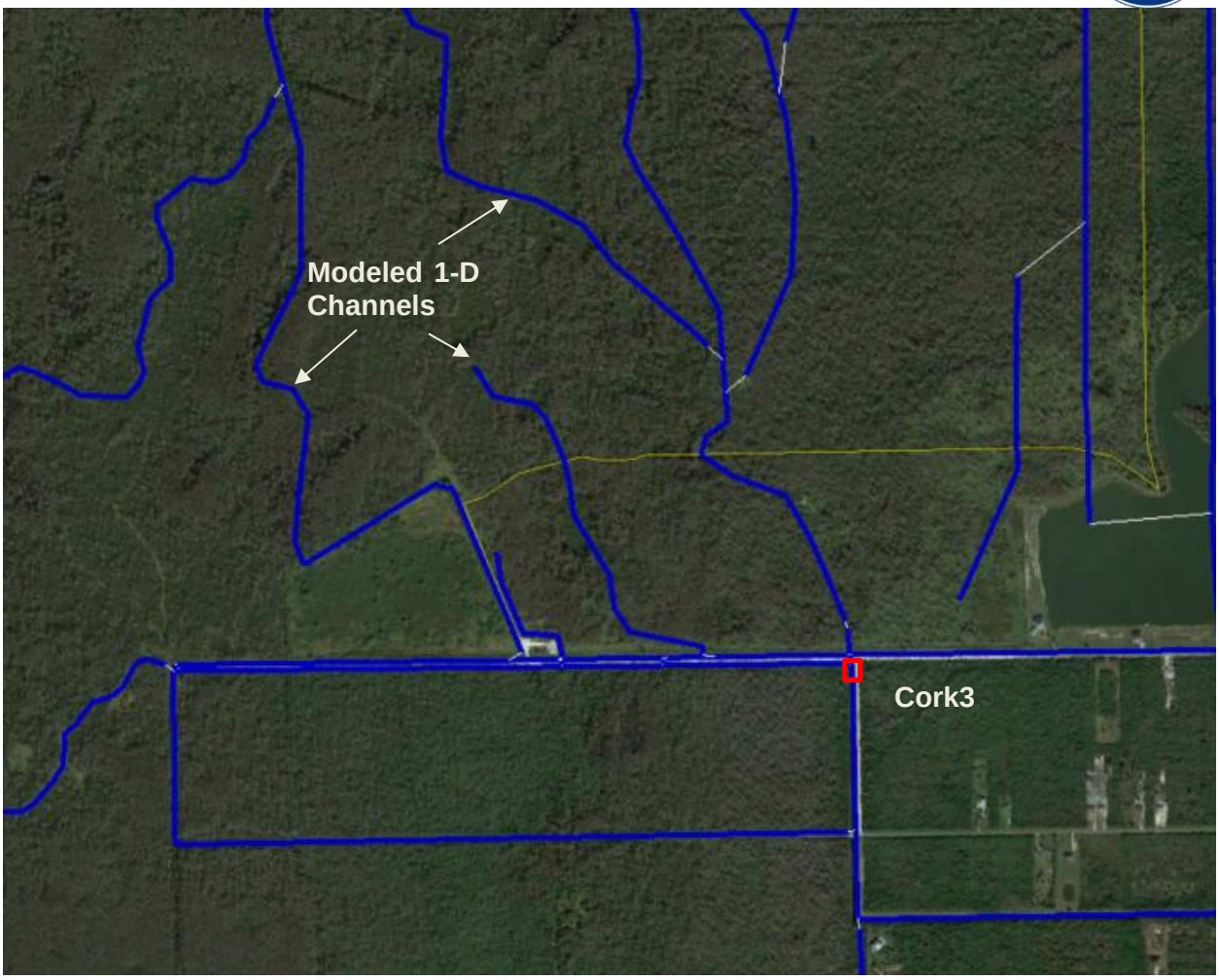


Figure 5-16. CWI Refined Model 1-D channels north of Shady Hollow Boulevard

Permitting Considerations

Additional review of the size and complexity of the project would be required to accurately capture permit requirements. However, environmental restoration projects of this size and scope generally qualify for state general permits and federal nationwide permits. An individual ERP may be required to ensure that neighboring properties are not impacted by the project. Additionally, a federal Section 404 permit may be required for the various components of this project due to the total acreage of impacts to wetlands. Local permits may also be needed for work within areas outside SFWMD's ownership.

Initial Screening Results

Based on the analysis presented above, this project is retained for inclusion within the restoration alternatives formulation. The benefits could be significant; however, this depends on the stages that could be achieved without impacts that extend beyond the berm. The project is readily implementable with standard technologies and provides minimal disturbance of natural areas. The inclusion of adjustable weirs reduces project risk.

5.3.2 Project 5: Corkscrew Canal Gate and Berm

Project Description and Objective

As described above, a significant flow path exists, draining the eastern portion of Bird Rookery Swamp discharging to the Corkscrew Canal, north of the Cork2 structure. Although discharge to this canal is to be controlled by Cork2 to the south, the operation of this structure needs to consider the private properties between Cork2 and the Bird Rookery Swamp discharge. This project includes placing a variable weir gate at the north end of the Corkscrew Canal so that water levels within Bird Rookery Swamp can be directly managed. In addition, the location of the discharge appears to be in a topographic low and the structures alone would result in water flowing around the structure and discharging to the Corkscrew Canal. Therefore, a limited berm is proposed through the low area to enable the gate structure to function. The extent of this berm will be defined through modeling to avoid impacts to adjacent privately owned property. In general, the longer and higher the berm, the higher the stage that can be achieved as well as the greater amount of storage, resulting in increased groundwater infiltration and longer hydroperiods. The ditch and access road to the east of the proposed structure is relatively low; raising the road, which appears to be on private property, and/or construction of a new berm extending to the west, may be required if this is determined to be beneficial and easements cannot be obtained.

Project Challenges

The proposed project is internal to the CWI Project area and readily implementable from a technical perspective. A significant challenge is preventing impacts to adjacent privately owned property resulting from the higher stages. This could be mitigated through the construction of an additional berm along the east side of the Bird Rookery Swamp at significant additional construction and O&M costs. Modeling may assist in better determining the benefits achieved by such a berm.

Related Performance Metrics

Performance metrics related to this project include the following:

Hydrologic Restoration of Wetlands

- **Saltwater Intrusion**: Water level control options provided by project implementation cannot have significant potential for adverse impacts to salinity levels in areas at risk to high salinity. Dry season groundwater levels will be assessed in areas at risk, as well as flows at key downstream outfall structures (such as Coco1, GG1, Imperial River, Kehl Canal, etc.).
- **Sheet Flow**: Water level control options provided by project implementation should provide enhanced sheet flow. Weir settings may be varied to promote water distribution among the culverts.
- **Water Depth Targets:** Water level control options provided by project implementation should result in the system being better able to meet water depth targets. Achieving an appropriate schedule of weir settings could be further examined through modeling and in the field through adaptive management.
- **Hydroperiods:** Water level control options provided by project implementation should result in the system being better able to meet hydroperiod targets. Achieving an appropriate schedule of

weir settings could be further examined through modeling and after project implementation through adaptive management.

- **Dry Season Water Level:** Water level control options provided by project implementation should result in reducing the groundwater recession rate and improving dry season water levels. The weir may be used to control the gradual release of water over the dry season to maintain beneficial hydrology as defined within the project performance measures and metrics.

Habitat Restoration

- **Vegetative Community**: Options provided by project implementation should provide land management staff with the ability to better control water levels to promote more appropriate vegetative communities.
- **Wildlife Use:** Control options provided by project implementation should provide land management staff with the ability to better control water levels to promote more wildlife use. Hydrologic impacts (increased water levels or hydroperiods) to the nearby sparrow wintering fields within Bird Rookery Swamp will need to be avoided in coordination with SFWMD land management staff.
- **Threatened and Endangered Species:** Improved hydrology should result in improved habitat for threatened and endangered species. No potential impacts to threatened and endangered species have been identified.
- **Connectivity:** Although the proposed project will allow for high stages within Bird Rookery Swamp, the western access road will remain in place; therefore, connectivity will not be significantly improved. However, higher stages to the north should result in greater areas of wetland connected to other habitats.

Flood Protection

- It is not expected the proposed project will play a role in flood protection. However, the amount of flow released needs to be managed so as not to create a flooding issue.

Water Supply

- Increased groundwater recharge should benefit local permitted water supply wells.

Project Elements

Project elements include a gate structure similar to that proposed for Project 3 and shown in **Error! Reference source not found.** as well as a berm. The length and height of the berm will be determined through modeling to determine an appropriate balance between berm height, length, and benefit achieved. Based on a review of LiDAR, a small berm with a length of 600 feet could be implemented with a crest elevation of about 13.5 feet NAVD (Figure 5-17). However, there would likely be minimal benefit in terms of higher stages. An approximately 6,000-foot berm would connect higher land to the east with the former logging road on the north side of the lake. With this berm, a crest height of about 15 feet NAVD is achievable (Figure 5-18). At its eastern extent, the highest berm that would be considered would have a similar crest height as the private land perimeter berm to the east with a crest elevation of about 17 feet. This berm would extend about 12,000 feet around the lake, increasing in crest elevation

to tie in with the proposed Shady Hollow berm with a crest of 20 feet NAVD (Figure 5-19). Fill necessary to build the berm may be gathered on site through the excavation of collection ditches or from other on-site locations. These elevations and length will be better defined based on a more detailed review of local topography as part of alternative development.

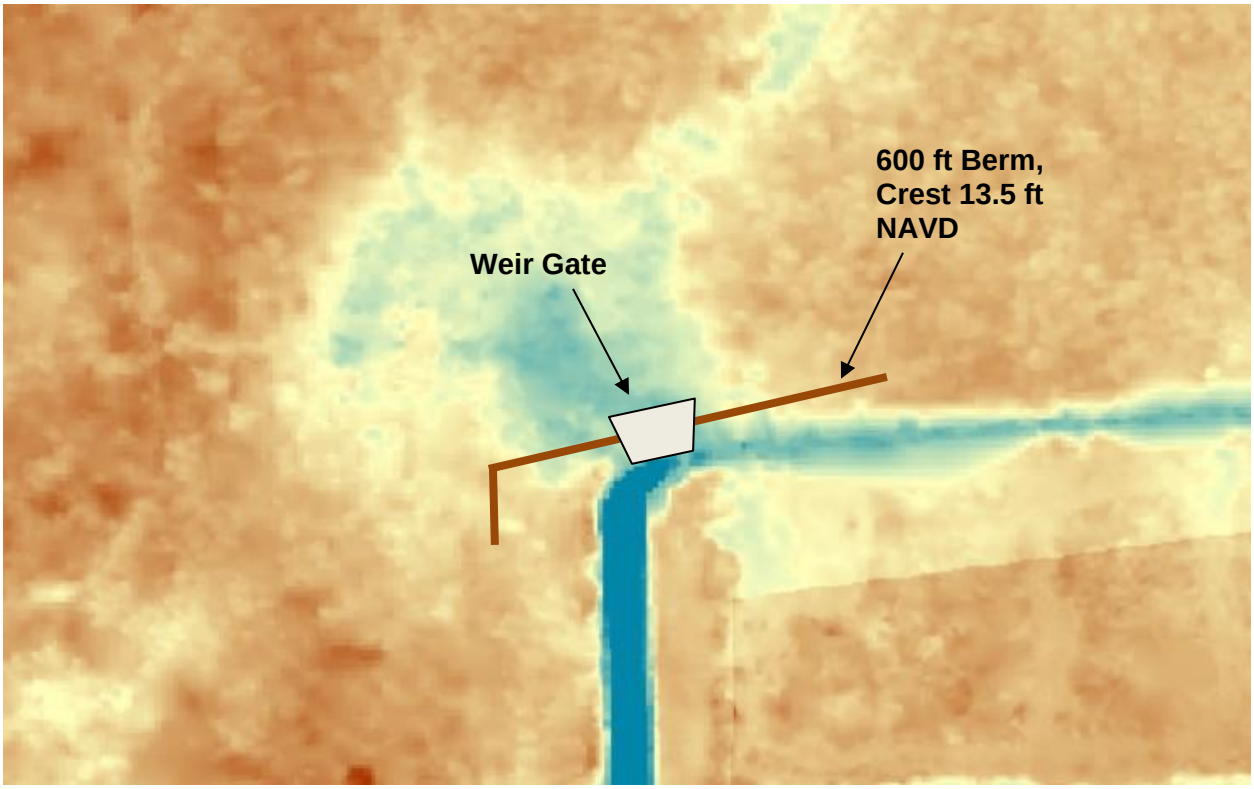


Figure 5-17. Berm Option 1 – Crest at 13.5 Feet, Length of 600 Feet

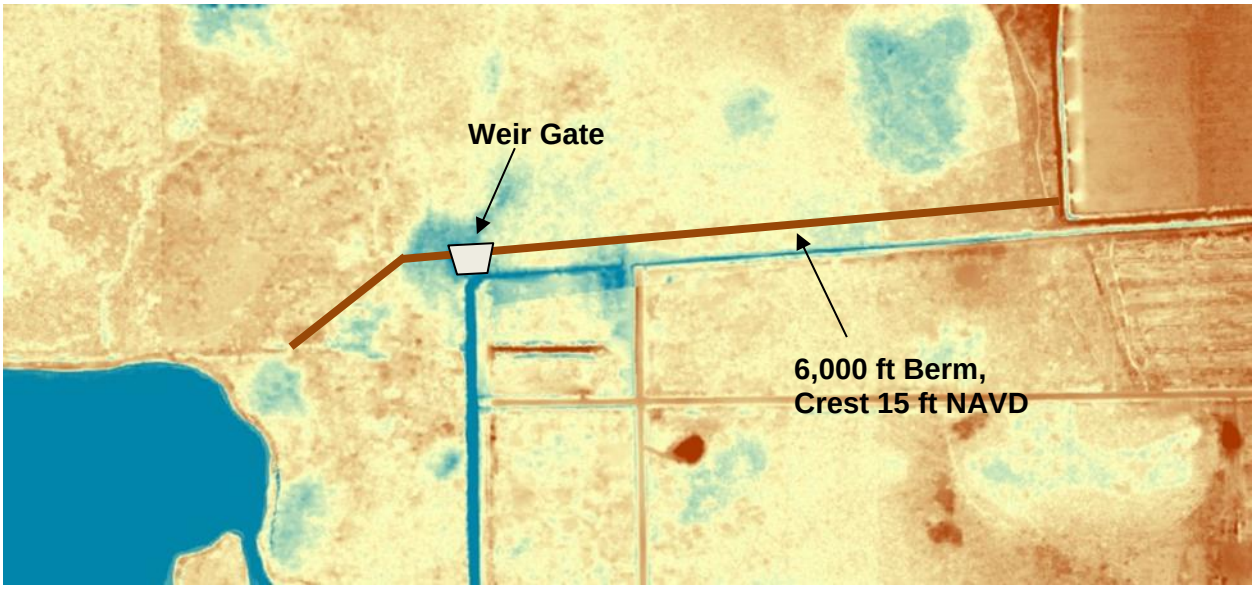


Figure 5-18. Berm Option 2 – Crest at 15 Feet, Length of 6,000 Feet

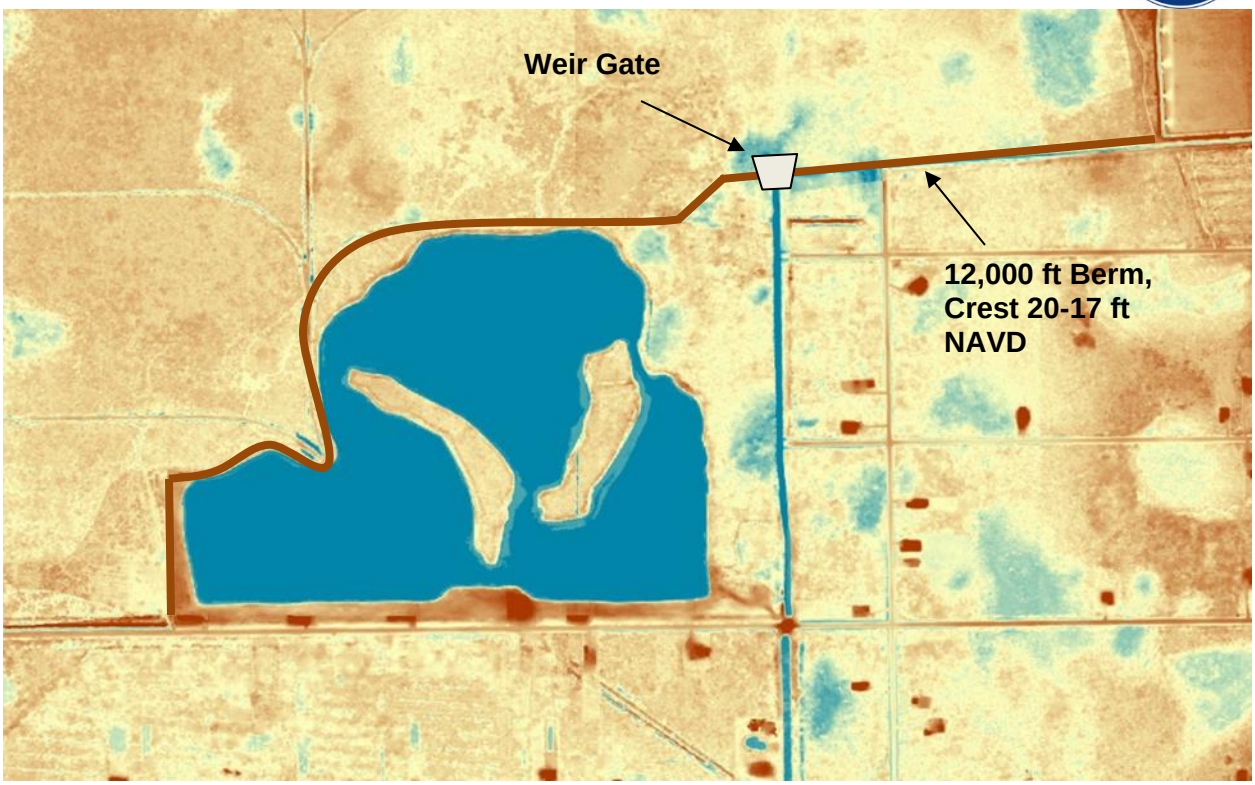


Figure 5-19. Berm Option 3 – Crest Varies from 17 Feet NAVD to 20 Feet NAVD, Length of 12,000 Feet

Modeling Approach

Within the refined CWI model, flow north of Corkscrew Canal has been conceptualized to include a groundwater component, a surface sheet flow component, and a 1-D channel component. To simulate the connection between flow paths within the natural area to the north and the Corkscrew Canal, wetland flow-way branches are directly connected to the canal (Figure 5-22).

To simulate the proposed project condition, a berm would be added by identifying the areas to the north and south of the proposed berm as separated flow areas with weirs to allow overtopping. The adjustable weir and culvert will be added to the existing flow-way connected to the Corkscrew Canal.

Accessibility and Maintenance

There is no existing access road to this location. There is a former logging road on the north side of the lake that follows the berm alignment shown in Figure 5-20. However, this road will require significant improvement. Alternatively, based on a review of the Collier County parcel map, there is a strip of land owned by the county along the northern portion of the Corkscrew Canal west bank. This land may be accessed at the west end of 47th Street; however, a canal crossing would be required. In either case, impacts associated with access road construction need to be considered. Following construction, routine maintenance of the structures would be required including adjustment of gates, regular exercising of mechanical equipment, and mowing.

Constructability and Project Risk

Overall, the project is considered readily implementable with commonly employed technologies. The addition of variable weirs minimizes risks since the amount of flow can be adjusted to project conditions

if needed. It is not expected that the structure would require operations in a flood control capacity, posing a risk in the event of gate failure.

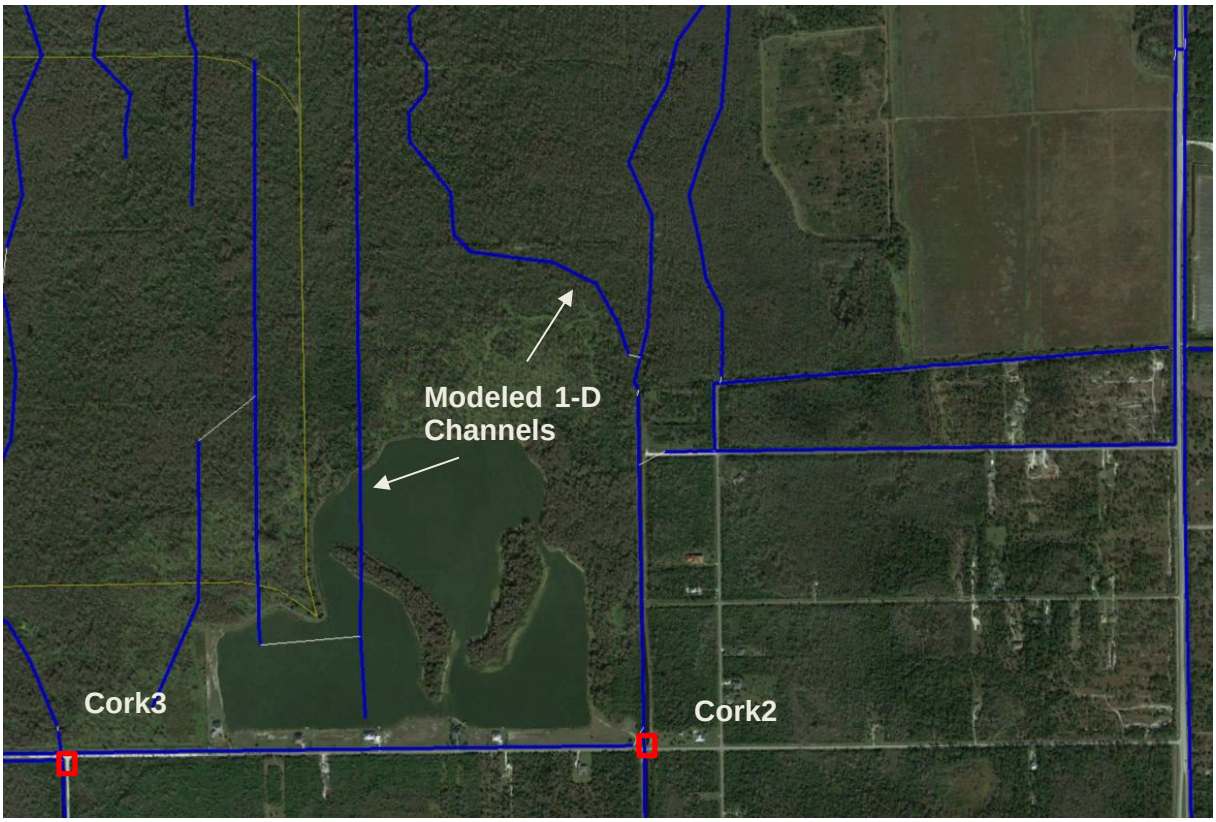


Figure 5-20. CWI Refined Model 1-D Channels North of Cork2

Permitting Considerations

Additional review of the size and complexity of the project would be required to accurately capture permit requirements. An individual ERP may be required to ensure that neighboring properties are not impacted by the project and to address wetland impacts. Additionally, a federal Section 404 permit may be required for the various components of this project due to the total acreage of impacts to wetlands. Local permits may also be needed for work within areas outside SFWMD's ownership.

Initial Screening Results

Based on the analysis presented above, this project is retained for inclusion within the restoration alternatives formulation. The benefits could be significant; however, this depends on the stages that could be achieved without impacts that extend beyond the immediate vicinity of the berm. This will likely depend on the height and length of the constructed berm. It is recommended this be analyzed through model runs that evaluate results at selected key locations to better inform the berm crest height selection. The project is readily implementable with standard technologies. The inclusion of adjustable weirs reduces project risk.

5.3.3 Project 6: Former Agricultural Area Restoration

Project Description and Objective

The former agricultural area includes an approximate 34-acres parcel of land west of the Bird Rookery trail head along Shady Hollow Boulevard (Figure 5-21). Based on a review of LiDAR data, significant modification of the site has not taken place (i.e., extensive ditching and grading) and the area appears to have retained its natural topography. However, a perimeter ditch and berm appear to have been constructed. The berm is most pronounced on the east side, and less so on the north and west sides. The berm and ditch may be redirecting sheet flow from its natural course. In addition, based on input from the TWG, the site is dominated by invasive and nuisance vegetation.

This project would involve degrading the berm on the north side and plugging the ditch to restore the natural sheet flow. The trailhead path would have to be maintained. Restoration activities would also include removal of invasive and nuisance vegetation and planting with native species as necessary. The site also provides a good location for an expanded visitor center at the Bird Rookery trail head. This would include added space for parking, informational signage, public restrooms, and shaded pavilions.

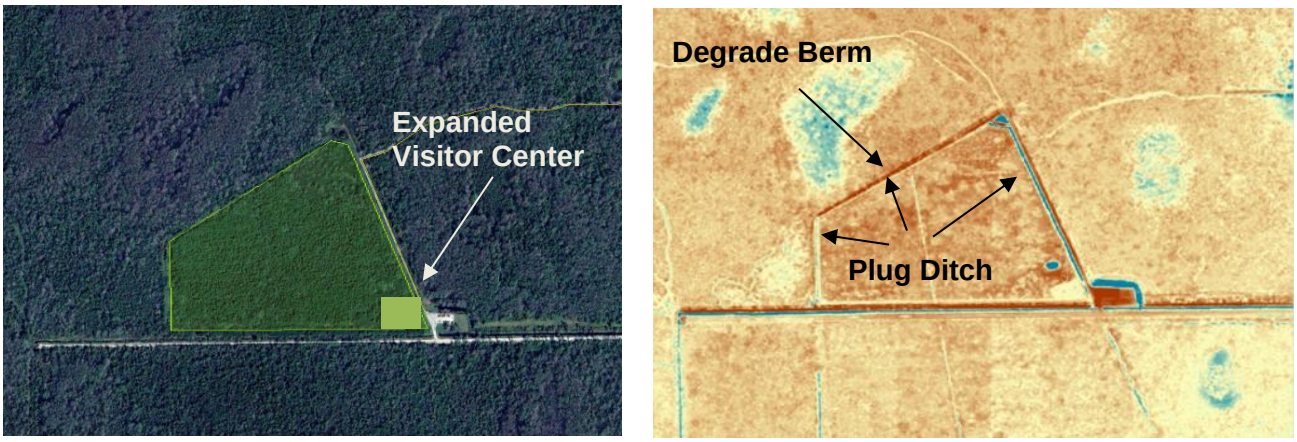


Figure 5-21. Former Agricultural Area and LiDAR Imagery

Project Challenges

No specific challenges related to restoration of the former agricultural area are identified.

Related Performance Metrics

Performance metrics related to this project include the following:

Hydrologic Restoration of Wetlands

- **Sheet Flow**: Removing manmade obstructions should promote sheet flow through the restoration area.
- **Water Depth Targets:** Water depths may be improved within the restoration area after plugging the ditch providing a preferential flow path.
- **Hydroperiods:** Hydroperiods within the restoration area may be improved after plugging the ditch causing drainage of the area.

- **Dry Season Water Level:** Recession rates and dry season water levels are not expected to be significantly changed by the project activities.

Habitat Restoration

- **Vegetative Community**: Removal of nuisance and invasive vegetation will improve the vegetation community.
- **Wildlife Use:** Improved hydrology and removal of unwanted vegetation should result in improved wildlife use.
- **Threatened and Endangered Species:** Improved hydrology and removal of unwanted vegetation should result in improved habitat for threatened and endangered species. No potential impacts to threatened and endangered species have been identified.
- **Connectivity:** Degrading the berm and improving the hydrology should result in enhanced connectivity.

Flood Protection

- It is not expected the proposed project will play a role in flood protection.

Water Supply

- The proposed project is not expected to affect water supplies.

Project Elements

Project elements include breaching the existing berm on the north side, plugging the existing ditch, removing nuisance and invasive vegetation, and adding a visitors' center. The location of breaches and plugs will be based on more detailed topographic data to capture low points and flow ways but could be expected to be about 50 feet long spaced every 500 feet. A visitors' center would include space for parking, informational signage, public restrooms, and shaded pavilions. The area would have to be raised to an elevation above 20 feet NAVD, which is the elevation for the berm described above. Fill necessary to achieve this grade may be gathered on site from the berm breaching activities or other on-site locations. The parking area would be elevated with 6 inches of shell rock or gravel. Public restrooms would require a well and sewage holding tank and would need to be accessible, including an area of paved handicapped parking. Another option would be to install a vault restroom, similar to the Bird Rookery Swamp parking lot expansion project. A plan for removal of nuisance and invasive vegetation would be developed based on a more detailed field reconnaissance. Replanting of native vegetation would be done as necessary.

Modeling Approach

Within the refined CWI model, flow in the former agricultural area has been conceptualized to include a groundwater component, a surface sheet flow component, and a 1-D channel component. A 1-D channel has been included to simulate the effects of the perimeter berm (Figure 5-22). To simulate the proposed project condition the channel and connecting structures will be removed.

Accessibility and Maintenance

Access during construction would be via the existing perimeter berm to minimize impacts to natural areas. Following construction, routine maintenance of the structures would include occasional mowing as well as visitor center maintenance.

Constructability and Project Risk

Overall, the project is considered readily implementable with commonly employed technologies.

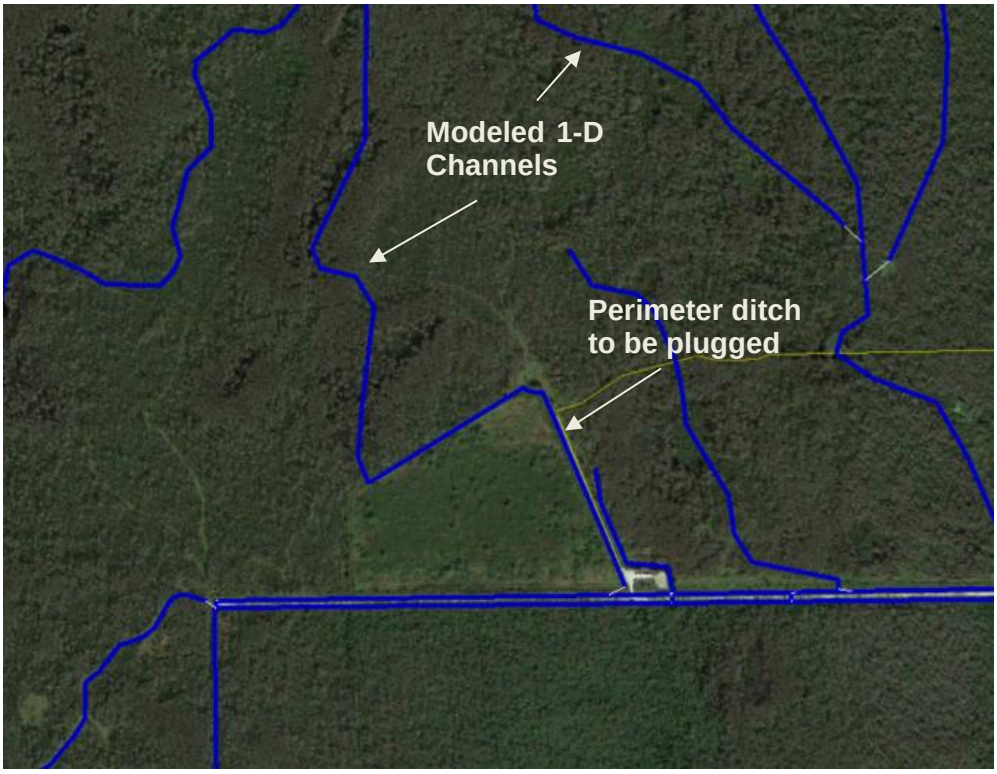


Figure 5-22. Modeled 1-D Channels in the Former Agricultural Area

Permitting Considerations

Additional review of the size and complexity of the project would be required to accurately capture permit requirements. However, environmental restoration projects of this size and scope generally qualify for state general permits and federal nationwide permits. Local permits may also be needed for work within areas outside SFWMD's ownership.

Initial Screening Results

Based on the analysis presented above, this project is retained for inclusion within the restoration alternatives formulation. The benefits could be significant, and significant challenges have not been identified. The project is readily implementable with standard technologies.

5.3.4 Project 7: Red Maple Swamp Restoration

Project Description and Objective

Red Maple Swamp consists of approximately 306 acres south of Shady Hollow Boulevard. Based on a review of LiDAR data, significant modification of the site topography has occurred; however, there appear to be remnant ditches, primarily in the central western portion of the site, that are in poor condition. In addition to the perimeter ditches and those along 41st Street, there appear to be two primary flows ways that traverse the site from north to south. The area generally grades to the east with elevation to the west at about 15 feet NAVD and elevations to the east about 14 feet NAVD. A low area exists in the southeast corner of the site with an elevation of about 13 feet NAVD (Figure 5-23). This project would involve plugging ditches to result in more natural sheet flow.

Project Challenges

The most significant challenge to implementing this project is ownership. Based on information provided by Collier Counter (Figure 5-24), 21 parcels that total about 61 acres are owned by private parties. Several of these parcels are within the area of ditch filling included in this project. These parcels would have to be acquired, or easements obtained prior to project implementation. In the interim, Collier County (Conservation Collier) is considering installing a monitoring well onsite to document baseline hydrologic conditions and assess post-restoration hydrology as a result of the CWI.

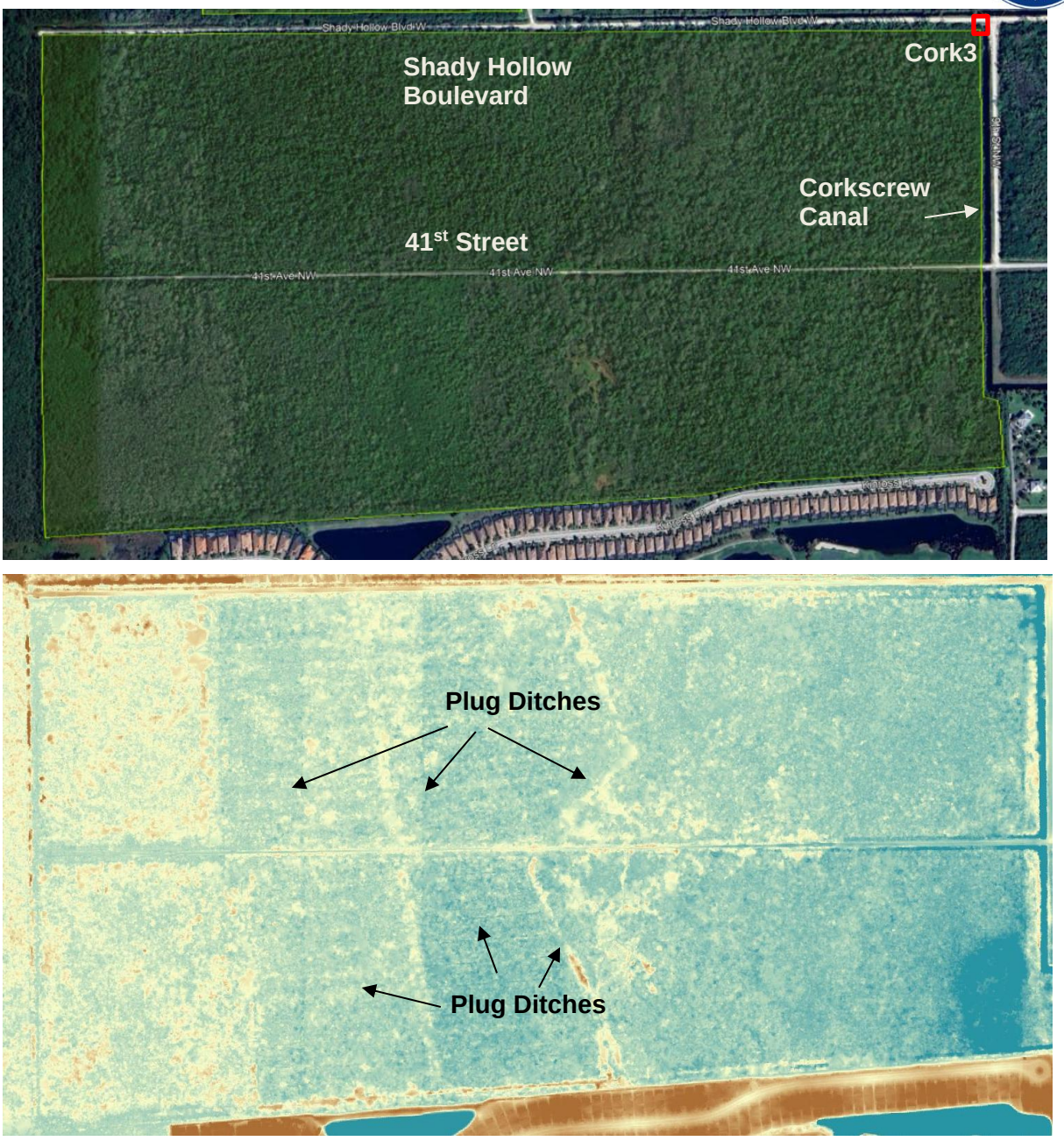


Figure 5-23. Red Maple Swamp Site Features and LiDAR Imagery

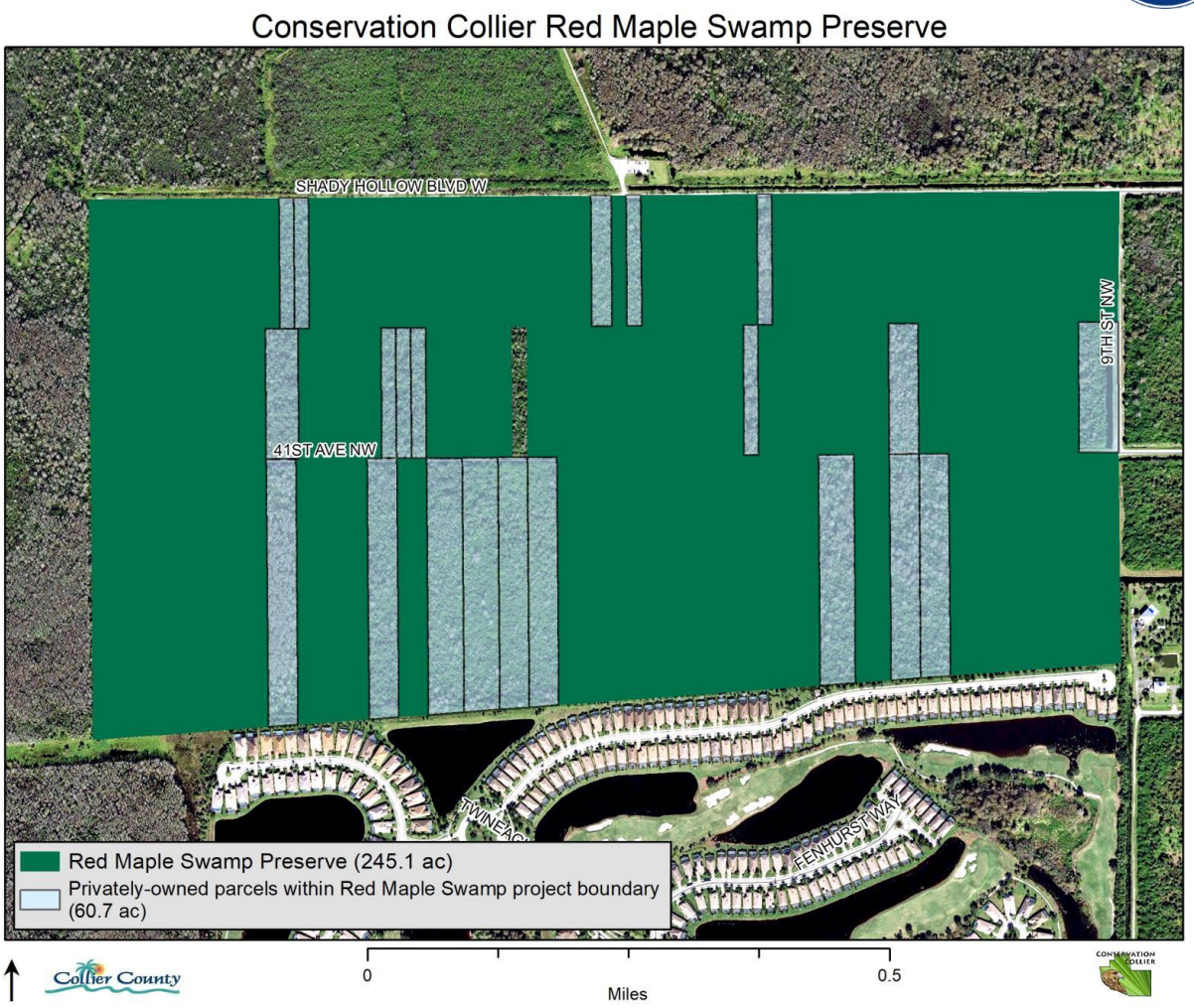


Figure 5-24. Red Maple Swamp Parcel Ownership

Related Performance Metrics

Performance metrics related to this project include the following:

Hydrologic Restoration of Wetlands

- **Sheet Flow**: Removing manmade obstructions should promote sheet flow through the restoration area.
- **Water Depth Targets:** Water depths may be improved within the restoration area after plugging ditches providing a preferential flow path.
- **Hydroperiods:** Hydroperiods within the restoration area may be improved after plugging the ditches causing drainage of the area.
- **Dry Season Water Level:** Recession rates and dry season water levels are not expected to be significantly changed by the project activities.

Habitat Restoration

- **Vegetative Community**: Improved sheet flow should improve the vegetation community.
- **Wildlife Use:** Improved hydrology should result in improved wildlife use.
- **Threatened and Endangered Species:** Improved hydrology should result in improved habitat for threatened and endangered species. No potential impacts to threatened and endangered species have been identified.
- **Connectivity:** Removal of man-made drainage features and improving the hydrology should result in enhanced connectivity.

Flood Protection

- It is not expected the proposed project will play a role in flood protection.

Water Supply

- The proposed project is not expected to affect water supplies.

Project Elements

Project elements include plugging the existing ditches onsite. The location of breaches and plugs will be based on more detailed topographic data to capture low points and flows ways but could be expected to be about 50 feet long spaced every 500 feet. Local permits may also be needed for work within areas outside SFWMD's ownership.

Modeling Approach

Within the refined CWI model, flow in the vicinity of Red Maple Swamp has been conceptualized to include a groundwater component, a surface sheet flow component, and a 1-D channel component. A 1-D channel has been included to simulate the effects of the ditches around the northern half including the Shady Hollow ditch, and the 41st Street ditch (Figure 5-25). To simulate the proposed project condition, the proposed wetland flow-ways will be added that will redirect some of the flow that goes east along the 41st Ave ditch to the south.

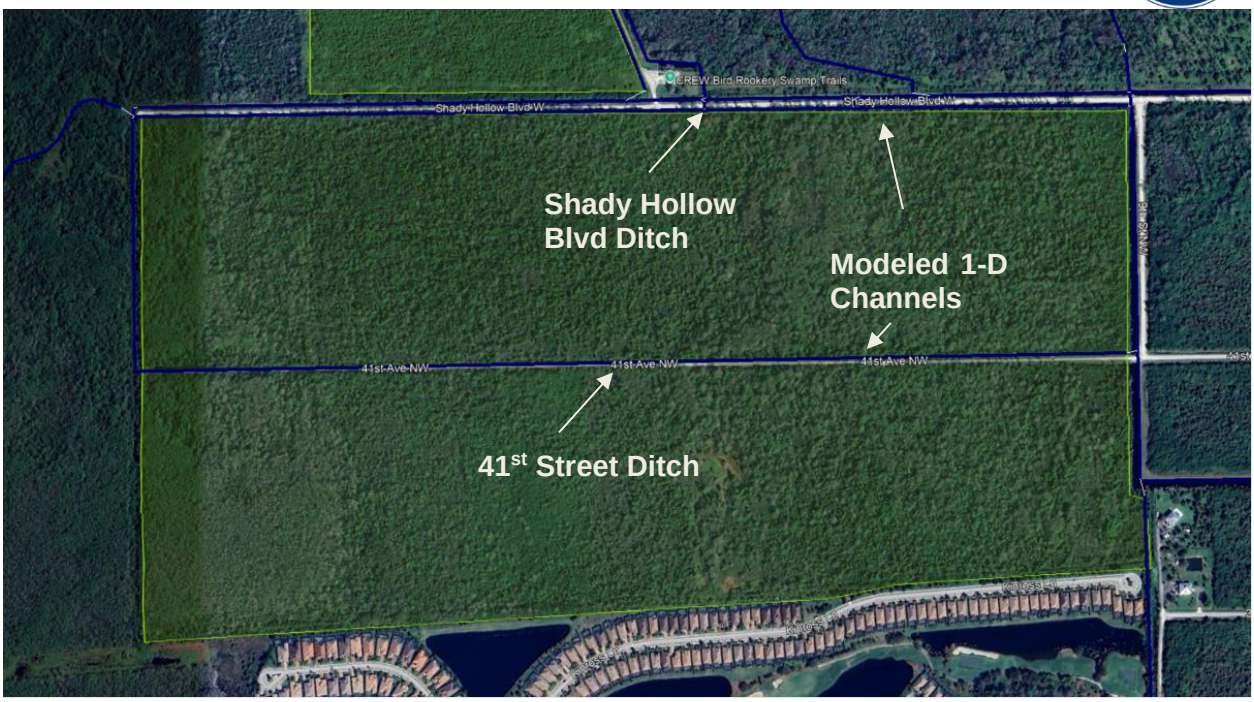


Figure 5-25. Modeled 1-D Channels in the Vicinity of Red Maple Swamp

Accessibility and Maintenance

Access during construction would occur by constructing temporary access roads to plug the ditches. The disturbance would be temporary in nature and restored as part of construction activities.

Constructability and Project Risk

Overall, the project is considered readily implementable with commonly employed technologies.

Permitting Considerations

Environmental restoration projects of this size and scope generally qualify for state general permits and federal nationwide permits. Local permits may also be needed for work within areas outside SFWMD's ownership.

Initial Screening Results

Pursuant to a meeting with Collier County staff, including Conservation Collier, on August 8, 2025, this project is excluded from further evaluation until such time as ownership of the entire Preserve is complete. While there may be some hydrologic benefits within Red Maple Swamp and the project is readily implementable with standard technologies, the potential impacts to private property owners are a major concern, and extensive hydrologic restoration of the onsite wetlands is not needed. Given the property acquisition required, this is considered a long-range project.

5.3.5 Project 8: GG Main Branch Canal Connection at Immokalee Road

Project Description and Objective

The GG Main Branch Canal extends approximately 2 miles from the Golden Gate Canal in the east to Immokalee Road in the west (Figure 5-26). The canal receives runoff from residential areas to the south

and conveys water via the GG7 fixed weir structure to the Golden Gate Canal. From there, water flows south toward Picayune Strand and the BCB or to the west towards the Cypress Canal. To the west of Immokalee Road is a ditch extending to Bird Rookery Swamp. A connection between the GG Main Branch and this drainage ditch via a culvert under Immokalee Road may reroute water toward Bird Rookery Swamp. The connection would include a culvert under Immokalee Road with an adjustable weir gate for flow control.

Project Challenges

The proposed project is external to the CWI Project area and may require access easements both during construction and after to facilitate maintenance. The project would require work within the roadway right-of-way and the temporary diversion of traffic. In addition, the GG Main Branch provides flood protection, so proposed changes need to be thoroughly evaluated to ensure a similar level of flood protection will be provided. The GG Main Branch currently discharges to Picayune Strand and the BCB, which are also in need of additional water. Although the amount of water that may be rerouted to Bird Rookery Swamp may be insignificant, this issue needs to be considered.

Another significant challenge is that based on a review of Collier County parcel information, the drainage ditch to the west is on private property. Therefore, proposed improvements to the drainage ditch would require an easement or land acquisition. In addition, the transfer of water between the Golden Gate Main Basin and the Lake Trafford Basin is problematic.

Finally, this project may not be compatible with Project 6 - Corkscrew Canal Gate and Berm, since the ditch is located outside of the proposed berm area. If it is determined that this project can provide significant benefit, land acquisition or easements could be obtained to provide a separate ditch for conveyance for local drainage and the current ditch could discharge into the bermed area via a gate structure. Modeling may be used to assess the benefits of this project to determine whether it should be further investigated.

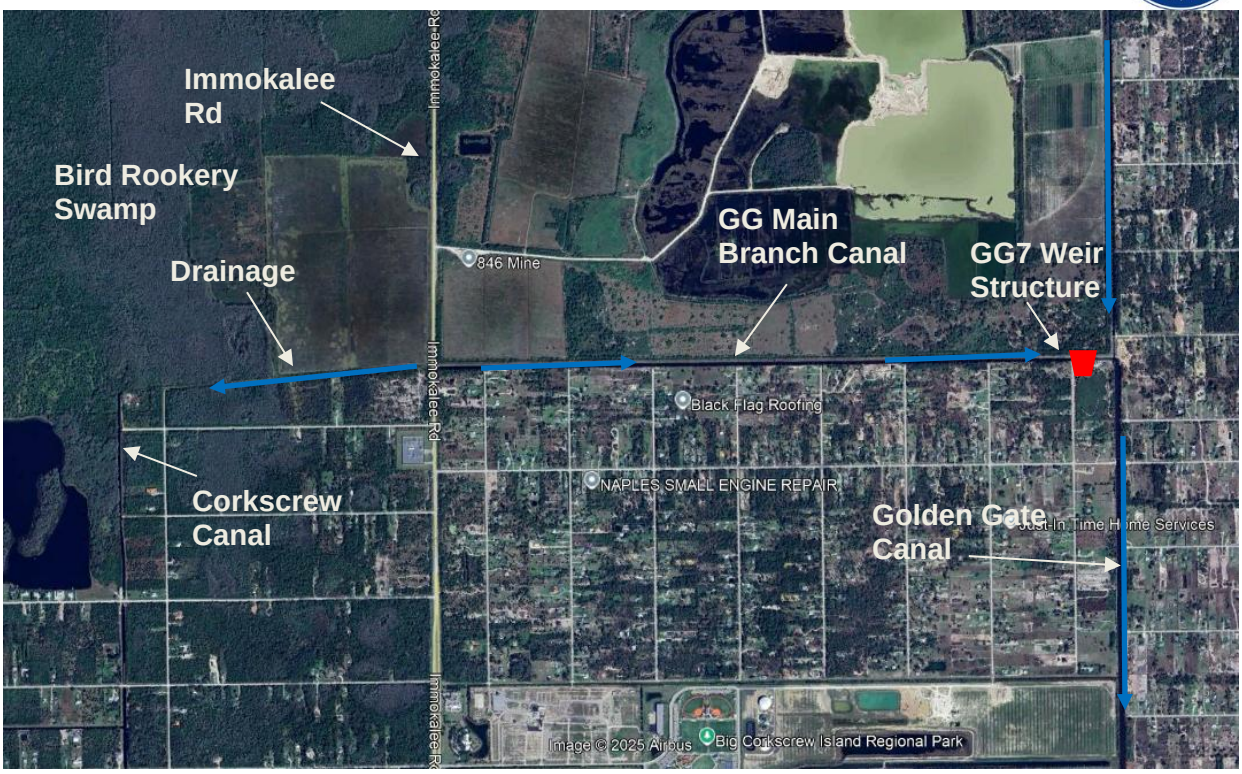


Figure 5-26. GG Main Branch Connection Drainage

Related Performance Metrics

Performance metrics related to this project include the following:

Hydrologic Restoration of Wetlands

- **Sheet Flow**: Additional water brought to Bird Rookery Swamp provided by project implementation should provide enhanced sheet flow.
- **Water Depth Targets:** Additional water brought to Bird Rookery Swamp provided by project implementation should result in the system being better able to meet water depth targets.
- **Hydroperiods:** Additional water brought to Bird Rookery Swamp provided by project implementation should result in the system being better able to meet hydroperiod targets.
- **Dry Season Water Level:** Additional water brought to Bird Rookery Swamp provided by project implementation should result in reduced recession rates and improved dry season water levels.

Habitat Restoration

- **Vegetative Community**: Additional water brought to Bird Rookery Swamp provided by project implementation should provide land management staff with the ability to better control water levels to promote more appropriate vegetative communities.
- **Wildlife Use:** Additional water brought to Bird Rookery Swamp provided by project implementation should provide land management staff with the ability to better control water levels to promote more wildlife use. Hydrologic impacts (increased water levels or hydroperiods)

to the nearby sparrow wintering fields within Bird Rookery Swamp will need to be avoided in coordination with SFWMD land management staff.

- **Threatened and Endangered Species:** Additional water brought to Bird Rookery Swamp provided by project implementation should provide land management staff with the ability to better control water levels to result in conditions more suitable for endangered species.
- **Connectivity:** Although the proposed project will provide more water to Bird Rookery Swamp, connectivity will not be significantly improved.

Flood Protection

- It is not expected the proposed project will play a role in flood protection. However, the amount of flow diverted needs to be controlled so as not to create a flooding issue.

Water Supply

- Permitted water users downstream of the project area as well as the BCB may rely on water currently discharged to the Golden Canal. Diverting this water through Corkscrew Swamp may limit their access to this water. This requires further investigation to ensure any impacts are not significant.

Project Elements

Project elements include a culvert under Immokalee Road connecting the GG Main Branch canal to the ditch. Further modeling may determine that improvements to the ditch are required to enhance conveyance. The purpose of the GG7 weir structure is to maintain stages along the GG Main Branch Canal. A similar weir structure or gate may be needed on the west side near Immokalee Road.

Modeling Approach

Within the refined CWI model, both the GG Main Branch Canal and ditch on the west side of Immokalee Road were included as 1-D channels (Figure 5-27). However, the two are not connected. To simulate the proposed project conditions, the two will be linked by a culvert under Immokalee Road and any additional elements to achieve the objective of the project.

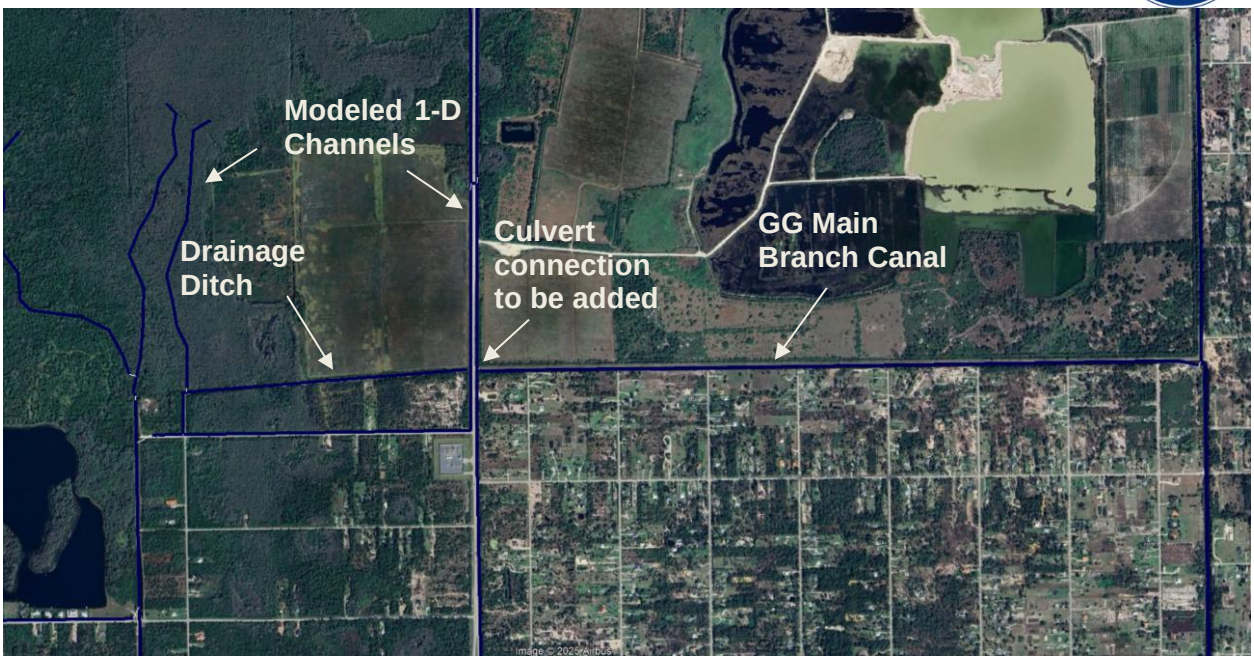


Figure 5-27. GG Main Branch Modeled Channels and Modeling

Accessibility and Maintenance

Access during construction would be via Immokalee Road. Following construction, routine maintenance of the drainage ditch would be required including mowing and vegetation control.

Constructability and Project Risk

Overall, the project is considered readily implementable. Risks would be common to a typical roadway culvert construction.

Permitting Considerations

An individual Environmental Resource Permit (ERP) may be required to ensure that neighboring properties are not impacted by the project. Additionally, a federal Section 404 permit may be required for the various components of this project due to the total acreage of impacts to wetlands. Local permits may also be needed for work within areas outside SFWMD's ownership.

Initial Screening Results

Based on the analysis presented above, this project is excluded from further consideration. The benefits are expected to be minimal whereas the challenges appear significant. Based on a review of headwater stages, there may be some positive gradient to the west but it is relatively small and generally occurs during the wet season when stages within the Bird Rookery Swamp are also high. Challenges are significant including the potential need for land acquisitions or permanent easements.

5.4 Western Flow-way Improvements

As described in Section 4.5.1, the Kiker Preserve project will have a significant effect on the hydrology of the western flow-way. Although originally conceived as a flood control project, it is understood that the

project should result in improvement in management of stages within Flint Pen Strand, which will be further evaluated through modeling during the design phase.

Flow within the western flow-way originates within the AMP (Figure 5-28). Based on discussions with AMP personnel, this system is primarily rainfall-driven but also receives some runoff from adjacent agricultural and mining areas. The system becomes too wet during the wet season and has extended hydroperiods, impeding park maintenance activities. However, in the dry season, the system is characterized as too dry with relatively large differences between wet season and dry season water levels.

Flow from the AMP discharges to Flint Pen Strand via culverts beneath Corkscrew Road and the adjacent access roads leading to the Lee County well field. Just South of Corkscrew Road is an area that was described as too dry in discussions with the TWG. From Flint Pen Strand, water discharges either to the west through culverts beneath I-75 or to the south to the Kehl Canal. Phases 1 and 2 of the Kiker Preserve project should mitigate any over-drainage to the west through the introduction of a berm with gates. The third phase of the Kiker Preserve project includes a segment on the north side of the Kehl Canal. However, due to the need for land acquisition of properties located to the north of the proposed Phase 3 Berm location, this phase of the Kiker Preserve project is not moving forward at this time.

Water that does not flow west toward the Kiker Preserve project continues south, ultimately discharging to Kehl Canal. Discharge to Kehl Canal is controlled by the presence of a berm on its north side. However, the berm is in a state of disrepair, resulting in uncontrolled discharge.

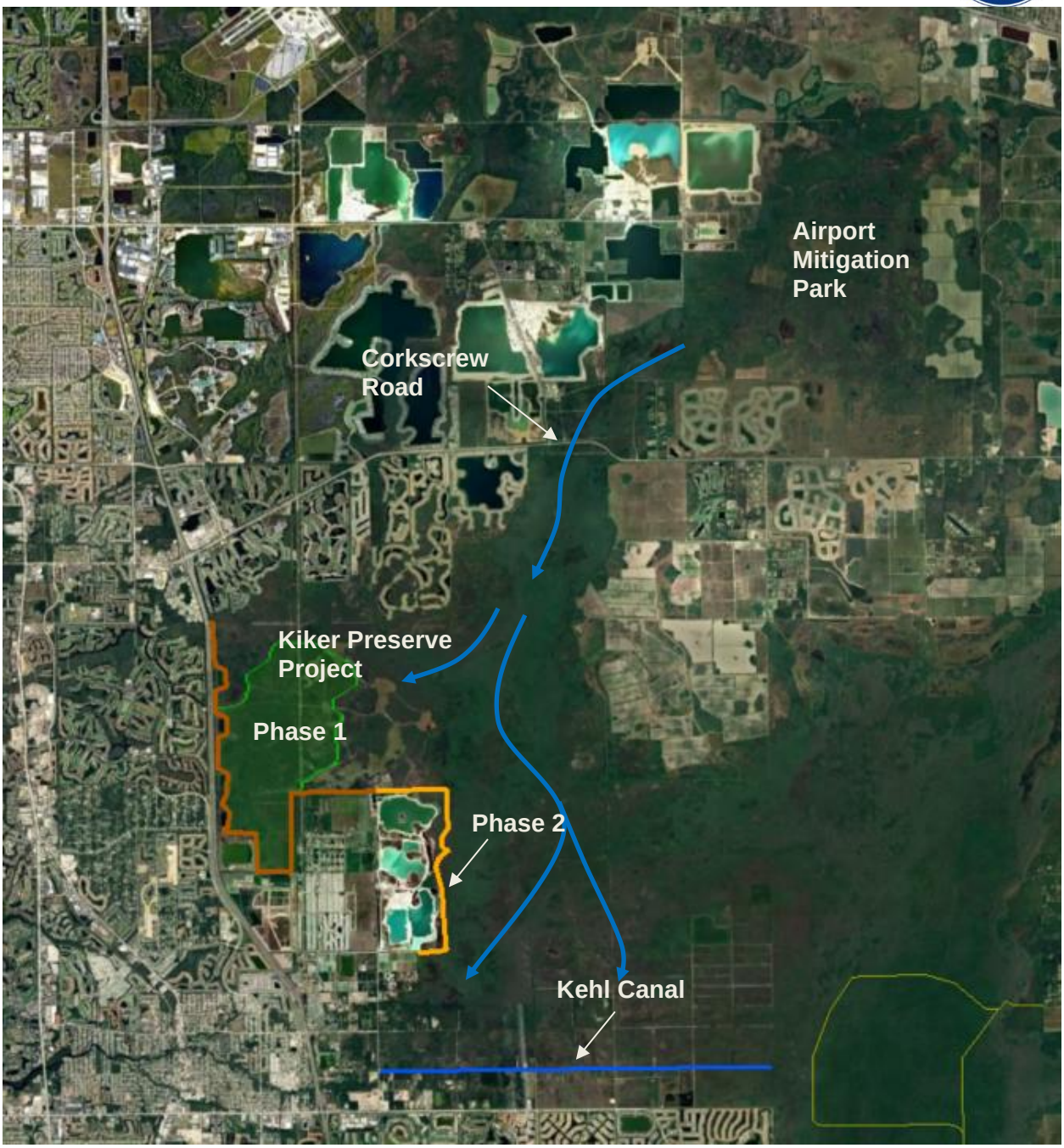


Figure 5-28. Western Flow-way Flow Paths

Two projects are proposed for the western flow path. The first involves repairing the berm on the north side of the canal and installation of adjustable weir gates to allow better management of water levels and discharge from the north (Figure 5-29). This project is in the same location as the Kiker Phase 3 project; however, as described above, this phase is not moving forward at this time. Therefore, this project would be an interim measure, and improvements made as part of this project would be incorporated into future Phase 3 improvements. The second involves improving conveyance under Corkscrew Road. This project will allow for better management of stages within the AMP and provide more water to Flint Pen Strand which may be managed as part of the Kiker Preserve Project.

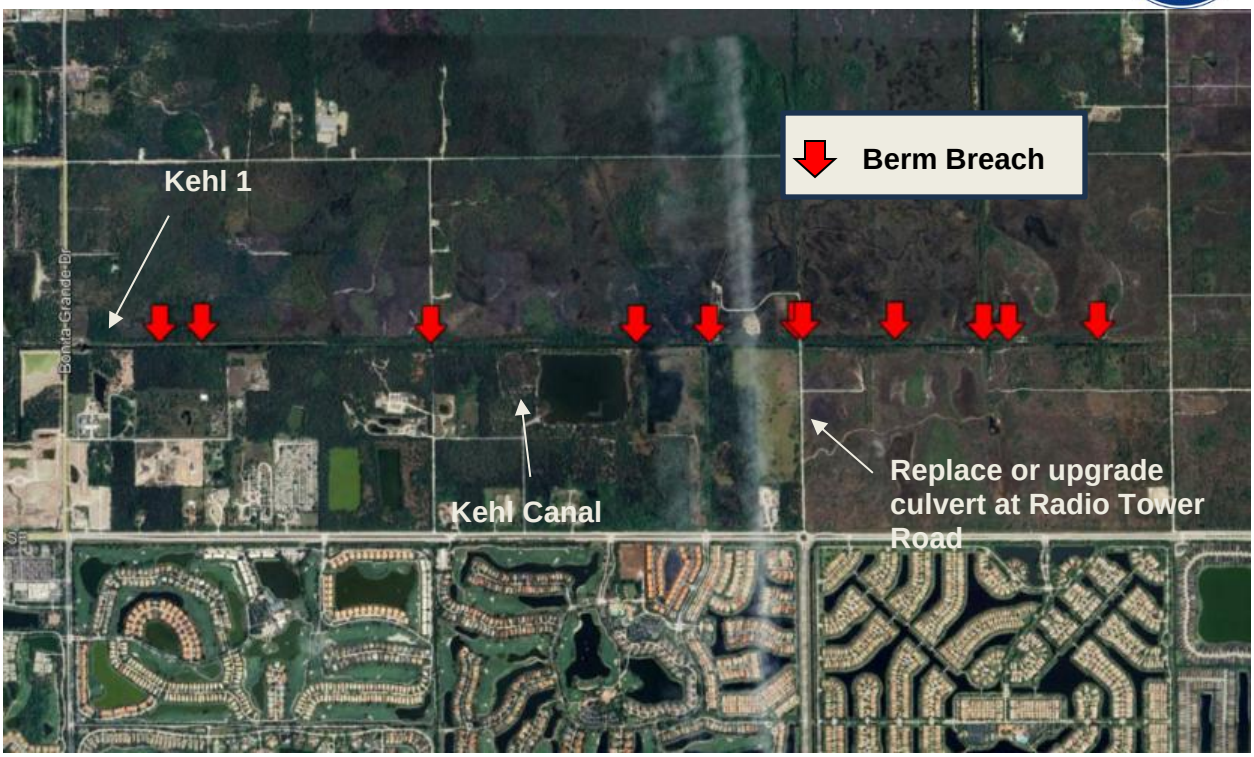


Figure 5-29. Western Flow-way Flow Paths

5.4.1 Project 9: Kehl Canal Berm Repair

As described above, discharge to Kehl Canal through the breaches in the northern berm is uncontrolled. This could result in over-drainage of the area to the north. This project would involve the repair of the Kehl Canal north berm and the installation of adjustable weir structures to allow better control and management of water levels within Southern Flint Pen Strand to the north.

Project Challenges

The proposed project is readily implementable from a technical perspective. A significant challenge is to avoid impacting privately owned properties located in Flint Pen Strand to the north, which is the same issue impeding progress on Phase 3 of the Kiker Preserve project. However, the objective of the project is to improve the integrity of the existing berm to help avoid further breaches and introduce structures that may be used to improve water levels. For instance, although gates may be opened during the wet season to prevent high surface water stages, better management of water levels during the dry season may improve storage and groundwater recharge, resulting in longer hydroperiods and reducing excessive groundwater drainage.

Related Performance Metrics

Performance metrics related to this project include the following:

Hydrologic Restoration of Wetlands

- **Saltwater Intrusion**: Water level control options provided by project implementation cannot have significant potential for adverse impacts to salinity levels in areas at risk to high salinity.

Dry season groundwater levels will be assessed in areas at risk, as well as flows at key downstream outfall structures (such as Coco1, GG1, Imperial River, Kehl Canal, etc.).

- **Sheet Flow**: Water level control options provided by project implementation should provide enhanced sheet flow. Weir settings may be varied to promote water distribution among the culverts.
- **Water Depth Targets:** Water level control options provided by project implementation should result in the system being better able to meet water depth targets. Achieving an appropriate schedule of weir setting could be further examined through modeling and adjusted after project implementation through adaptive management.
- **Hydroperiods:** Water level control options provided by project implementation should result in the system being better able to meet hydroperiod targets. Weirs may be used to control the gradual release of water over the dry season to maintain beneficial hydrology. Achieving an appropriate schedule of weir settings could be further examined through modeling.
- **Dry Season Water Level:** Water level control options provided by project implementation should result in reducing the groundwater recession rate and improving dry season water levels. Weirs may be used to control the gradual release of water over the dry season to maintain beneficial hydrology. Achieving an appropriate schedule of weir setting could be further examined through modeling.

Habitat Restoration

- **Vegetative Community**: Options provided by project implementation should provide land management staff with the ability to better control water levels to promote more appropriate vegetative communities.
- **Wildlife Use:** Options provided by project implementation should provide land management staff with the ability to better control water levels to promote more wildlife use.
- **Threatened and Endangered Species:** Options provided by project implementation should provide land management staff with the ability to better control water levels to result in conditions more suitable for endangered species.
- **Connectivity:** Although the proposed project will allow higher stages in the southern portion of Flint Pen Strand, the berm will remain in place; therefore, connectivity will not be significantly improved.

Flood Protection

- If the project involves altering weir levels to prevent flooding of privately owned properties to the north, additional assurances may be needed depending on the magnitude of the potential impact. This issue will require further evaluation through modeling.

Water Supply

- Permitted wells within the southern portion of Flint Pen Strand rely on local groundwater recharge to maintain groundwater levels for extraction. Higher stages provided by project implementation should improve groundwater recharge.

Project Elements

The Kehl Canal extends approximately 26,000 feet east of Bonita Grande Drive. The proposed Kiker Preserve berm extends only about 15,600 feet between Bonita Grande Drive and Vincent Road since the natural topography rises in the east and further extension of the berm provided little benefit. Similarly, the 15,600 feet between Bonita Grande Drive and Vincent Drive are the focus of this project. The existing berm north of Kehl Canal was likely constructed of material excavated from the canal. The berm ties into Bonita Grande Drive to the west with a crown elevation of about 14 feet NAVD. The berm crest elevation normally varies from about 17 and 20 feet NAVD. There are several breaches in the berm with lower elevations, in some cases less than 10 feet NAVD. These breaches provide uncontrolled drainage of Flint Pen Strand (Figure 5-30).

The proposed project will be similar to that proposed for the Shady Hollow berm and include berm reinforcement and repair and the introduction of adjustable weir gates for better water level management. The target elevation for improvements has been set at 14 feet NAVD, the same elevation as Bonita Grande Drive. This elevation would be refined based on more detailed review of elevation data. This would allow for adjustment of water levels with a peak stage of 13 feet with allowance for 1 foot of freeboard. To the north, berm collection ditches will be excavated, each approximately 2,000 feet long and connected to an adjustable weir structure (Figure 5-31). Separate collection ditches will allow for better management of water levels locally and varying stages from one end of the berm to the other (i.e., higher in the east than in the west). The project would also include an assessment of the integrity of the berm over its entire length and reinforcement or reconstruction where the berm is determined to be vulnerable through geotechnical investigation. Material from the excavation of collection ditches will be used to improve the berm.

There is one crossing of Kehl Canal at Radio Tower Road. Water is conveyed from east to west along Kehl Canal through a series of culverts, reportedly six total. These culverts are in poor condition and will be replaced and upsized as part of this project.

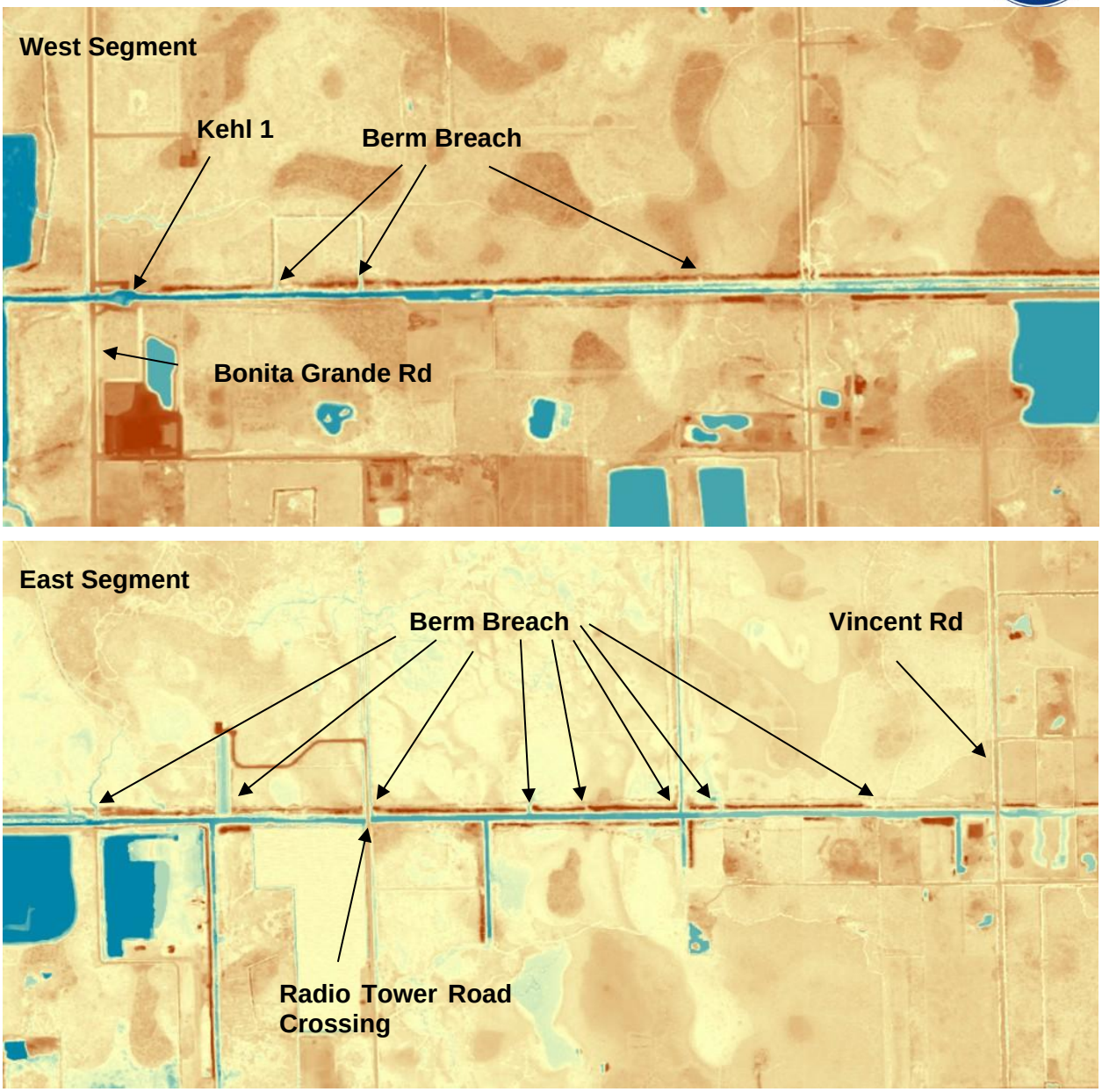


Figure 5-30. Kehl Canal LiDAR Imagery (East and West Segments)

Figure 5-31. Kehl Canal Repair Project Features

Modeling Approach

Within the refined CWI model, flow in the vicinity of Kehl Canal has been conceptualized to include a groundwater component, a surface sheet flow component, and a 1-D channel component. Several of the flow paths north of Kehl Canal were incorporated as 1-D channels as shown on Figure 5-32. To simulate the connection between flow paths within the natural area to the north and Kehl Canal, wetland flow-way branches directly discharge to the Kehl Canal at several of the berm breach locations.

To simulate the proposed project condition areas north and south of Kehl Canal, cross sections in the canal will be adjusted to represent the proposed reinforced berm on the north side of the canal. The existing Flint Pen flow-ways that connect to the Kehl Canal will be disconnected and instead connected to the collection ditches to be added north of the canal. Adjustable weirs and culverts will be added connecting the collection canals to the Kehl Canal. Weirs may be adjusted seasonally to store water in the wet season for gradual release over the dry season.

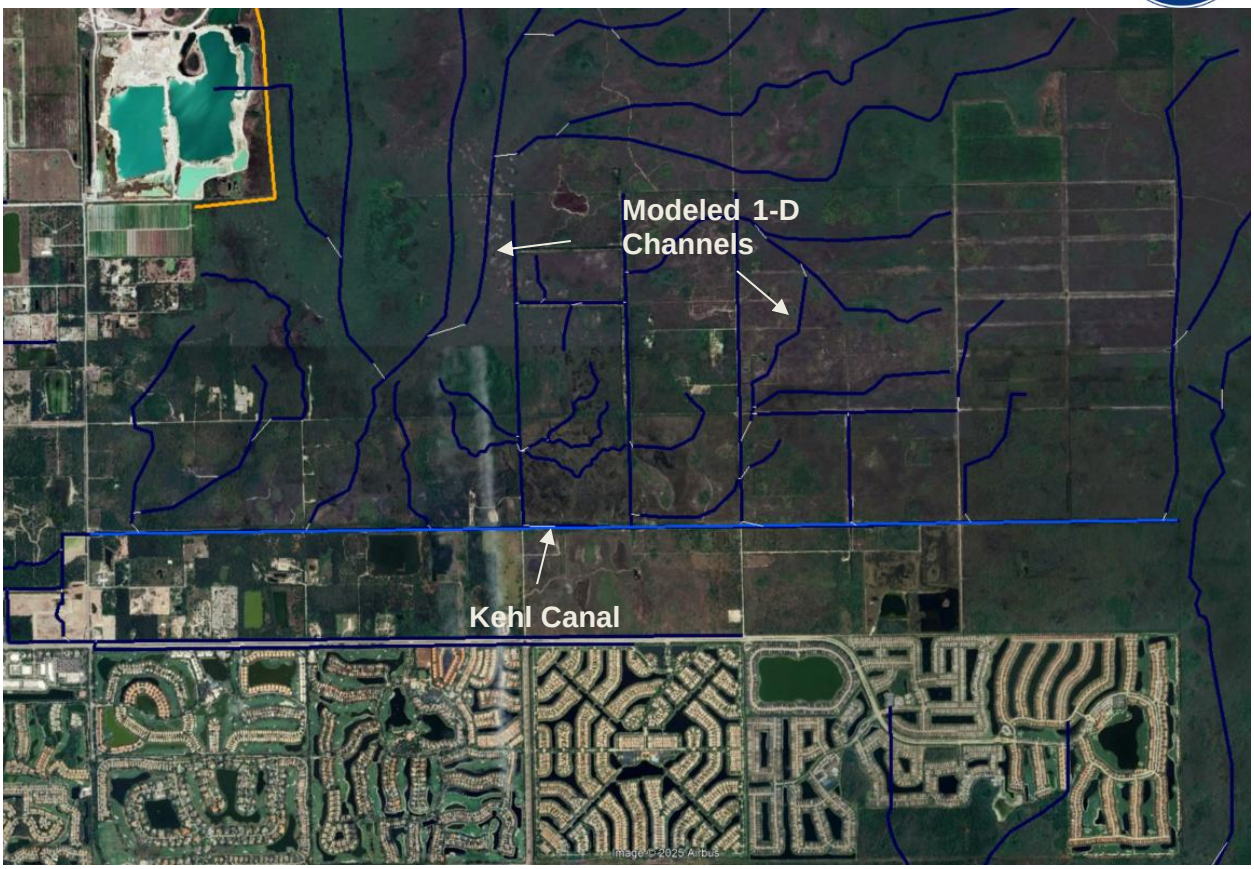


Figure 5-32. Kehl Canal Vicinity Modeled Channels

Accessibility and Maintenance

Access during construction would be via the existing access road/berm on the north side of Kehl Canal resulting in minimal damage to natural areas. Following construction, routine maintenance of the structures would be required including adjustment of gates, regular exercising of mechanical equipment, and mowing.

Constructability and Project Risk

Overall, the project is considered readily implementable with commonly employed technologies. The addition of variable weirs minimizes risks since the amount of flow and water levels to the north can be adjusted to project conditions as needed. As discussed above, if weirs require adjustment to prevent flooding of privately owned property, assurances need to be put in place to mitigate the increased risk of flooding. However, if automation were provided, higher stages could be attained without the increased risk of flooding.

Permitting Considerations

Berm maintenance activity and should qualify for state regulatory exemptions and/or federal nationwide permits. The addition of variable weirs may require a higher level of permitting. In addition, a Section 408 authorization may be required from the U.S. Army Corps of Engineers, as a portion of this project overlaps with the Southern CREW Restoration Comprehensive Everglades Restoration Plan project.

Initial Screening Results

Based on the analysis presented above, this project is retained for inclusion within the restoration alternatives formulation. The benefits could be significant; however, this depends on the stages that could be achieved without impacts that extend beyond the vicinity of the berm. Although the challenges include the acquisition of several properties, the use of variable weirs could allow for adjustment over time with higher stages and areas of inundation as these properties are acquired. The project is readily implementable with standard technologies and requires minimal disturbance of natural areas.

5.4.2 Project 10: Corkscrew Road Culvert Improvements

Project Description and Objective

As described above, the primary source of water to Flint Pen Strand (and the Kiker Preserve project) is from the AMP via culverts beneath Corkscrew Road. The area north of Corkscrew Road is characterized as too wet in the wet season, causing routine maintenance to be difficult, and too dry in the dry season. To the south of Corkscrew Road, the area of Flint Pen Strand is characterized as being too dry. This suggests the culverts under Corkscrew Road may be restricting flow during the wet season. The purpose of this project is to improve the culvert connection between the AMP and Flint Pen Strand. Water moved to the south during the wet season, may be placed in storage within Flint Pen Strand and better managed within the Kiker Preserve project. The additional water placed in storage could result in extended hydroperiods, enhanced groundwater recharge, and reduced groundwater recession rates extending into the dry season.

To the north and south of Corkscrew Road are access roads to Lee County potable supply wells (Figure 5-33). Based on a review of LiDAR (Figure 5-34), these are at a higher elevation than the surrounding topography and may be impeding surface water flow. This project would improve the culverts beneath Corkscrew Road as well as the adjacent access roads. Culverts would be improved through upsizing and/or deepening. In addition, variable weir gates would be installed for better stage and flow management.

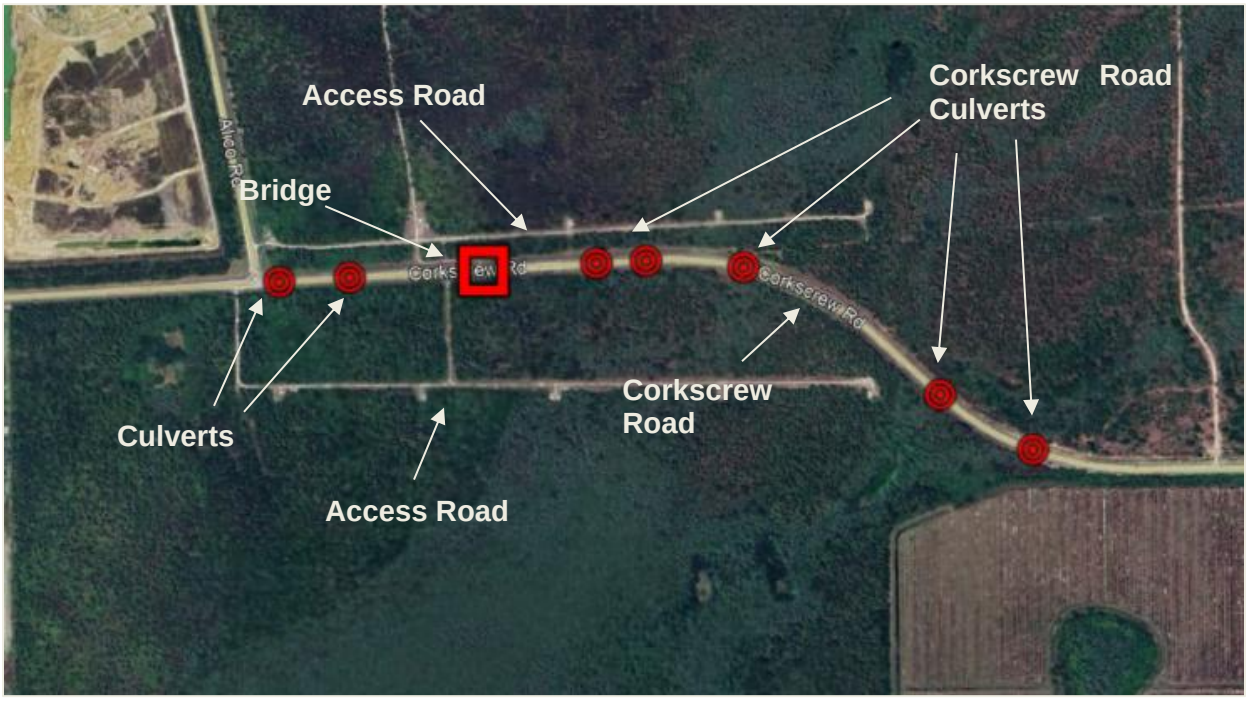


Figure 5-33. Corkscrew Road Culverts

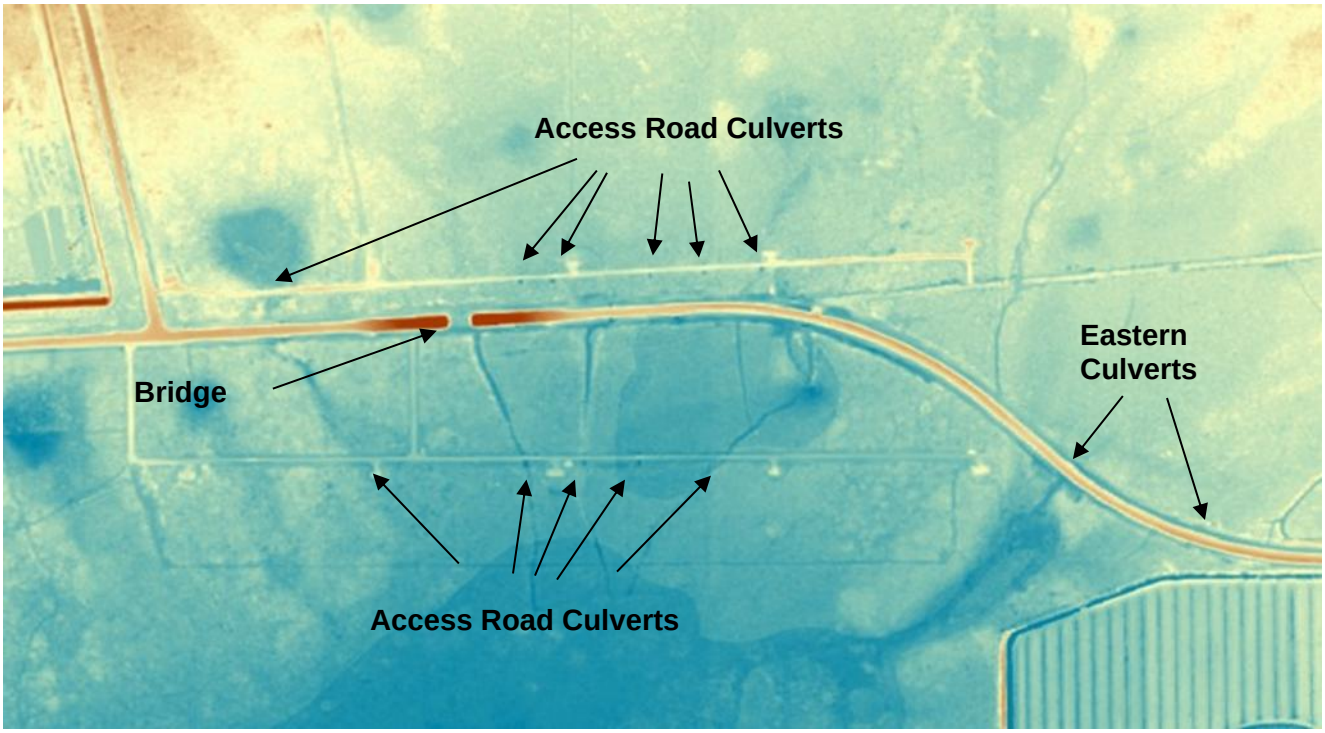


Figure 5-34. Corkscrew Road Access Road Culverts and LiDAR Imagery

In addition to the culverts located adjacent to the access road, there are two eastern culverts. No work is proposed at these culverts. A review of aerial imagery suggests ponding on the south side of Corkscrew Road with limited ponding on the north (Figure 5-35). This suggests a backwater condition at the culvert and that conditions to the south, within the natural area, are limiting the flow of water; therefore, improvement of the eastern culverts would have limited effect. It is notable that this same imagery shows conditions in the west to be relatively dry with no ponding on either side of the culverts.

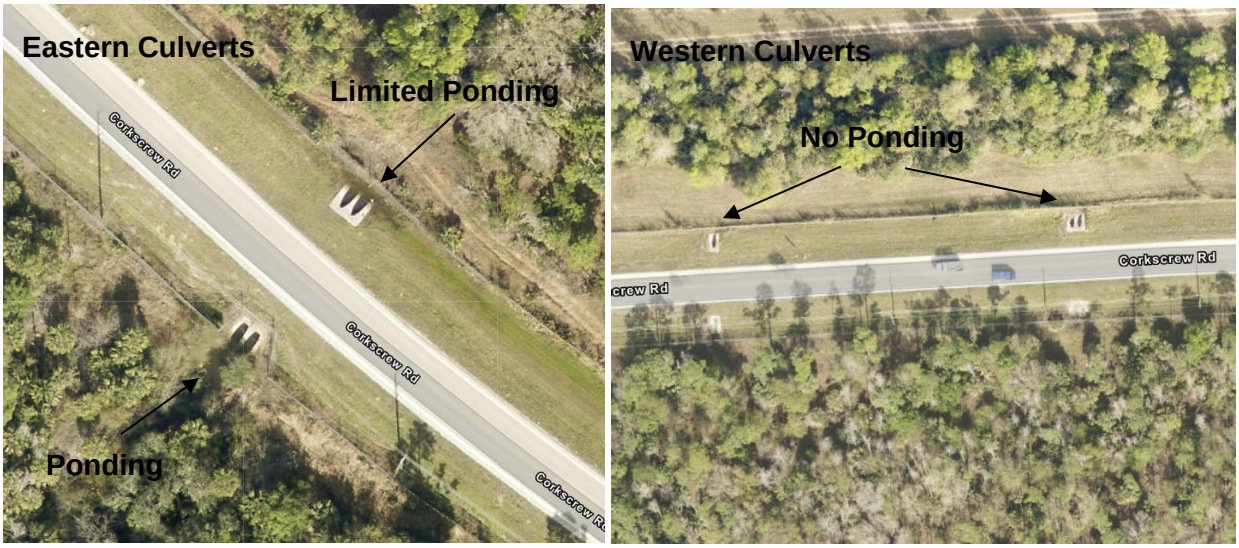


Figure 5-35. Corkscrew Road Eastern and Western Culverts Imagery

Project Challenges

AMP reported conditions as being too wet during the wet season and too dry in the dry season, with notable rapid groundwater recession, a similar problem as experienced in Corkscrew Swamp. Although the proposed project would include variable weir gates that could be raised during the dry season to help prevent over drying at the AMP, this would reduce the amount of water discharged to Flint Pen Strand, which could exacerbate the problem. In addition, the release of this water could raise wet season stages in the south, including privately owned property north of Kehl Canal. Therefore, the success of this project will rely heavily on the operation of the Kiker Preserve gates to place additional water from AMP into storage during the wet season when it is available and then maintain this water into the dry season to provide benefit. Since the Kiker Preserve project serves in a flood control capacity, storage must remain available for flood events. This limits the amount of storage available for hydroperiod improvement. Further modeling would help determine if the benefits of the increased wet season water volume within Flint Pen Strand offsets negative impacts resulting from less water in AMP.

Related Performance Metrics

Performance metrics related to this project include the following:

Hydrologic Restoration of Wetlands

- **Sheet Flow**: Additional water brought to Flint Pen Strand provided by project implementation should provide enhanced sheet flow.

- **Water Depth Targets:** Additional water brought to Flint Pen Strand provided by project implementation should result in the system being better able to meet water depth targets.
- **Hydroperiods:** Additional water brought to Flint Pen Strand provided by project implementation should result in the system being better able to meet hydroperiod targets.
- **Dry Season Water Level:** Additional water brought to Flint Pen Strand provided by project implementation should result in reducing the groundwater recession rate and improving dry season water levels.

Habitat Restoration

- **Vegetative Community**: Additional water brought to Flint Pen Strand provided by project implementation should provide land management staff with the ability to better control water levels to promote more appropriate vegetative communities.
- **Wildlife Use:** Additional water brought to Flint Pen Strand provided by project implementation should provide land management staff with the ability to better control water levels to promote wildlife use.
- **Threatened and Endangered Species:** Additional water brought to Flint Pen Strand provided by project implementation should provide land management staff with the ability to better control water levels to result in conditions more suitable for endangered species.
- **Connectivity:** Although the proposed project will provide more water to Flint Pen Strand, connectivity will not be significantly improved.

Flood Protection

- It is not expected the proposed project will play a role in flood protection. However, the amount of flow diverted needs to be managed so as not to create a flooding issue.

Water Supply

- Permitted wells associated with Lee County's wellfield within the vicinity of the AMP rely on local recharge to maintain groundwater levels for extraction. The extent to which lowering surface water levels within the AMP will reduce this recharge may be further evaluated through modeling. Although likely insignificant, the future project would need to be operated to avoid significant impacts to these water supplies.

Project Elements

Six culverts have been identified on the northern access road (Figure 5-36). As part of this project, it is proposed that each would be upsized and/or lowered as needed. Each would be retrofitted with an adjustable weir gate. Existing channels between the access road and Corkscrew Road would be enlarged if necessary. The stormwater ditch on the north side of Corkscrew Road would be enlarged to collect water from the culverts and convey it to a proposed channel beneath the existing bridge, which has a span of about 85 feet. A distribution ditch would be excavated on the south side of Corkscrew Road to evenly distribute water. Water from the distribution ditch would flow over land to the culvert in the south access road. A determination would be made if the southern access road culverts also require

upsizing and/or deepening as well as the channels leading to them. However, it is preferred to leave this flow as overland to the extent possible.

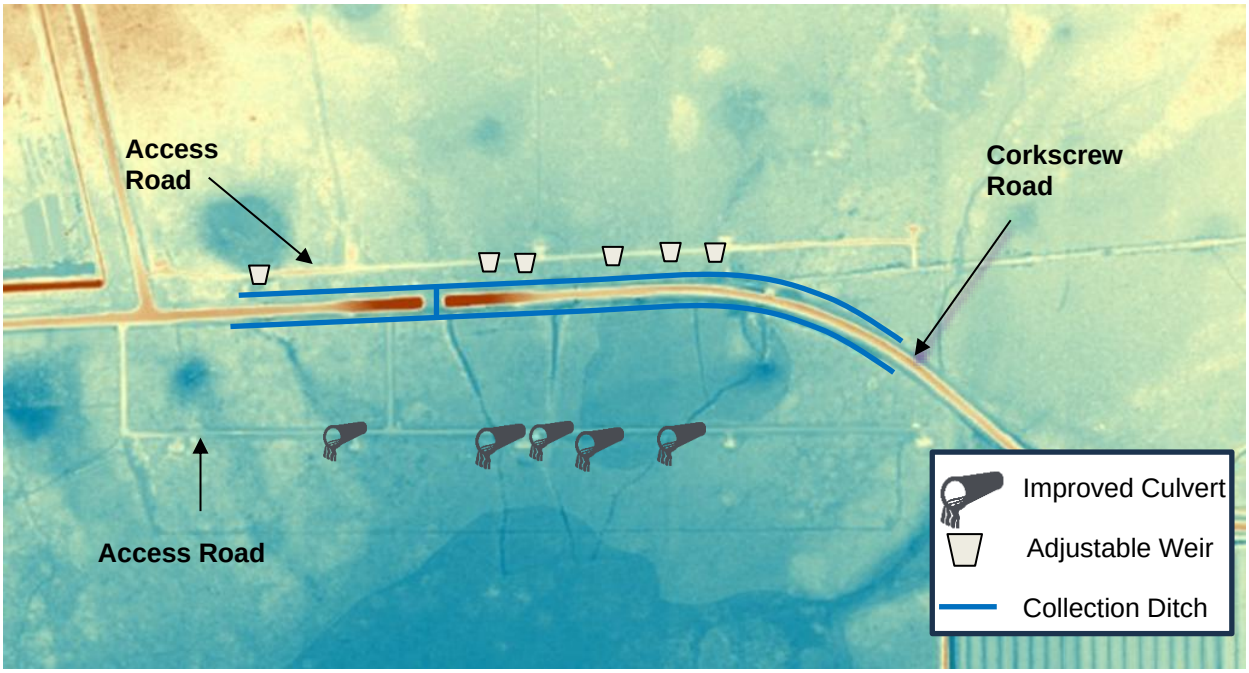


Figure 5-36. Corkscrew Road Project Features and LiDAR Imagery

Modeling Approach

Within the refined CWI model, flow in the vicinity of Corkscrew Road has been conceptualized to include a groundwater component, a surface sheet flow component, and a 1-D channel component. Three wetland flow-ways are included that can convey flow under Corkscrew Road via culverts, one west of Alico Road and two east of Alico Road (Figure 5-37).

To simulate the proposed project condition, the middle flow-way, which contains the bridge crossing underneath Corkscrew Road, will be split north and south of the northern and southern access roads to represent the project features. The adjustable weirs and culverts will be added along the northern access road to new 1D branches that connect to the existing flow-way (now split) to the north. The six structures will be combined into three locations of equal sizes, lumping the structures that are at distances of less than 500 feet apart, which is the model cell size. The collection ditches will be added north and south of the road with a link that contains the bridge. The improved culverts south of the road will be added to three new branches that will connect to the south collection ditch to the north and to the existing flow-way (now split) to the south.

Figure 5-37. Corkscrew Road Project Modeled Channels

Accessibility and Maintenance

Structures to be improved as part of this project will be located along existing access roads and readily accessible. If channel improvements are needed between the access roads and the collection and/or distribution ditches, this would require the construction of access roads adjacent to the channel to facilitate maintenance. These channel improvements and access roads would be located within existing natural areas and should be avoided if possible.

Constructability and Project Risk

Overall, the project is considered readily implementable with commonly employed technologies. The addition of variable weirs minimizes risks since the amount of flow and water levels to the north can be adjusted to project conditions if needed. It is not expected that the structures would be used in a flood control capacity, posing the risk of failure. However, if automation were provided, higher stages could be attained without the increased risk of flooding.

Permitting Considerations

An individual ERP may be required to ensure appropriate sizing of the culverts and operational constraints. Additionally, a federal Section 404 permit may be required for the various components of this project due to the total acreage of impacts to wetlands.

Initial Screening Results

Based on the analysis presented above, this project is retained for inclusion within the restoration alternatives formulation. The benefits could be significant, and challenges are reasonable and could be overcome. The project is readily implementable with standard technologies and requires minimal disturbance of natural areas. The inclusion of adjustable weirs reduces project risk.

5.5 Corkscrew System-wide Projects

5.5.1 Project 11: Kiker Preserve Berm Extension

Project Description and Objective

As described in Section 4.5.1, Phase 3 of the Kiker Preserve project would extend a berm along the southern portion of Flint Pen Strand to Vincent Road. Completion of Project 5 would repair the berm along Shady Hollow Boulevard and Project 6 could extend this berm to the east to Immokalee Road. This project examines if there is additional added benefit of connecting these berms to result in one continuous berm around the western and southern sides of the Corkscrew System. A completed berm would allow enhanced water level management throughout the Corkscrew System for longer hydroperiods. Additional adjustable weir gates would be added at locations of primary flow-ways.

Project Challenges

The proposed project is readily implementable from a technical perspective. However, significant challenges exist, similar to those described for Project 9 along the Kehl Canal and Projects 4 and 5 in the vicinity of Shady Hollow Boulevard associated with offsite impacts. A continuous berm could allow greater water storage and higher stages and hydroperiods within the Corkscrew System; however, there are several low-lying areas east of the eastern flow-way, as well as those north of Kehl Canal. Further analysis of this alternative would determine if higher stages could be achieved with a continuous berm without resulting in offsite impacts.

Related Performance Metrics

Performance metrics related to this project include the following:

Hydrologic Restoration of Wetlands

- **Saltwater Intrusion**: Water level control options provided by project implementation cannot have significant potential for adverse impacts to salinity levels in areas at risk to high salinity. Dry season groundwater levels will be assessed in areas at risk, as well as flows at key downstream outfall structures (such as Coco1, GG1, Imperial River, Kehl Canal, etc.).
- **Sheet Flow**: Water level control options provided by project implementation should provide enhanced sheet flow. Weir settings may be varied to promote water distribution among the culverts.
- **Water Depth Targets:** Water level control options provided by project implementation should result in the system being better able to meet water depth targets. Achieving an appropriate schedule of weir settings could be further examined through modeling.

- **Hydroperiods:** Water level control options provided by project implementation should result in the system being better able to meet hydroperiod targets. Weirs may be used to control the gradual release of water over the dry season to maintain beneficial hydrology. Achieving an appropriate schedule of weir setting could be further examined through modeling.
- **Dry Season Water Level:** Water level control options provided by project implementation should result in reducing the groundwater recession rate and improving dry season water levels. Weirs may be used to control the gradual release of water over the dry season to maintain beneficial hydrology. Achieving an appropriate schedule of weir settings could be further examined through modeling.

Habitat Restoration

- **Vegetative Community**: Options provided by project implementation should provide land management staff with the ability to better control water levels to promote more appropriate vegetative communities.
- **Wildlife Use:** Options provided by project implementation should provide land management staff with the ability to better control water levels to promote more wildlife use.
- **Threatened and Endangered Species:** Options provided by project implementation should provide land management staff with the ability to better control water levels to result in conditions more suitable for endangered species.
- **Connectivity:** Although the proposed project results in a larger wetland footprint and, therefore, better connection between wetland and upland habitats, it does not directly remove a physical barrier and introduces a new one, the berm.

Flood Protection

- Since the project would be tied into the Kehl Canal project, which is for flood control, there may be some flood control aspects to the proposed project. Further analysis would be needed to determine if automated gates, telemetry, and backup power would be needed to ensure the system functions as needed during major storm events.

Water Supply

- Permitted wells downstream of the Corkscrew System rely on local recharge maintaining groundwater levels for extraction. In addition, discharge from the Corkscrew System currently feed areas such as Picayune Strand and the BCB. The extent to which limiting discharge from the Corkscrew System will impact permitted water users and natural areas to the south requires further evaluation.

Project Elements

The proposed project includes 4.6 miles of new berm from Vincent Road along Kehl Canal to the west end of Shady Hollow Boulevard (Figure 5-38). LiDAR elevations in this area represent a topographic high with elevations on the order of about 15 feet NAVD Figure 5-39). The permitted crest elevation for the Bonita Grande site development project is 20 feet NAVD and it is assumed the Kiker Preserve Phase 3 berm would be at least this high. The berm for Project 5 at Shady Hollow Boulevard is also proposed to

be improved to an elevation of 20 feet. Therefore, the connecting berm is proposed to have a crest elevation of 20 feet. The berm will have a 14-foot-wide crest with access road and 3-to-1 side slopes to meet the existing ground surface on either side. Three adjustable weir gates would be installed within primary flow paths in the area west of Shady Hollow Boulevard. Fill needed to construct the berm would be gathered locally through the excavation of collection and spreader ditches to promote sheet flow. To the east of the Project 4 berm along Shady Hollow Berm, the Project 9 berm would extend an additional 2.2 miles around the north side of the Saddlebrook Lakes pond and tie into Immokalee Road to the east.

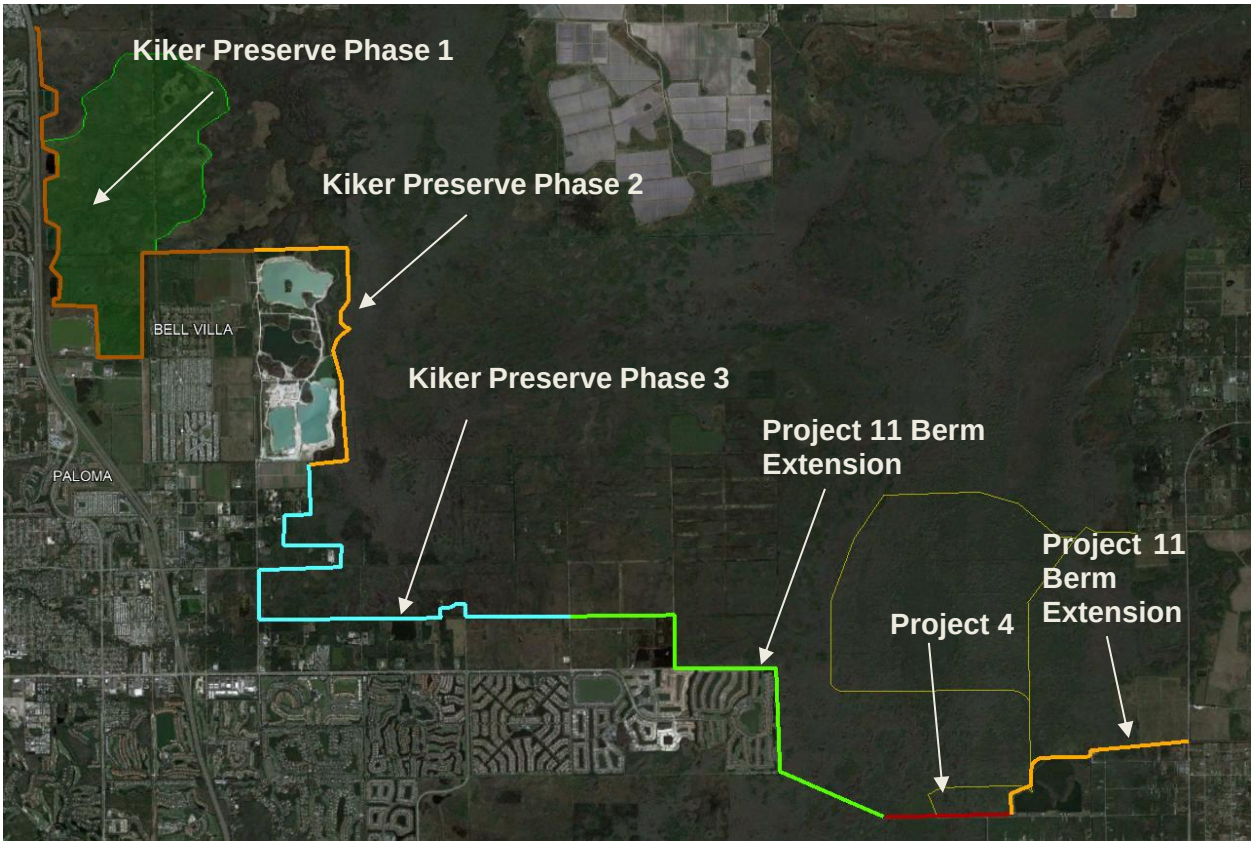


Figure 5-38. Continuous Berm Projects

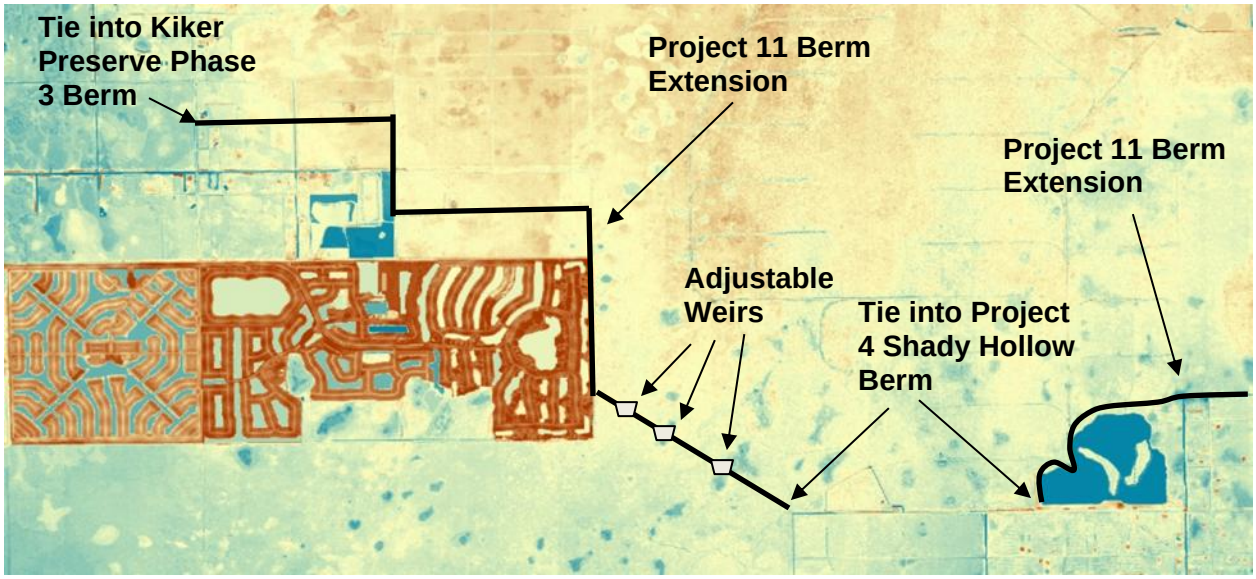


Figure 5-39. Proposed Berm Location and LiDAR Imagery

Modeling Approach

Within the refined CWI model, flow in the north end of Corkscrew Canal has been conceptualized to include a groundwater component, a surface sheet flow component, and a 1-D channel component. There are major flow paths in the area west of Shady Hollow Boulevard, that were modeled as 1-D channels as shown on Figure 5-40.

To simulate the proposed project condition, a berm would be added by identifying the areas to the north and south of the proposed berm as separated flow areas. The adjustable weirs will be implemented where flow-ways cross the berm.

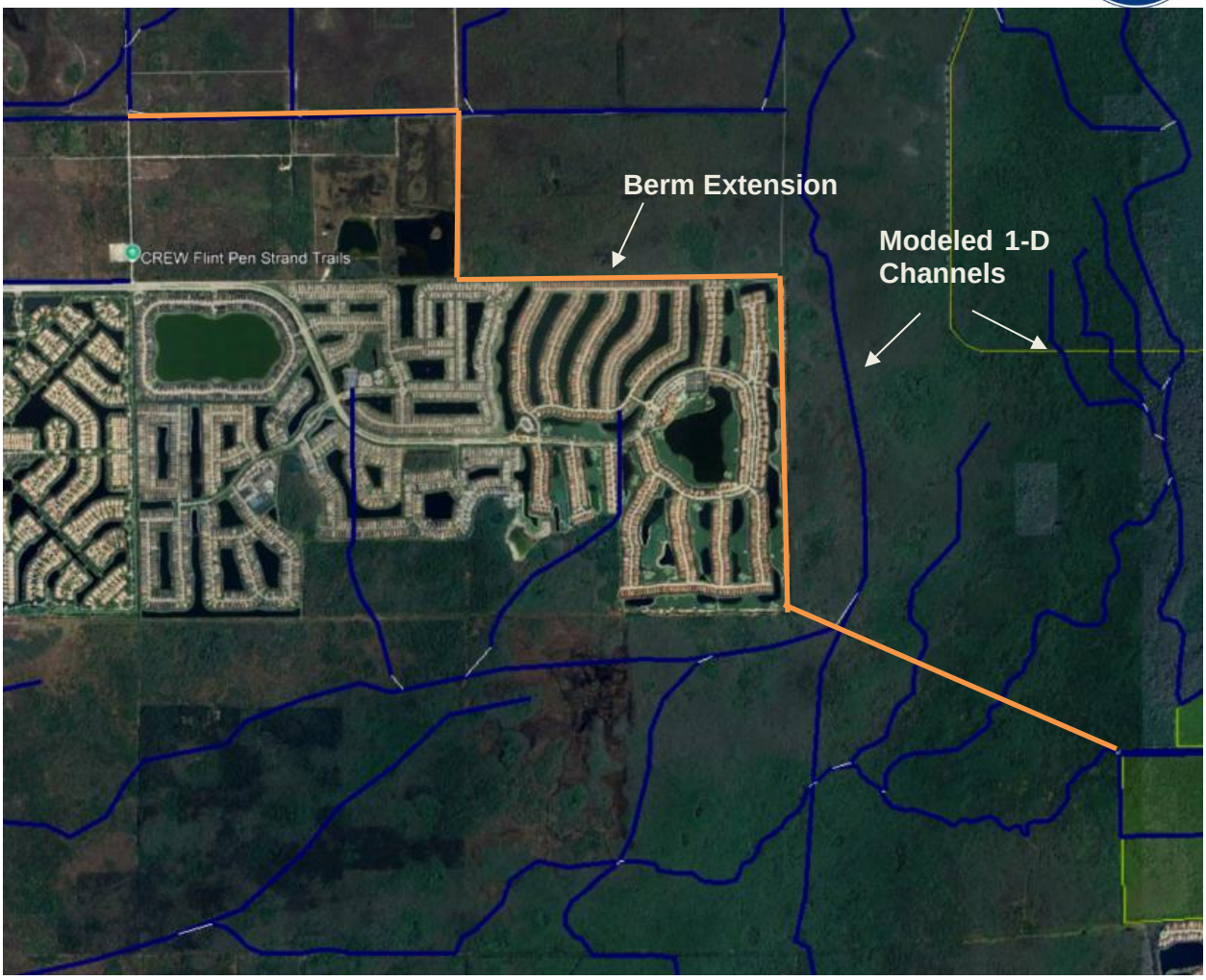


Figure 5-40. 1-D Channels Modeled Within the CWI Project Area

Accessibility and Maintenance

Most of the proposed berm is located along existing roads. Access during construction would be via the existing access road resulting in minimal damage to natural areas. However, there is a 1.1-mile segment through the natural area east of Shady Hollow Boulevard. Work in this area would require construction of an access road, which would be in the footprint of the proposed berm as well as work areas to either side. Assuming limits of work to be about 60 feet wide, construction of the project would impact about 8 acres of natural area.

Following construction, routine maintenance of the structures would be required including adjustment of gates, regular exercising of mechanical equipment, and mowing.

Constructability and Project Risk

Overall, the project is considered readily implementable with commonly employed technologies. The addition of variable weirs minimizes risks since the amount of flow and water levels to the north can be adjusted to project conditions if needed. It is not expected that the structures would be used in a flood control capacity, presenting the risk of failure. However, as noted above, since the berm will tie into the

Kiker Preserve berm, which will serve in a flood control capacity, further analysis is needed to determine if similar requirements would be required for gates added as part of this project.

Permitting Considerations

An individual ERP may be required to ensure that neighboring properties are not impacted by the project. Additionally, a federal Section 404 permit may be required for the various components of this project due to the total acreage of impacts to wetlands.

Initial Screening Results

Based on the analysis presented above, this project is retained for inclusion within the restoration alternatives formulation. The benefits could be significant; however, this depends on the stages that could be achieved without impacts that extend beyond the immediate vicinity of the berm. This is a long-term project as it depends on other projects including the Kiker Preserve Phase 3 project, which is currently not moving forward. Results from further analysis could better inform decisions with regard to other projects and serve as a benchmark for an aggressive approach. The project is readily implementable with standard technologies. The inclusion of adjustable weirs reduces project risk.

6.0 Preliminary Alternative Formulation

Each of the individual projects addresses a specific concern, often within a localized area. However, the benefits will be enhanced when projects are implemented in conjunction with each other. For example, the benefits of improving flow into Bird Rookery Swamp from Corkscrew Marsh would be greatly enhanced if steps were also taken to reduce over-drainage. Therefore, projects were combined to formulate comprehensive, Corkscrew System-wide restoration alternatives for modeling. Per the CWI Work Plan, five initial restoration alternatives are identified. An initial matrix of projects by alternative is presented in Table 6-1, and these restoration alternatives will be further developed as part of the project matrix portion of Task 6 (Deliverable 6.2). The project matrix will be used to refine the five restoration alternatives to three restoration alternatives that best meet the project objectives. These three alternatives will be evaluated using modeling (Task 7), and based on the modeling results along with a comprehensive assessment of project benefits, cost, regulatory requirements, public input, constraints, etc., the highest ranked projects (Task 8) will be included in the final CWI Public Planning Project Report (Task 9) for implementation. The five initial restoration alternatives include the following:

- **Alternative 1** focuses on the eastern flow-way with elements to better control flow from Corkscrew Marsh, slowing down water as it moves through Corkscrew Swamp and Bird Rookery Swamp, and reducing over-drainage at Shady Hollow Boulevard.
- **Alternative 2** builds on Alternative 1 with restoration projects at the former fish farm and the former agricultural area along Shady Hollow Boulevard.
- **Alternative 3** includes elements in both the eastern and western flow ways, building on Alternative 2 with improvements along Kehl Canal and Corkscrew Road.
- **Alternative 4** investigates the benefits gained by using subsurface barriers within Bird Rookery Swamp and/or within other areas of CREW where appropriate.
- **Alternative 5** examines benefits of a continuous berm extending along the southern and western sides of the Corkscrew System combined with all other conceptual restoration projects.

The five restoration alternatives may be refined through further evaluation during the project matrix portion of Task 6 (Deliverable 6.2).

Projects have been identified as being either short- or long-terms projects. Whereas projects identified as short-term are considered readily implementable in the near future (within approximately 5 years), long-term projects will require more time to develop. In general, projects located entirely on publicly owned lands, expected to have minimal impacts to adjacent private properties, and involving more easily implemented project features are considered short-term projects.

Table 6-1. Summary of Restoration Alternatives

Projects	Timing	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Project 1: Washout Road Culvert Improvements	Short-term	X	X	X	X	X
Project 2: Restoration of Former Fish Farm	Short-term		X	X	X	X
Project 3: Culvert Improvements along Bird Rookery Trail	Short-term	X	X	X	X (with subsurface barriers)	X (with subsurface barriers)
Project 4: Shady Hollow Boulevard Berm Repair and Gate Installation	Long-term	X	X	X	X (with subsurface barriers)	X (with subsurface barriers)
Project 5: Corkscrew Canal Gate and Berm	Long-term	X	X	X	X	X
Project 6: Former Agricultural Area Restoration	Short-term		X	X	X	X
Project 9: Kehl Canal Berm Repair	Short-term			X	X	X
Project 10: Corkscrew Road Culvert Improvements	Long-term			X	X	X
Project 11: Kiker Preserve Berm Extension	Long-term					X

6.1 Potential Future Ecological Management Projects

In addition to the hydrologic improvement projects described above, SFWMD land management staff have developed a list of ecological management projects that would benefit the CWI Project. Although not currently funded, these projects would provide significant benefit and include:

- Additional Carolina willow mapping and removal in Corkscrew Marsh and other portions of CREW where needed.
- Ecological enhancement (invasive species management and planting native species) of wintering sparrow fields within Bird Rookery Swamp.
- Additional prescribed fires within CREW (including additional staffing, equipment, etc.).
- Additional site security measures, such as fencing and gates, to better control illegal access within CREW.

7.0 References

Clem, S.E., and B. Cornell. 2021. Investigation of Observed Drier Conditions in Long Term Data at Lettuce Lake by National Audubon Society's Corkscrew Swamp Sanctuary.

Water Science Associates. 2022. Report of Test Borings for Audubon Corkscrew Swamp Sanctuary.