C-43 West Basin Storage Reservoir
Water Quality Component

Deliverable 7.2.4 *Final* Water Quality Component Siting Evaluation

Prepared for

South Florida Water Management District

Date

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Prepared by

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Acronyms and Abbreviations

ac	Acre
ac-ft/d	Acre-Feet/Day
CERP	Comprehensive Everglades Restoration Plan
cfs	Cubic Feet Per Second
DEP	Department of Environmental Protection
FLUCCS	Florida Land Use, Cover and Forms Classification System
GIS	Geographic Information Systems
gpd	Gallons Per Day
HWTT	Hybrid Wetland Treatment Technology
LAMSID	Lehigh Acres Municipal Services Improvement District
lbs/d	Pounds Per Day
MFL	Minimum Flow and Level
mg/L	Milligrams Per Liter
N	Nitrogen
NRC	North Rim Canal
NRCS	Natural Resources Conservation Service
O&M	Operation and Maintenance
P	Phosphorus
PIR	Project Implementation Report
POR	Period of Record
RCP	Reinforced Concrete Pipe
SFWMD	South Florida Water Management District
SHPO	State Historic Preservation Office
STA	Stormwater Treatment Area
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WBSR	West Basin Storage Reservoir
WQC	Water Quality Component
WQFS	Water Quality Feasibility Study

Executive Summary

On January 10, 2019, Governor Ron DeSantis signed Executive Order 19-12, calling for greater protection of Florida's environment and water quality. The Executive Order directed the state's agencies to take an aggressive approach to address some of the environmental issues plaguing the state, with a significant emphasis on south Florida and recent harmful algal blooms associated with blue-green algae. Specifically, the Executive Order directed the Florida Department of Environmental Protection (DEP) to "work with the South Florida Water Management District (SFWMD) to add stormwater treatment to the C-43 reservoir to provide additional treatment and improve the quality of water leaving this important storage component" of the Comprehensive Everglades Restoration Plan (CERP).

The C-43 West Basin Storage Reservoir (WBSR) project is designed to capture and store water from Lake Okeechobee and the C-43 basin during Florida's rainy season. The reservoir is under construction on a 10,700-acre (ac) parcel owned by SFWMD in Hendry County and, when fully constructed, it will store approximately 57 billion gallons of water (170,000 ac-feet), for the congressionally authorized CERP project. The C-43 WBSR, expected to be completed in 2023, will include construction of two 5,000-ac reservoir storage cells (Cells 1 and 2), three pump stations, a perimeter canal along with associated water control structures, and improvements to the State Road 80 Bridge and the Townsend Canal, which ultimately connects to the Caloosahatchee River.

It is imperative that releases from the C-43 WBSR do not contribute to impairments of downstream water quality constituents compared to existing conditions in the Caloosahatchee River Watershed. To examine conventional and innovative biological, physical, and chemical technologies available and applicable to treating water discharging from the C-43 WBSR or reducing potential algal biomass within the reservoir, SFWMD, DEP, and local governments (Working Group) partnered to develop the C-43 WBSR Water Quality Feasibility Study (WQFS) (J-Tech, 2020). The WQFS (Phase 1) was finalized on October 19, 2020 and identified the following water quality treatment alternatives for further site evaluation to identify an alternative as the selected Water Quality Component (WQC) Plan, which will move forward in a future contract to detailed design, engineering, and permitting:

- Off-line alum treatment
- 600-ac hybrid wetland treatment technology (HWTT)
- 1,000-ac stormwater treatment area (STA) with 104-ac parallel Bold and Gold® treatment
- 200-ac sand filter with 104-ac parallel Bold and Gold® treatment

A full-scale STA (5,000 ac) ranked fifth based on water quality cost-effectiveness; however, the capital cost used for the analysis did not include the acquisition of additional land that would be needed for project implementation. This alternative was retained based on stakeholder feedback supporting continued consideration based on the proven history of success across south Florida, magnitude of ancillary benefits, additional storage volume, and avoidance of chemical application.

The WQFS also recommended that the selected WQC Plan include both in-reservoir alum application to help prevent algal blooms within the reservoir itself, as well as a post-storage WQC to treat reservoir discharges that can be monitored prior to being returned to the Caloosahatchee River.

Phase 2 of the C-43 WBSR WQC includes this Siting Evaluation. The objectives of this phase are to evaluate the four water quality treatment technology alternatives identified in the C-43 WBSR WQFS as viable alternatives, as well as the full-scale STA, using a siting study to determine land availability, conveyance feasibility, and specific infrastructure needs; water quality analysis to evaluate and identify the maximum water quality treatment efficiencies for each alternative, as well as a more in-depth analysis of expected water quality and chemistry to more specifically evaluate project performance and identify attainable target total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) reductions; and development of conceptual plans and corresponding conceptual cost estimates to identify one alternative as the selected WQC Plan. The Siting Evaluation takes into consideration the existing C-43 reservoir flow intake and discharge projections and considers the approximately 1,900 ac of SFWMD-owned lands north of the reservoir but is not restricted to only those lands.

As a first step, a desktop siting analysis was conducted, which relied on readily available, existing information that was obtained through a search of sources in the public domain. The siting analysis characterized existing environmental resource data and regulatory requirements, issues, constraints, data gaps, and limitations. This analysis identified potential locations for the C-43 WBSR WQC by eliminating areas with existing or future constraints (Figure ES-1). There are planned development constraints to the north and south of the reservoir. The lands to the east and west of the reservoir are not limited in zoning; however, they are privately owned agricultural (citrus) production lands.

Throughout the WQFS and Siting Evaluation, the Working Group evaluated opportunities to use publicly-owned lands and collaborate with local governments. The Lee County-owned GS-10 property and Lehigh Acres Municipal Services Improvement District (LAMSID) Greenbriar Swamp Preserve, which are 2.5 and 3.5 miles west, respectively, of the C-43 WBSR, were evaluated as a potential WQC alternative for the C-43 WBSR. The Lee County/LAMSID stated goals for these properties are to reduce a 15,000 ac-feet water deficit, restore the Greenbriar Preserve hydrology, and provide aquifer recharge. It is anticipated that SFWMD will need all the C-43 WBSR stored water to meet the minimum flow and level (MFL) for the Caloosahatchee River and Estuary, as well as a water reservation specific to the C-43 WBSR that requires the stored water be sent to the Caloosahatchee River and Estuary for protection of fish and wildlife. Moving any stored water from the C-43 WBSR through the GS-10/Greenbriar Swamp Preserve project would significantly impact the C-43 WBSR primary project purpose and operation by reducing the reservoir's target flow efficiency to meet the MFL and water reservation. In addition to the mandated delivery of flows, the conveyance capital and operation and maintenance (O&M) cost estimates for infrastructure needed to send water to the west were determined not to be cost effective as water would need to be pumped over the Townsend Canal. In addition, infrastructure envisioned to make the flow connections may trigger dam and public safety concerns. For these reasons, GS-10 and Greenbriar Swamp Preserve were determined not to be viable locations for the WQC.

Based on the results of the desktop siting analysis, the SFWMD-owned lands were identified as the best option for locating the WQC.

As part of the Siting Evaluation, J-Tech evaluated multiple options to route water from the C-43 WBSR to the WQC for treatment and then from the WQC back to the Caloosahatchee River following treatment. Feasible and cost-effective options for each WQC alternative were identified. All the alternatives may require additional land acquisition and associated costs for conveyance improvements. Additional detailed cost estimations will be calculated for the approved alternatives as part of the Conceptual Design for Phase 2.

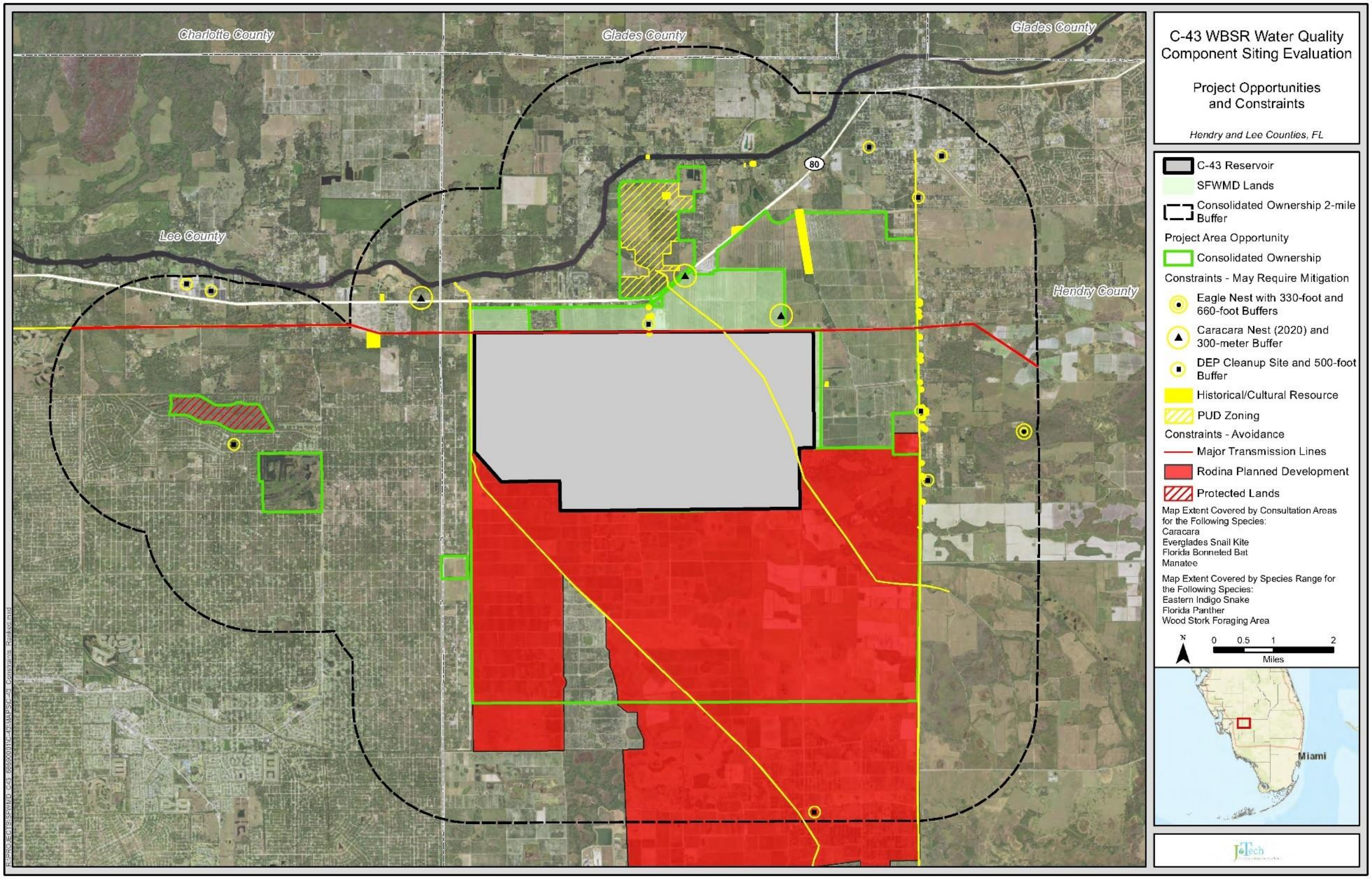


Figure ES-1. Summary of Project Opportunities and Constraints

Measured water quality data at S-78, upstream of the reservoir, were paired with C-43 WBSR Project Implementation Report (PIR) modeled flows in a water quality spreadsheet model. The spreadsheet model was used to estimate the TN, TP, and TSS concentrations and loads that would be released from the reservoir and sent to the WQC for treatment. Updated water quality targets for treatment were developed for the purpose of the Siting Evaluation, which were based on the dry season average concentrations at S-79, downstream of the reservoir. The updated targets are 1.23 milligrams per liter (mg/L) of TN, 0.088 mg/L of TP, and 1.50 mg/L of TSS. Additional analysis of each alternative was performed using the outputs from the water quality spreadsheet model and updated targets to ensure the sizing of the technologies was appropriate. The four treatment technology alternatives recommended in the WQFS remained feasible in terms of overall performance for the refined TN and TP targets. Based on discussions with the SFWMD Design Review Team and the Working Group members, the focus on the WQC sizing will be to achieve the TN and TP target concentrations and not overdesigned to achieve the refined TSS target.

The offline alum treatment, HWTT, STA plus Bold and Gold®, and sand filter plus Bold and Gold® alternatives remained at a size sufficient to occupy the current, SFWMD-owned lands. Relatively minor modifications to area and performance were made from the WQFS. The 5,000-ac STA is also able to achieve target concentrations, however, significant land acquisition would be required (Table ES-1). Overall, the Siting Evaluation criteria matrix ranked the technologies in the following order: (1) offline alum treatment, (2) sand filter with Bold and Gold®, (3) HWTT, (4) STA with Bold and Gold®, and (5) full-scale STA.

Table ES-1. Estimated Discharge Concentrations and Recommended Updates to Treatment Technology Alternatives

Alternative	TP Discharge (mg/L)	TN Discharge (mg/L)	TSS Discharge (mg/L)	Area Change	Recommend Update from WQFS
Alum (offline)	0.086	1.00	3.33	No change	Reduced alum dose from 0.30 mg/L or 1,500 gallons per day (gpd) to 0.25 mg/L or 1,250 gpd.
HWTT	0.080	1.23	2.35	Adjusted	Reduced total system area from 660 ac to 439 ac.
STA (925-ac) + Bold and Gold®	0.059	1.22	2.12	Adjusted	Assuming vendor removal rates for Bold and Gold®, system meets TN and TP targets. STA meets all targets. Media filter bed area increased to 105 ac.
Sand filter + Bold and Gold®	0.056	1.19	1.95	Adjusted	Assuming vendor removal rates for Bold and Gold®, system meets TN and TP targets. Media filter bed area increased to 105 ac.
STA (5,000-ac)	0.081	1.17	1.50	No Change	System meets all targets.

Evaluation of a full-scale STA was included in the Siting Evaluation due to stakeholder input; however, the lands required for a full-scale STA exceed the SFWMD-owned lands near the C-43 WBSR resulting in the need to purchase additional lands. Based on the results of the Siting Evaluation, the lands to the north and east of the reservoir were evaluated at a conceptual level to prepare rough order of magnitude costs. At the conceptual location, the full-scale STA would require the construction of a three-mile distribution canal to provide water from the C-43 WBSR Cell 2 to the higher elevation STA cells at the south end of project. The water would need to be pumped over the Banana Branch Canal to treat reservoir-specific flows. The topography of these lands includes approximately a six-foot drop in elevation moving north back toward the Caloosahatchee River. The change in elevation will require extensive regrading to support the STA vegetation, avoid short circuiting, and ensure accurate operation of the STA to meet water quality targets. Discharge flows could be sent to the Caloosahatchee River via the Banana Branch Canal; however, significant improvements and channelization would be required to accommodate flows. Ultimately, the rough order of magnitude costs for an STA in the general area of the C-43 WBSR is estimated at approximately $300 million, which includes an estimate of $50 million in land purchase costs, only for the lands required for the STA itself. In addition, Hendry County expressed concerns about the socio-economic impacts of additional lands being acquired for the STA since this will limit development potential within the county and City of LaBelle, especially since the evaluated area is along several major roads. The purpose of the C-43 WQFS and Siting Evaluation was to conduct an extensive evaluation of both conventional and innovative technologies to determine the most cost-effective technology for treatment of Caloosahatchee River water, which is predominantly dissolved organic nitrogen, as well as that will work within the many constraints of the existing C-43 WBSR project and surrounding area. STAs are more efficient at treating TP, and not as efficient at treating dissolved organic nitrogen, and there are siting constraints to locating an STA of adequate size to treat the necessary C-43 WBSR flows. Therefore, for all the above reasons, the full-scale STA option will not move forward to Conceptual Design.

Based on the results of the Siting Evaluation, the offline alum treatment system, HWTT, STA and Bold and Gold®, and sand filter and Bold and Gold® alternatives will go to Conceptual Design within the SFWMD owned lands to further develop the WQC components, site layout, water conveyance, treatment capabilities, and costs. After Conceptual Design, one of these alternatives will be selected as the WQC Plan. In addition, through a parallel effort, the inline alum treatment system will go to design, so it can be constructed and online concurrently with the C-43 WBSR.

1.0 Background/Introduction

On January 10, 2019, Governor Ron DeSantis signed Executive Order 19-12, calling for greater protection of Florida's environment and water quality. The Executive Order directed the state's agencies to take an aggressive approach to address some of the environmental issues plaguing the state, with a significant emphasis on south Florida and recent harmful algal blooms associated with blue-green algae. Specifically, the Executive Order directed the Florida Department of Environmental Protection (DEP) to "work with the South Florida Water Management District (SFWMD) to add stormwater treatment to the C-43 reservoir to provide additional treatment and improve the quality of water leaving this important storage component" of the Comprehensive Everglades Restoration Plan (CERP).

The C-43 West Basin Storage Reservoir (WBSR) project is designed to capture and store water from Lake Okeechobee and the C-43 basin during Florida's rainy season. The reservoir is under construction on a 10,700-acre (ac) parcel owned by SFWMD in Hendry County and is a 50-50 cost-share between SFWMD and the U.S. Army Corps of Engineers. Fully constructed, the C-43 WBSR will store approximately 57 billion gallons of water (approximately 170,000 ac-feet), for the congressionally authorized CERP project. The project, expected to be completed in 2023, will include construction of two 5,000-ac reservoir storage cells (Cells 1 and 2), three pump stations, a perimeter canal along with associated water control structures, and required improvements to the State Road 80 Bridge and the Townsend Canal, which ultimately connects to the Caloosahatchee River.

Depending on storage needs, water depth in the reservoir will range from 15 to 25 feet. All water stored in the reservoir is protected for the environment by a water reservation rule and will be released on a regulated schedule to help achieve minimum flow requirements at the S-79 structure (Franklin Lock and Dam) during dry season low-flow conditions. The water reservations rule for the Caloosahatchee River (C-43 WBSR) is defined in subsection 40E-10.041(3), Florida Administrative Code. This project is one component of a larger restoration project for the Caloosahatchee River and Estuary and will comprise a large portion of the overall water storage requirement for the Caloosahatchee River Watershed.

The C-43 WBSR will serve multiple purposes. It is intended to support Caloosahatchee River and Estuary restoration by helping to attenuate peak stormwater flows during the wet season and to provide additional base flow to the estuary during the dry season. The reservoir will capture and store a portion of both the watershed runoff and regulatory releases from Lake Okeechobee, reducing the frequency and volume of discharges to the Caloosahatchee River and Estuary during the wet season. In addition, it is envisioned to provide public access and recreational opportunities, and the perimeter canal is intended to maintain allocated water supply to the local agricultural areas adjacent to the reservoir.

It is imperative that releases from the C-43 WBSR do not contribute to impairments of downstream water quality constituents compared to existing conditions in the Caloosahatchee River Watershed. DEP identified the Caloosahatchee Estuary to be impaired for total nitrogen (TN). DEP has not identified the Caloosahatchee River and Estuary to be impaired for total phosphorus (TP), but this nutrient is also considered for reduction for the water from the C-43 WBSR. The reduction of nutrient concentrations and loads to these waterbodies is required by the Northern Everglades and Estuaries Protection Program, which was passed by the Florida Legislature and signed into law in 2007 and amended in 2016, and by the Caloosahatchee River and Estuary Total Maximum Daily Load adopted in 2009 by DEP.

To examine conventional and innovative biological, physical, and chemical technologies available and applicable to treating water entering and discharging from the C-43 WBSR or reducing potential algal biomass within the C-43 WBSR, SFWMD, DEP, and local governments (Working Group) partnered to develop the C-43 WBSR Water Quality Feasibility Study (WQFS) (J-Tech, 2020). A group of alternatives and technologies were evaluated based on scalability, confidence in performance estimates, available Florida case studies, residuals production, habitat benefits, ecosystem services, energy efficiency, land requirements, operation and maintenance (O&M) requirements, and schedule of implementation. Cost effectiveness was also evaluated. The WQFS recommended four alternatives for further evaluation through the Water Quality Component (WQC) Siting Evaluation.

With input from the Working Group and feedback from the public meetings, the WQFS (Phase 1) was finalized October 19, 2020 and identified the following water quality treatment technology alternatives for further site evaluation to identify an alternative as the selected WQC Plan, which will move forward in a future contract to detailed design, engineering, and permitting:

- Off-line alum treatment
- 600-ac hybrid wetland treatment technology (HWTT)
- 1,000-ac stormwater treatment area (STA) with 104-ac parallel Bold and Gold® treatment
- 200-ac sand filter with 104-ac parallel Bold and Gold® treatment

The WQFS also recommended that the selected WQC Plan include both in-reservoir treatment with alum to help prevent algal blooms within the reservoir itself, as well as a post-storage WQC to treat reservoir discharges that can be closely monitored prior to being returned to the Caloosahatchee River.

For the WQFS cost-benefit analysis, estimates of the capital and O&M costs were prepared for each alternative. Table 1-1 lists the costs for the final recommended alternatives and the full-scale STA (see below). These costs will be further refined during Conceptual Design.

Table 1-1. Summary of Capital, O&M, and Net Present Value Costs for the Alternatives

Alternative	Capital Cost ($ millions)	Annual O&M Costs ($ millions/year)	Net Present Value 20-year ($ millions)
Off-line Alum Treatment	$51.8	$5.67	$115.5
HWTT	$47.8	$8.53	$163.8
STA with Bold and Gold®	$134.6	$1.58	$156.1
Sand Filter with Bold and Gold®	$152.4	$1.91	$178.3
Full-Scale STA	$148.1	$2.41	$180.8

A full-scale STA (5,000 ac) ranked fifth based on water quality cost-effectiveness; however, the capital cost used for the analysis did not include the acquisition of additional land that would be needed for project implementation. Despite the higher total cost that would be expected for the STA alternative, J-Tech and the Working Group received several stakeholder comments supporting the continued consideration of this alternative based on the proven history of success across south Florida, magnitude of ancillary benefits these systems offer to humans and wildlife, provision of additional storage volume, and avoidance of chemical application to meet water quality improvement objectives. For these reasons, SFWMD has chosen to retain the STA alternative for further consideration in this Siting Evaluation. It should be noted that a full-scale STA was not originally considered in conjunction with the design of the C-43 WBSR, which adds complications related to topographic variations between the C-43 WBSR and a potential full-scale STA site. As part of this Siting Evaluation, an investigation to identify potential land acquisition opportunities near the C-43 WBSR was conducted and a revised cost estimate for the STA alternative was determined.

Phase 2 of the C-43 WBSR WQC is the Siting Evaluation. The objectives of this phase are to evaluate the four water quality treatment technology alternatives identified in the C-43 WBSR WQFS as viable alternatives, as well as the full-scale STA, using a siting study to determine land availability, conveyance feasibility and specific infrastructure needs; water quality analysis to evaluate and identify the maximum water quality treatment efficiencies for each alternative, as well as a more in-depth analysis of expected water quality and chemistry to more specifically evaluate project performance and identify attainable target TN, TP, and total suspended solids (TSS) reduction rates; and development of conceptual plans and corresponding conceptual cost estimates to identify one alternative as the selected WQC Plan. The Siting Evaluation takes into consideration the existing C-43 WBSR flow intake and discharge projections and considers the approximately 1,900 ac of lands that SFWMD owns north of the reservoir but is not restricted to only those lands.

This Siting Evaluation Report summarizes the findings from Task 7 (Siting Evaluation) and Task 8 (Water Quality Analysis) of Phase 2 of the project.

2.0 Siting Evaluation

As part of Task 7, J-Tech was tasked with evaluating and identifying potential location(s) for construction of the top four water quality treatment alternatives identified in the C-43 WBSR WQFS. The evaluation included identification of infrastructure requirements to determine how best to integrate the project needs with the reservoir and evaluation of alternative locations to return water to the Caloosahatchee River. The evaluation also determined if additional lands are needed beyond the SFWMD-owned lands in the project vicinity (Hendry and Lee Counties).

2.1 Desktop Siting Analysis

As a first step in the Siting Evaluation, J-Tech performed a desktop evaluation of existing data for the SFWMD-owned lands (Figure 2-1) and lands adjacent to the C-43 WBSR considered to be potentially viable for siting the WQC. The desktop evaluation included a base map of parcel data including ownership, rights-of-way, and easements. Existing available geographic information system (GIS) data or other information to support the siting analysis were reviewed, including but not limited to:

- Wetlands, vegetation, and habitat maps
- Protected species
- Cultural resources
- Environmental site assessment reports
- Soils and geology data
- Land use and zoning
- Land valuation (potential acquisitions)
- Transmission lines and substations
- Existing water conveyance features (ditches, canals, agriculture pump stations)

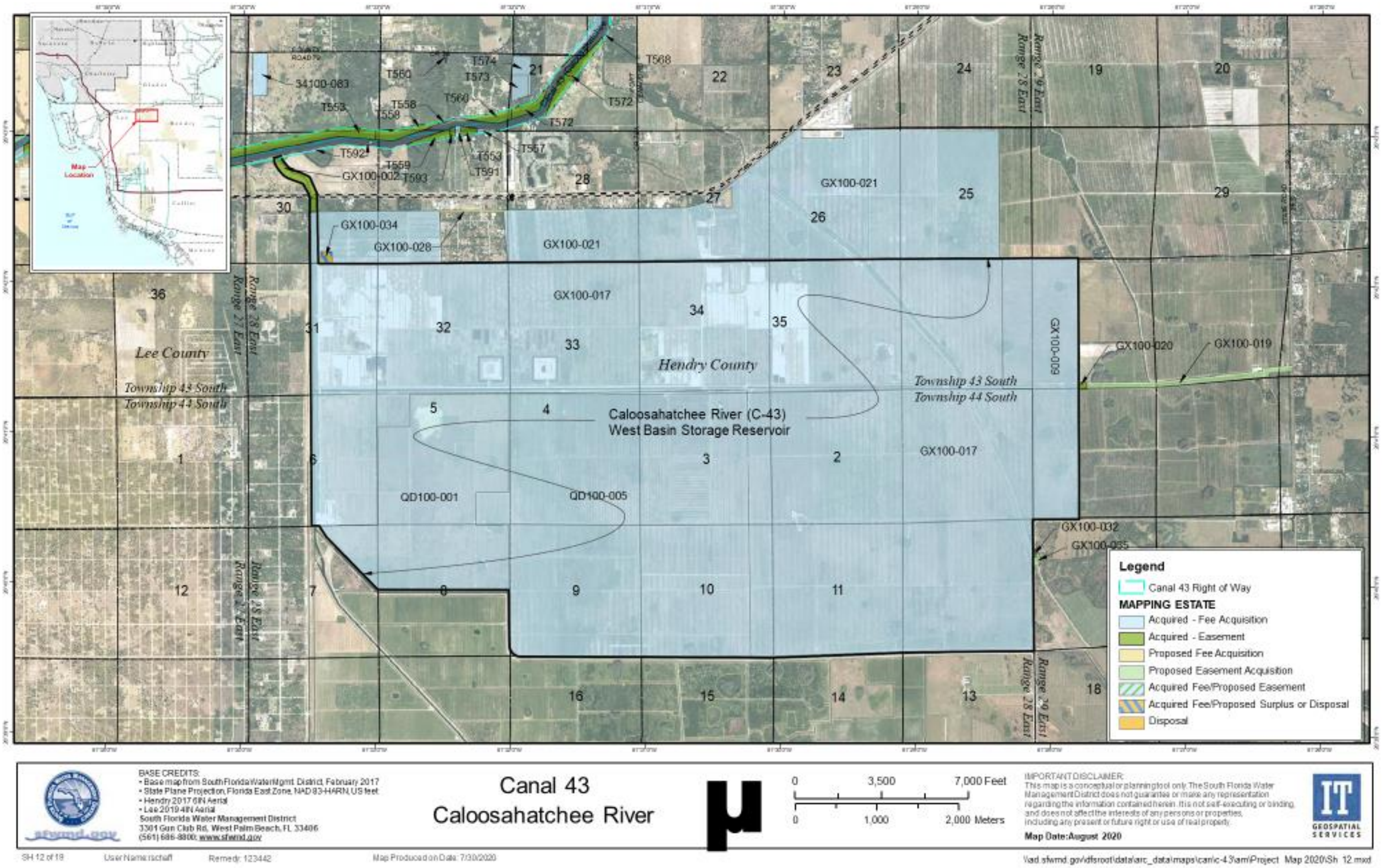


Figure 2-1. SFWMD-owned Lands and Lands Adjacent to the C-43 WBSR

2.1.1 Desktop Analysis Data Sources

A desktop analysis was performed for the Siting Evaluation, which relied on readily available, existing information that was obtained through a search of sources in the public domain. The Siting Evaluation characterizes existing environmental resource data and regulatory requirements, issues, constraints, data gaps, and limitations. The major resources evaluated include water, soils, biological, cultural, land use, and protected species.

The sources accessed for the desktop analysis included literature, online databases, aerial photography, permitting regulations, and spatial data related to sensitive species distributions, wetlands and water resources, land use, and cultural resources. Additional sources for biological information included state and federal regulatory documents, listed species databases, federal compliance reports, state and federal recovery plans, critical habitat designations, conservation and management plans, and other relevant and publicly available scientific literature. Due to the nature of the project and association with the C-43 WBSR, J-Tech focused the desktop analysis for the Siting Evaluation within a two-mile area (Study Area) of the reservoir.

Additional data were provided by SFWMD staff and Working Group members that were not specifically available for the desktop analysis. The additional information included consolidated ownership parcels, map of the planned Rodina Development in Hendry County, and C-43 WBSR Biological Opinion. Updated survey data (2021) for Caracara performed by SFWMD staff within the immediate vicinity of the reservoir were also included in the protected species map. A list of sources is provided in Section 5.0.

2.1.1.1 Wetlands, Vegetation, and Habitat

J-Tech reviewed aerial photography and data sets including the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory data, U.S. Geological Survey (USGS) National Hydrography Dataset, U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) web soil survey, and other available publications, technical reports, and GIS datasets to collect information on wetlands and streams potentially in the area.

Wetland habitat types on site include freshwater forested/shrub, freshwater emergent (herbaceous), and riverine (ditches and canals). Figure 2-2 shows the location and extent of the wetland features as listed in the National Wetlands Inventory within the Study Area.

2.1.1.2 Protected Species

J-Tech reviewed a variety of available scientific and technical literature with respect to biological resources within the Study Area. This review included species recovery plans, regulatory documents, listed species databases, federal compliance reports, critical habitat designations, conservation and management plans, and available unpublished data that were likely to contain information relevant to the natural history and ecology of the area. In addition, J-Tech reviewed available geospatial data and aerial photographs of the area to identify any unique plant communities or features that could harbor federal or state listed species or other elements of interest. Figure 2-3 shows the results of the desktop analysis and recent Caracara surveys performed by SFWMD. Appendix A includes a list of the potential for listed species and their habitats to occur within the Study Area and may be impacted by the proposed WQC.

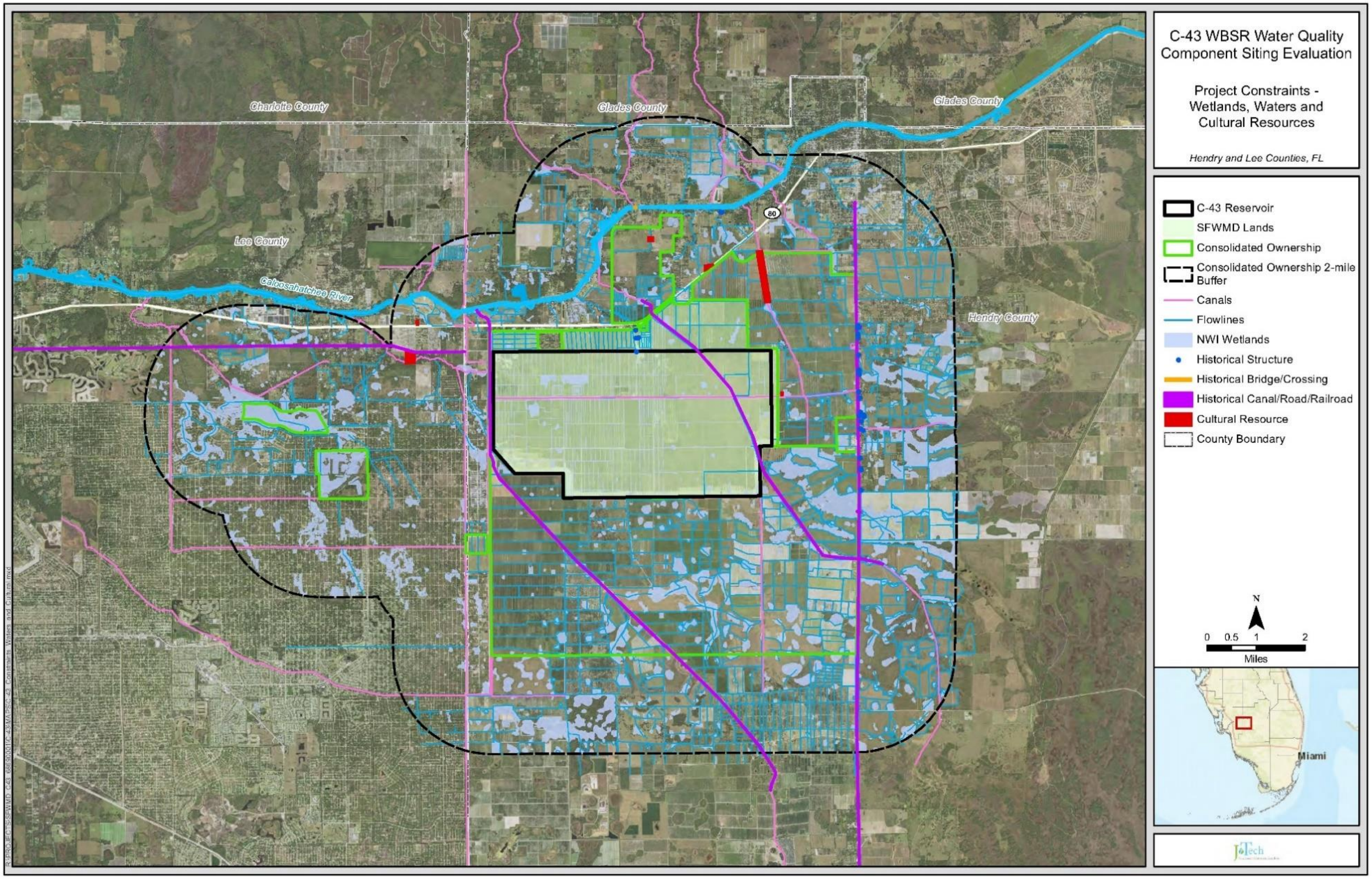


Figure 2-2. Wetlands, Waters, and Cultural Resources Near the C-43 WBSR

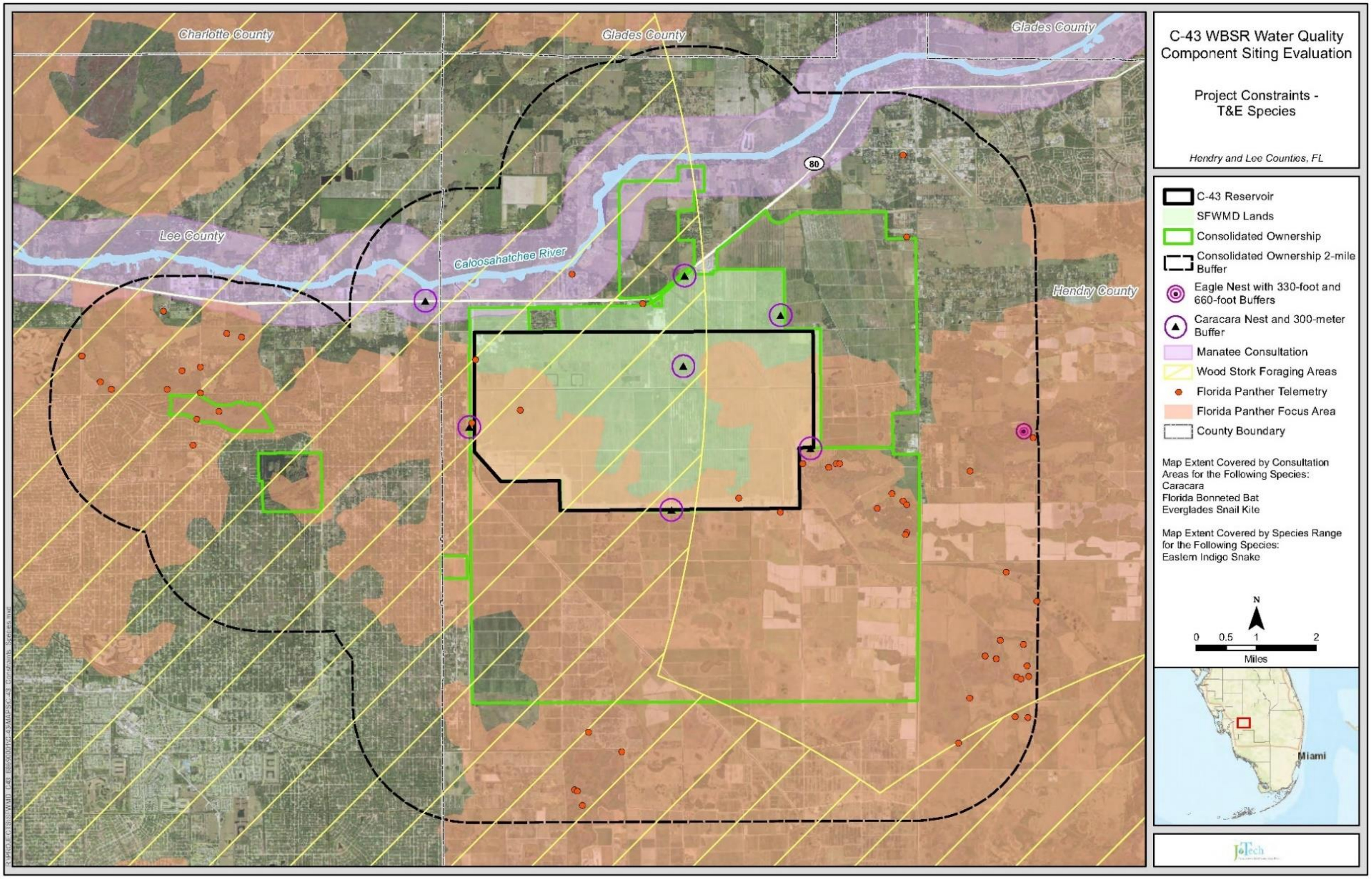


Figure 2-3. Threatened and Endangered Species Near the C-43 WBSR

2.1.1.3 Cultural Resources

The information provided in this desktop analysis is intended to assist in planning for compliance with federal, state, and local laws and regulations that pertain to cultural resources, which include Section 106 of the National Historic Preservation Act of 1966, as amended (Public Law 113-287 [Title 54 U.S. Code]), and Chapter 267, Florida Statutes. The sites in Table 2-1 are located within the two-mile Study Area and are depicted on Figure 2-2. The site locations include a large buffer and are not labeled for sensitivity.

Table 2-1. Summary of Cultural Resources in the Study Area

Site ID	Site Name	Site Type	State Historic Preservation Office (SHPO) Evaluation
HN00042	Murray Mound	Prehistoric midden(s)	Not evaluated by SHPO
HN00129	Hammock Midden	Land-terrestrial	Potentially eligible for National Register of Historic Places
HN00135	Bryan Paul Ditch	Land-terrestrial	Ineligible for National Register of Historic Places
HN00270	Boulman Mound	Land-terrestrial	Not Evaluated by SHPO
LL00741	Bedman Creek	Prehistoric mound(s)	Not Evaluated by SHPO
LL02042	Oak Grove Sand Mound	Land-terrestrial	Eligible for National Register of Historic Places

2.1.1.4 Environmental Site Assessment Reports

J-Tech reviewed a variety of available scientific information regarding environmental analyses and assessments within the two-mile Study Area to determine any potential contamination sites. The data were obtained through publicly available sources provided by DEP and are included on Figure 2-4. It should be noted that there is a site located immediately north of the reservoir on parcel S-4 that was used to dispose of contaminated soils (copper) from the reservoir footprint. Remedial actions will be required prior to using the area for the WQC.

2.1.1.5 Soils and Geology Data

Sandy soils are the dominant soil type, accounting for greater than 97% of the soil types within the two-mile Study Area (Figure 2-5). Based on the NRCS Soil Survey, 41 soil types are present in the Study Area; however, approximately 69% of the soil cover is represented by five soil types: Boca sand (13%), Malabar sand (14%), Oldsmar sand (19%), Pineda sand (12%), and Wabasso sand (11%). Thirty-one (31) soil types are classified as hydric, representing 45.8% (46,300 ac) of the Study Area (Figure 2-6). Appendix B provides the areal extent and acreage by soil type for the Study Area.

2.1.1.6 Land Use and Zoning

Specific land use designations and future development areas as they relate to the proposed WQC were identified. The Florida (SFWMD 2013–2014) Land Use, Cover and Forms Classification System (FLUCCS) is arranged in hierarchical levels with each level containing information of increasing detail. The system uses four levels (I–IV) within classification categories. The GIS land use and land cover database showed a number of FLUCCS categories within the Study Area (see Figure 2-7).

The information shown in Figure 2-8 includes information collected from Lee County and Hendry County property maps. The majority of the land in the vicinity of the reservoir is zoned A-2 – General Agriculture by Hendry County. The project lands to the east of the C-43 WBSR are zoned within the boundaries of the City of Labelle. There are also some areas listed in the Protected Areas Database that fall within the Study Area (Figure 2-9). Additional Lee County lands evaluated during this analysis are described in Section 2.1.1.10.

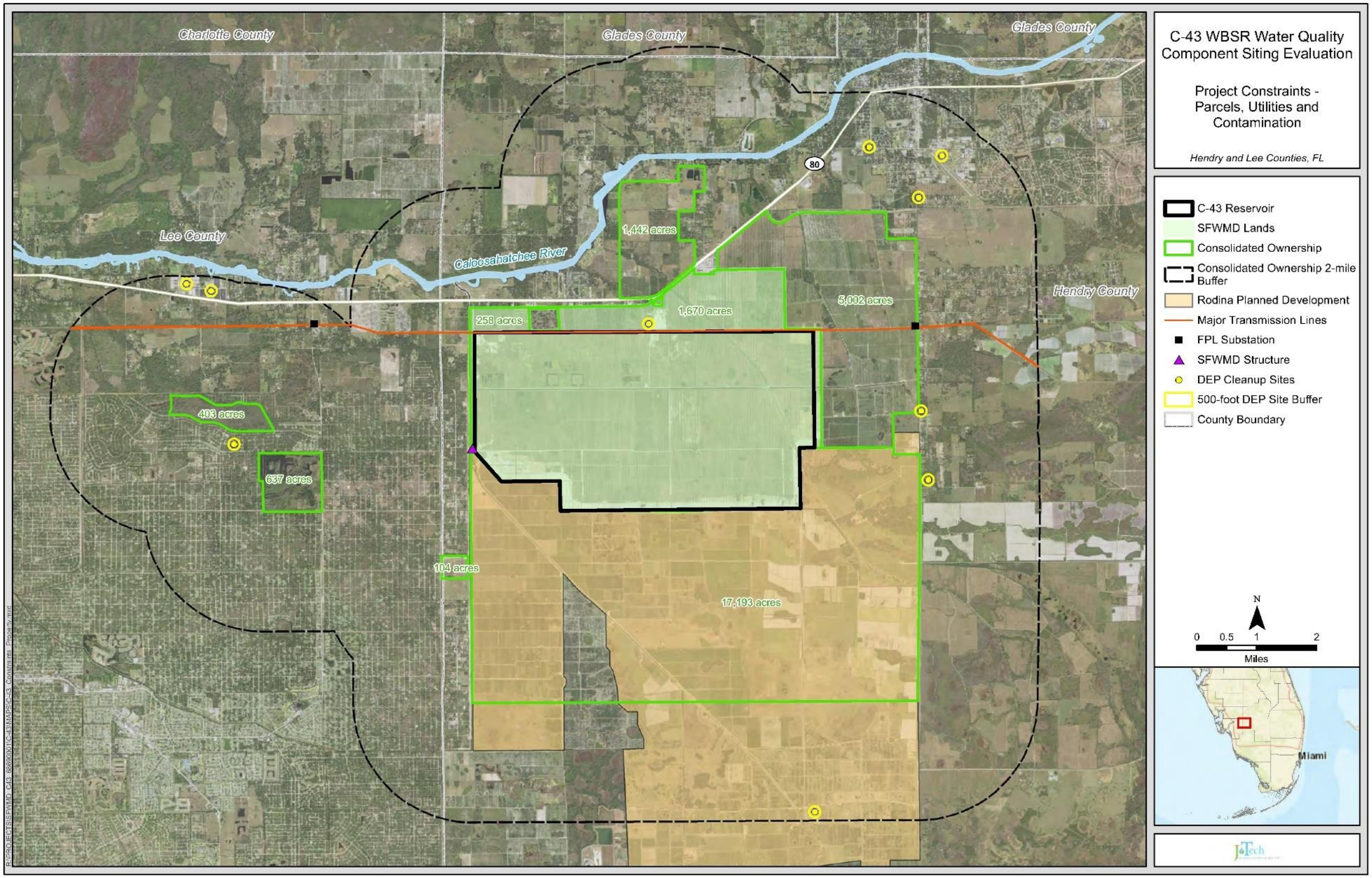


Figure 2-4. Parcels, Utilities, and Contamination Near the C-43 WBSR

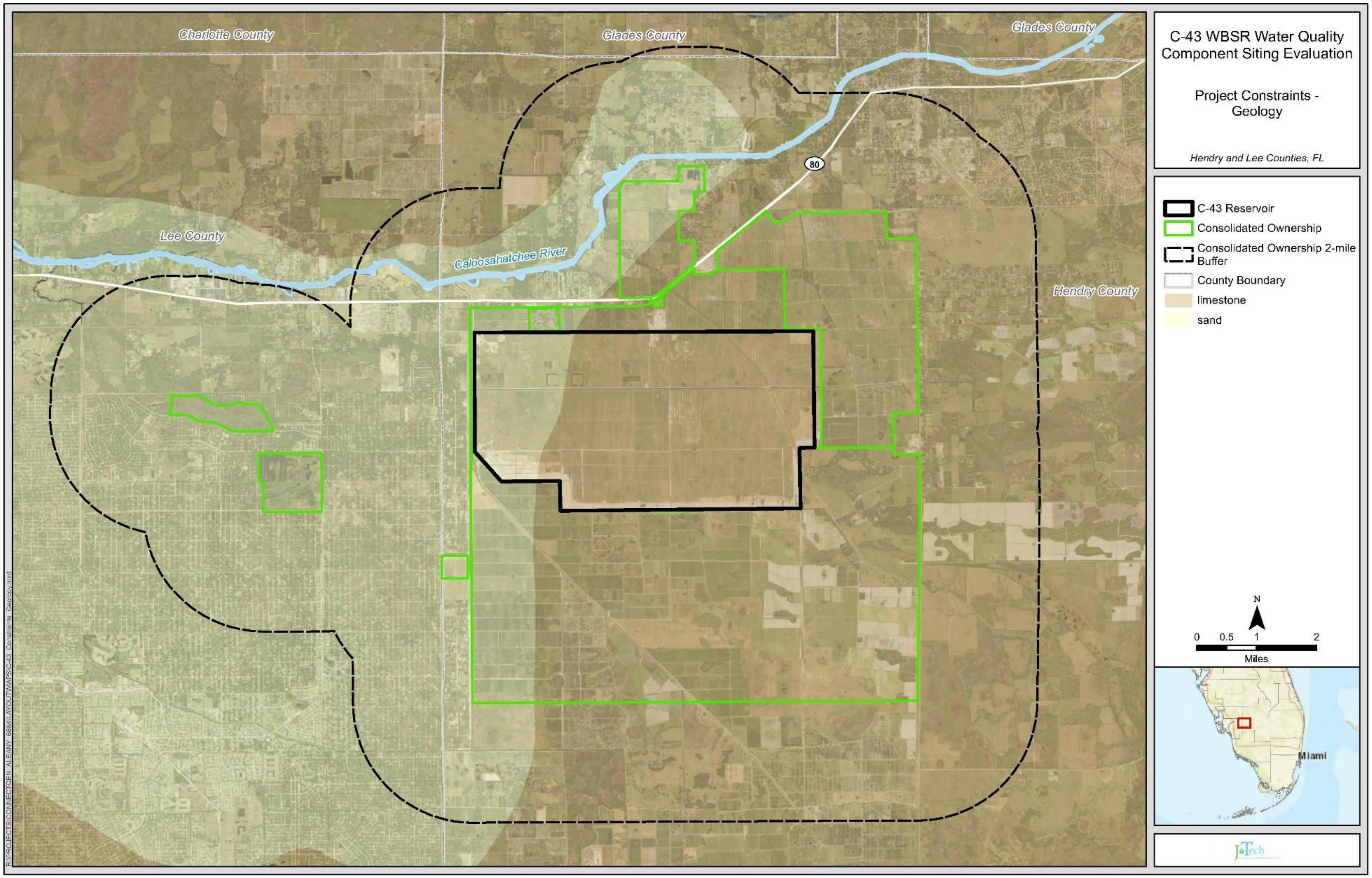


Figure 2-5. Geology Near the C-43 WBSR

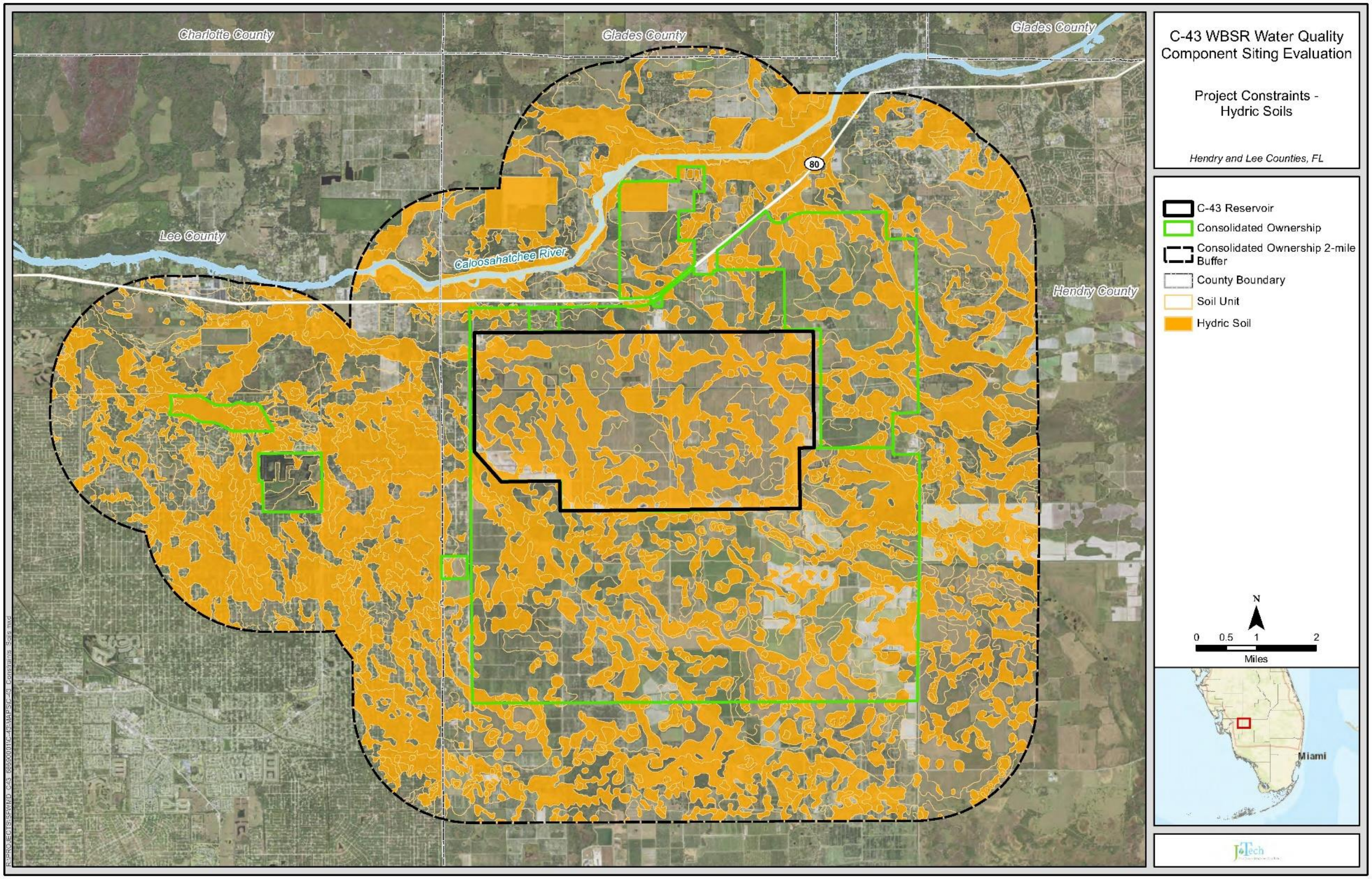


Figure 2-6. Hydric Soils Near the C-43 WBSR

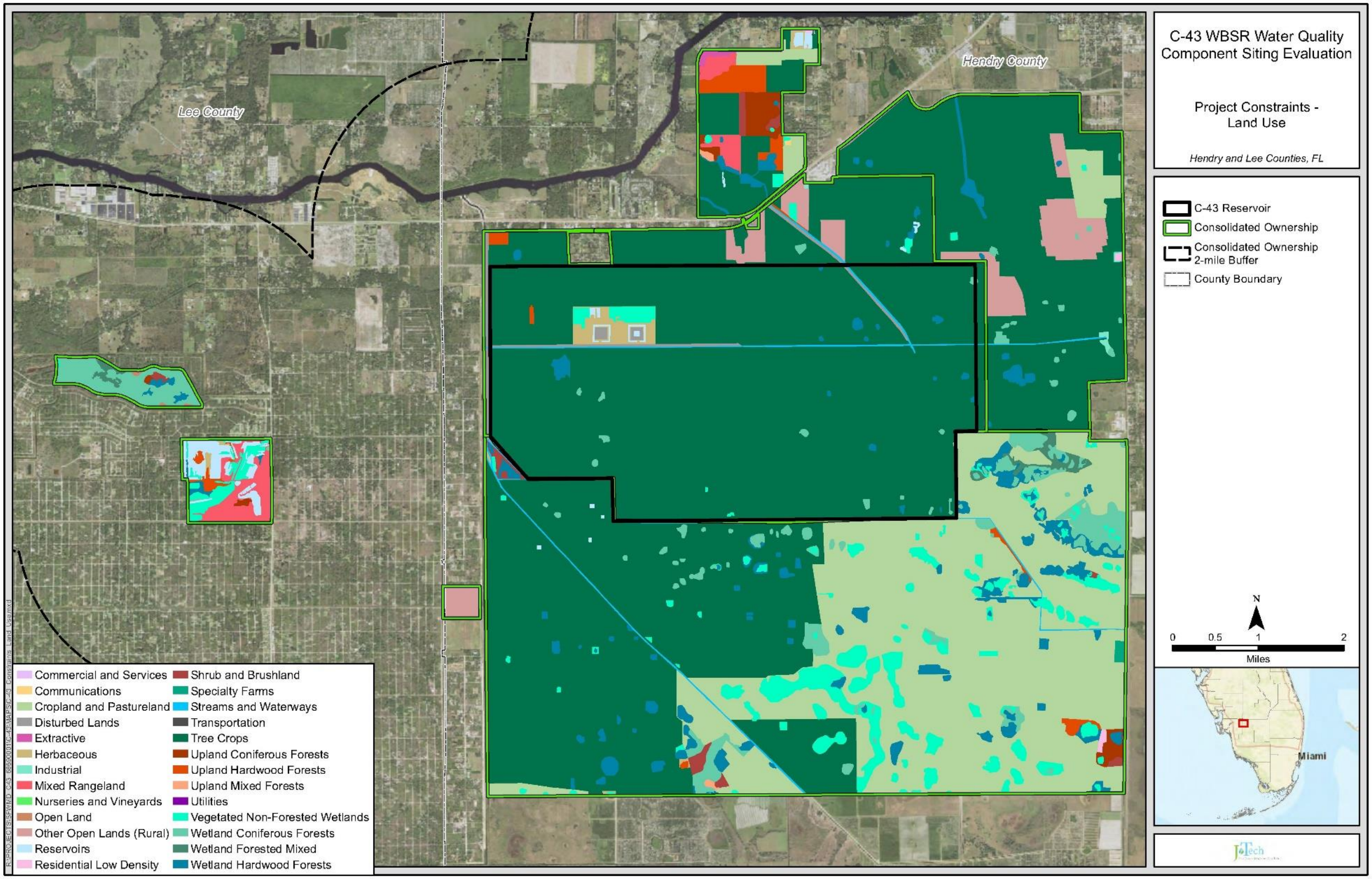


Figure 2-7. Land Use Near the C-43 WBSR

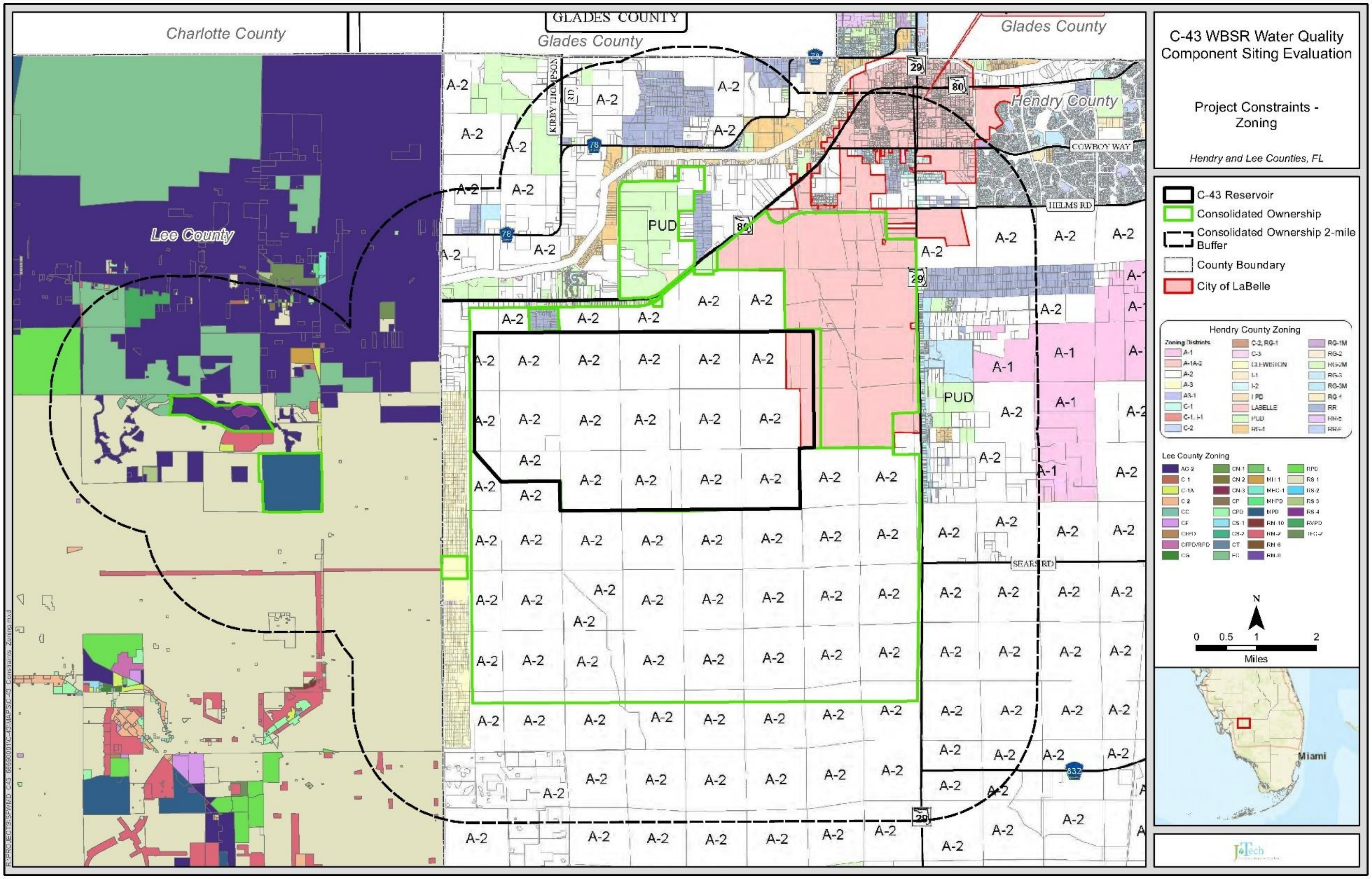


Figure 2-8. Zoning Near the C-43 WBSR

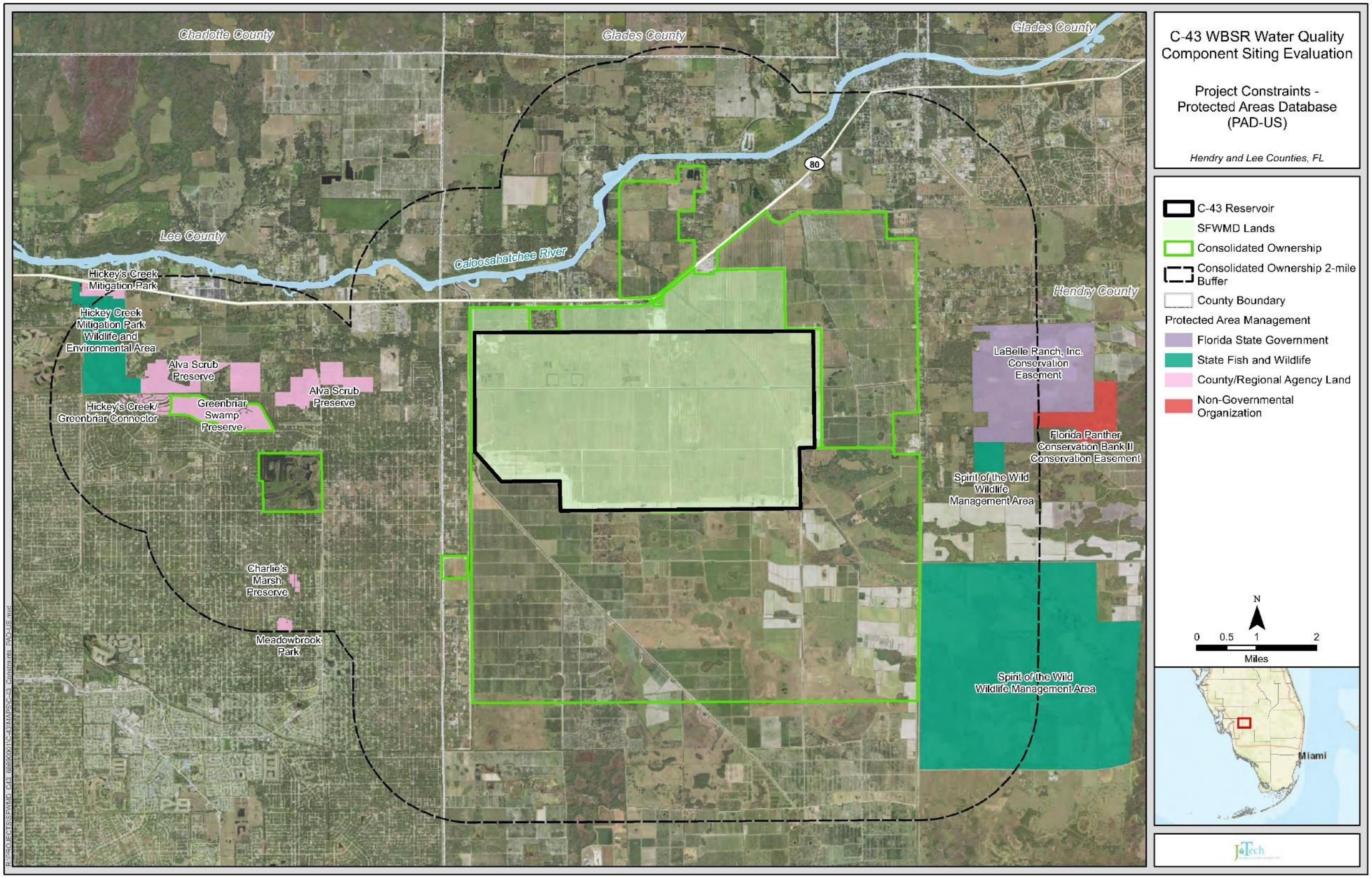


Figure 2-9. Protected Areas Near the C-43 WBSR

2.1.1.7 Land Valuation

A high-level cost analysis was conducted as part of the Siting Evaluation for the areas proposed for the WQC. To facilitate this, a valuation of parcels was needed to understand the underlying cost of acquiring additional lands, as needed, to meet project requirements. The source data for this information were obtained from publicly available data sets provided by both the Hendry County Property Appraiser and Lee County Property Appraiser. Figure 2-10 shows the range in value for parcels within the Study Area. The groupings of colored parcels are represented in the legend with the estimated value. Generally, the land value for agricultural lands within the Study Area is estimated at $10,000 per acre, while commercial land is valued at $150,000 per acre (LandAndFarm.com, 2020).

2.1.1.8 Easements and Rights-of-Way

J-Tech evaluated potential constraints due to granted easements and rights-of-way within the Study Area. Figure 2-4 shows the location of the new Florida Power & Light substation immediately adjacent to the reservoir and the existing major transmission line which runs east to west along the north boundary of the reservoir. Other easements and rights-of-way that were identified include the North Rim Canal (owned by SFWMD), State Road 80, and Townsend Canal (Figure 2-11). The Florida Department of Transportation holds an easement along portions of the Banana Branch Canal near the Fort Denaud Bridge crossing, which is used for maintenance activities along the canal (Figure 2-11).

2.1.1.9 Existing Water Conveyance Features

J-Tech evaluated existing water conveyance features within the two-mile Study Area. The major water features include the Banana Branch Canal, Fort Townsend Canal, Roberts Canal, North Rim Canal (NRC), and agricultural ditch that runs along the southern boundary of the Double J residential area. Additional review of these conveyance features is included in Section 2.2.1.

2.1.1.10 Lee County-Owned Properties

Representatives from Lee County approached SFWMD during the WQFS to indicate that publicly owned lands are available, if appropriate, for siting of the WQC. The request included evaluating opportunities to send flows from the C-43 WBSR to the available lands for water quality treatment. The properties that were highlighted are Lee County's GS-10 and Lehigh Acres Municipal Services Improvement District's (LAMSID) Greenbriar Swamp Preserve, which are 2.5 and 3.5 miles west, respectively, of the C-43 WBSR. The Lee County/LAMSID stated goals for the GS-10/Greenbriar Swamp Preserve project are to reduce a 15,000 acre-feet water deficit, restore the Greenbriar Preserve hydrology, and provide aquifer recharge. These properties have been evaluated for water storage and water quality improvements and could potentially be connected to the C-43 WBSR through a series of canals including the King, Fox, and Hickey Creek canals. The GS-10 Caloosahatchee Cross-link Project (Figure 2-12) identifies possible flow patterns to connect these properties, including accepting flows from the C-43 WBSR.

Throughout the WQFS, the Working Group evaluated opportunities to use publicly owned lands and collaborate with local governments. However, operational constraints, minimum flow and level (MFL), and a specific water reservation for the C-43 WBSR limit the use of these lands. Subsection 40E-10.041(3), Florida Administrative Code, reserves all water from the C-43 WBSR and requires that water be sent to the Caloosahatchee River and Estuary for protection of fish and wildlife. All water identified in the reservation must meet the MFL established for the Caloosahatchee River and Estuary. Based on the current C-43 WBSR modeling (2007 Project Implementation Report [PIR]), SFWMD does not anticipate that there will be additional water supply deliveries available beyond the MFL. In addition to the mandated delivery of flows, the conveyance capital and O&M cost estimates for infrastructure needed to send water to the west from the reservoir were determined not to be cost effective as water would need to be pumped over the Townsend Canal, which is the current intake and discharge canal for the reservoir. In addition, infrastructure envisioned to make the flow connections may trigger dam safety concerns, depending on the means of delivery, and would need to be carefully scrutinized to ensure public safety. For these reasons, the GS-10 property and Greenbriar Swamp Preserve were determined not to be viable locations for the WQC.

2.1.2 Siting Evaluation Resources, Opportunities, and Constraints Maps

J-Tech prepared several base maps (described above) and a cumulative "ranking map" to identify and classify opportunities and constraints based on the character of the resource relative to its compatibility with the proposed water quality improvement technology. The cumulative map that contains the constraints and opportunities for the siting analysis is shown in Figure 2-13. A resource was classified as an opportunity or as one of two types of constraints – avoidance areas or exclusion areas. Opportunity areas (shown in green on the map) are those that are compatible with the proposed project such as SFWMD-owned lands, rights-of-way, or existing water conveyance features. Avoidance areas (shown in yellow) are sensitive areas where environmental impacts or land use conflicts can be minimized or mitigated using specific measures. Exclusion areas (shown in red) represent the greatest potential for environmental, social, and/or economic impacts. These areas generally are excluded as siting options. The opportunities and constraints map was used to facilitate the identification of sites for the WQC.

Overall, the desktop analysis indicated the greatest opportunities for siting the WQC exist to the north and east of the reservoir where there are available lands, existing conveyance features**,** and existing connections to Caloosahatchee River.

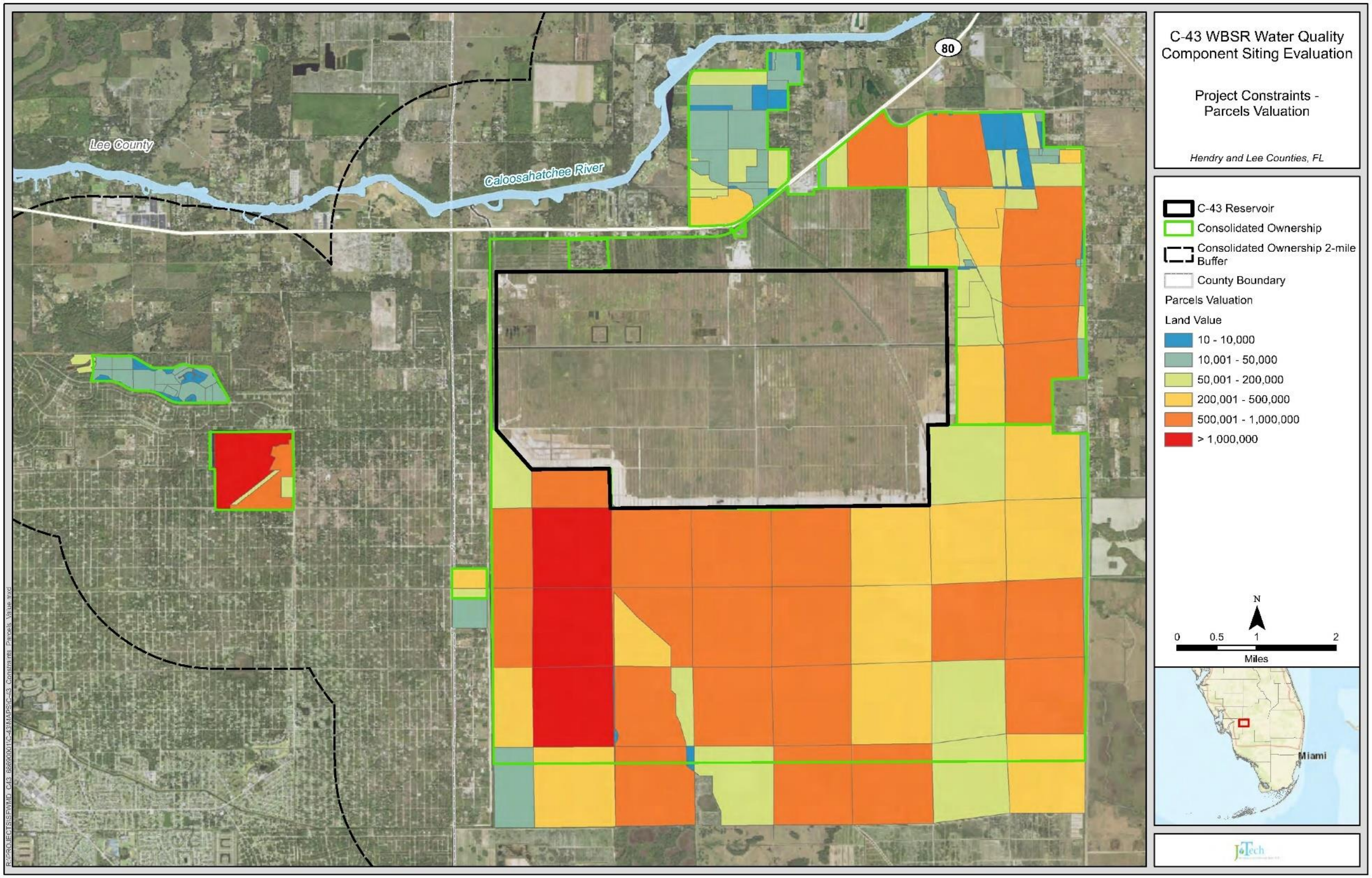


Figure 2-10. Parcels Valuation Near the C-43 WBSR

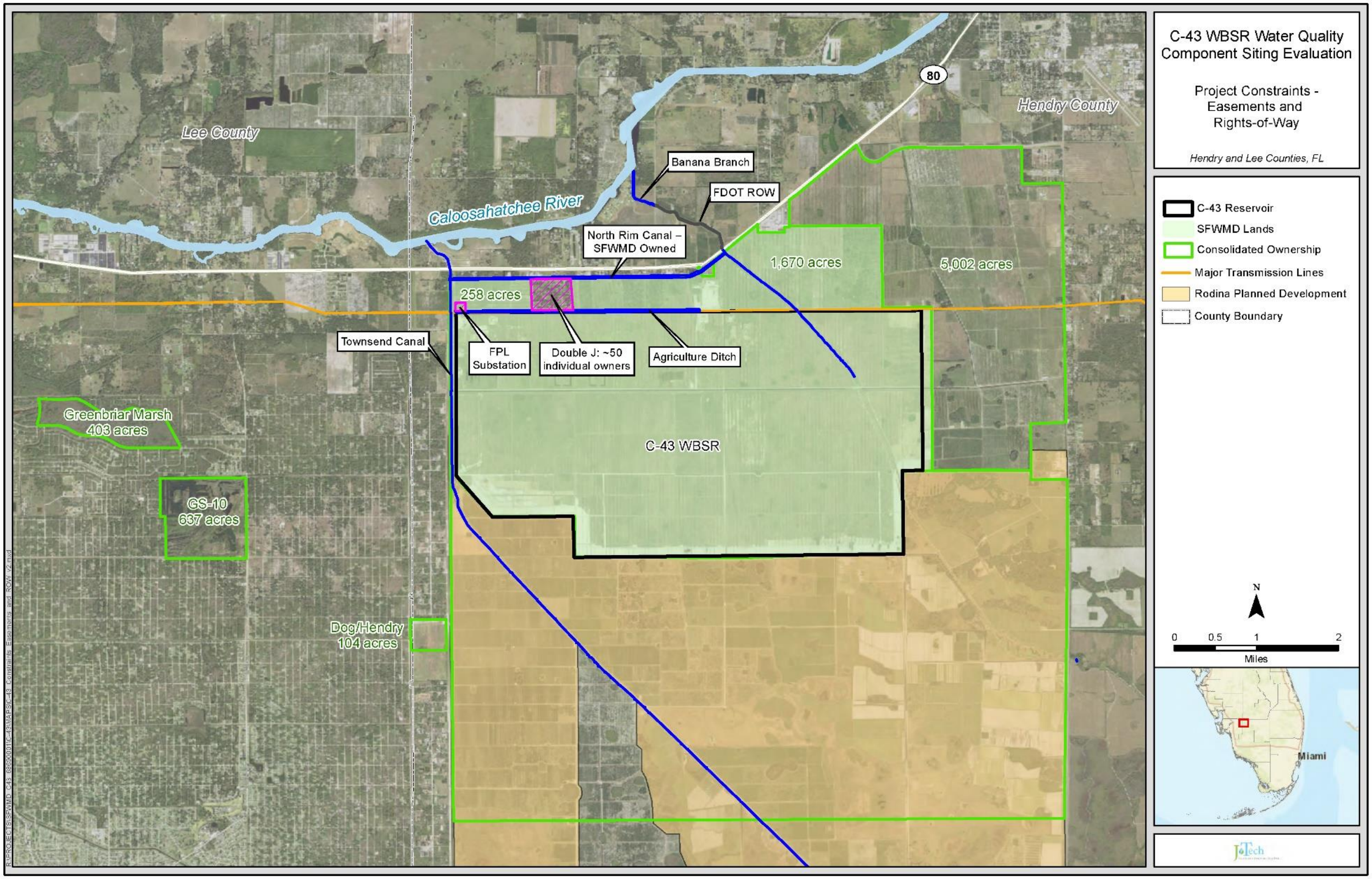


Figure 2-11. Easements and Rights-of-way Near the C-43 WBSR

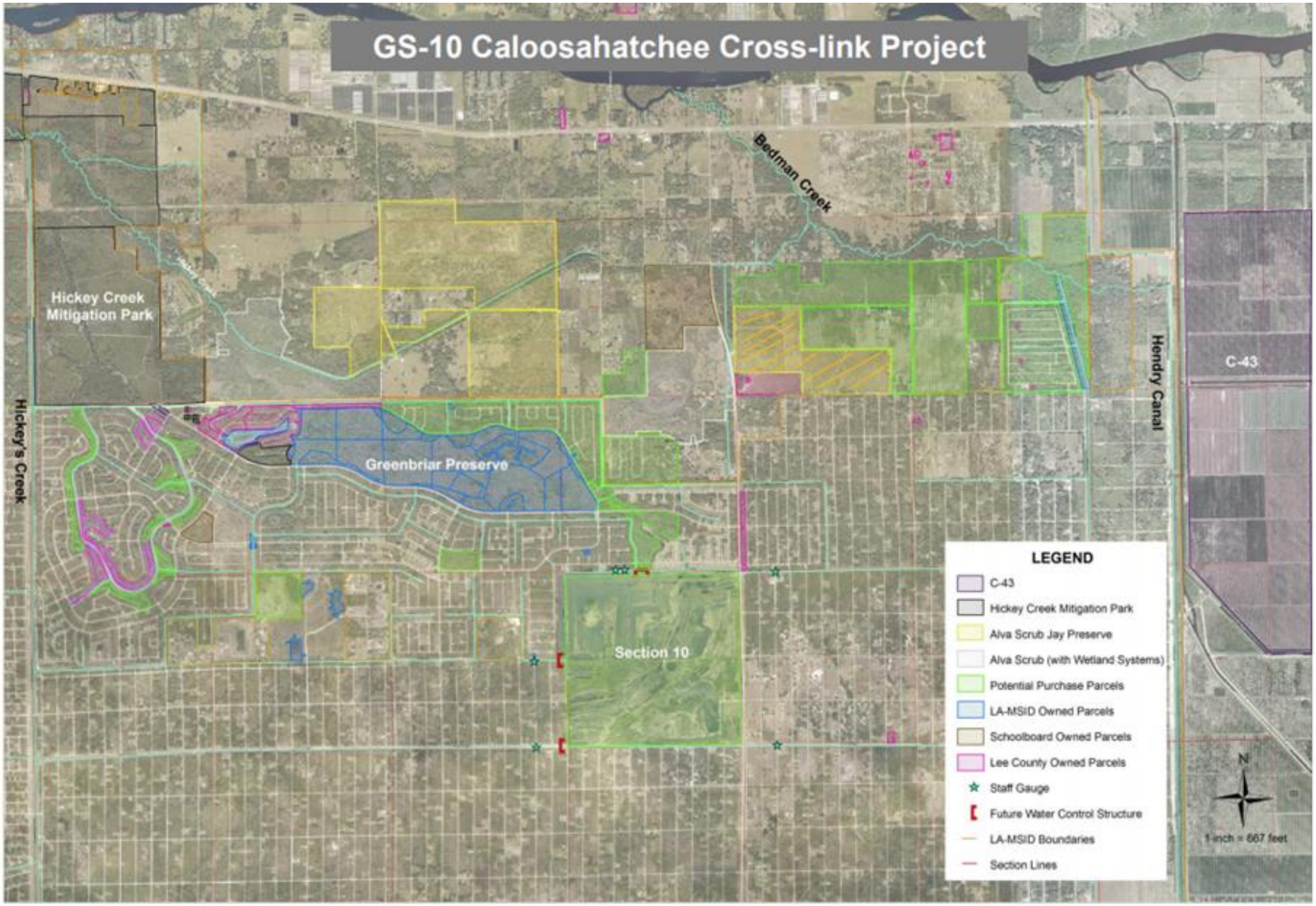


Figure 2-12. GS-10 Caloosahatchee Cross-link Project

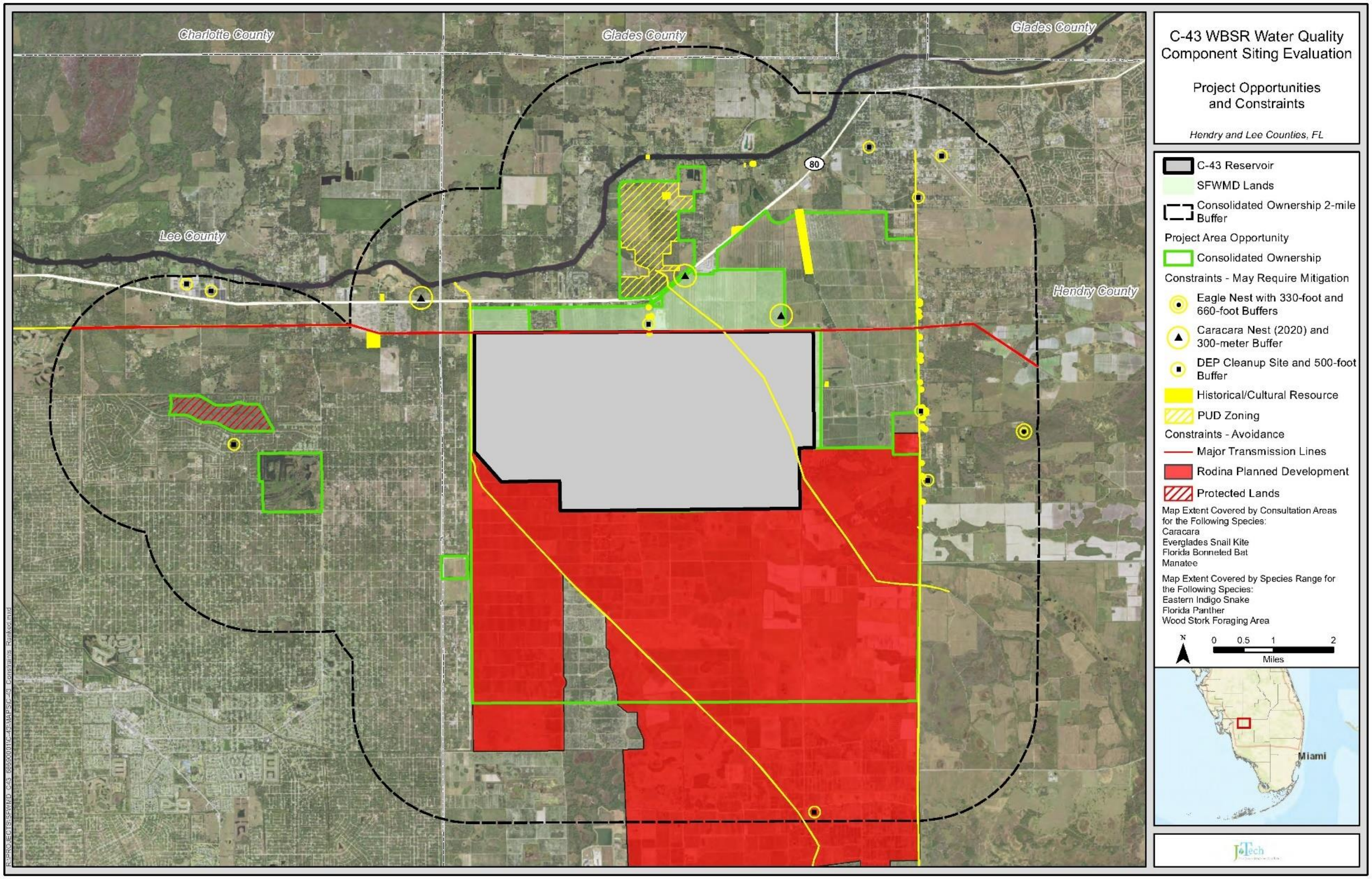


Figure 2-13. Summary of Project Opportunities and Constraints

2.2 Evaluation for Siting the Alternatives on SFWMD Lands

Using the resources, opportunities, and constraints maps, J-Tech identified potential alternative sites within the Study Area, as well as conveyance alternatives to return water to the Caloosahatchee River. J-Tech evaluated construction and operating parameters of the selected alternatives as compared to the opportunities and constraints map. J-Tech performed a detailed conveyance and siting evaluation for the alternatives identified in the WQFS and recommended by SFWMD for further evaluation.

Comparative evaluation criteria were used to evaluate the alternatives including, but not limited to, sensitive resources, state and local siting requirements, engineering, general cost, land ownership, assessment of previous and current use of the land, topographic constraints, water conveyance needs, access roads for maintenance of infrastructure, and other project-specific factors as appropriate. J-Tech prepared a summary matrix based on the evaluation criteria for each alternative (Table 2-4).

2.2.1 Siting and Conveyance Evaluation for Alternatives

As part of the Siting Evaluation, J-Tech evaluated multiple options to convey water from the C-43 WBSR to the WQC for treatment, and then, after treatment, from the WQC back to the Caloosahatchee River. Early in the evaluation it was determined that the conveyance options needed to be cost-effective to be further considered, eliminating major infrastructure and conveyance that required canals of significant length. The remaining conveyance options were compared based on pros and cons for their design features related to conveyance and optimization. The following attributes were evaluated:

Cell 1 and Cell 2 Flows – The reservoir is capable of discharging flows from Cell 1 and Cell 2. Most of the conveyance alternatives are only able to deliver water from Cell 2 to the WQC. Due to the proposed location of Option 1, the offline alum treatment system, on the easternmost parcel (S-5), it is able to treat both Cell 1 and Cell 2 flows. This was identified as a "pro." Note that in review of the preliminary operation plan for the reservoir, the intent is to send water from Cell 1 to Cell 2 and to discharge only from Cell 2 a majority of the time.

Gravity Discharge – The importance of gravity discharge is related to cost. This category indicates that pump stations are not needed to discharge water from the WQC. This was identified as a "pro." Option 4a requires that discharge flows be pumped and piped across the Banana Branch canal to the west.

Discharge to C-43 Canal – The discharge location was considered in the evaluation of the options. Discharging directly to the C-43 Canal (Caloosahatchee River) indicates that the flows will not be mixed with water that is used for water supply and that improvements to water quality from the WQC will be sent directly to the river. This category was identified as a "pro."

Discharges Sequenced with Water Supply – Because of the multi-purpose use of water within the Townsend Canal, including water supply and water to be pumped into the C-43 WBSR for storage, the need for operational changes related to discharges from the reservoir may be necessary. This category is a "con" because of potential operational constraints.

Land Acquisition Required – Several of the alternatives will require additional lands be acquired to construct project features needed to convey the flows expected to be discharged from the WQC. This category was identified as a "con" because of the additional costs and potential project delays for land acquisition.

Significant Upgrades for Conveyance – New conveyance features (construction of new canals) were eliminated early on due to cost and lack of available lands. This category describes utilization of existing canals for conveyance where significant upgrades to the canal or ditch will be required to accommodate the expected discharge flows. This category was identified as a “con.”

The feasible conveyance options are presented below and summarized in Table 2-2. This table is a high-level overview of each of the options and only includes the pros and cons related to water conveyance to the WQC for treatment and conveyance for treated water from the WQC to the river.

Table 2-2. Conveyance Options Comparison

Alternative Features			Pros			Cons		
Option	**Alternative**	**Features**	**Cells 1 and 2 Flows**	**Gravity Discharge**	**Discharge to C-43 Canal**	**Discharges Sequenced with Water Supply**	**Land Acquisition Required**	**Significant Upgrades for Conveyance**
1	Offline Alum Treatment	• Intake canal and pump station from perimeter canal • New bridge over perimeter canal • Discharges to Townsend Canal	✓	✓		X		
2	Sand Filter with Bold and Gold®	• Intake canal and pump station from perimeter canal • Discharges through single canal (upgraded NRC)		✓		X	X	
3	HWTT	• Intake canal and pump station from perimeter canal • New bridge • Discharges through conveyance canal system (upgraded NRC and agricultural ditch)		✓		X	X	
4a	STA with Bold and Gold® discharge to Townsend Canal	• Intake canal and pump station from perimeter canal • Bypass maintenance road or bridge • Aerial pipe crossings for discharge • Discharges through single canal (upgraded NRC)				X	X	X
4b	STA with Bold and Gold® discharge to Banana Branch	• Intake canal and pump station from perimeter canal • Bypass maintenance road or bridge • Aerial pipe crossings for discharge • Discharge to C-43 via Banana Branch		✓	✓		X	X
5	Full-scale STA	• Intake canal and pump station from perimeter canal • Three-mile distribution canal • Significant grading • Discharge to C-43 via Banana Branch		✓	✓		X	X

In **Option 1**, untreated water will be pumped into a 50-ac WQC through a newly constructed intake canal on the reservoir perimeter canal between reservoir structures S-483 and S-471. Once treated, a culvert will discharge water by gravity into the existing NRC, which will be improved, to the proposed discharge junction where it will flow into the Townsend Canal and then to the Caloosahatchee River (Figure 2-14). Option 1 considers the following features and requirements:

- Construction of an intake canal, pump station, and two bridges
- 50-ac WQC and perimeter earthen berm
- One gravity discharge structure (one reinforced concrete pipe [RCP]-type culvert)
- Flow capacity improvements to approximately 1,000 feet of the existing section at NRC, on SFWMD lands
- Does not require land acquisition

In **Option 2**, untreated water will be pumped into a 298-ac WQC through a newly constructed intake canal on the reservoir perimeter canal between the reservoir structure S-474 and site access bridge. From the 298-ac WQC, water will flow by a gravity discharge system comprised of the improved NRC to the Townsend Canal and then to the Caloosahatchee River (Figure 2-15). Option 2 considers the following features and requirements:

- Construction of an intake canal and pump station
- 298-ac WQC and perimeter earthen berm
- Gravity discharge structure (one RCP-type culvert)
- Flow capacity improvements to approximately 8,100 feet of the existing NRC to meet 10-foot bottom and 6-foot deep canal geometry requirements
- Construction of a canal junction at the discharge end of NRC to Townsend Canal and a new bridge
- Requires land acquisition lands to facilitate NRC widening

In **Option 3**, untreated water will be pumped into a 298-ac WQC through a newly constructed intake canal on the reservoir perimeter canal between the reservoir structure S-474 and site access bridge. From the 298-ac WQC, water will flow by gravity discharge system into a dual conveyance canal system, comprised of the improved NRC and a significantly upgraded agricultural ditch. The proposed canal will connect to the Townsend Canal. Additionally, located on parcel S-5, there is a 154-ac area available to install the WQC, as needed. The 154-ac area is located within the dual canal conveyance system, where water can be pumped into the WQC and be discharged by gravity (Figure 2-16). Option 3 considers the following features and requirements:

- Construction of an intake canal and pump station
- 298-ac and 154-ac WQCs and perimeter earthen berms
- Gravity discharge system:
    - Two RCP-type structures at the 298-ac WQC
    - Two RCP-type structure culverts at the 154-ac WQC
- Dual canal conveyance system:
    - Flow capacity improvements to approximately 8,100 feet of the existing NRC to meet 10-foot bottom and 6-foot deep canal geometry requirements

  - Construction of approximately 10,000 feet of upgraded agricultural ditch canal to meet 10-foot bottom and 6-foot deep canal geometry requirements
- Construction of a canal junction at discharge end of the NRC to Townsend Canal and a new bridge
- Requires land acquisition facilitate NRC widening and new canal construction where existing agricultural ditch currently runs in the east-west direction

In **Option 4A**, untreated water will be pumped into two, 862-ac and 168-ac, WQCs from a newly constructed intake canal, which would be located on the reservoir perimeter canal immediately west of structure S-481A. Treated water will flow by a gravity structure from the 168-ac WQC, and pumped over the Banana Branch Canal from the 862-ac WQC into the improved NRC. A new junction would be constructed at the intersection of the NRC and Townsend Canal and will connect with the Caloosahatchee River (Figure 2-17). Option 4A considers the following features and requirements:

- Construction of an intake canal, pump station, and bypass maintenance road or possibly bridge
- Two groups of aerial pipe crossings with a total length of approximately 1,900 feet (950 feet to each WQC)
- 862-ac and 168-ac WQCs and perimeter earthen berms
- One gravity discharge structure (one RCP-type culvert at one WQC)
- Flow capacity improvement to approximately 14,400 feet of the existing NRC
- Requires land acquisition to facilitate NRC widening

In **Option 4B**, untreated water will be pumped into two, 862-ac and 168-ac, WQCs from a newly constructed intake canal, which would be located on the reservoir perimeter canal immediately west of structure S-481A. Treated water would flow by gravity systems from each WQC into an improved Banana Branch Canal which will connect directly to the Caloosahatchee River (Figure 2-18). Option 4B considers the following features and requirements:

- Construction of an intake canal, pump station, and bypass maintenance road or possibly bridge
- Two groups of aerial pipe crossings with a total length of approximately 1,900 feet (950 feet to each WQC)
- 862-ac and 168-ac WQCs and perimeter earthen berms
- Two gravity discharge structures (one RCP-type culvert at each WQC)
- Flow capacity improvement to approximately 9,500 feet of the existing Banana Branch Canal
- Construction of new bridge at State Road 78A
- Requires land acquisition or flow easements along the Banana Branch Canal, north of State Road 80, for canal improvements

In **Option 5**, untreated water will be pumped from a newly constructed intake canal, which would be located on the reservoir perimeter canal immediately west of structure S-481A. Water will flow through a newly constructed distribution canal into a 5,000-ac WQC. After grading, water would flow through a series of cells, and then treated water would flow by gravity into an improved Banana Branch Canal which will connect directly to the Caloosahatchee River (Figure 2-19). Option 5 considers the following features and requirements:

- Acquisition of at least 4,200 ac of land for the STA feature
- Construction of an intake canal and pump station
- Aerial pipe crossings with a total length of over 350 feet
- Construction of a three-mile distribution canal to convey water
- Extensive regrading for consistent elevation and water depth within the STA cells
- One gravity discharge structure
- A minimum of two water control structures on each levee between each cell (8 total)
- Requires additional land acquisition or flow easements along the Banana Branch Canal, north of State Road 80, for canal improvements

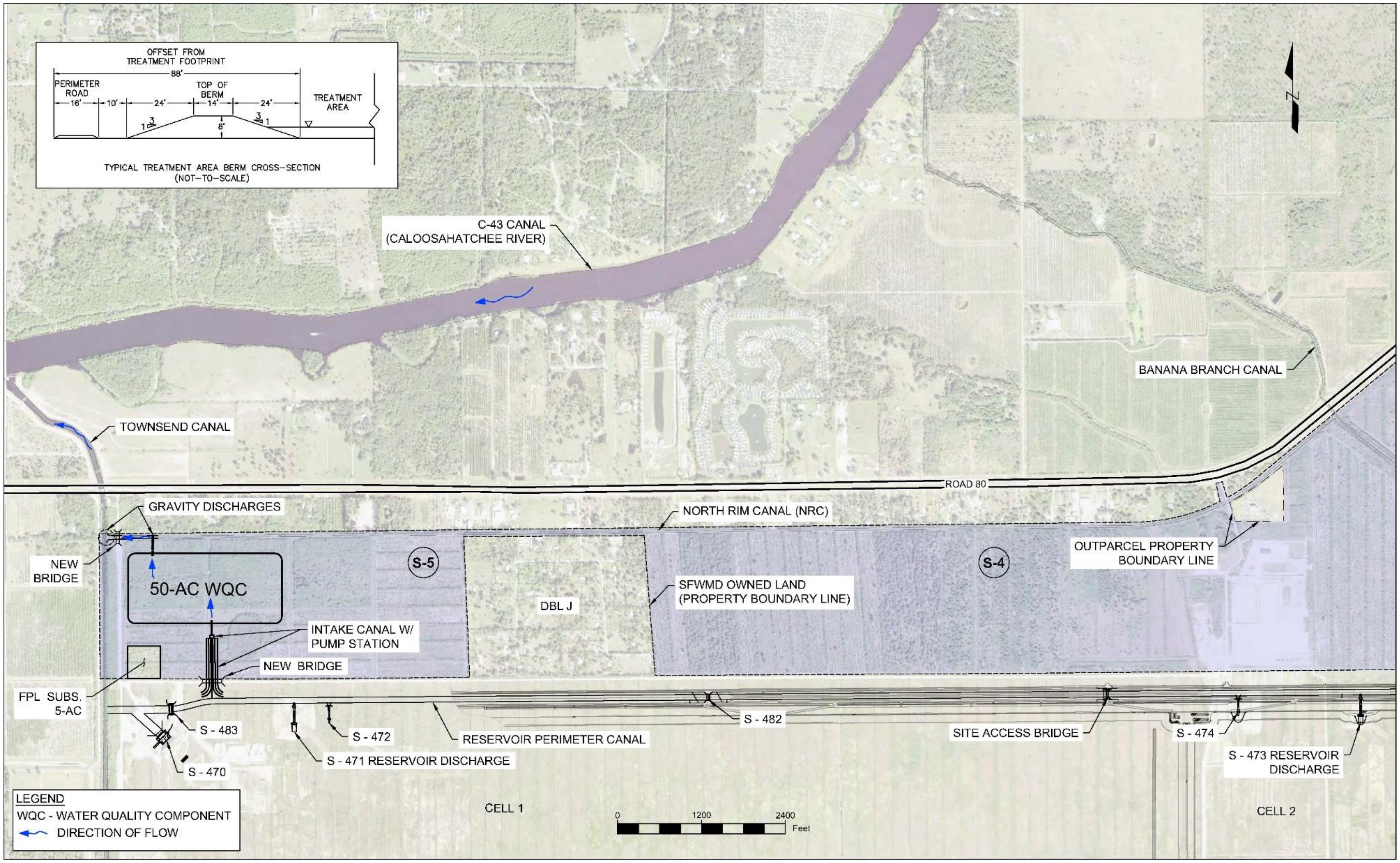


Figure 2-14. Option 1 for Water Conveyance

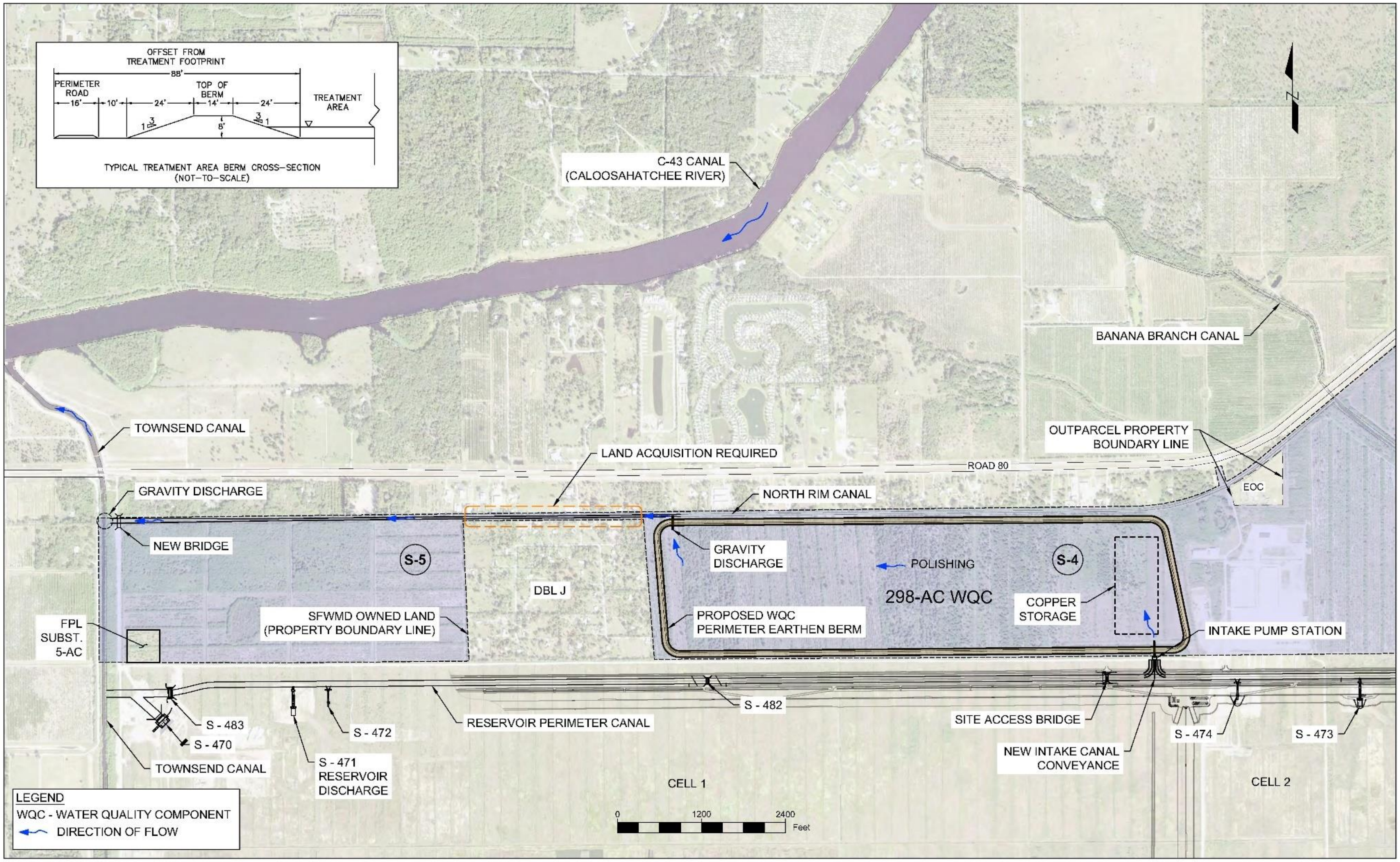


Figure 2-15. Option 2 for Water Conveyance

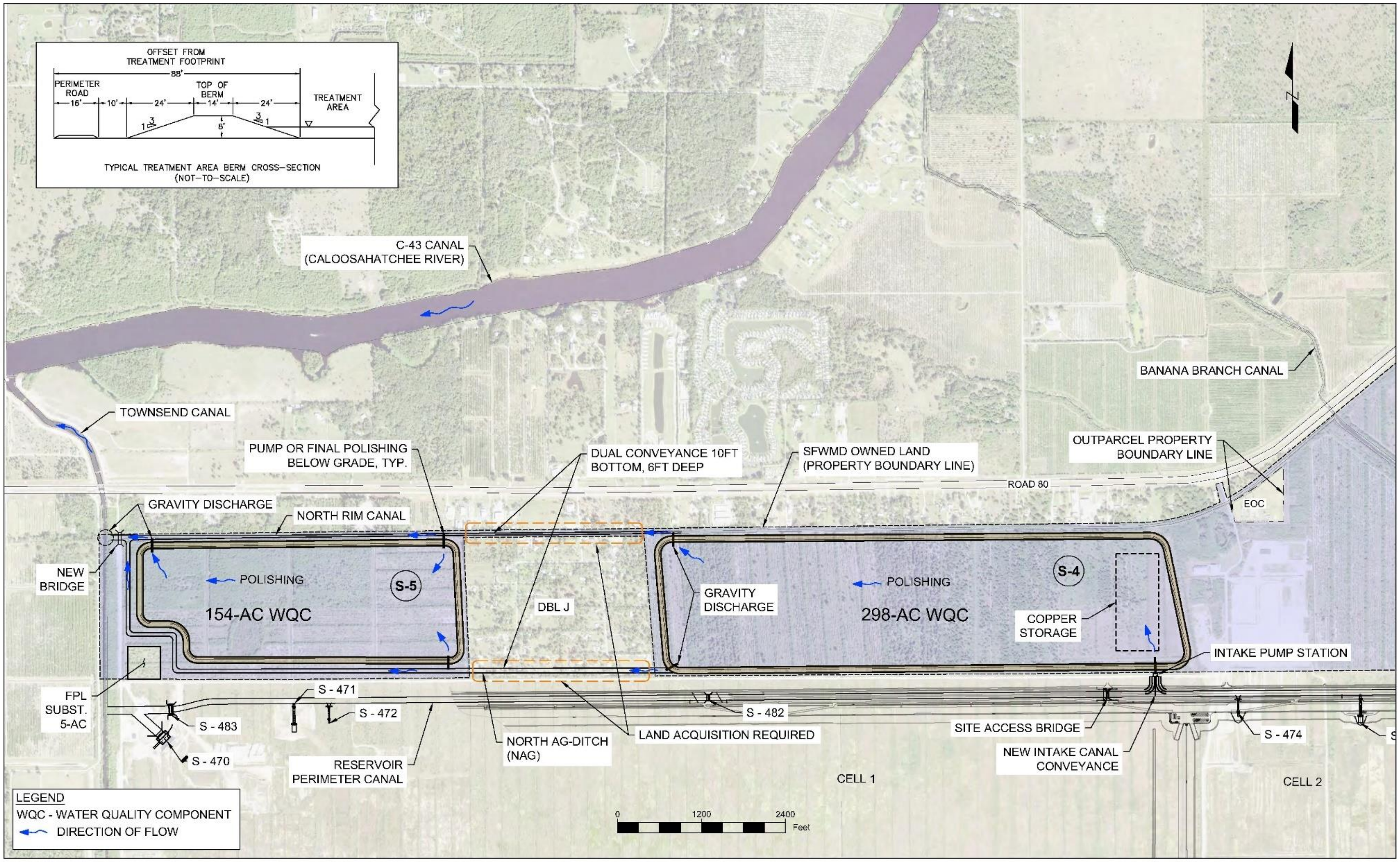


Figure 2-16. Option 3 for Water Conveyance

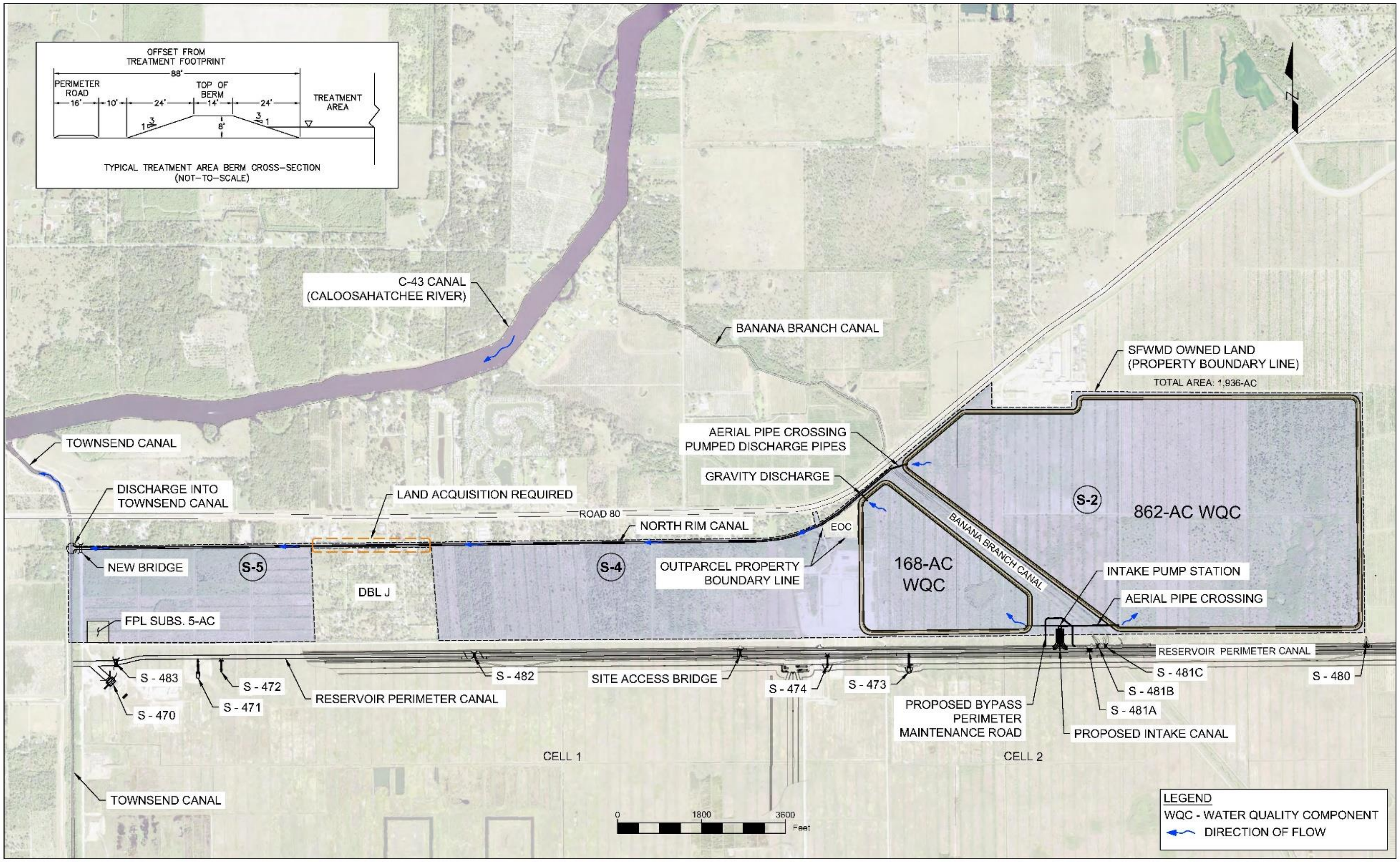


Figure 2-17. Option 4A for Water Conveyance

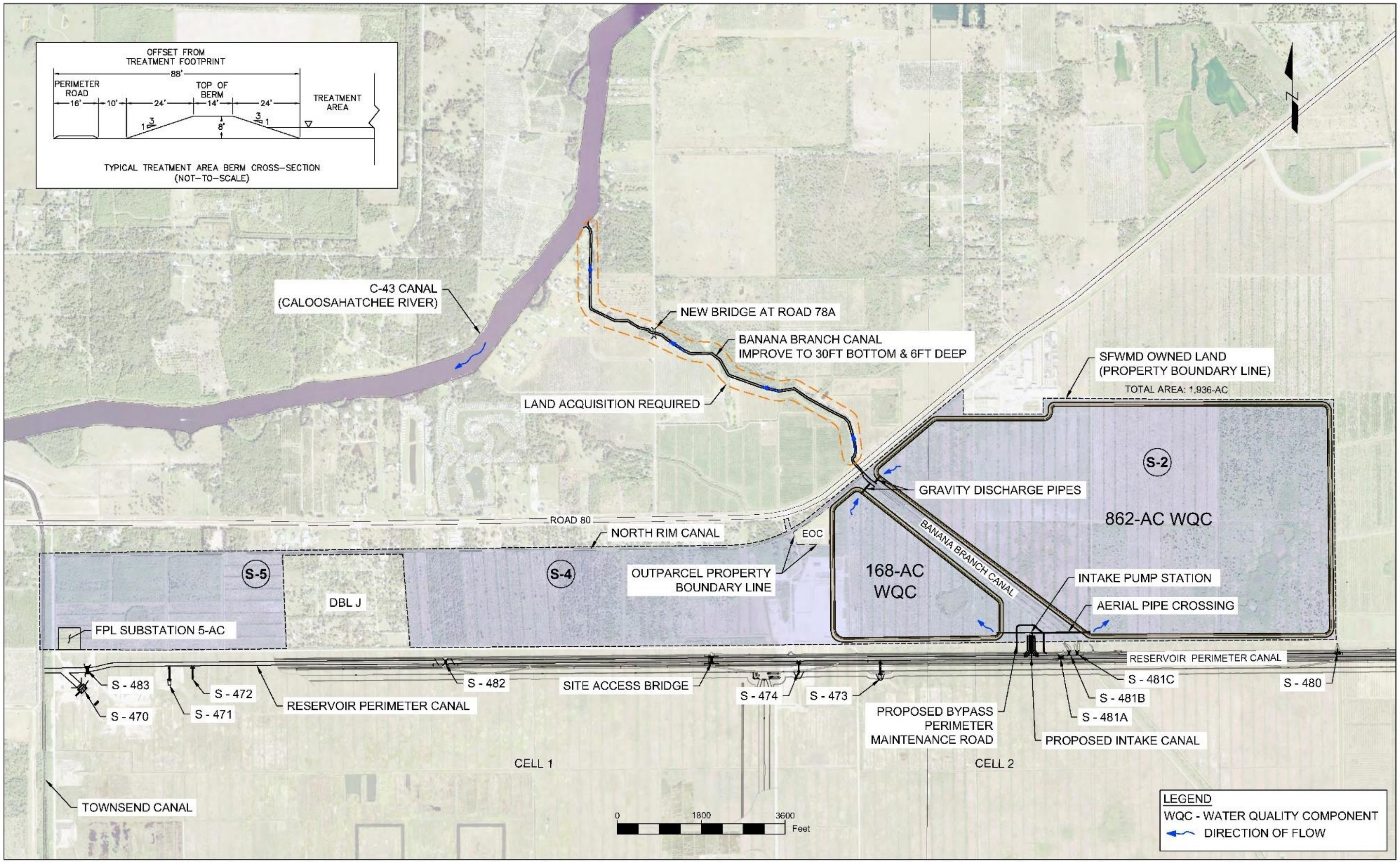


Figure 2-18. Option 4B for Water Conveyance

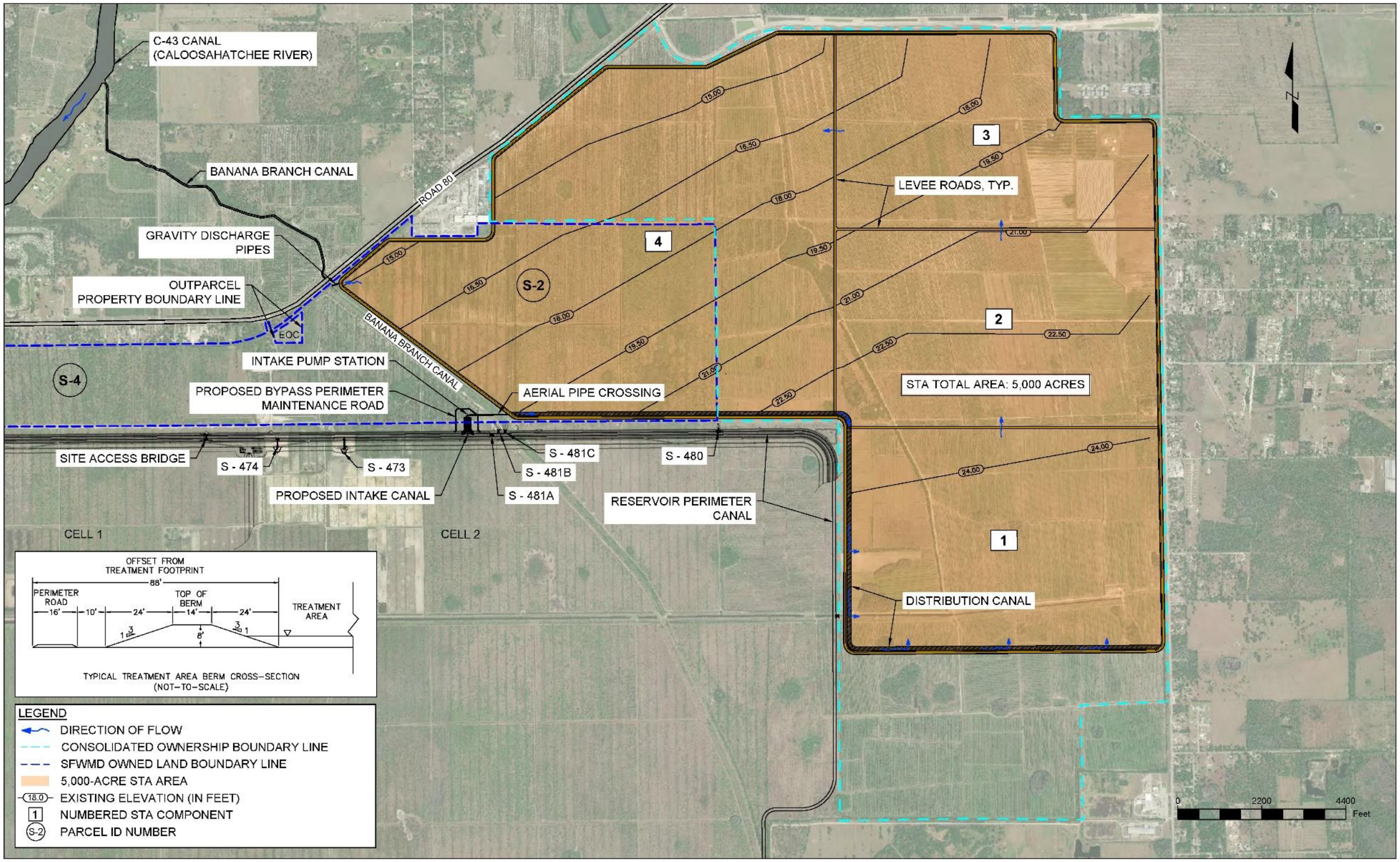


Figure 2-19. Option 5 for Water Conveyance

2.2.2 Ground Investigation Summary

J-Tech performed a site investigation in February 2021 to document important features in the landscape that may have an impact on the design of the WQC and conveyance options for flows. Appendix C includes photographic documentation of the prominent features from the ground investigation including:

- Reservoir access road and trailers
- Townsend Canal at the perimeter canal discharge location
- Pump station construction
- Banana Branch Canal at the reservoir and perimeter canal
- Berry Farms ditch #2
- Fort Denaud Bridge
- Duda pump station and discharge structure
- NRC
- Double J development
- Agricultural ditch along south boundary of Double J development

The photographs depicting the water conveyance features provide insight into the improvements that will be needed to use these flow ways for the WQC Conceptual Design (Task 9).

2.2.3 Summary Criteria Matrix

Each of the five WQC alternatives were evaluated and ranked against a series of criteria for siting considerations to determine which technologies would work best to provide water quality treatment for the C-43 WBSR. Each of the criteria was assigned a weight with the highest weight of 5 indicating the most important criteria and the lowest weight of 1 indicating the least important criteria. Criteria evaluated, in order of weight, include:

- **Use of SFWMD Land** – SFWMD owns approximately 1,900-ac of land to the north of the C-43 WBSR. Alternatives that can be sited entirely within these lands will allow for more cost-effective achievement of the water quality targets and are ranked higher.
- **Conveyance Options Comparison** (Table 2-2) – This criterion is based on the number of pros from the conveyance options comparison table.
- **Confidence in Performance Estimates** – This criterion evaluates whether reliable and reasonable performance data are available for nutrient and TSS removal efficiencies and whether the technologies can achieve the water quality targets.
- **Redundant Chemical Treatment** – Alum treatment is planned within the C-43 WBSR. This criterion evaluates whether the alternative provides for additional chemical treatment, which may not be needed given the chemical treatment within the reservoir.
- **Preference for Natural Treatment** – During development of the WQFS, feedback was received from the public that more natural treatment alternatives were preferred for the C-43 WBSR WQC. Alternatives that rely on natural treatment are ranked higher.
- **Topographic Constraints** – The elevations around the C-43 WBSR vary and may present challenges to moving water from the C-43 WBSR to the WQC and then back to the river, depending on the location of the WQC. Alternatives sited in areas with minimal topographic change are ranked higher.

- **WQC Size/Footprint** – This attribute assesses the relative amount of land needed to properly implement each alternative. A higher ranking was assigned to technologies with smaller land requirements.
- **Wetland Impacts** – As noted in Section 2.1.1.1, extensive wetlands are found throughout the area surrounding the C-43 WBSR. Siting the WQC should minimize impacts to these wetlands to the extent possible.
- **Protected Species** – As noted in Section 2.1.1.2, several protected species use the areas surrounding the C-43 WBSR. Siting the WQC should minimize the impacts to these species to the extent possible.
- **Cultural/Historical Resources** – As noted in Section 2.1.1.3, cultural and historical resources are located in the vicinity of the C-43 WBSR. Siting the WQC should minimize the impacts to these resources to the extent possible.
- **Associated Infrastructure** – In addition to the alternative itself, additional infrastructure may be needed such as storage tanks, access roads, and maintenance easements. Alternatives with less associated infrastructure ranked higher.
- **Cost from the WQFS** – Costs for construction and O&M of each alternative were estimated in the WQFS. The alternatives that achieve the water quality targets more cost effectively are preferred. The costs will be refined in as part of the WQC Siting Evaluation Conceptual Design (Task 9).
- **Planning/Zoning Constraints** – As noted in Section 2.1.1.6, existing and planned developments are near the C-43 WBSR. Alternatives that can be sited in locations that avoid these planning and zoning constraints ranked higher.
- **Remediation** – As noted in Section 2.1.1.4, DEP has identified some contaminated sites near the C-43 WBSR. Alternatives that can be sited in locations that avoid or minimize the need for remediation ranked higher.

Each of these attributes was scored for each alternative. Assigned scores were 0, 1, or 2, with a higher score being better. The criteria used to assign the score for each attribute are summarized in Table 2-3. The scores were multiplied by the weight for each attribute and then added together to determine a total score. The technologies were then ranked from 1 to 5 with 1 assigned to the highest (best) score and 5 assigned to the lowest (worst) score. The scoring and rank for each attribute are shown in Table 2-4. In Table 2-4, the criteria with the highest importance are green, criteria with medium importance are yellow, and criteria of lower importance are pink.

The formula to calculate the total score for each alternative is:

> Alternative total score = (Use of SFWMD Land score x 5) + (Conveyance Options Comparison score x 5) + (Confidence in Performance Estimates score x 5) + (Redundant Chemical Treatment score x 5) + (Natural Treatment Components score x 5) + (Topographic Constraints score x 4) + (WQC Size/Footprint score x 4) + (Wetland Impacts score x 3) + (Protected Species score x 3) + (Cultural/ Historical Resources score x 3) + (Associated Infrastructure score x 3) + (Cost from WQFS score x 3) + (Planning/ Zoning Constraints score x 2) + (Remediation score x 1).

Table 2-3. Scoring for Each Criteria

Scoring	Use of SFWMD Land	Conveyance Options Comparison	Confidence in Performance Estimates	Redundant Chemical Treatment	Natural Treatment Components	Topographic Constraints	WQC Size/ Footprint	Wetland Impacts	Protected Species	Cultural/ Historical Resources	Associated Infrastructure	Cost from WQFS	Planning/ Zoning Constraints	Remediation
2	Entirely	2 or More Pros	High	No	All Components	No Constraints	Low	No Impacts	No impacts	No Impacts	Minimal	Low	No Constraints	None
1	Partially	1 Pro	Moderate	Moderate	Some Components	Some Constraints	Moderate	Some Impacts	Some Impacts	Some Impacts	Medium	Moderate	Some Constraints	Some
0	Minimal	No Pros	Low	High	No Components	Major Constraints	High	Major Impacts	Major impacts	Major Impacts	Extensive	High	Major Constraints	Extensive

Table 2-4. Summary Criteria Matrix

Alternative	Use of SFWMD Land	Conveyance Options Comparison	Confidence in Performance Estimates	Redundant Chemical Treatment	Preference for Natural Treatment	Topographic Constraints	WQC Size (Footprint)	Wetland Impacts	Protected Species	Cultural/ Historical Resources	Associated Infrastructure	Cost from WQFS	Planning/ Zoning Constraints	Remediation	Total Score	Rank
Weight -->	**5**	**5**	**5**	**5**	**5**	**4**	**4**	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**-**	**-**
Alum	2	2	2	0	0	2	2	2	1	2	1	2	2	2	76	1
Sand Filter with Bold and Gold®	2	1	0	2	1	2	1	2	1	2	1	0	2	2	66	2
HWTT	1	1	2	1	1	1	1	1	1	1	1	1	2	1	58	3
STA with Bold and Gold®	1	1	0	2	1	1	1	1	1	1	1	1	2	1	53	4
Full Scale STA	0	2	2	2	2	0	0	1	0	0	0	0	0	1	44	5

Note: The score times the weight for each criteria were added together to determine a total score for each alternative. The highest total score received a rank of 1, which is the highest (best) ranking. The lowest total score received a rank of 5, which is the lowest (worst) ranking.

2.2.4 Local Laws, Zoning, and Ordinance

J-Tech evaluated whether the alternatives as conceived are allowable with respect to local laws, zoning, and ordinances.

2.2.4.1 Hendry County Zoning, Planning, and Development

The Study Area is currently zoned A-2 – General Agriculture with an Agriculture Future Land Use Element designation, which has a Level One use identified, in part, "for State of Florida Everglades Restoration projects and activities specifically designed to meet the water quality and/or quantity goals related to restoration efforts and resource protection as outlined in the Comprehensive Everglades Restoration Plan (CERP)" (Policy 1.1.1, 2013 Hendry County Comprehensive Plan). A Level One use may occur as permitted uses, special exceptions, or accessory uses in the Hendry County Land Development Code and does not require rezoning of the property.

The WQC will require county staff approval of a site development plan with potential buffer requirement (Chapter 1-58, Article IV, Hendry County Code of Ordinances). The buffer requirement will be based on the intensity of the use and potential impacts to the adjacent uses and will be determined by the planning and community development director. The buffer may be used for passive recreation such as pedestrian, bike, or equestrian trails. Site development plan approvals are valid for two years from the date of approval. A construction permit for compliance with Hendry County Land Development Code is also required for any land clearing or demolition of structures. Therefore, Site Development Approval will likely be the only authorization required by the county for the WQC.

2.2.4.2 City of LaBelle

If the WQC is sited within lands that were annexed from Hendry County into the City of LaBelle through the Comprehensive Plan Amendment in 2005, then additional city approval will be required. These lands are identified as the South LaBelle Community and were anticipated to be developed with a future land use designation of residential, commercial, and industrial. In March 2019, City Ordinance 2019-06 was passed, which changed the designated future land uses in the South LaBelle Community to "conceptual future land use" to provide more flexibility as the site is constructed. The ordinance provides a conceptual land use framework as guidance for the land uses within the annexed area and requires that all development in the area, except for uses allowed by the underlying Agriculture zoning district, to be rezoned to Planned Unit Development zoning. As such, a Comprehensive Plan Amendment may be required to change the land use. The review process for this permit includes public hearings before the local planning agency and Board of City Commissioners. The project will also require a development plan permit and building permits.

The City of LaBelle also regulates "natural resource management areas" as part of the development plan review. These areas are defined, in part, as (1) a connected or isolated wetland, including wetland fringe areas (25-feet surrounding the wetland); (2) wetland or upland habitat for threatened or endangered species (also known as critical habitats); (3) within 500-feet of a potable water wellfield; and (4) within 500-feet of a historic structure or known or suspected archaeological site that is eligible for listing on the National Register of Historic Places.

Regarding wetland impacts, the City Commission must find that no practical alternatives exist to the proposed wetland impacts, and the impacts should be the minimum disturbance necessary to meet the needs of the use. Prior to any such approval of wetland impacts, the applicant will need to provide evidence of approval via an issued permit by the applicable state or federal agency (Section 6-4, Standards for

Management of Natural Resources, City of LaBelle Municode). Additionally, a 75-foot undisturbed vegetative buffer around the wetlands is required, though exceptions to the buffer requirement may be considered by the City Commission if the modification still fulfills the intent of wetland protection.

Critical habitats are required to be preserved with a conservation easement. Land use and development near critical habitat may also be restricted to prevent adverse impacts. Where development in or near critical habitat will reduce its viability, the City Commission may require mitigation. Mitigation, which is subject to appropriate state or federal agency approval, may include restoration of contiguous or disturbed areas or relocation of the species to appropriate noncontiguous areas dedicated for permanent use as habitat areas.

The city also requires that historic sites/areas be protected by no construction or disturbance taking place within 500 feet of a historical structure or area. Archaeological sites are also required to be protected and evaluated for eligibility on the National Register of Historic Places.

As the siting of the WQC moves forward, detailed review for compliance with city ordinances may be necessary to determine the approvals necessary if the project is sited within city boundaries.

2.2.5 Habitat and Ecosystem Services

As part of the C-43 WQFS, technologies with adverse environmental impacts, including potential harm to the ecosystem, were removed. The technologies evaluated for the WQC will help create habitat for fish and wildlife, as well as provide for ecosystem service benefits. Ecosystem services are the benefits that ecosystems provide to people. These services can be divided into four inter-related categories: (1) provisioning services, which provide goods such as food; freshwater; timber, fiber, fuel, and other raw materials; genetic materials for resistance to plant pathogens; biochemical products and medicinal resources; ornamental species and/or resources for direct human use; (2) regulating services, which include air quality regulation, climate regulation, natural hazard regulation, disease regulation, erosion protection, soil formation and regeneration, biological regulation, and water purification; (3) cultural services, which provide opportunities and inspiration for education, science, recreation, spiritual, religious, and aesthetic activities; and (4) supporting services, which include nutrient cycling, nursery habitat, soil formation, and primary production (Brauman et al., 2007; de Groot et al., 2010).

Potential habitat and ecosystem service benefits from each technology in the WQC alternatives include:

- Creating wildlife habitat
- Improving water quality for fish and wildlife
- Increasing biodiversity
- Providing opportunities for recreation and education

The WQC alternatives evaluated as part of this Siting Evaluation each provide some level of habitat and ecosystem service benefits, which is one of the criteria that was used to determine which technologies would move to this Siting Evaluation (Phase 2).

3.0 Water Quality Analysis

3.1 WBSR Inflow and Outflow Water Quality Time Series

As part of Task 8, J-Tech conducted a more detailed analysis of available water quality data collected near the C-43 WBSR to identify an appropriate water quality time series for inflow to the C-43 WBSR and outflow concentrations to the WQC. The water quality time series was used in conjunction with SFWMD modeled flows into and out of the reservoir to determine the maximum treatment capabilities for each alternative and refine the expected nutrient load reduction estimates (see Sections 3.2 and **Error! Reference source not found.**). The available water quality data were used to calculate a representative time series of TN, TP, and TSS concentrations.

TN, TP, and TSS water quality data collected by SFWMD at S-78 and S-79 were obtained from DBHYDRO on December 21, 2020 for the period of January 1, 2010 through November 16, 2020, which were the most recent data uploaded at that time. A quality check was performed to: (1) remove any data with qualifiers that identify potential data issues (i.e., H, J, K, N, O, V, Q, Y, G, or ?); (2) remove any data with autosampler collection methods; and (3) change any data with negative or zero values to half the method detection limit.

The data remaining after the quality check were used for further analysis. Several assumptions and equations were used to tabulate the species of nitrogen (N) and phosphorus (P) from the available monitoring data:

- Ammonia-N was assumed to be 100% dissolved
- Nitrate + Nitrite-N was assumed to be 100% dissolved
- Nitrogen, Total Dissolved was directly measured beginning July 2014
  - Through May 2014, it was calculated as Kjeldahl Nitrogen, Dissolved plus Nitrate + Nitrite-N
- TN was directly measured beginning June 2014
  - Through May 2014, it was calculated as Kjeldahl Nitrogen, Total plus Nitrate + Nitrite-N
- Organic-Nitrogen-N Total was calculated as TN minus Ammonia-N and Nitrate + Nitrite-N
- Organic Nitrogen-N Dissolved was calculated as Nitrogen, Total Dissolved minus Ammonia-N and Nitrate + Nitrite
- Organic Nitrogen-N Particulate was calculated as Organic Nitrogen-N Total minus Organic Nitrogen-N Dissolved
- Orthophosphate-P or soluble reactive P was assumed to be 100% dissolved
- Organic Phosphorus-P was calculated as Total Phosphorus-P minus Orthophosphate-P, which assumes that condensed P or polyphosphates are an insignificant component of TP
- Organic Phosphorus-P Dissolved was calculated as Dissolved Phosphorus-P minus Orthophosphate-P
- Organic Phosphorus-P Particulate was calculated as Organic Phosphorus-P minus Organic Phosphorus-P Dissolved

The time series for inflow and outflow are only for TN and TP. However, the datasets for the species were developed to help refine the treatment efficiencies of the WQC alternatives.

For both the S-78 and S-79 datasets, the frequency distribution of the available data were tested to determine the central tendency by tabulating the count, arithmetic mean, geometric mean, median, 75th percentile, 25th percentile, and the interquartile range. Additionally, time series plots of TN, TP, TSS, N species, and P species were created to allow for visualization of the data.

The water quality data for the S-78 and S-79 datasets were then aggregated into daily (i.e., Julian or ordinal day), weekly, and monthly summaries. The daily summary had many days with no or only one data point, so it was difficult to conduct statistical summaries. To fill the data gaps, the arithmetic mean concentration from the day before and day after were used and then time series plots were created. The daily summaries were not recommended as the final time series.

The frequency distribution of weekly and monthly summaries were investigated by tabulating the count, arithmetic mean, geometric mean, median, 75th percentile, 25th percentile, standard deviation, and 95% confidence interval of the arithmetic mean. Plots showing the arithmetic mean, median, and 95% confidence interval of the arithmetic mean (i.e., summary plots) and plots showing the mean, median, 75th percentile, 25th percentile, and outliers (i.e., boxplots) were prepared to allow for visualization of the data central tendency.

The monthly summaries were determined to best represent the seasonal trends in water quality for the WQC evaluation. Excel workbooks were used to conduct the detailed TN and TP monthly distribution statistics and evaluations to test if the normal distribution model fits the observations using the Shapiro-Wilk test. The results for this test at S-78 found that six months of the TN data are normally distributed, and six months are not. For TP, three months were normally distributed, and nine months were not. In addition, the workbooks compared the S-78 and S-79 TN and TP monthly arithmetic means and medians to determine how these time series should be used to inform C-43 WBSR inflow and outflow concentrations.

3.1.1 Recommended Water Quality Targets for the WQC

Based on these water quality evaluations, J-Tech recommended using the S-78 monthly median time series (Table 3-1 and Figure 3-1 through Figure 3-3) as the inflow concentrations to the C-43 WBSR. The S-78 data are collected upstream of the reservoir and are more representative of the water quality expected to enter the reservoir. It should be noted that the S-78 data are collected under both flowing and non-flowing conditions, and additional tributaries contribute to the river between S-78 and the Townsend Canal, which is where the reservoir will pull water from when it is online. In addition, the TN concentrations at S-78 were slightly higher than at S-79, so selection of the S-78 data as the inflow time series will focus treatment on the higher TN concentrations. The arithmetic mean values for the time series were slightly higher than the median and would be more conservative. However, based on feedback from SFWMD and the results of the Shapiro-Wilk test, the median values were used. The monthly time series (rather than weekly or daily) was recommended to represent the seasonal changes in water quality that will be entering the reservoir.

In addition, the S-79 monthly median time series (Table 3-2 and Figure 3-4 through Figure 3-6) was recommended as the target concentrations for the WQC to ensure that the quality of water returned to the river from the reservoir and WQC will meet or exceed the ambient water quality in the river.

Table 3-1. Monthly Median Water Quality at S-78 (January 1, 2010 – November 16, 2020)

Month	TN Concentration (mg/L)	TP Concentration (mg/L)	TSS Concentration (mg/L)
January	1.26	0.074	4.0
February	1.29	0.080	4.0
March	1.22	0.080	4.5
April	1.25	0.085	7.0
May	1.34	0.089	5.0
June	1.46	0.107	4.0
July	1.52	0.157	4.5
August	1.51	0.150	4.0
September	1.56	0.144	1.5
October	1.59	0.122	1.5
November	1.40	0.095	4.5
December	1.34	0.079	2.8

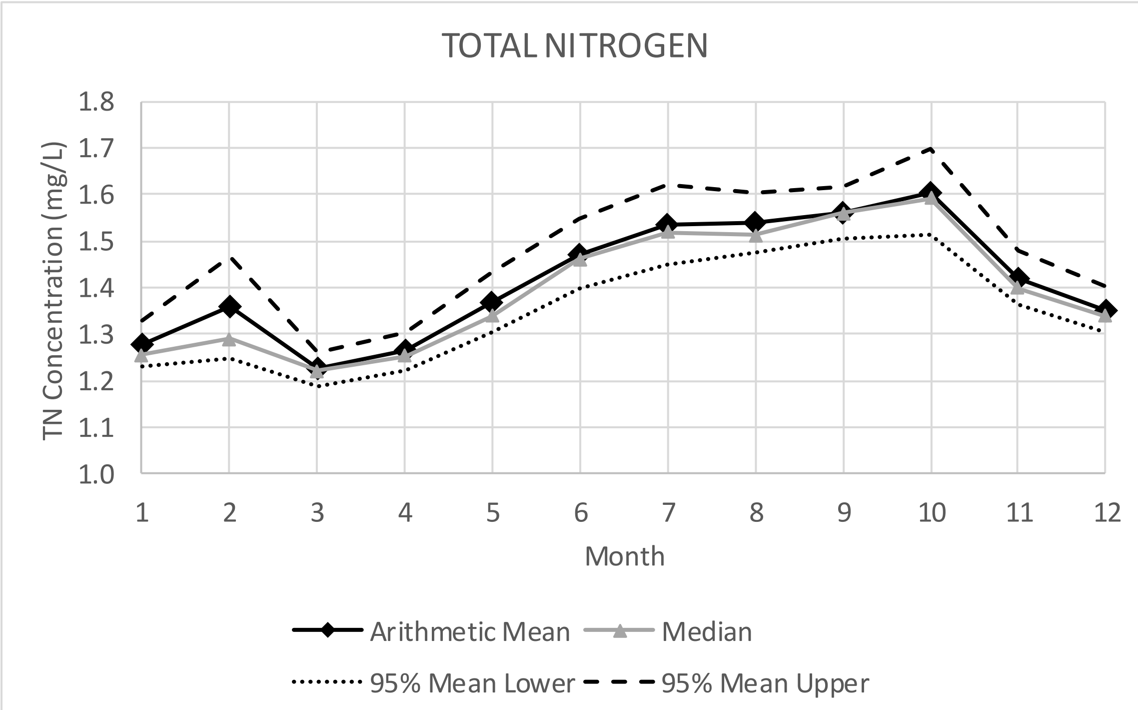


Figure 3-1. S-78 TN Monthly Time Series (January 1, 2010 – November 16, 2020)

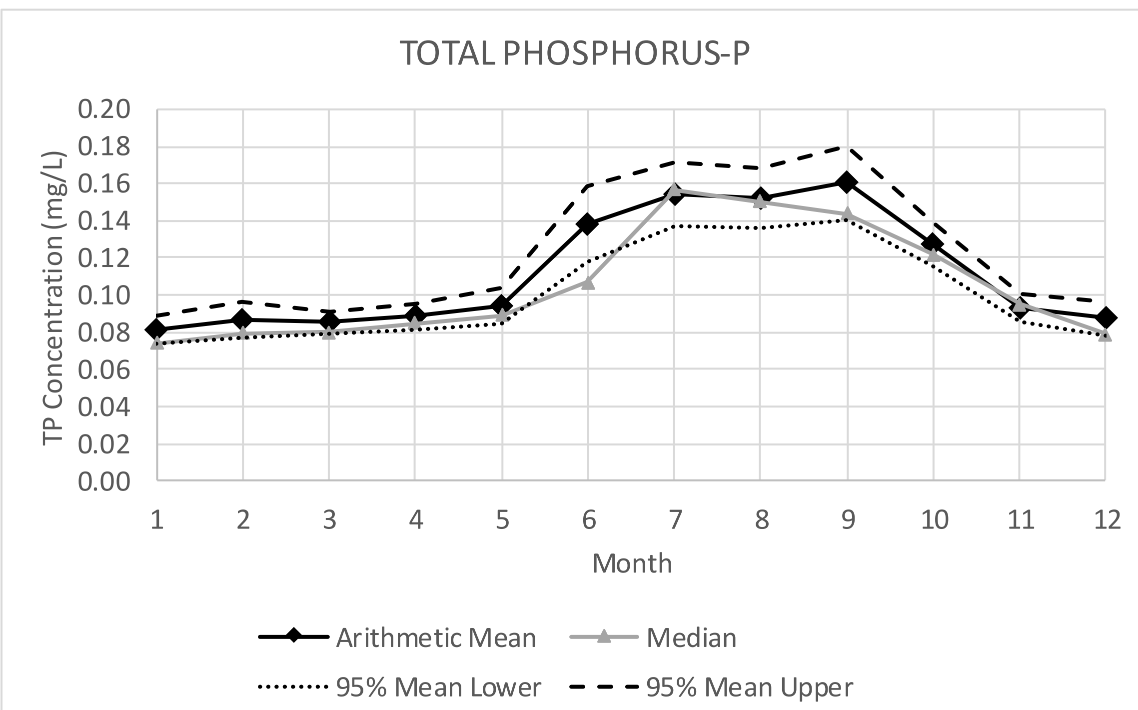


Figure 3-2. S-78 TP Monthly Time Series (January 1, 2010 – November 16, 2020)

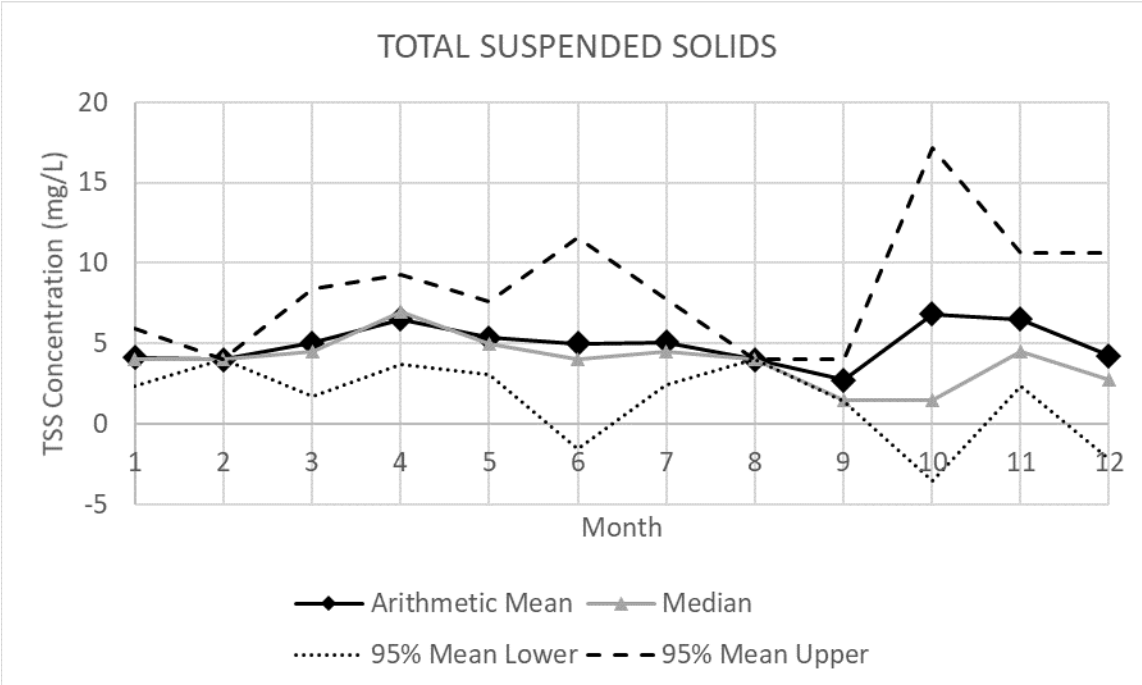


Figure 3-3. S-78 TSS Monthly Time Series (January 1, 2010 – November 16, 2020)

Table 3-2. Monthly Median Water Quality at S-79 (January 1, 2010 – November 16, 2020)

Month	TN Concentration (mg/L)	TP Concentration (mg/L)	TSS Concentration (mg/L)
January	1.25	0.088	1.5
February	1.22	0.080	1.5
March	1.15	0.087	1.8
April	1.17	0.102	1.5
May	1.26	0.122	4.0
June	1.37	0.162	4.0
July	1.38	0.157	4.0
August	1.37	0.148	3.0
September	1.40	0.138	2.0
October	1.38	0.124	2.8
November	1.45	0.105	1.5
December	1.28	0.088	1.5

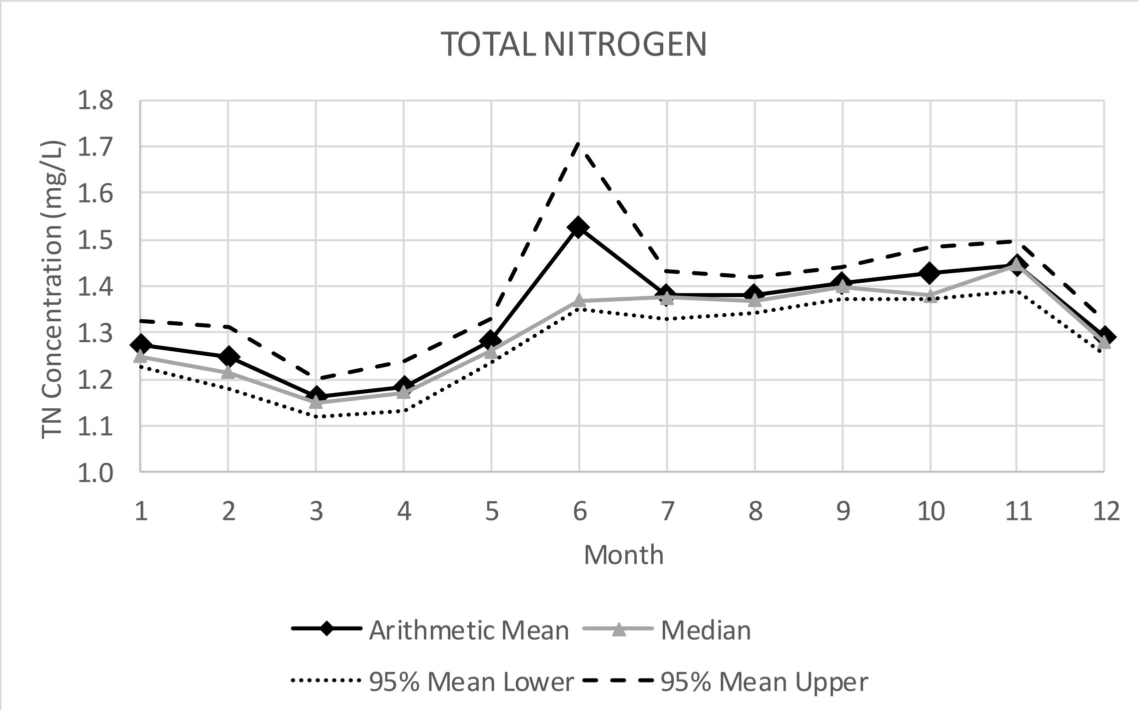


Figure 3-4. S-79 TN Monthly Time Series (January 1, 2010 – November 16, 2020)

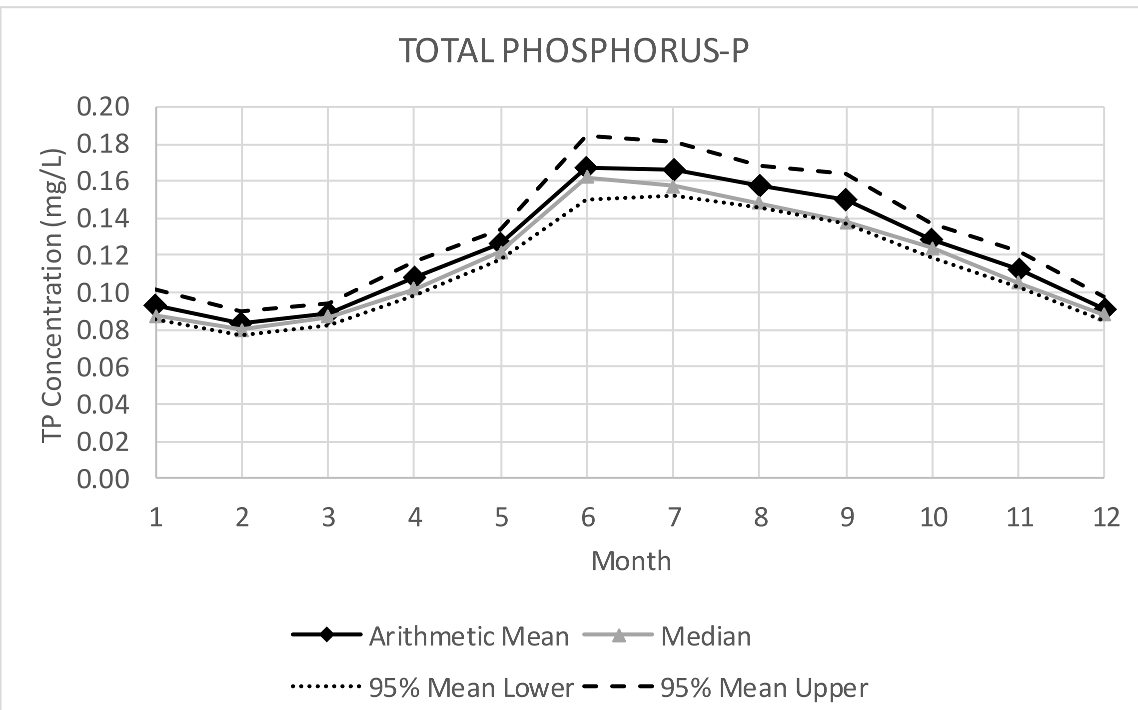


Figure 3-5. S-79 TP Monthly Time Series (January 1, 2010 – November 16, 2020)

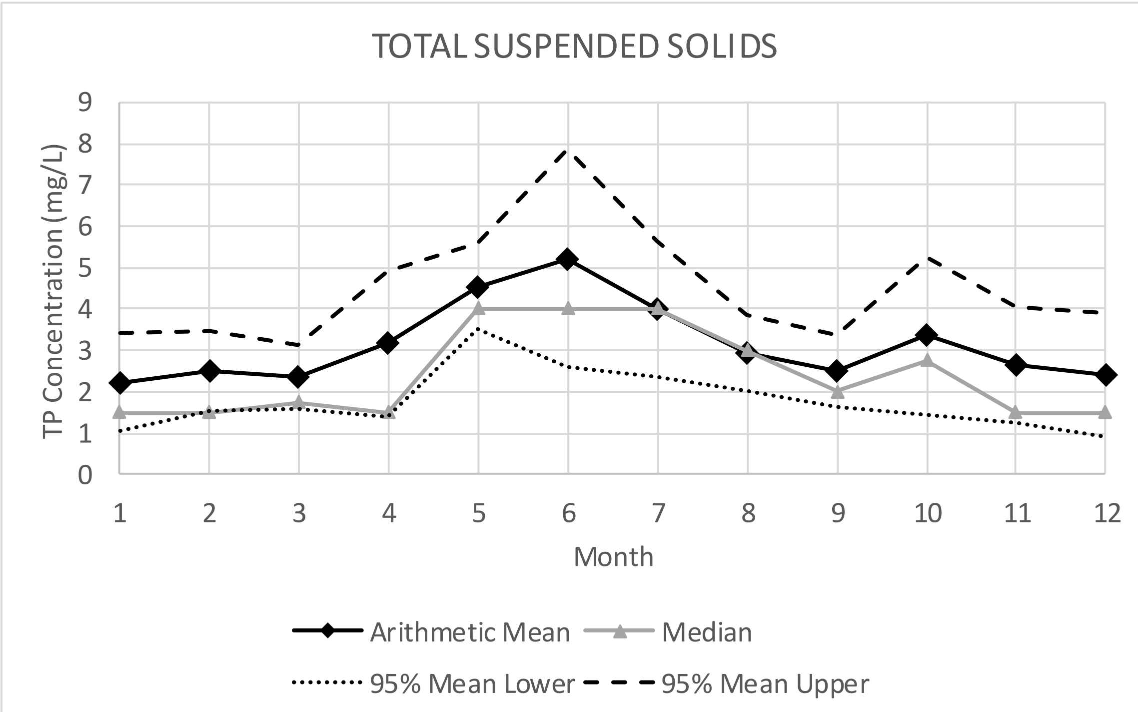


Figure 3-6. **S-79 TSS Monthly Time Series (January 1, 2010 – November 16, 2020)**

3.2 C-43 WBSR WQC Loading Calculations

J-Tech developed a spreadsheet tool that combines the water quality and reservoir flow data to serve as the basis-of-design for the updated conceptual plans for the treatment alternatives. The spreadsheet tool was developed to track inflow and outflow concentrations and loads based on a conservative mass balance approach. The spreadsheet tool does not include algorithms to account for in-reservoir settling processes or algal growth dynamics.

3.2.1 Input Data Sources

Based on discussions with SFWMD staff, J-Tech used data from the PIR for the Caloosahatchee River (C-43) WBSR Project (U.S. Army Corps of Engineers, 2007) to define hydrologic inputs and outputs for the spreadsheet tool. SFWMD staff provided the 2007 PIR data, which included daily values for reservoir inflow, rainfall, evapotranspiration, stage, and reservoir discharge for a 41-year simulation period (January 1, 1965 – December 31, 2005). The 2007 PIR reservoir hydrology was based on operating rules that may differ from those that will ultimately be used to manage operations of the completed C-43 WBSR.

As noted above, and for purposes of sizing alternatives for the WQC Siting Evaluation, inflow water quality for the C-43 WBSR has been established as the median monthly concentrations in mg/L for TN, TP, and TSS measured at S-78 between January 2010 and November 2020 (Table 3-1). Individual nutrient species including organic N, ammonia, nitrate, soluble reactive P, and organic P are also tracked in the spreadsheet based on median monthly values from the same data source.

Rainfall quality was estimated using wet deposition water quality data collected at the S-7 structure for the period from December 1988 through February 1999. The S-7 structure is located near the outlets from STA-2 and STA-3/4 and is the closest station with available wet deposition water quality data. Monthly arithmetic mean concentrations for the primary parameters of interest (TN, TP, and TSS) are summarized in Table 3-3.

Table 3-3. Monthly Average Wet Deposition Water Quality at S-7 (December 1988 – February 1999)

Month	TN (mg/L)	TP (mg/L)	TSS (mg/L)
January	0.52	0.012	1.72
February	0.79	0.022	0.50
March	0.62	0.009	0.88
April	0.88	0.042	2.29
May	1.09	0.027	1.00
June	0.66	0.010	0.73
July	0.84	0.028	1.21
August	0.77	0.011	1.71
September	0.72	0.021	1.38
October	0.61	0.017	1.50
November	0.56	0.022	3.00
December	0.95	0.040	3.13

As noted above, J-Tech developed summary statistics for parameters measured at the S-79 structure, downstream of the discharge from the C-43 WBSR (Table 3-2). J-Tech selected the median dry season (November–April) concentrations as the target concentrations to be achieved by the treatment alternatives for the C-43 WBSR. The median dry season values are 1.23 mg/L for TN, 0.088 mg/L for TP, and 1.50 mg/L for TSS. For comparative purposes, the treatment technology target outflow concentrations used during the C-43 WBSR WQFS (Phase 1) were 1.00 mg/L for TN, 0.080 mg/L for TP, and 10 mg/L for TSS.

3.2.2 Spreadsheet Tool Development

The foundation of the spreadsheet tool is a daily water budget for the C-43 WBSR. As noted above, hydrologic inflows and outflows are consistent with the 2007 PIR modeling. In the PIR model, seepage was assumed to be negligible. Figure 3-7 shows a schematic of the water budget component of the spreadsheet tool. The spreadsheet tool tracks the daily inflows, outflows, and volume of water in the reservoir. The general water budget equation is as follows:

$$\Delta S = Q_{IN} + Q_{PPT} - Q_{ET} - Q_S - Q_{OUT}$$

Where,

ΔS = change in storage (ac-feet)

Q_{IN} = pumped inflow from the Caloosahatchee River (ac-feet)

Q_{PPT} = rainfall volume (ac-feet)

Q_{ET} = evapotranspiration (ac-feet)

Q_S = seepage (ac-feet) (Seepage out of the reservoir is not expected due to the cutoff wall design)

Q_{OUT} = reservoir discharge (ac-feet)

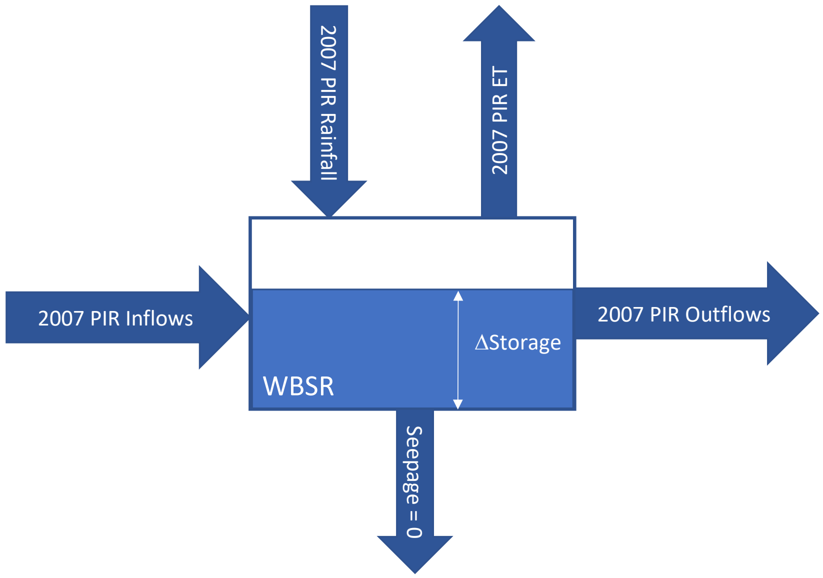


Figure 3-7. C-43 WBSR Spreadsheet Tool Water Budget Schematic

Quality control review of the water budget included the calculation of daily residual terms that would indicate an imbalance between the left and right sides of the water budget equation. Daily and period-of-record (POR) residuals were equal to zero. Table 3-4 shows a sample of the water budget component of the spreadsheet tool. Reservoir inflow and discharge are shown in cubic feet per second (cfs). Flows are also shown in ac-feet per day (ac-ft/d).

Table 3-4. C-43 WBSR Spreadsheet Tool Water Budget Sample Data

	Reservoir Inflow		Rainfall		Total Inflow	Initial Storage	Reservoir Discharge		ET		Seepage		Total Outflow	Final Storage	Stage	Wtr Bal Residual
Time Period	cfs	ac-ft/d	in	ac-ft/d	ac-ft/d	ac-ft	cfs	ac-ft/d	in	ac-ft/d	in	ac-ft/d	ac-ft/d	ac-ft	ft	ac-ft
POR	207.4	411	2,146	112.0	523	112,853	204.7	406	2,166	105.6	0	0.0	512	112,341	34.56	0.00
1/1/1965	1,500	2,975	0.00	0	2,975	2,975	0	0	0.12	11.1	0.00	0	11.1	2,964	20.41	0.00
1/2/1965	1,500	2,975	0.00	0	2,975	5,939	0	0	0.11	10.1	0.00	0	10.1	5,929	21.58	0.00
1/3/1965	1,500	2,975	0.00	0	2,975	8,905	0	0	0.12	22.5	0.00	0	22.5	8,882	22.74	0.00
1/4/1965	1,500	2,975	0.00	0	2,975	11,857	0	0	0.10	28.2	0.00	0	28.2	11,829	23.34	0.00
1/5/1965	1,500	2,975	0.00	0	2,975	14,804	0	0	0.12	42.7	0.00	0	42.7	14,762	23.77	0.00
1/6/1965	1,500	2,975	0.00	0	2,975	17,737	0	0	0.13	55.1	0.00	0	55.1	17,682	24.20	0.00
1/7/1965	1,500	2,975	0.00	0	2,975	20,657	0	0	0.11	54.0	0.00	0	54.0	20,603	24.63	0.00
1/8/1965	1,500	2,975	0.00	0	2,975	23,578	0	0	0.12	66.9	0.00	0	66.9	23,511	25.06	0.00
1/9/1965	1,500	2,975	0.00	0	2,975	26,487	0	0	0.12	75.0	0.00	0	75.0	26,412	25.48	0.00
1/10/1965	1,500	2,975	0.00	0	2,975	29,387	0	0	0.13	89.9	0.00	0	89.9	29,297	25.91	0.00
1/11/1965	1,500	2,975	0.04	34	3,009	32,306	0	0	0.11	83.4	0.00	0	83.4	32,223	26.25	0.00
1/12/1965	1,500	2,975	0.04	32	3,008	35,231	0	0	0.09	69.3	0.00	0	69.3	35,161	26.57	0.00
1/13/1965	1,500	2,975	0.01	5	2,980	38,141	0	0	0.12	92.5	0.00	0	92.5	38,048	26.88	0.00
1/14/1965	1,000	1,984	0.00	0	1,984	40,032	0	0	0.11	84.8	0.00	0	84.8	39,947	27.09	0.00

Water quality data were applied to the pumped inflows and rainfall volumes in the following manner:

- Each day in January, irrespective of the year, was assigned inflow concentrations for TN, TP, and TSS consistent with the January values shown in Table 3-1. The same process was repeated for each month in the time series. If there was a corresponding inflow volume for the day, then an inflow load was calculated from the product of the volume and concentration (Table 3-5). Inflow is shown in mg/L and pounds per day (lbs/d).

- An option is included to allow the adjustment of inflow concentrations, by parameter, to reflect assumed performance of the proposed inline alum treatment system. The default pumped inflow concentrations have a scaling multiplier of 1, indicating no adjustment to the S-78 monthly median values. As an example, the user can set the scaling multiplier at 0.8 for TN to represent a 20% reduction in TN inflow concentration. Each water quality parameter can be adjusted independently, but the adjustment applies to each day of inflow in the 41-year POR.

Table 3-5. C-43 WBSR Spreadsheet Tool Inflow Load Sample Data

Reservoir Inflow															
TN		Ammonia		NOx		Org N		TP		SRP		Org P		TSS	
mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d
1.46	1,637	0.06	72	0.08	91	1.27	1,420	0.126	141	0.074	83	0.051	57	3.70	4,143
1.26	10,162	0.05	421	0.13	1,028	1.06	8,576	0.074	599	0.037	299	0.038	307	4.00	32,363
1.26	10,162	0.05	421	0.13	1,028	1.06	8,576	0.074	599	0.037	299	0.038	307	4.00	32,363
1.26	10,162	0.05	421	0.13	1,028	1.06	8,576	0.074	599	0.037	299	0.038	307	4.00	32,363
1.26	10,162	0.05	421	0.13	1,028	1.06	8,576	0.074	599	0.037	299	0.038	307	4.00	32,363
1.26	10,162	0.05	421	0.13	1,028	1.06	8,576	0.074	599	0.037	299	0.038	307	4.00	32,363
1.26	10,162	0.05	421	0.13	1,028	1.06	8,576	0.074	599	0.037	299	0.038	307	4.00	32,363
1.26	10,162	0.05	421	0.13	1,028	1.06	8,576	0.074	599	0.037	299	0.038	307	4.00	32,363
1.26	10,162	0.05	421	0.13	1,028	1.06	8,576	0.074	599	0.037	299	0.038	307	4.00	32,363
1.26	10,162	0.05	421	0.13	1,028	1.06	8,576	0.074	599	0.037	299	0.038	307	4.00	32,363
1.26	10,162	0.05	421	0.13	1,028	1.06	8,576	0.074	599	0.037	299	0.038	307	4.00	32,363
1.26	10,162	0.05	421	0.13	1,028	1.06	8,576	0.074	599	0.037	299	0.038	307	4.00	32,363
1.26	10,162	0.05	421	0.13	1,028	1.06	8,576	0.074	599	0.037	299	0.038	307	4.00	32,363
1.26	10,162	0.05	421	0.13	1,028	1.06	8,576	0.074	599	0.037	299	0.038	307	4.00	32,363
1.26	6,775	0.05	280	0.13	685	1.06	5,717	0.074	399	0.037	200	0.038	205	4.00	21,575

Table 3-6. C-43 WBSR Spreadsheet Tool Rainfall Load Sample Data

Rainfall															
TN		Ammonia		NOx		Org N		TP		SRP		Org P		TSS	
mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d	mg/L	lbs/d
0.75	229	0.20	61	0.28	85	0.27	83	0.019	5.9	0.010	2.9	0.010	2.9	1.37	416
0.52	0	0.16	0	0.16	0	0.20	0	0.012	0.0	0.006	0.0	0.006	0.0	1.72	0
0.52	0	0.16	0	0.16	0	0.20	0	0.012	0.0	0.006	0.0	0.006	0.0	1.72	0
0.52	0	0.16	0	0.16	0	0.20	0	0.012	0.0	0.006	0.0	0.006	0.0	1.72	0
0.52	0	0.16	0	0.16	0	0.20	0	0.012	0.0	0.006	0.0	0.006	0.0	1.72	0
0.52	0	0.16	0	0.16	0	0.20	0	0.012	0.0	0.006	0.0	0.006	0.0	1.72	0
0.52	0	0.16	0	0.16	0	0.20	0	0.012	0.0	0.006	0.0	0.006	0.0	1.72	0
0.52	0	0.16	0	0.16	0	0.20	0	0.012	0.0	0.006	0.0	0.006	0.0	1.72	0
0.52	0	0.16	0	0.16	0	0.20	0	0.012	0.0	0.006	0.0	0.006	0.0	1.72	0
0.52	0	0.16	0	0.16	0	0.20	0	0.012	0.0	0.006	0.0	0.006	0.0	1.72	0
0.52	0	0.16	0	0.16	0	0.20	0	0.012	0.0	0.006	0.0	0.006	0.0	1.72	0
0.52	48	0.16	15	0.16	15	0.20	18	0.012	1.1	0.006	0.6	0.006	0.6	1.72	159
0.52	46	0.16	14	0.16	14	0.20	18	0.012	1.1	0.006	0.5	0.006	0.5	1.72	152
0.52	6	0.16	2	0.16	2	0.20	2	0.012	0.1	0.006	0.1	0.006	0.1	1.72	21
0.52	0	0.16	0	0.16	0	0.20	0	0.012	0.0	0.006	0.0	0.006	0.0	1.72	0

Water quality parameter mass storages in the reservoir are computed daily based the prior day's mass with adjustments for the current day's mass fluxes for the pumped inflow, rainfall, and reservoir discharge (Table 3-7). A minimum storage volume of 10 ac-feet is held in the spreadsheet mass balance calculations, so unrealistic concentrations are not calculated during periods of near-zero but non-zero storage. The mass balance equations reset following dry-out events.

Table 3-7. C-43 WBSR Spreadsheet Tool Reservoir Mass Storage Sample Data

Reservoir																							
TN			Ammonia			NOx			Org N			TP			SRP			Org P			TSS		
mg/L	lbs/d	lbs	mg/L	lbs/d	lbs	mg/L	lbs/d	lbs	mg/L	lbs/d	lbs	mg/L	lbs/d	lbs	mg/L	lbs/d	lbs	mg/L	lbs/d	lbs	mg/L	lbs/d	lbs
1.60	54.6	---	0.11	5.0	---	0.14	6.8	---	1.31	41.5	---	0.127	4.22	---	0.074	2.66	--	0.053	1.60	---	4.03	128	---
1.26	10,162	10,162	0.05	421	421	0.13	1,028	1,028	1.06	8,576	8,576	0.074	599	599	0.037	299	299	0.038	307	307	4.01	32,363	32,363
1.26	10,162	20,324	0.05	421	841	0.13	1,028	2,055	1.06	8,576	17,152	0.074	599	1,197	0.037	299	599	0.038	307	615	4.01	32,363	64,726
1.26	10,162	30,486	0.05	421	1,262	0.13	1,028	3,083	1.07	8,576	25,728	0.074	599	1,796	0.037	299	898	0.038	307	922	4.02	32,363	97,088
1.26	10,162	40,648	0.05	421	1,683	0.13	1,028	4,110	1.07	8,576	34,305	0.074	599	2,395	0.037	299	1,197	0.038	307	1,230	4.02	32,363	129,451
1.27	10,162	50,810	0.05	421	2,104	0.13	1,028	5,138	1.07	8,576	42,881	0.075	599	2,994	0.037	299	1,497	0.038	307	1,537	4.03	32,363	161,814
1.27	10,162	60,972	0.05	421	2,524	0.13	1,028	6,165	1.07	8,576	51,457	0.075	599	3,592	0.037	299	1,796	0.038	307	1,845	4.04	32,363	194,177
1.27	10,162	71,133	0.05	421	2,945	0.13	1,028	7,193	1.07	8,576	60,033	0.075	599	4,191	0.037	299	2,095	0.038	307	2,152	4.04	32,363	226,540
1.27	10,162	81,295	0.05	421	3,366	0.13	1,028	8,220	1.07	8,576	68,609	0.075	599	4,790	0.037	299	2,395	0.038	307	2,460	4.05	32,363	258,903
1.27	10,162	91,457	0.05	421	3,786	0.13	1,028	9,248	1.07	8,576	77,185	0.075	599	5,388	0.038	299	2,694	0.039	307	2,767	4.06	32,363	291,265
1.28	10,162	101,619	0.05	421	4,207	0.13	1,028	10,275	1.08	8,576	85,761	0.075	599	5,987	0.038	299	2,994	0.039	307	3,074	4.06	32,363	323,628
1.28	10,210	111,829	0.05	436	4,643	0.13	1,042	11,317	1.08	8,594	94,356	0.075	600	6,587	0.038	300	3,293	0.039	308	3,382	4.06	32,522	356,150
1.28	10,208	122,037	0.05	435	5,078	0.13	1,042	12,359	1.08	8,594	102,950	0.075	600	7,187	0.038	300	3,593	0.039	308	3,690	4.06	32,515	388,665
1.28	10,168	132,206	0.05	423	5,501	0.13	1,029	13,389	1.08	8,579	111,528	0.075	599	7,786	0.038	299	3,893	0.039	308	3,998	4.07	32,384	421,049
1.28	6,775	138,980	0.05	280	5,781	0.13	685	14,074	1.08	5,717	117,246	0.075	399	8,185	0.038	200	4,092	0.039	205	4,203	4.07	21,575	442,624

The spreadsheet tool also tracks the target discharge load and load reduction required to meet the target on a daily basis. The target load is calculated as the product of each day's reservoir discharge volume and target outflow concentration (TN = 1.23 mg/L, TP = 0.088 mg/L, TSS = 1.50 mg/L). The load reduction required is calculated as the difference between the actual discharged load and target load and represents the improvement needed in the downstream WQC that polishes water before discharging to the Caloosahatchee River.

3.2.3 Spreadsheet Tool Output Worksheets

The spreadsheet tool includes the following output worksheets:

- PIR(POR) – POR charts for reservoir inflows and outflows, rainfall, evapotranspiration, storage volume, and reservoir stage (Figure 3-8 and Figure 3-9).
- QCM – Time series plots (Figure 3-10) and summary statistics (Figure 3-11) for reservoir hydrology, concentrations, and loads for selected annual or multi-annual periods.
- Target – Time series plots (Figure 3-12) and summary statistics (Figure 3-13) for reservoir hydrology, actual loads, target loads, and load reduction required for selected annual or multi-annual periods.
- Freq (Monthly) – Cumulative frequency distribution plots and tables (Figure 3-14) of monthly discharge loads, target loads (based on both the concentration targets used for the WQFS and this updated analysis) and required load reductions to meet the targets. A cumulative frequency is the number of times that a value and all values that precede it occur. In this case, a 25th percentile frequency load is the load that equals or exceeds 25% of the calculated loads. A 50th percentile value is the median of all observations (i.e., half are above, half are below). A 90th percentile load is the value that equals or exceeds 90% of all observed values.

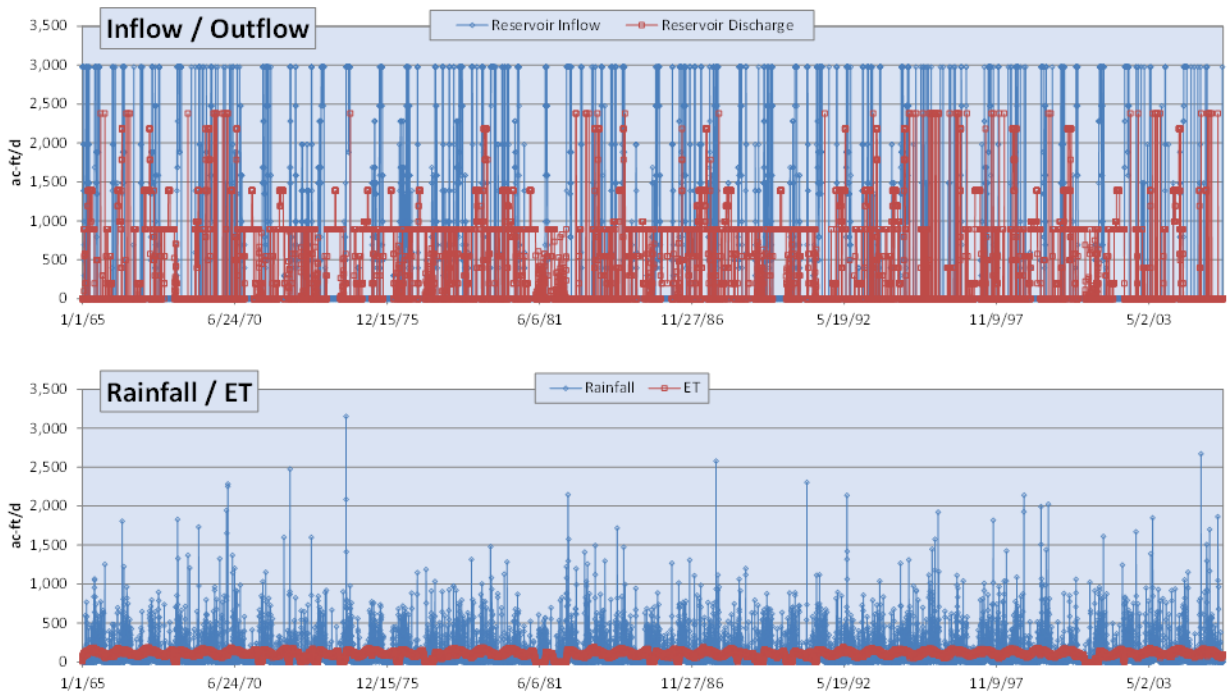


Figure 3-8. C-43 WBSR Spreadsheet Tool POR Reservoir Hydrology Summary Charts (Part A)

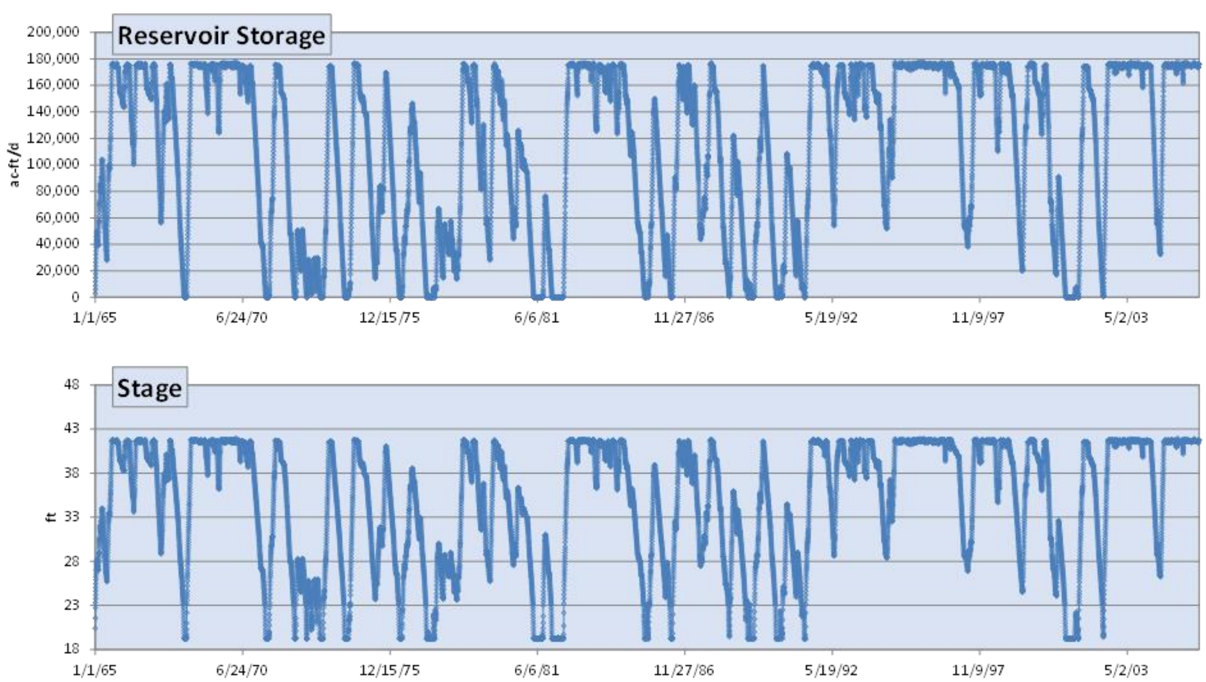
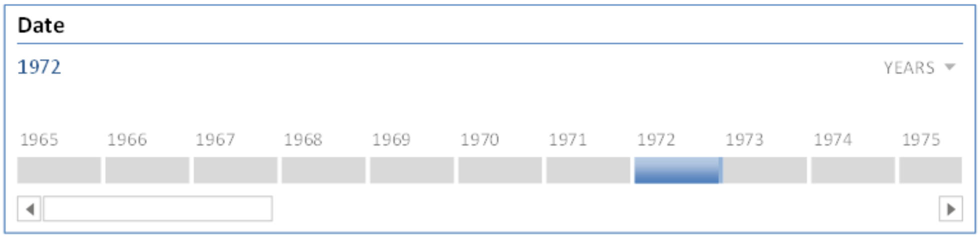


Figure 3-9. C-43 WBSR Spreadsheet Tool POR Reservoir Hydrology Summary Charts (Part B)

Note: In this example, the proposed inline alum system performance is not reflected. The "Inflow" and "Inflow w/Alum" time series are therefore the same and are superimposed.

Figure 3-10. C-43 WBSR Spreadsheet Tool Hydrology, Concentrations, and Load Charts for Selected Time Period



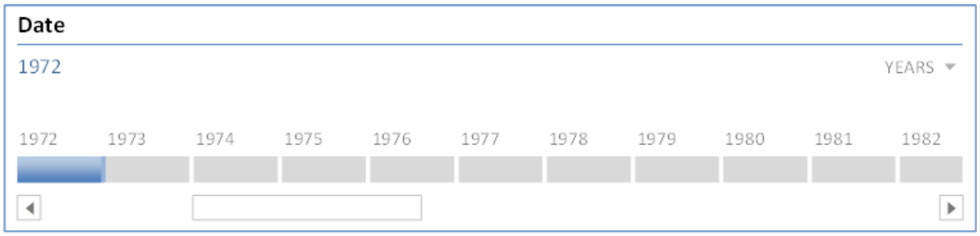
Parameter	Location	Average*	Median	Min	Max	StdDev	Count
Flow (cfs)	Inflow	149.2	0.0	0.0	1500.0	358.1	366
	Outflow	338.2	450.0	0.0	700.0	242.2	366
Storage (ac-ft)	Initial	45,767	34,140	0	150,483	40,829	366
	Final	44,997	33,107	0	150,389	40,667	366
TN (mg/L)	Inflow	1.40	1.37	1.22	1.59	0.13	366
	Inflow-Alum	1.40	1.37	1.22	1.59	0.13	366
	Rainfall	0.75	0.74	0.52	1.09	0.16	366
	Reservoir	1.61	1.61	0.67	2.08	0.20	346
	Outflow	1.57	1.60	0.56	2.08	0.28	364
TN (lbs/d)	Inflow	1,179	0	0	12,622	2,845	366
	Inflow-Alum	1,179	0	0	12,622	2,845	366
	Rainfall	186	29	0	4,455	382	366
	Reservoir	-1,654	-3,715	-6,419	13,519	4,573	366
	Outflow	3,019	3,868	0	6,419	2,221	366
TP (mg/L)	Inflow	0.105	0.092	0.074	0.157	0.029	366
	Inflow-Alum	0.105	0.092	0.074	0.157	0.029	366
	Rainfall	0.022	0.021	0.009	0.042	0.011	366
	Reservoir	0.130	0.140	0.010	0.171	0.027	346
	Outflow	0.124	0.136	0.010	0.171	0.036	364
TP (lbs/d)	Inflow	94	0	0	1,214	229	366
	Inflow-Alum	94	0	0	1,214	229	366
	Rainfall	5	1	0	70	9	366
	Reservoir	-152	-313	-571	1,223	372	366
	Outflow	250	320	0	571	195	366
TSS (mg/L)	Inflow	4.96	5.06	2.72	6.83	1.17	366
	Inflow-Alum	4.96	5.06	2.72	6.83	1.17	366
	Rainfall	1.59	1.50	0.50	3.13	0.81	366
	Reservoir	4.81	4.68	0.74	6.35	0.72	346
	Outflow	4.65	4.65	0.73	6.35	1.01	364
TSS (lbs/d)	Inflow	3,846	0	0	40,454	9,402	366
	Inflow-Alum	3,846	0	0	40,454	9,402	366
	Rainfall	361	53	0	5,498	775	366
	Reservoir	-4,391	-10,718	-17,609	42,178	14,094	366
	Outflow	8,598	10,756	0	17,609	6,278	366

Note: Negative loads reflect an increase in concentration in the reservoir.

Figure 3-11. C-43 WBSR Spreadsheet Tool Hydrology, Concentrations, and Load Table for Selected Time Period

Note: In this example, the proposed inline alum system performance is not reflected. The “Inflow” and “Inflow w/Alum” time series are therefore the same and are superimposed.

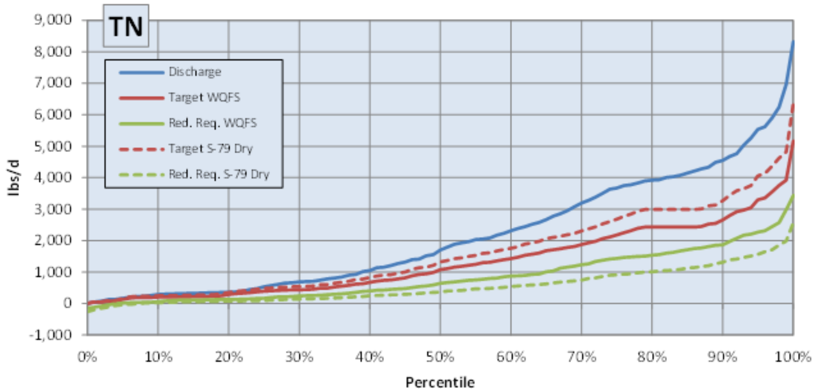
Figure 3-12. C-43 WBSR Spreadsheet Tool Hydrology, Load, and Load Reduction Charts for Selected Time Period



Parameter	Location	Average*	Median	Min	Max	StdDev	Count
Flow (cfs)	Inflow	149.2	0.0	0.0	1500.0	358.1	366
	Outflow	338.2	450.0	0.0	700.0	242.2	366
Storage (ac-ft)	Initial	45,767	34,140	0	150,483	40,829	366
	Final	44,997	33,107	0	150,389	40,667	366
TN (lbs/d)	Inflow	1,179	0	0	12,622	2,845	366
	Inflow-Alum	1,179	0	0	12,622	2,845	366
	Rainfall	186	29	0	4,455	382	366
	Outflow	3,019	3,868	0	6,419	2,221	366
	Target	2,244	2,985	0	4,644	1,607	366
	Reduction Req.	775	883	-1,335	2,061	699	366
TP (lbs/d)	Inflow	94	0	0	1,214	229	366
	Inflow-Alum	94	0	0	1,214	229	366
	Rainfall	5	1	0	70	9	366
	Outflow	250	320	0	571	195	366
	Target	161	214	0	332	115	366
	Reduction Req.	90	107	-184	239	89	366
TSS (lbs/d)	Inflow	3,846	0	0	40,454	9,402	366
	Inflow-Alum	3,846	0	0	40,454	9,402	366
	Rainfall	361	53	0	5,498	775	366
	Outflow	8,598	10,756	0	17,609	6,278	366
	Target	2,736	3,641	0	5,663	1,959	366
	Reduction Req.	5,862	7,116	-1,808	11,946	4,384	366

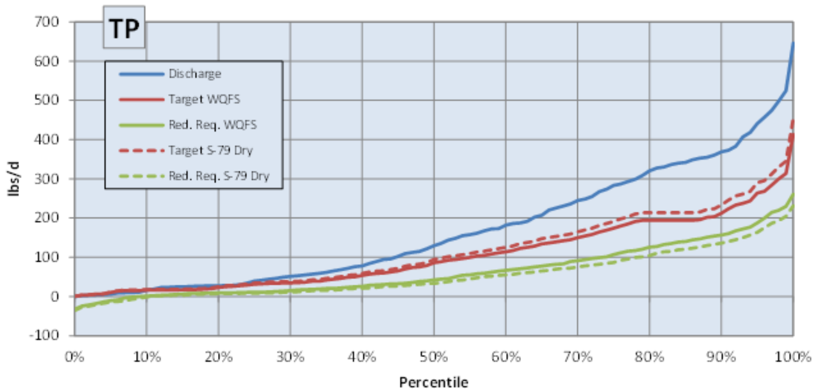
Note: Negative values for “Reduction Req.” reflect periods where reservoir outflow concentrations (and loads) are lower than needed to meet the conditions at the S-79 structure.

Figure 3-13. C-43 WBSR Spreadsheet Tool Hydrology, Load, and Load Reduction Tables for Selected Time Period



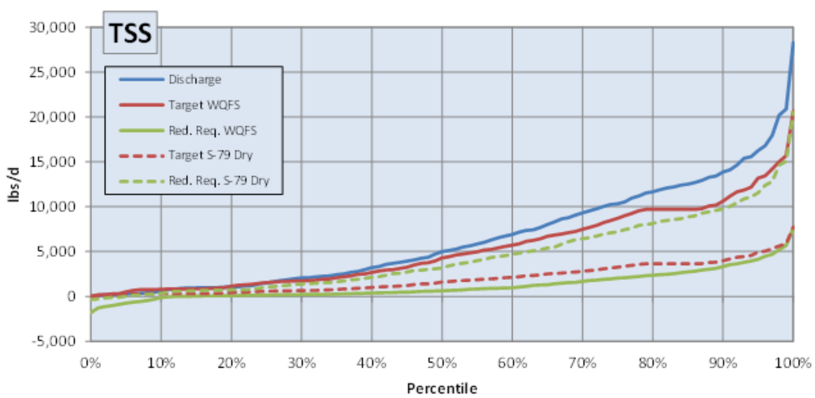
TN Summary (lbs/d)

Percentile	Discharge	Target		Red. Req.	
		WQFS	S-79 Dry	WQFS	S-79 Dry
100%	8,316	5,160	6,347	3,428	2,563
90%	4,542	2,654	3,264	1,864	1,311
75%	3,668	2,175	2,676	1,429	909
50%	1,704	1,076	1,324	638	366
25%	530	389	479	165	94
10%	289	202	248	54	24
0%	2.6	3.3	4.1	-153	-258



TP Summary (lbs/d)

Percentile	Discharge	Target		Red. Req.	
		WQFS	S-79 Dry	WQFS	S-79 Dry
100%	646	413	454	260	231
90%	369	212	234	156	136
75%	283	174	191	107	87
50%	129	86	95	42	33.8
25%	40	31	34	11	8.6
10%	16	16	18	1.2	-1
0%	0.1	0.3	0.3	-32	-36



TSS Summary (lbs/d)

Percentile	Discharge	Target		Red. Req.	
		WQFS	S-79 Dry	WQFS	S-79 Dry
100%	28,265	20,640	7,740	7,624	20,525
90%	13,852	10,615	3,981	3,324	9,745
75%	10,327	8,702	3,263	2,047	7,201
50%	4,998	4,306	1,615	629	3,178
25%	1,504	1,557	584	154	1,046
10%	631	808	303	-120	332
0%	1.6	13	4.9	-1,796	-349

Figure 3-14. C-43 WBSR Spreadsheet Tool Hydrology, Load, and Load Reduction Tables for Selected Time Period

3.2.4 Spreadsheet Tool Results

This section provides a high-level summary of the output from the spreadsheet tool. Figure 3-15 shows the frequency distribution of monthly average reservoir inflow and discharge for the 41-year POR. Monthly average inflows to the C-43 WBSR ranged from 0 to 1,500 cfs, with a median inflow of 48.4 cfs. Monthly average discharges ranged from 0 to 957 cfs, with a median of 133 cfs.

Monthly average TN loads discharged from the reservoir, assuming no treatment, ranged from 2.60 to 8,316lbs/d, with a median of 1,704 lbs/d (Figure 3-16). Monthly average target TN loads for flow returned to the Caloosahatchee River ranged from 4.06 to 6,362 lbs/d, with a median of 1,327 lbs/d. The estimated monthly average TN load reduction required to meet the assumed dry season TN concentration at S-79 of 1.23 mg/L ranged from -259 (no treatment required) to 2,555 lbs/d, with a median of 362 lbs/d.

Monthly average TP loads discharged from the reservoir, assuming no treatment, ranged from 0.074 to 646 lbs/d, with a median of 77.8 lbs/d (Figure 3-17). Monthly average target TP loads for flow returned to the Caloosahatchee River ranged from 0.290 to 454 lbs/d, with a median of 94.7 lbs/d. The estimated monthly average TP load reduction required to meet the assumed dry season TP concentration at S-79 of 0.088 mg/L ranged from -35.5 (no treatment required) to 231 lbs/d, with a median of 33.8 lbs/d.

Monthly average TSS loads discharged from the reservoir, assuming no treatment, ranged from 1.65 to 25,948 lbs/d, with a median of 3,809 lbs/d (Figure 3-18). Monthly average target TSS loads for flow returned to the Caloosahatchee River ranged from 4.94 to 7,740 lbs/d, with a median of 1,615 lbs/d. The estimated monthly average TSS load reduction required to meet the assumed dry season TSS concentration at S-79 of 1.50 mg/L ranged from -349 (no treatment required) to 18,208 lbs/d, with a median of 2,344 lbs/d.

Figure 3-19 shows that median monthly discharge and load reduction requirements vary seasonally, assuming no alum pre-treatment of reservoir inflows or in-reservoir treatment via natural processes. Discharges and corresponding load reduction requirements are larger in the dry season (November–April) than in the wet season (May–October).

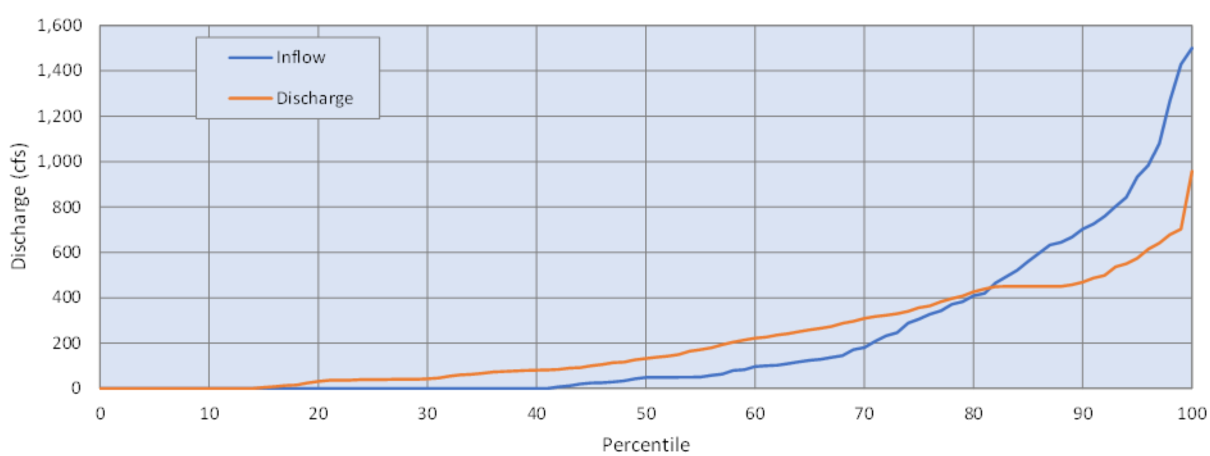


Figure 3-15. C-43 WBSR Spreadsheet Tool Monthly Average Inflow and Discharge Frequency Distributions

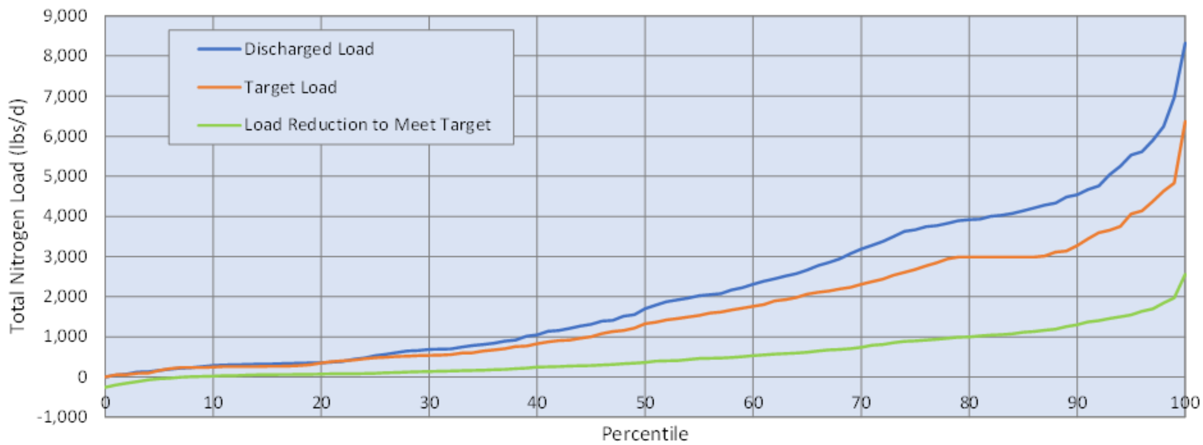


Figure 3-16. C-43 WBSR Spreadsheet Tool Monthly Average TN Load Frequency Distributions

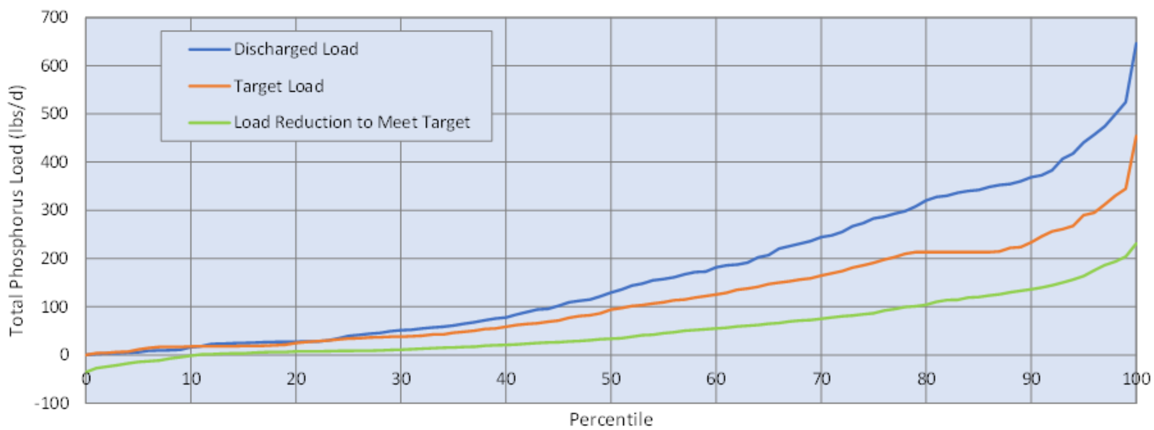


Figure 3-17. C-43 WBSR Spreadsheet Tool Monthly Average TP Load Frequency Distributions

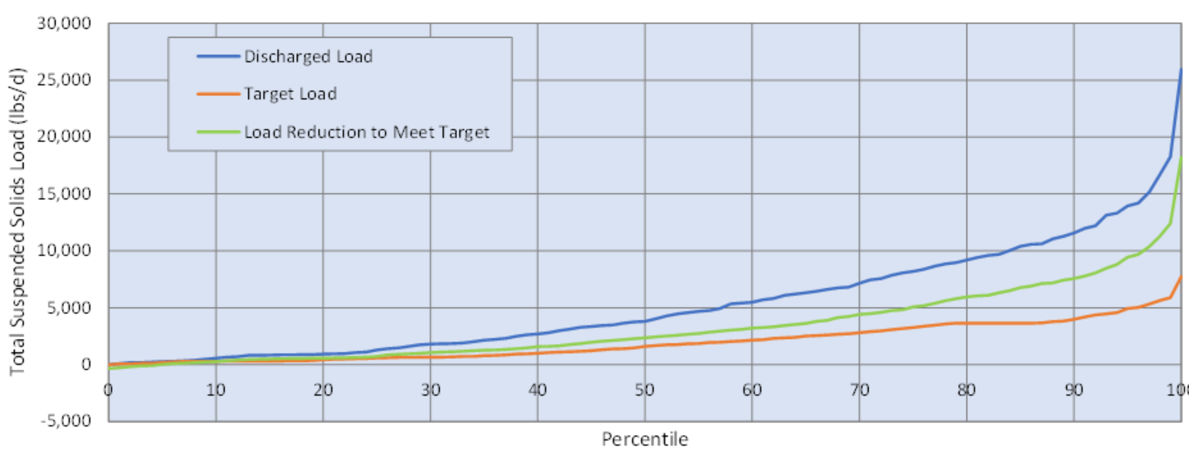


Figure 3-18. C-43 WBSR Spreadsheet Tool Monthly Average TSS Load Frequency Distributions

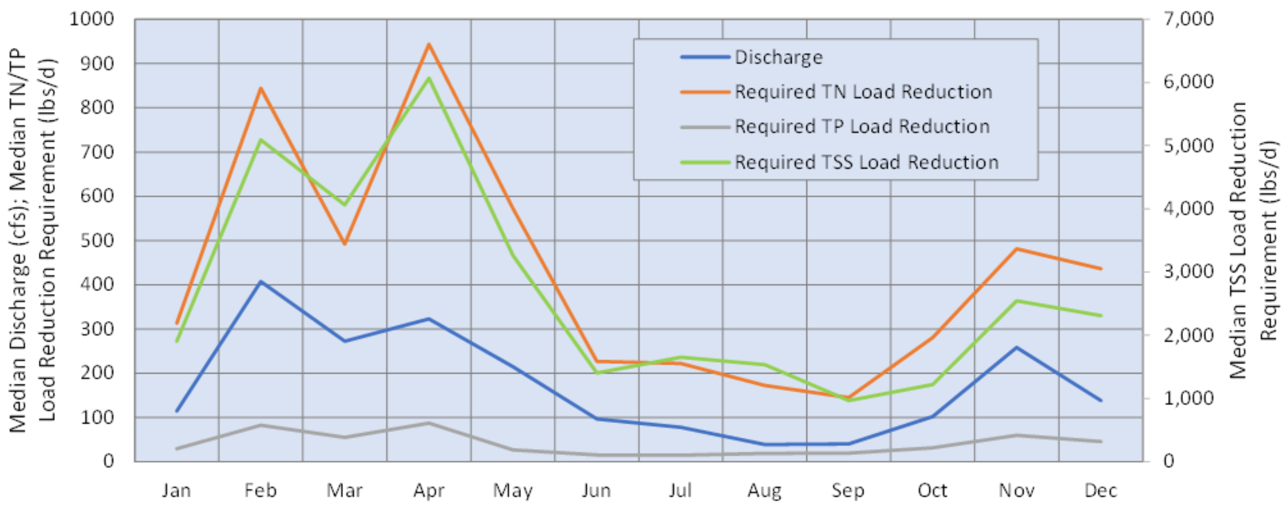


Figure 3-19. C-43 WBSR Spreadsheet Tool Monthly Average TN Load Frequency Distribution

3.3 Conceptual WQC Sizing

As noted in Section 1.0, the C-43 WQFS concluded that four water quality treatment alternatives should receive further evaluation to identify an alternative as the selected WQC Plan for future design, engineering, and permitting. The four alternatives include offline alum treatment, HWTT, STA with media filtration, and sand filter with media filtration. In addition, the WQFS recommended that a 5,000-ac STA receive further conceptual cost evaluation.

The WQFS also recommended that an inline alum treatment system receive further evaluation as an operational control over algal management in the reservoir. Follow up correspondence, team experience, and literature review determined that alum treatment poses no adverse ecological effect and warrants continued evaluation as a WQC technology. Cooke et al. (2005) concluded the body of evidence falls decisively in favor of ecological safety for alum application. To reduce P levels, the St. Johns River Water Management District has applied alum to re-flooded fields, injected liquid alum into waterbodies, and spread residual alum on fields. In all consultations and risk assessments, USFWS has determined that the use of alum is not likely to adversely affect protected species (H. Rauschenberger, pers. commun., January 14, 2021). Reports issued by the St. Johns River Water Management District over 20 years ago provide guidance on ecologically safe aluminum ion concentrations (Gensemer and Playle, 1998), which are now superseded by the U.S. Environmental Protection Agency aluminum toxicity criterion (2018), and provide summaries of literature and lake application case histories (Water & Air Research, 1999).

This section reviews the conceptual sizes of the recommended treatment technology alternatives considering the results of the WQC spreadsheet model analysis.

3.3.1 Sizing Assumptions

Conceptual sizing of the C-43 WBSR WQC is a function of the assumed flow rate, reservoir discharge concentrations and river water quality targets. The WQC spreadsheet model results provided a long-term data set useful for characterizing the range of annual and seasonal flows expected from the reservoir. Given the significant differences in river flow and concentrations between seasons, the monthly distribution of flows was determined and reviewed. Figure 3-20 presents the cumulative frequency distribution of median inflow and outflow from the WBSR for each month over the POR.

Based upon review of the cumulative frequency distributions, the 90th percentile value offered a guide for establishing a maximum flow rate for sizing. For October–February, the 90th percentile represents a peak outflow rate, and for March–September, there is an increase in outflow rates to the maximum value. For the purpose of this conceptual sizing review, the 90th percentile monthly outflows were used to represent a practical maximum flow rate. This general approach to flow selection is consistent with common methods for sizing full-scale treatment systems.

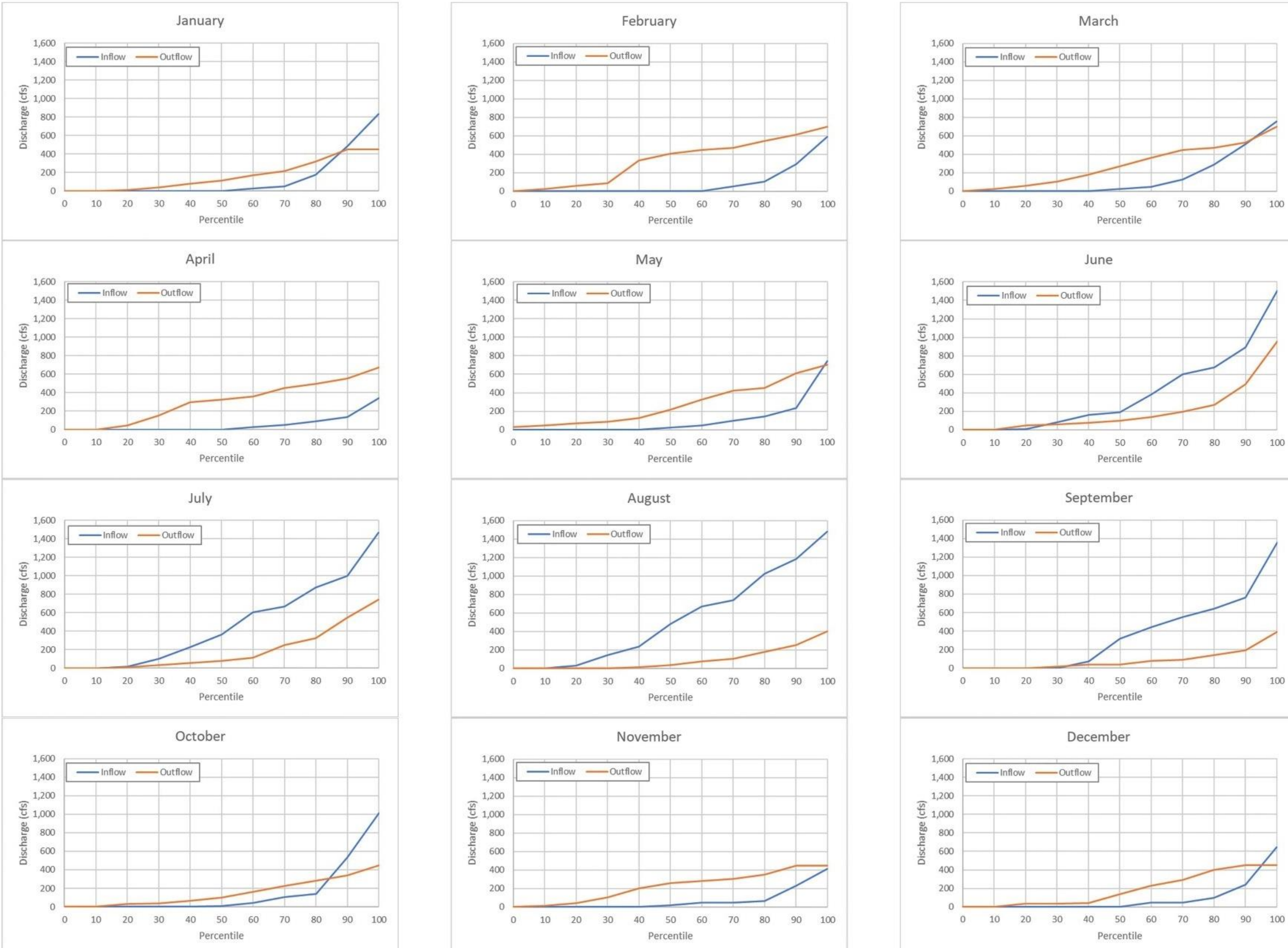


Figure 3-20. Cumulative Frequency Distribution Curves of Inflows and Outflows by Month

Because river concentrations and reservoir discharges vary by season, a review was conducted to determine if all the flow for a particular month would need to be treated, or it would be possible to treat a fraction of the flow and blend the treated and untreated flows to achieve the river target. For example, for May, the total median 90th percentile flow is 611 cfs. The fraction of the flow requiring treatment to achieve the river target, assuming the monthly median TN value for that month (1.91 mg/L), was 457 cfs, or 75% of the monthly median flow (Table 3-8). The calculated treated flow rate for May is the maximum estimated treatment flow rate for all months of the year (Table 3-9) and agrees with initial WQFS assumptions of 457 cfs. This flow value was selected as a sizing assumption for the technology comparison.

Following the review of the monthly 90th percentile values, the POR 90th percentile values in the reservoir outflow for nutrients and suspended solids were selected to represent maximum inflow concentrations (Table 3-10). **These values assume no reduction in concentration during storage through either natural or alum-assisted sedimentation and assimilation, and are therefore conservative** (i.e., higher than expected). For the purpose of this conceptual sizing review, water quality target concentrations selected were the median dry-season values determined from the S-79 data.

Table 3-8. Example Calculation of Treated Flow Rate

Category of Flow	Flow (cfs)	Fraction of Total Flow Treated	TN (mg/L)	Flow-Weighted Concentration (mg/L)
Treated	457	75%	1.00	0.75
Untreated	154	25%	1.91	0.48
Total	611	Not applicable	1.23	1.23

Table 3-9. Flows Treated by Month

Month	90th Percentile Reservoir Discharge (cfs)	Treated (cfs)	Treated Fraction (%)
January	450	310	69%
February	611	426	70%
March	529	389	74%
April	550	425	77%
May	611	457	75%
June	489	350	72%
July	548	382	70%
August	256	171	67%
September	189	123	65%
October	339	221	65%
November	450	296	66%
December	450	304	68%
Maximum	611	457	75%
Median	470	330	70%

Table 3-10. Assumed Treated System Inflow Concentrations from the POR Monthly 90th Percentile Values

Parameter	Value (mg/L)	Basis
Organic N	1.41	POR 90th percentile
Ammonia N	0.17	POR 90th percentile
Oxidized N	0.23	POR 90th percentile
TN	1.81	Sum
Soluble reactive P	0.094	POR 90th percentile
Organic P	0.058	POR 90th percentile
TP	0.152	Sum

3.3.2 Performance

The performance of the individual treatment technologies was assessed using a variety of information sources and models. The offline alum treatment system was assessed using Sumo (www.dynamita.com), a dynamic wastewater treatment process model. The HWTT system was assessed using spreadsheet and performance data provided by Watershed Technologies, LLC, the HWTT system vendor. Table 3-11 summarizes HWTT performance for TN and TP, and Table 3-12 summarizes HWTT land area requirements. The available area for the HWTT performance was reduced to 439 ac consistent with Option 3.

The STA performance was assessed using the p-K-C* wetland treatment model developed by R.H. Kadlec and S. Wallace and calibrated to South Florida treatment wetland performance data. Table 3-13 and Table 3-14 summarize performance for the 5,000-ac and 925-ac STAs, respectively. The size of the STA was reduced to 925 acres based upon the area defined for Option 4 (A and B) using the S-2 and S-4 parcels. The analysis assumes a portion of the WQC on the west side of the Banana Branch Canal will be an STA and act as a flow way into the Bold and Gold® media.

The sand filter performance was estimated using a p-K-C* model calibrated to performance data available from full-scale and demonstration-scale systems constructed in Florida (Table 3-15). The available area for the sand filter was assumed to be reduced to 193 aces, with 105 acres Bold and Gold® media, based upon the area defined for Option 2.

The Bold and Gold® media bed performance was assessed using the p-K-C* model calibrated to performance assumptions provided by ECS Inc. (Table 3-16). The media filter bed area was increased to 105 acres, to be consistent with the vendor's five-ac sizing units. Performance data from ongoing testing by SFWMD of the Bold and Gold® media were not available but will be factored into future assessments for this project as it becomes available.

Table 3-17 summarizes the performance of the treatment technologies. Outflow TN and TP targets are achieved by all technologies, with the alum and Bold and Gold® assisted technologies achieving slightly lower TN and TP concentrations. All systems were found to be of similar size as originally assessed in the WQFS except for HWTT. The total treatment system facility footprint for the HWTT concept was adjusted downward by the vendor to 439 ac, based upon the flow rate for sizing of 457 cfs.

Achieving the river target TSS of 1.5 mg/L was found to be more challenging than the previous target of 10 mg/L applied during the WQFS. Only the 5,000-ac STA was estimated to achieve the 1.5 mg/L TSS target. All remaining technologies achieved TSS concentrations of 2.0 mg/L to 3.3 mg/L. The TSS concentrations in the river naturally encompass this range. As shown in Figure 3-6, the 95% confidence interval extends from 1.0 mg/L to 4.0 mg/L throughout the dry season. The S-79 TSS values are drawn from fewer samples than the nutrient parameters and do not capture observed algal blooms when TSS concentrations may have been higher in the river. Based on discussions with the SFWMD Design Review Team and Working Group members, the focus on the WQC sizing will be to achieve the TN and TP target concentrations. The WQC will not be designed to achieve the TSS target of 1.5 mg/L.

At this project stage, these results are intended to provide confirmation of the continued feasibility for the recommended alternatives. An important consideration is the recognition that the inline alum treatment system will result in concentrations of TN, TP, and TSS that will be lower relative to the reservoir water quality discharge scenario used for the purpose of this assessment. The sizing presented in this analysis should be considered conservative. Approaches to conceptual optimization of the inline reservoir treatment and offline discharge to the WQC will be investigated during Conceptual Design.

Table 3-18 summarizes key observations about each technology as a result of this analysis. No significant changes in technology area requirements were noted during this analysis, except for HWTT in response to setting the average flow rate to 457 cfs. The previous sizing had been based on a peak flow of 600 cfs. For the offline alum system, a reduction in alum dosing and daily requirements was noted, which will provide a cost savings. The Bold and Gold® media filter was increased slightly to 105 ac to be consistent with the vendor's sizing recommendation of five-ac units, each sized for 26.2 cfs.

Table 3-11. HWTT Performance Estimate

	HWTT Treated Flow to Achieve TP Outflow Targets				
Month	Reservoir Inflow TP (mg/L)	Reservoir Outflow/HWTT Inflow TP (mg/L)	Outflow Target (mg/L)	HWTT Outflow Conc (mg/L)	Total Flow
1	0.152	0.152	0.088	0.086	450.00
2	0.152	0.152	0.088	0.086	611.00
3	0.152	0.152	0.088	0.086	529.00
4	0.152	0.152	0.088	0.086	550.00
5	0.152	0.152	0.088	0.086	611.00
6	0.152	0.152	0.088	0.086	489.00
7	0.152	0.152	0.088	0.086	548.00
8	0.152	0.152	0.088	0.086	256.00
9	0.152	0.152	0.088	0.086	189.00
10	0.152	0.152	0.088	0.086	339.00
11	0.152	0.152	0.088	0.086	450.00
12	0.152	0.152	0.088	0.086	450.00
Average	***0.152***		***0.088***		***456.0***
	HWTT Treated Flow to Achieve TN Outflow Targets				
Month	**Reservoir Inflow TN (mg/L)**	**Reservoir Outflow/HWTT Inflow TN (mg/L)**	**Outflow Target (mg/L)**	**HWTT Outflow Conc (mg/L)**	**Total Flow**
1	1.810	1.810	1.230	1.230	450.00
2	1.810	1.810	1.230	1.230	611.00
3	1.810	1.810	1.230	1.230	529.00
4	1.810	1.810	1.230	1.230	550.00
5	1.810	1.810	1.230	1.230	611.00
6	1.810	1.810	1.230	1.230	489.00
7	1.810	1.810	1.230	1.230	548.00
8	1.810	1.810	1.230	1.230	256.00
9	1.810	1.810	1.230	1.230	189.00
10	1.810	1.810	1.230	1.230	339.00
11	1.810	1.810	1.230	1.230	450.00
12	1.810	1.810	1.230	1.230	450.00
Average	***1.810***		***1.230***		***456.0***

Source: Watershed Technologies, LLC, 2021

Table 3-12. HWTT Land Area Requirements

Component	Area (ac)
Mixing Area	1
Settling Pond	89
Drying Beds	115
Floating Aquatic Vegetation Pond	80
Submerged Aquatic Vegetation Ponds	104
Supporting Facilities	50
Total	***439***

Source: Watershed Technologies, LLC, 2021

Note: The treatment area totals 273 ac and is comprised of the settling, floating aquatic vegetation, and submerged aquatic vegetation ponds.

Table 3-13. 5,000-ac STA Performance Estimate

Area =	**5000.0**	ac
Mean Depth =	**1**	ft
Porosity =	**0.95**	
α =	**0.5**	fraction of ET that is transpired

		Hydrology				Inflow Concentration, C_i					
Month	**Temp (°C)**	**Precip in/mo**	**ET in/mo**	**Infiltration in/d**	**Inflow cfs**	**TSS (mg/L)**	**ORG-N (mg/L)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**TN_{seq} (mg/L)**	**TP (mg/L)**
January	16.6	1.88	2.00	0.0	457	4.47	1.41	0.17	0.23	1.81	0.152
February	18.5	1.54	2.73	0.0	457	4.49	1.41	0.17	0.23	1.81	0.152
March	19.9	2.05	3.75	0.0	457	4.56	1.41	0.17	0.23	1.81	0.152
April	22.7	2.31	4.68	0.0	457	5.09	1.41	0.17	0.23	1.81	0.152
May	24.9	4.67	5.39	0.0	457	5.00	1.41	0.17	0.23	1.81	0.152
June	26.4	8.78	5.19	0.0	457	4.86	1.41	0.17	0.23	1.81	0.152
July	27.0	6.92	5.32	0.0	457	4.68	1.41	0.17	0.23	1.81	0.152
August	27.2	7.80	5.01	0.0	457	4.74	1.41	0.17	0.23	1.81	0.152
September	26.6	6.34	4.28	0.0	457	4.46	1.41	0.17	0.23	1.81	0.152
October	24.3	2.57	3.53	0.0	457	4.24	1.41	0.17	0.23	1.81	0.152
November	20.5	1.05	2.35	0.0	457	4.38	1.41	0.17	0.23	1.81	0.152
December	18.6	1.37	1.87	0.0	457	4.36	1.41	0.17	0.23	1.81	0.152
Mean/Total	**22.8**	**3.9**	**3.8**	**0.0**	**457.0**	**4.61**	**1.41**	**0.17**	**0.23**	**1.81**	**0.152**

	TSS	ORG-N	NH3-N	NO3-N	TN_{seq}	TP
C* (mg/L) =	1.3	0.9	0.01	0.01		0.02
PTIS =	3		3			3
k Percentile =		70	90	100		70
k_{20} (m/yr) =	100	27.4	85.6	133.1		16.7

	Hydrology					Estimated Outflow Concentration, C_o					
Month	**Inflow m^3/d**	**Precip m^3/d**	**ET m^3/d**	**Infiltration m^3/d**	**Outflow m^3/d**	**TSS (mg/L)**	**ORG-N (mg/L)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**TN_{seq} (mg/L)**	**TP (mg/L)**
January	1118096	67502	65817	0	1119781	1.47	1.07	0.085	0.084	1.24	0.083
February	1118096	26304	46746	0	1097654	1.47	1.06	0.079	0.071	1.21	0.083
March	1118096	35121	64285	0	1088932	1.47	1.05	0.075	0.062	1.19	0.083
April	1118096	39608	80201	0	1077503	1.50	1.04	0.066	0.048	1.15	0.083
May	1118096	80022	92279	0	1105839	1.49	1.03	0.058	0.038	1.12	0.082
June	1118096	150497	88981	0	1179612	1.47	1.01	0.052	0.032	1.09	0.079
July	1118096	118623	91062	0	1145658	1.46	1.01	0.051	0.031	1.09	0.080
August	1118096	133557	85861	0	1165792	1.46	1.01	0.050	0.030	1.09	0.079
September	1118096	108533	73377	0	1153252	1.45	1.01	0.053	0.032	1.10	0.080
October	1118096	44055	60413	0	1101738	1.45	1.03	0.061	0.041	1.13	0.083
November	1118096	17975	40278	0	1095793	1.46	1.05	0.073	0.059	1.18	0.083
December	1118096	23499	32083	0	1109513	1.46	1.06	0.079	0.070	1.21	0.083
Mean	1118096	70441	68449	0	1120089	1.47	1.04	0.07	0.05	1.15	0.082

	TSS	ORG-N	NH3-N	NO3-N	TN_{seq}	TP
Annual Concentration Reduction Efficiency =	68%	27%	62%	78%	36%	46%
Annual Inflow Surface Load (kg/yr) =	1,881,843	575,428	69,378	93,864	738,670	62,032
Annual Outflow Surface Load (kg/yr) =	599,928	423,330	26,546	20,192	470,068	33,371
Annual Surface Load Reduction (kg/yr) =	1,281,915	152,098	42,832	73,673	268,602	28,661
Annual Mass Reduction Efficiency =	68%	26%	62%	78%	36%	46%

Source: Wetland Solutions, Inc., 2021

Table 3-14. 925-ac STA Performance Estimate

Area =	925.0	ac
Mean Depth =	1	ft
Porosity =	0.95	
α =	0.5	fraction of ET that is transpired

		Hydrology				Inflow Concentration, C_i					
Month	Temp (°C)	Precip in/mo	ET in/mo	Infiltration in/d	Inflow cfs	TSS (mg/L)	ORG-N (mg/L)	NH3-N (mg/L)	NO3-N (mg/L)	TN_{seq} (mg/L)	TP (mg/L)
January	16.6	1.88	2.00	0.0	91	4.47	1.41	0.17	0.23	1.81	0.152
February	18.5	1.54	2.73	0.0	91	4.49	1.41	0.17	0.23	1.81	0.152
March	19.9	2.05	3.75	0.0	91	4.56	1.41	0.17	0.23	1.81	0.152
April	22.7	2.31	4.68	0.0	91	5.09	1.41	0.17	0.23	1.81	0.152
May	24.9	4.67	5.39	0.0	91	5.00	1.41	0.17	0.23	1.81	0.152
June	26.4	8.78	5.19	0.0	91	4.86	1.41	0.17	0.23	1.81	0.152
July	27.0	6.92	5.32	0.0	91	4.68	1.41	0.17	0.23	1.81	0.152
August	27.2	7.80	5.01	0.0	91	4.74	1.41	0.17	0.23	1.81	0.152
September	26.6	6.34	4.28	0.0	91	4.46	1.41	0.17	0.23	1.81	0.152
October	24.3	2.57	3.53	0.0	91	4.24	1.41	0.17	0.23	1.81	0.152
November	20.5	1.05	2.35	0.0	91	4.38	1.41	0.17	0.23	1.81	0.152
December	18.6	1.37	1.87	0.0	91	4.36	1.41	0.17	0.23	1.81	0.152
Mean/Total	22.8	3.9	3.8	0.0	91.4	4.61	1.41	0.17	0.23	1.81	0.152

	TSS	ORG-N	NH3-N	NO3-N	TN_{seq}	TP
C* (mg/L) =	1.3	0.9	0.01	0.01		0.02
PTIS =	3	3				3
k Percentile =		70	90	100		70
k_{20} (m/yr) =	100	27.4	85.6	133.1		16.7

	Hydrology					Estimated Outflow Concentration, C_o					
Month	Inflow m^3/d	Precip m^3/d	ET m^3/d	Infiltration m^3/d	Outflow m^3/d	TSS (mg/L)	ORG-N (mg/L)	NH3-N (mg/L)	NO3-N (mg/L)	TN_{seq} (mg/L)	TP (mg/L)
January	223619	12488	12176	0	223931	1.49	1.08	0.090	0.089	1.26	0.086
February	223619	4866	8648	0	219837	1.49	1.07	0.085	0.076	1.23	0.086
March	223619	6497	11893	0	218224	1.50	1.07	0.080	0.067	1.21	0.086
April	223619	7327	14837	0	216110	1.53	1.05	0.071	0.052	1.17	0.086
May	223619	14804	17072	0	221352	1.52	1.04	0.063	0.041	1.14	0.085
June	223619	27842	16461	0	235000	1.50	1.02	0.056	0.034	1.11	0.082
July	223619	21945	16846	0	228718	1.49	1.02	0.056	0.033	1.11	0.083
August	223619	24708	15884	0	232443	1.49	1.02	0.055	0.032	1.11	0.083
September	223619	20079	13575	0	230123	1.48	1.03	0.057	0.034	1.12	0.083
October	223619	8150	11176	0	220593	1.48	1.04	0.066	0.044	1.15	0.086
November	223619	3325	7452	0	219493	1.49	1.06	0.078	0.063	1.21	0.087
December	223619	4347	5935	0	222031	1.49	1.07	0.084	0.075	1.23	0.086
Mean	223619	13032	12663	0	223988	1.49	1.05	0.07	0.05	1.17	0.085

	TSS	ORG-N	NH3-N	NO3-N	TN_{seq}	TP
Annual Concentration Reduction Efficiency =	68%	26%	59%	77%	35%	44%
Annual Inflow Surface Load (kg/yr) =	376,369	115,086	13,876	18,773	147,734	12,406
Annual Outflow Surface Load (kg/yr) =	122,196	85,653	5,708	4,329	95,690	6,938
Annual Surface Load Reduction (kg/yr) =	254,173	29,433	8,167	14,444	52,044	5,469
Annual Mass Reduction Efficiency =	68%	26%	59%	77%	35%	44%

Source: Wetland Solutions, Inc., 2021

Table 3-15. Sand Filter Performance Estimate

General Inflow Data

Parameter	Value	Units
Annual Average Daily Flow	91.4	cfs
Converted Flow	223,619	m^3/d
Wastewater Temperature	23.9	^oC

Water Quality Characteristics

Parameter		TSS			NH_4-N		TN	TP	FC	
Influent Concentration, mg/L	C_i =	4.7					1.81	0.1520		
Average Target Effluent Conc., mg/L	C_e =							0.08		
Desired Confidence Percentile		0.5			0		0.5	0.5	0.5	
Max Month/Annual Factor		1.7			2.5		1.6	1.8	2.6	
Design Target Conc., mg/L	C_d =							0.0		
Wetland Background Limit, mg/L	C^* =	0.5			0		0.9	0.02	300	
Reduction fraction to target	$F_e = 1 - C_e/C_i$=	1.000			No Value		1.000	0.474	No Value	
Reduction fraction to background	$F_b = 1 - C^*/C_i$ =	0.894					0.503	0.868		
Areal Rate Constant, 20°C, m/y	k_{20} =	492			25		164	152	83	
Temperature Factor	θ =	1.00			1.04		1.05	1.00	1.00	
P-Factor	P =	6			6		6	3	3	
Areal Rate Constant, m/y	k_T =	492			29.1		198.4	152	83	
Area required for each parameter, ac		C*>Cd	C*>Cd		C*>Cd		C*>Cd	300.3	C*>Cd	

Required Treatment Wetland Area

Required Treatment Wetland Area	A_{max} =	**300.3**	acres	Displays minimum wetland area to treat all pollutants down to desired targets
		121.6	ha	
User Defined Area	A_{user} =	**200.0**	acres	User specified wetland area; leave blank if you wish to use A_{max} (above) for effluent calculations below.
		80.9717	ha	

Final Effluent Concentrations and Percent Removal

Area (ha) used for Calculations = **81.0**		TSS			NH_4-N		TN	TP	FC	
Design Target Conc., mg/L	C_d =						1.0	0.044		
Influent concentrations, mg/L	C_i =	4.7					1.81	0.152		
Effluent concentrations, mg/L		0.6			0.0		1.07	0.059		
Percent Reduction (by concentration)		87%					41%	61%		
Mass Loading (lb/day)		2316					892	75		
Mass Loading (kg/ha/d)		13.0					5.0	0.4		
Mass Out (lb/day)		305			0		525	29		
Mass Out (kg/ha/d)		1.7			0.0		2.9	0.2		
Percent Reduction (by mass)		87%					41%	61%		

Source: J-Tech, 2021

Table 3-16. Bold and Gold® Filter Performance Estimate

General Inflow Data

Parameter	Value	Units
Annual Average Daily Flow	271	cfs
Converted Flow	663,029	m^3/d
Wastewater Temperature	23.9	°C

Add Results to NADB Plots

Water Quality Characteristics

Parameter		BOD5	TSS	Organic N	NH_4-N	$NO_{2/3}$-N	TN	TP	FC	
Influent Concentration, mg/L	C_i =		4.7	1.41	0.17	0.2	1.810	0.152		
Average Target Effluent Conc., mg/L	C_e =			0.56	0.07	0.09	0.72	0.123		
Desired Confidence Percentile		0.5		0.5	0.5	0.5	0.5	0.5	0.5	
Max Month/Annual Factor		1.7	1.9	1.8	2.5	2.5	1.6	1.8	3.0	
Design Target Conc., mg/L	C_d =			0.3	0.0	0.0	0.5	0.1		
Wetland Background Limit, mg/L	C^* =	2	0.50	0.5	0	0	0.8	0.02	40	
Reduction fraction to target	$F_e = 1 - C_e/C_i$=	No Value	1.000	0.600	0.600	0.600	0.600	0.191	No Value	No Value
Reduction fraction to background	$F_b = 1 - C^*/C_i$ =		0.894	0.645	1.000	1.000	0.558	0.868		
Confidence-based Rate Constant, 20°C, m/y	k_{20} =	33	977	2683	517	3962	3107	3750	83	
Temperature Factor	θ =	1.00	1.000	1.05	1.05	1.11	1.06	1.00	1.00	
P-Factor	P =	1	6	6	6	6	6	6.0	3	
Areal Rate Constant, m/y	k_T =	33	977	3245.3	623.3	5952.2	3842.3	3750.31	83	
Area required for each parameter, ac		C*>Cd	C*>Cd	C*>Cd	604.2	641.5	C*>Cd	17.4	C*>Cd	C*>Cd

Required Treatment Wetland Area

Required Treatment Wetland Area	A_{max} =	**641.5**	acres	Displays minimum wetland area to treat all pollutants down to desired targets
		259.7	ha	
User Defined Area	A_{user} =	**105.0**	acres	User specified wetland area; leave blank if you wish to use A_{max} (above) for effluent calculations below.
		42.5	ha	

Final Effluent Concentrations and Percent Removal

Area (ha) used for Calculations =	**42.5 ha**	BOD5	TSS	Organic N	NH_4-N	$NO_{2/3}$-N	TN	TP	FC	
Design Target Conc., mg/L	C_d =			0.313	0.027	0.037	0.453	0.068		
Influent concentrations, mg/L	C_i =		4.7	1.410	0.170	0.230	1.810	0.152		
Confidence-based Effluent concentration, mg/L	C_e =		1.4	0.517	0.454	0.052	1.022	0.022		
Percent Reduction (by concentration)			70%	63%	-167%	78%	44%	86%		
Mass Loading (lb/day)			6866	2060	248	336	2644	222		
Mass Loading (kg/ha/d)			73.3	22.0	2.7	3.6	28.2	2.4		
Mass Out (lb/day)			2087	755	663	75	1493	31		
Mass Out (kg/ha/d)			22.3	8.1	7.1	0.8	15.9	0.3		
Percent Reduction (by mass)			70%	63%	-167%	78%	44%	86%		

Source: J-Tech, 2021

Table 3-17. Estimated Performance of Recommended Treatment Technology Alternatives

Alternative	Area (ac)	Flow (cfs)	HLR (cm/d)	% Flow	TP out (mg/L)	Weighted TP out (mg/L)	TN out (mg/L)	Weighted TN out (mg/L)	TSS out (mg/L)	Weighted TSS out (mg/L)
Alum Treatment (offline)	18	457	1,534	100%	0.086	0.086	1.00	1.00	3.33	3.33
Untreated Flow	0	0	0	0%	0.152	0.000	1.23	0.00	4.70	0.00
Combined Flow	18	457		100%		0.086		1.00		3.33
HWTT	439	457	252	100%	0.080	0.080	1.23	1.23	2.35	2.35
Untreated Flow		0		0%	0.152	0.000	1.81	0.00	4.7	0.00
Combined Flow	439	457		100%		0.080		1.23		2.35
STA	925	91	5.5	20%	0.073	0.015	1.19	0.24	1.48	0.29
Bold and Gold®	105	271	156	59%	0.022	0.013	1.02	0.61	1.43	0.85
Untreated Flow	0	95	0	21%	0.152	0.032	1.81	0.38	4.70	0.98
Combined Flow	1,030	457		100%		0.059		1.22		2.12

Alternative	Area (ac)	Flow (cfs)	HLR (cm/d)	% Flow	TP out (mg/L)	Weighted TP out (mg/L)	TN out (mg/L)	Weighted TN out (mg/L)	TSS out (mg/L)	Weighted TSS out (mg/L)
Sand Filter	193	91	27.6	20%	0.059	0.012	1.07	0.21	0.62	0.12
Bold and Gold®	105	271	156	59%	0.022	0.013	1.02	0.61	1.43	0.85
Untreated Flow	0	95	0	21%	0.152	0.032	1.81	0.38	4.70	0.98
Combined Flow	298	457		100%		0.056		1.19		1.95
STA	5,000	457	5.5	100%	0.081	0.081	1.17	1.17	1.50	1.50
Untreated Flow	0	0	0	0%	0.152	0.000	1.81	0.00	4.70	0.00
Combined Flow	5,000	457		100%		0.081		1.17		1.50

Table 3-18. Estimated Discharge Concentrations and Recommended Updates to Treatment Technology Alternatives

Alternative	TP Discharge (mg/L)	TN Discharge (mg/L)	TSS Discharge (mg/L)	Area Change	Recommend Update from WQFS
Alum (offline)	0.086	1.00	3.33	No change	Reduced alum dose from 0.30 mg/L or 1,500 gallons per day (gpd) to 0.25 mg/L or 1,250 gpd.
HWTT	0.080	1.23	2.35	Adjusted	Reduced total system area from 660 ac to 439 ac.
STA (925-ac) + Bold and Gold®	0.059	1.22	2.12	Adjusted	Assuming vendor removal rates for Bold and Gold®, system meets TN and TP targets. STA meets all targets. Media filter bed area increased to 105 ac.
Sand filter + Bold and Gold®	0.056	1.19	1.95	Adjusted	Assuming vendor removal rates for Bold and Gold®, system meets TN and TP targets. Media filter bed area increased to 105 ac.
STA (5,000-ac)	0.081	1.17	1.50	No Change	System meets all targets.

3.4 Inline Alum

In addition to the offline treatment technologies described above, the C-43 WQFS recommended inline alum treatment at the WBSR inflow to help suppress potential nuisance algal growth within the reservoir while optimizing performance of the downstream WQC. As part of Task 9, a separate technical memorandum was prepared that provides detailed information on alum treatment and the inline system. This section provides a brief overview of the memorandum findings. The Siting Evaluation and sizing of the alternatives does not consider the potential reduction of nutrients and solids that will result from the inline alum system.

3.4.1 Dose Determination

The C-43 WBSR inline treatment facility was modeled to determine the appropriate alum dosing rate to achieve a target of 0.08 mg/L TP within the reservoir. The model determined that an alum dose of 0.6 mg/L is needed to achieve the TP target. At this dose, the model estimated that the incoming TN concentration of 1.6 mg/L could be reduced to about 1.2 mg/L through reductions in nitrate, ammonia, and colloidal nitrogen (Figure 3-21). The model also estimated that the incoming TP concentration of 0.15 mg/L could be reduced to less than 0.08 mg/L with large reductions in orthophosphate (Figure 3-22).

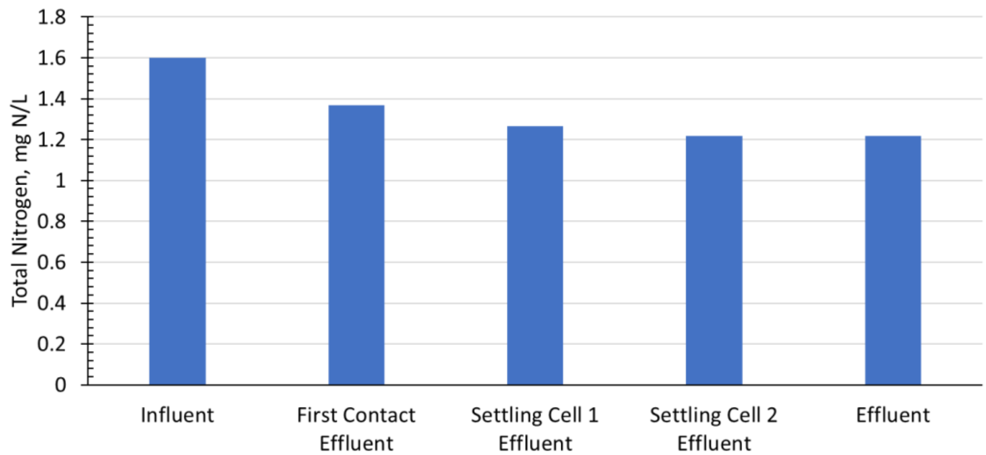


Figure 3-21. C-43 WBSR Model Results TN Reductions

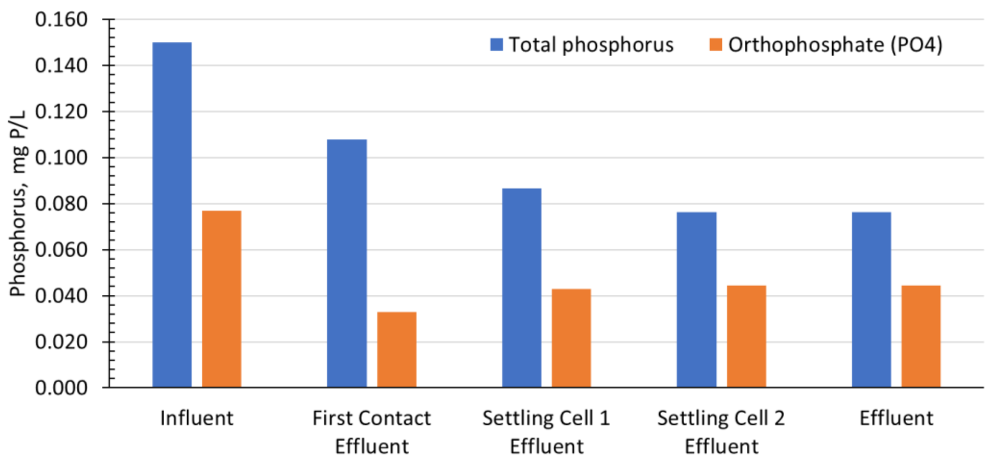


Figure 3-22. C-43 WBSR Model Results TP Reductions

The model was also used to estimate sediment deposition from the alum floc. Sediments are anticipated to be relatively uniform, with a deepening tendency near the reservoir pipe inlet. TSS concentrations adjacent to the inlet pipes are expected to be less than 10 mg/L. Based upon a typical solids content of 4% for settled alum solids, this deposition equates to an annual accretion rate of 0.33 centimeters per year in Cell 1, and about half that in Cell 2. Therefore, the estimated depth of accumulation after 50 years would be slightly over six inches.

Based on a literature review of alum projects throughout Florida and the U.S., no toxic responses from aquatic biota were reported. Some temporary impacts to benthic macroinvertebrate community composition were noted in several case studies, but these impacts were the result of changes in macroinvertebrate substrate suitability. Subsequent monitoring indicated a return to typical community structure. The ecological safety of the alum application was reviewed, and the proposed alum concentrations are significantly below U.S. Environmental Protection Agency standards, so no adverse effects are expected at the proposed doses.

3.4.2 Conceptual Design Inline Alum Application System

To apply alum to the C-43 WBSR, the conceptual plan is to blend bulk liquid alum into each pump intake channel with a high-speed submersible mixer. Alum will be metered by a control valve and flow-meter system at each channel to the high-speed mixer. The mixer will only be in operation while that channel is pumping through control interlocks, and there will be a separate automated valve that will close the alum feed line when the associated pump is not in service. Alum will be supplied from a tank farm that will be located on the north side of the S-470 Pump Station (Figure 3-23) and will include multiple double walled fiber reinforced plastic tanks for alum storage, and a fill station with spill control for offloading tanker trucks of alum.

3.4.3 Life Cycle Cost

A high-level capital cost was prepared for the inline alum treatment system, which was estimated between $3.55 million and $6.33 million. Annual O&M costs were estimated between $400,000 and $700,000, which include the cost and delivery of alum, operational maintenance, mechanical replacement, and general site upkeep and reporting. The long-term Net Present Value is estimated between $30 million and $46 million for a 50-year life cycle with theoretical replacements of all hardware at years 15, 30, and 35.

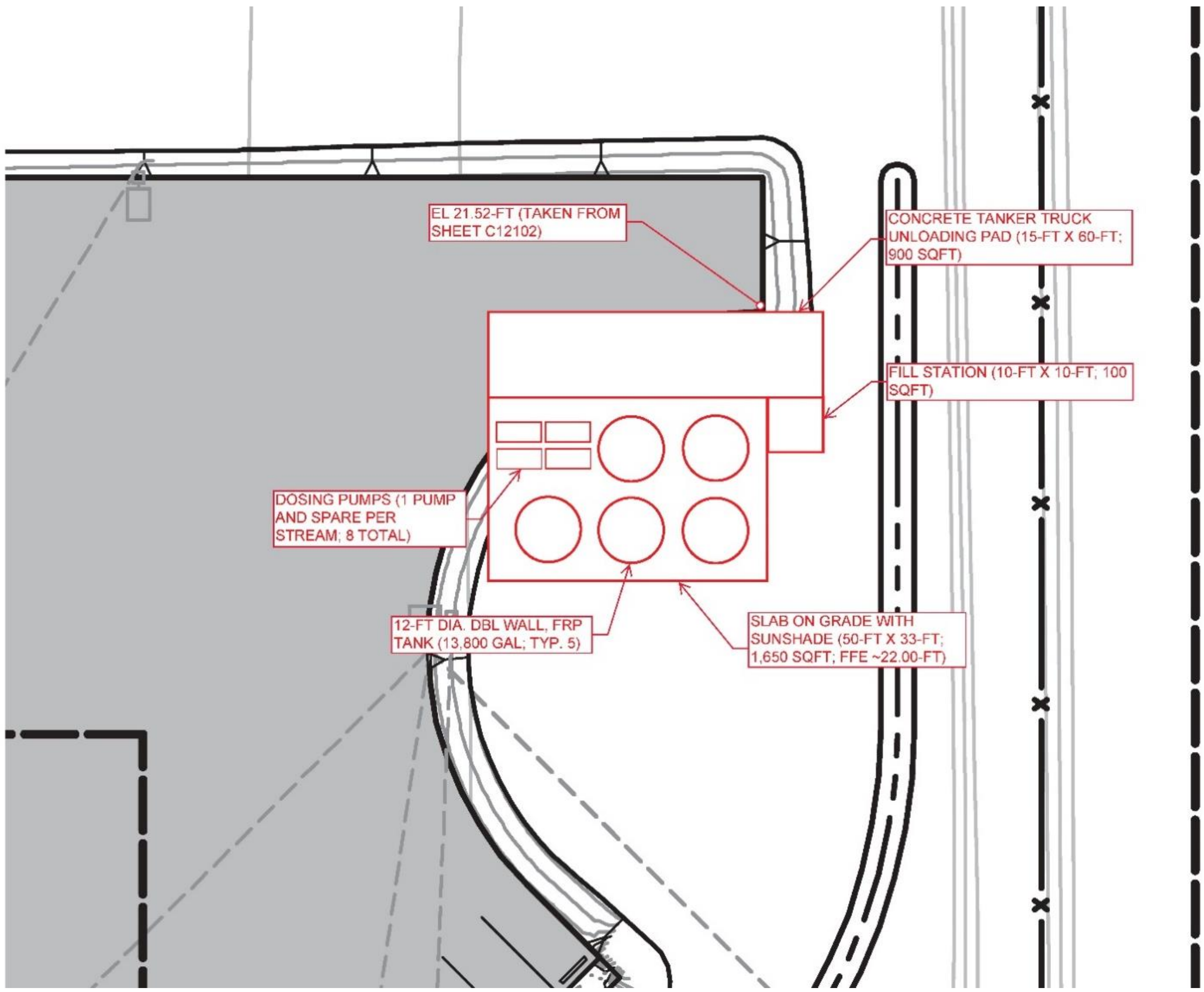


Figure 3-23. C-43 Inline Alum System Conceptual Layout Plan

4.0 Recommendations

The desktop siting analysis (Section 2.1) assisted in identifying potential locations for the C-43 WBSR WQC by eliminating areas with existing or future constraints. Planned residential development constraints are to the north and south of the reservoir. The lands to the east and west of the reservoir are not limited by planned developments or zoning; however, they are privately owned agricultural (citrus) production lands. Lands to the west of the reservoir were removed from consideration as water would need to be pumped over the Townsend Canal in order to reach the conveyance features and publicly owned lands. In addition, a water reservation specific to the C-43 WBSR (subsection 40E-10.041[3], Florida Administrative Code) requires all stored water be sent to the Caloosahatchee River and Estuary for protection of fish and wildlife. Redirecting any stored water from the C-43 WBSR to the west would significantly impact the C-43 WBSR primary project purpose and operation by reducing the reservoir's target flow efficiency to meet the water reservation and MFL. In addition, the infrastructure envisioned to make the flow connections to the west may trigger dam and public safety concerns. Therefore, the SFWMD-owned lands were identified as the best option for locating the WQC.

The acreage of wetlands and location of cultural resources that would be potentially impacted by the WQC is minimal, and avoidance of these features is recommended. One contamination site is located on the S-4 parcel, which contains copper-contaminated soil from the reservoir footprint. This area would need to be remediated or capped (depending on use) prior to construction if it cannot be avoided. Numerous protected species could be affected by the WQC; however, the overall improvements from the project could offset any adverse impacts. Consultation with USFWS will likely be required. Overall, the Siting Evaluation criteria matrix ranked the technologies in the following order: (1) offline alum treatment, (2) sand filter with Bold and Gold®, (3) HWTT, (4) STA with Bold and Gold®, and (5) full-scale STA.

As part of the Siting Evaluation, J-Tech explored multiple options to route water from the C-43 WBSR to the WQC for treatment and then, after treatment, from the WQC back to the Caloosahatchee River. The alternatives discussed herein are feasible and considered to be most cost-effective. Some of the alternatives may require additional land acquisition or flow easements, which will bring additional costs. All the conveyance alternatives will require improvements to water conveyance features; however, the offline alum treatment facility will require capacity improvements to only 1,000 feet of NRC, which will gravity feed back to the Townsend Canal. Detailed cost estimates will be determined as part of the Conceptual Design for Phase 2.

Updated water quality targets were developed for the purpose of the Siting Evaluation and additional analysis was performed to ensure the sizing of the technologies was appropriate. The four treatment technology alternatives recommended in the WQFS remain feasible in terms of overall performance for the refined TN and TP targets. Based on discussions with the SFWMD Design Review Team and the Working Group members, the focus on the WQC sizing will be to achieve the TN and TP target concentrations and not overdesigned to achieve the refined TSS target.

The offline alum treatment, HWTT, STA with Bold and Gold®, and sand filter with Bold and Gold® alternatives remained at a size sufficient to fit within the current, SFWMD-owned lands. Relatively minor modifications to area and performance were noted. The 5,000-ac STA is also able to achieve target concentrations. Evaluation of a full-scale STA was included in the Siting Evaluation due to stakeholder input; however, the lands required for a full-scale STA exceed the SFWMD-owned lands near the C-43 WBSR resulting in the need for acquisition.

Based on the results of the Siting Evaluation, the lands to the north and east of the reservoir were evaluated at a concept level to prepare rough order of magnitude costs. The full-scale STA requires the construction of a three-mile distribution canal to provide water from the C-43 WBSR Cell 2 to the higher elevation STA cells at the south end of project. The water would need to be pumped over the Banana Branch Canal to treat reservoir-specific flows. The topography of these lands includes an approximately six-foot drop in elevation moving north back toward the Caloosahatchee River. Although it may be considered an advantage to flow water by gravity through the STA cells, the change in elevation will require extensive regrading to support the STA vegetation, avoid short circuiting, and ensure accurate operation of the STA to meet water quality targets. Discharge flows could be sent to the Caloosahatchee River via the Banana Branch Canal; however, significant improvements and channelization would be required to accommodate flows, which would result in the need for additional land acquisition. Ultimately, the rough order of magnitude costs for an STA in the general area of the C-43 WBSR is estimated at approximately $300 million, which includes an estimate of $50 million in land purchase costs, only for the lands required for the STA itself. In addition, Hendry County expressed socio-economic concerns about additional lands being acquired for the STA. They noted that a large portion of the county is already covered by conservation easements, mitigation banks, wetland reserve program easements, SFWMD and DEP lands, and C-43 WBSR. Acquiring the conceptual site for the STA would remove those parcels from future development, especially given the location along three major roads, and would affect the future tax benefits to the county and City of LaBelle. The purpose of the C-43 WQFS and Siting Evaluation was to conduct an extensive evaluation of both conventional and innovative technologies to determine the most cost-effective technology for treatment of Caloosahatchee River water, which is predominantly dissolved organic nitrogen, as well as that will work within the many constraints of the existing C-43 WBSR project and surrounding area. STAs are more efficient at treating TP, and not as efficient at treating dissolved organic nitrogen, and there are siting constraints to locating an STA of adequate size to treat the necessary C-43 WBSR flows. Therefore, for all these reasons, the full-scale STA option will not move forward to Conceptual Design.

The offline alum treatment system, HWTT, STA with Bold and Gold®, and sand filter with Bold and Gold® alternatives will go to Conceptual Design to further develop the WQC components, site layout, water conveyance, treatment capabilities, and costs. Upon completion of the Conceptual Designs, one of the alternatives will be selected as the WQC Plan. In addition, through a parallel effort, the inline alum treatment system will be designed, to be constructed concurrently with the C-43 WBSR.

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Appendix A: Protected Species List

Class	Scientific Name	Common Name	State Status[1]	Federal Status	Potential of Occurrence	Further Action Required	Habitats Used
Birds							
	Ammodramus savannarum floridanus	Florida grasshopper sparrow	Endangered	Endangered	Low		Florida grasshopper sparrow is non-migratory, and is limited to the prairie region of south-central Florida
	Antigone canadensis pratensis	Florida sandhill crane	Threatened	–	Moderate		Most of peninsular FL within appropriate habitat; rare south of Lake Okeechobee. Prairies, freshwater marshes, and pasture lands..
	Aphelocoma coerulescens	Florida scrub-jay	Threatened	Threatened	Low		Restricted to peninsular Florida, with largest populations occurring in Brevard, Highlands, Polk, and Marion counties Inhabits fire dominated, low-growing, oak scrub habitat found on well-drained sandy soils.
	Aramus guarauna	Limpkin	No longer listed, but part of ISMP	–	Moderate		Mangrove Swamp, Freshwater Marsh & Ponds, Cypress Swamp, Springs, Slough, Sawgrass Marsh, Ruderal (impoundments, canals, sugarcane, etc.)
	Athene cunicularia floridana	Florida burrowing owl	Threatened	–	Low		N. & S. FL Flatwoods (dry prairie or grassland habitat), Ruderal (primarily pasture)
	Caracara cheriway	Crested caracara	Threatened	Threatened	Moderate	√	Most abundant in south-central Florida in Osceola, Highlands, Okeechobee, De Soto, Glades, and Hendry counties. Open country, including dry prairie and pasture lands with cabbage palm, cabbage palm/live oak hammocks, and shallow ponds and sloughs.
	Egretta caerulea	Little blue heron	Threatened	–	Moderate		N. & S. FL Coastal Strand, Wet Prairie or Slough, Freshwater Marsh & Ponds, Mangrove Swamps, Cypress Swamp, Sawgrass Marsh, Salt Marsh, Shrub Bog & Bay Swamp, Ruderal
	Egretta thula	Snowy egret	No longer listed, but part of ISMP	–	Moderate		N. & S. FL Coastal Strand, Wet Prairie or Slough, Freshwater Marsh & Ponds, Mangrove Swamps, Cypress Swamp, Sawgrass Marsh, Salt Marsh, Shrub Bog & Bay Swamp, Ruderal
	Egretta tricolor	Tricolored heron	Threatened	–	Moderate		N. & S. FL Coastal Strand, Wet Prairie or Slough, Freshwater Marsh & Ponds, Mangrove Swamps, Cypress Swamp, Sawgrass Marsh, Salt Marsh, Shrub Bog & Bay Swamp, Ruderal
	Eudocimus albus	White ibis	No longer listed, but part of ISMP	–	Moderate		N. & S. FL Coastal Strand, Wet Prairie or Slough, Freshwater Marsh & Ponds, Mangrove Swamps,

Class	Scientific Name	Common Name	State Status[1]	Federal Status	Potential of Occurrence	Further Action Required	Habitats Used
							Cypress Swamp, Sawgrass Marsh, Salt Marsh, Shrub Bog & Bay Swamp, Ruderal
	Falco sparverius paulus	Southeastern American kestrel	Threatened	–	Low		Open Forests, Clearings, Ruderal, Various Open Habitats
	Haliaeetus leucocephalus	American Bald eagle	No longer listed	–	Low		Nearly throughout (estuarine, lacustrine, riverine, terrestrial); nests are usually near water
	Mycteria americana	Wood stork	Threatened	Threatened	Moderate		N. & S. FL, Everglades & Cabbage Palm Flatwoods, Pitcher Plant Bog, Sloughs, Sawgrass Marsh, Swamp & Bottomland Hardwoods, Cypress Swamp, Freshwater Marsh & Ponds, Salt Marsh, Wetland Hardwood Hammock, Shrub Bog and Bay Swamp, Cutthroat Seeps
	Rostrhamus sociabilis	Snail kite	Endangered	Endangered	Low		Formerly in freshwater marshes throughout peninsular Florida. Also smaller wetlands in above counties plus St. Lucie, Martin, Hendry, and Lee counties. Large open freshwater marshes and lakes with shallow water.
Mammals							
	Eumops floridanus	Florida bonneted bat	Endangered	Endangered	Low	√	Few counties in south FL. Forages in semitropical forests with tropical hardwood, pineland, and mangrove habitats, as well as man-made areas such as golf courses and neighborhoods.
	Puma concolor coryi	Florida panther	Endangered	Endangered	Low	√	Collier, Glades, and Lee counties; dispersing individuals may range well north. Requires extensive blocks of mostly forested communities. Large wetlands that are generally inaccessible to humans are important for diurnal refuge.
	Sciurus niger avicennia	Big Cypress fox squirrel	Threatened	–	Moderate		Occurs southwest of Lake Okeechobee and south of the Caloosahatchee River. A variety of forested habitats with open to moderately dense understory and shrub cover.
Reptiles							
	Alligator mississippiensis	American alligator	Threatened (Similarity of Appearance to the American Crocodile)	Federally-designated Threatened (Similarity of Appearance)	Low		All Flatwoods, Bogs, Sloughs, Swamps, Marshes, Sloughs and Perennial Water Bodies

Class	Scientific Name	Common Name	State Status[1]	Federal Status	Potential of Occurrence	Further Action Required	Habitats Used
	Drymarchon corais couperi	Eastern indigo snake	Threatened	Threatened	Moderate	√	E. indigo snakes use just about all FL Ecol. Communities, Ruderal.
	Gopherus polyphemus	Gopher tortoise	Threatened	–	Moderate	√	N. & S. Coastal Strand, Longleaf Pine/Turkey Oak Hills, Sand Pine Scrub, Scrubby Flatwoods, Tropical Hammock, Ruderal

Appendix B: Soil Types

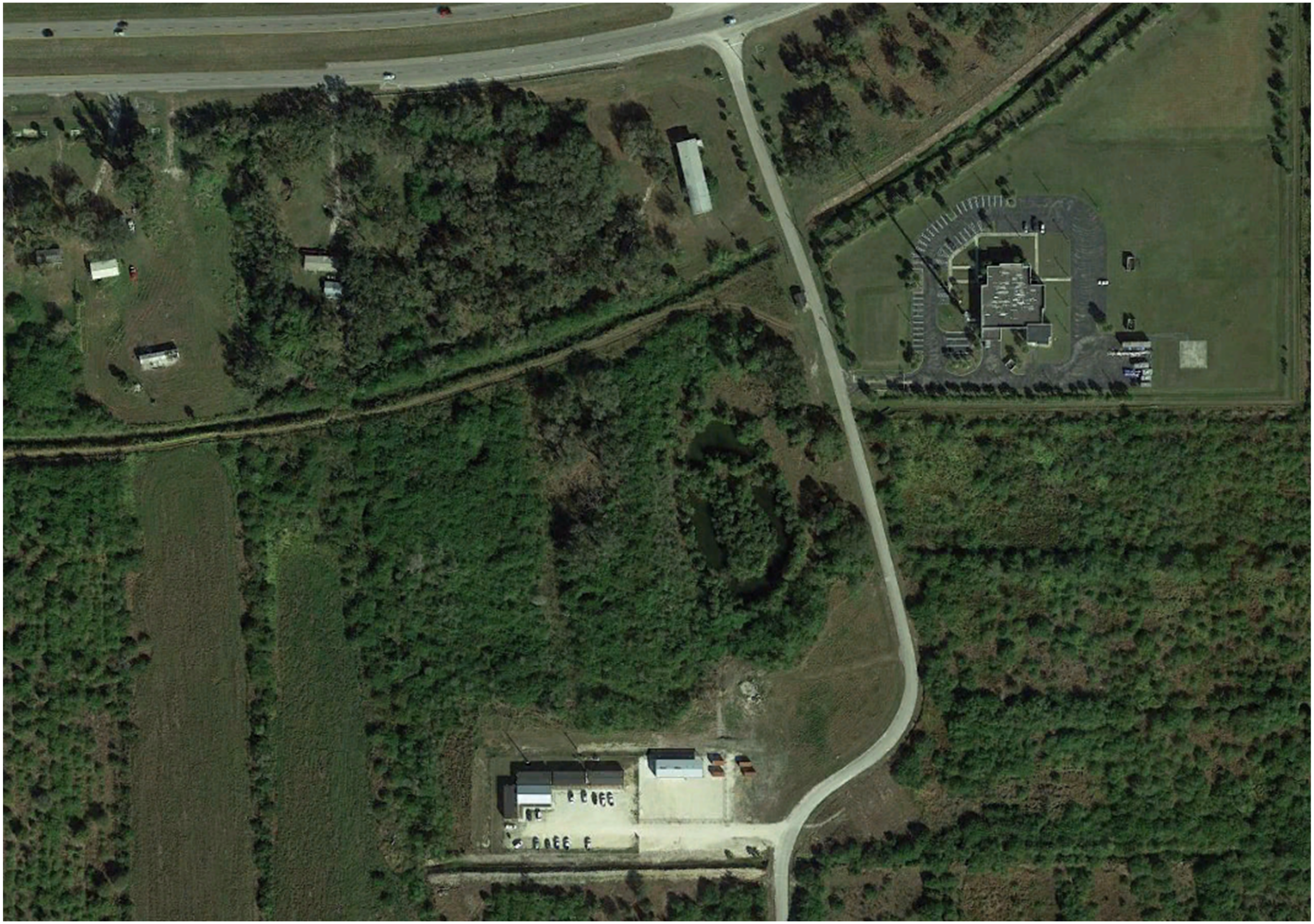
Soil Type	Sum of acr
Anclote sand, frequently ponded, 0 to 1 percent slopes	14.4
Aquents, organic substratum	128.4
Basinger fine sand, frequently ponded, 0 to 1 percent slopes	11.2
Basinger sand, 0 to 2 percent slopes	776.9
Boca fine sand, 0 to 2 percent slopes	1300.0
Boca fine sand, slough, 0 to 1 percent slopes	277.9
Boca fine sand, slough-Urban land complex, 0 to 1 percent slopes	766.0
Boca fine sand-Urban land complex, 0 to 2 percent slopes	3421.1
Boca sand	6704.8
Boca sand, depressional	276.0
Bradenton fine sand, 0 to 2 percent slopes	303.0
Bradenton fine sand-Urban land complex, 0 to 2 percent slopes	140.3
Caloosa fine sand, 0 to 2 percent slopes	236.0
Chobee fine sandy loam, frequently ponded, 0 to 1 percent slopes	638.5
Chobee fine sandy loam, limestone substratum, depressional	326.9
Cocoa fine sand, 0 to 2 percent slopes	56.0
Copeland fine sandy loam, frequently ponded, 0 to 1 percent slopes	494.6
Copeland fine sandy loam, ponded-Urban land complex, 0 to 1 percent slopes	147.7
Daytona sand, 0 to 5 percent slopes	222.2
Daytona sand-Urban land complex, 0 to 5 percent slopes	13.5
Delray sand, depressional	6.9
EauGallie fine sand, 0 to 2 percent slopes	4.0
EauGallie sand-Urban land complex, 0 to 2 percent slopes	116.7
Electra fine sand, 0 to 2 percent slopes	367.8
Electra fine sand-Urban land complex, 0 to 2 percent slopes	200.8
Felda fine sand, 0 to 2 percent slopes	462.5
Felda fine sand, frequently ponded, 0 to 1 percent slopes	162.3
Felda fine sand, ponded-Urban land complex, 0 to 1 percent slopes	94.4
Felda fine sand-Urban land complex, 0 to 2 percent slopes	65.8
Floridana sand, frequently ponded, 0 to 2 percent slopes	7.9
Floridana sand, ponded-Urban land complex, 0 to 1 percent slopes	24.5
Gator muck, frequently ponded, 0 to 1 percent slopes	900.7
Gator muck, ponded-Urban land complex, 0 to 1 percent slopes	8.8
Gentry fine sand, depressional	88.6
Hallandale fine sand, wet, 0 to 2 percent slopes	259.4
Hallandale fine sand, wet-Urban land complex, 0 to 2 percent slopes	153.9
Hallandale sand, 0 to 2 percent slopes	133.8
Holopaw sand, 0 to 2 percent slopes	2339.8
Holopaw sand, frequently ponded, 0 to 1 percent slopes	1414.3
Immokalee sand, 0 to 2 percent slopes	6243.0
Immokalee sand-Urban land complex, 0 to 2 percent slopes	264.7
Isles fine sand, frequently ponded, 0 to 1 percent slopes	50.1
Isles fine sand, ponded-Urban land complex, 0 to 1 percent slopes	19.1
Jupiter fine sand, 0 to 2 percent slopes	69.5
Malabar fine sand, 0 to 2 percent slopes	116.8
Malabar fine sand, high, 0 to 2 percent slopes	4311.3

Malabar fine sand, high-Urban land complex, 0 to 2 percent slopes	1044.7
Malabar fine sand, ponded-Urban land complex, 0 to 1 percent slopes	98.3
Malabar fine sand-Urban land complex, 0 to 2 percent slopes	2339.6
Malabar sand, 0 to 2 percent slopes	4933.2
Malabar sand, frequently ponded, 0 to 1 percent slopes	813.0
Matlacha gravelly fine sand, 0 to 2 percent slopes	7.2
Matlacha gravelly fine sand, limestone substratum, 0 to 2 perent slopes	58.4
Matlacha gravelly fine sand, limestone substratum-Urban land complex, 0 to 2 percent slopes	3.9
Matlacha gravelly fine sand-Urban land complex, 0 to 2 percent slopes	266.6
Myakka fine sand, 0 to 2 percent slopes	225.6
Myakka fine sand, frequently ponded, 0 to 1 percent slopes	22.7
Myakka fine sand, ponded-Urban land complex, 0 to 1 percent slopes	32.4
Myakka fine sand-Urban land complex, 0 to 2 percent slopes	69.0
Myakka sand, 0 to 2 percent slopes	453.9
Myakka sand, depressional	29.8
Okeelanta muck	190.2
Okeelanta muck, frequently ponded, 0 to 1 percent slopes	4.3
Oldsmar fine sand, limestone substratum, 0 to 2 percent slopes	133.4
Oldsmar fine sand, limestone substratum-Urban land complex, 0 to 2 percent slopes	1006.1
Oldsmar sand, 0 to 2 percent slopes	11885.1
Oldsmar sand, depressional	32.6
Oldsmar sand, limestone substratum	5182.3
Oldsmar sand-Urban land, 0 to 2 percent slopes	1269.2
Pahokee muck, drained, 0 to 1 percent slopes	14.8
Pineda fine sand, frequently ponded, 0 to 1 percent slopes	56.1
Pineda fine sand, limestone substratum, 0 to 2 percent slopes	3.8
Pineda fine sand, limestone substratum-Urban land complex, 0 to 2 percent slopes	2307.8
Pineda fine sand, ponded-Urban land complex, 0 to 1 percent slopes	280.9
Pineda fine sand-Urban land complex, 0 to 2 percent slopes	538.3
Pineda sand, depressional	1876.8
Pineda sand, limestone substratum	5398.1
Pineda-Pineda, wet, fine sand, 0 to 2 percent slopes	1621.0
Pomello fine sand, 0 to 5 percent slopes	269.4
Pompano fine sand, ponded-Urban land complex, 0 to 1 percent slopes	9.0
Pompano sand, 0 to 2 percent slopes	249.2
Riviera fine sand, 0 to 2 percent slopes	1279.6
Riviera sand, frequently ponded, 0 to 1 percent slopes	3142.9
Riviera sand, limestone substratum	3034.8
Riviera sand, limestone substratum, depressional	323.5
Terra Ceia muck, frequently ponded, 0 to 1 percent slopes	62.9
Terra Ceia muck, ponded-Urban land complex, 0 to 1 percent sloeps	23.1
Tuscawilla fine sand	1404.5
Udifluvents	1725.2
Udorthents	350.9
Valkaria sand	97.0
Wabasso sand, 0 to 2 percent slopes	2467.2
Wabasso sand, limestone substratum, 0 to 2 percent slopes	7377.0

Wabasso sand, limestone substratum-Urban land complex, 0 to 2 percent slopes	1200.5
Wabasso sand-Urban land complex, 0 to 2 percent slopes	17.3
Water	984.8
Winder fine sand, 0 to 2 percent slopes	191.3
Winder fine sand, frequently ponded, 0 to 1 percent slopes	413.0
Winder sand, frequently ponded, 0 to 1 percent slopes	10.7
Winder sand, ponded-Urban land complex, 0 to 1 percent slopes	29.1
Wulfert muck, tidal, 0 to 1 percent slopes	3.8
Wulfert muck, tidal-Urban land complex, 0 to 1 percent slopes	7.1
Grand Total	**101015.7**

Appendix C: Photographs from the Ground Investigation

RESERVOIR ACCESS ROAD AND TRAILERS



Google Earth – showing Congen Road, Hendry County EOC upper Right, Project Construction Trailer Complex – lower left

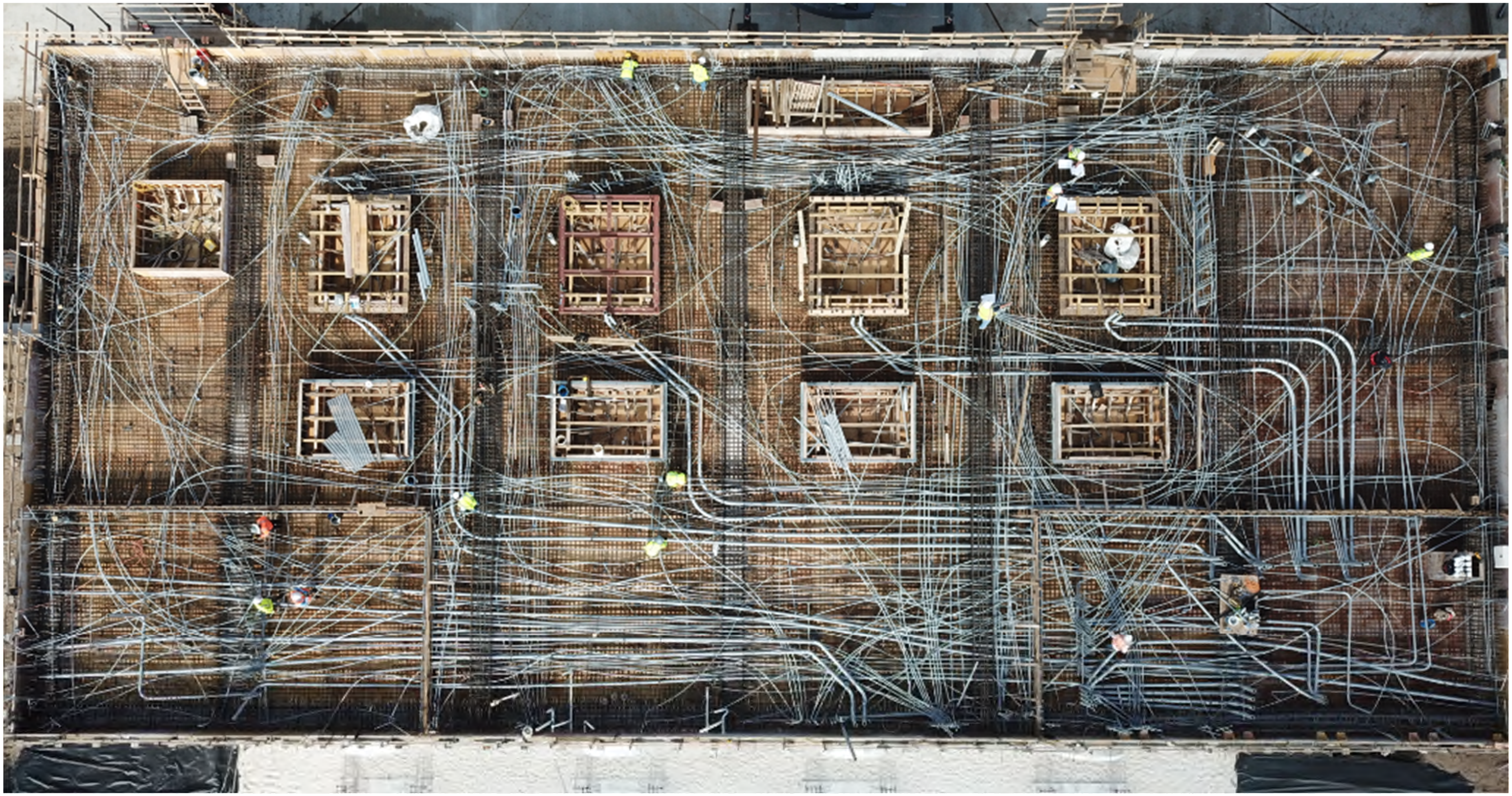
Congen Road entrance off SR80 – Looking South – (2/09/21)

TOWNSEND CANAL AND PERIMETER CANAL DISCHARGE LOCATIONS

Google Earth Image – Pump Station S-470, Shows Townsend canal (Center).

Drone Image – Townsend canal looking south at the SR80 bridges (near the top of the photo). Small wood bridge in foreground is farmer's bridge.

PUMP STATION PHOTOS



Drone Image – Showing conduit network – Alum conduits added to area in lower right corner. (zoom in to find people for scale)

Drone Image – Pump Station S470 from December 2020. Townsend Canal in background. Reservoir to the left, SR 80 to the right.

S-381 STRUCTURE COMPLEX

CONFLUENCE OF BANANA BRANCH CANAL,
PERIMETER CANAL, AND BERRY FARMS DITCH #2

Photo of perimeter canal and the S381 structure complex at the intersection of the Banana Branch/FPL right-of-way, looking east.
Perimeter Canal runs (off the page to the top) or East in this photo. Banana Branch is running north/south (across the page). December 2020.

Banana Branch channel at perimeter Canal intersection looking North, February 9, 2021 (Dry Season) – (2/09/21)

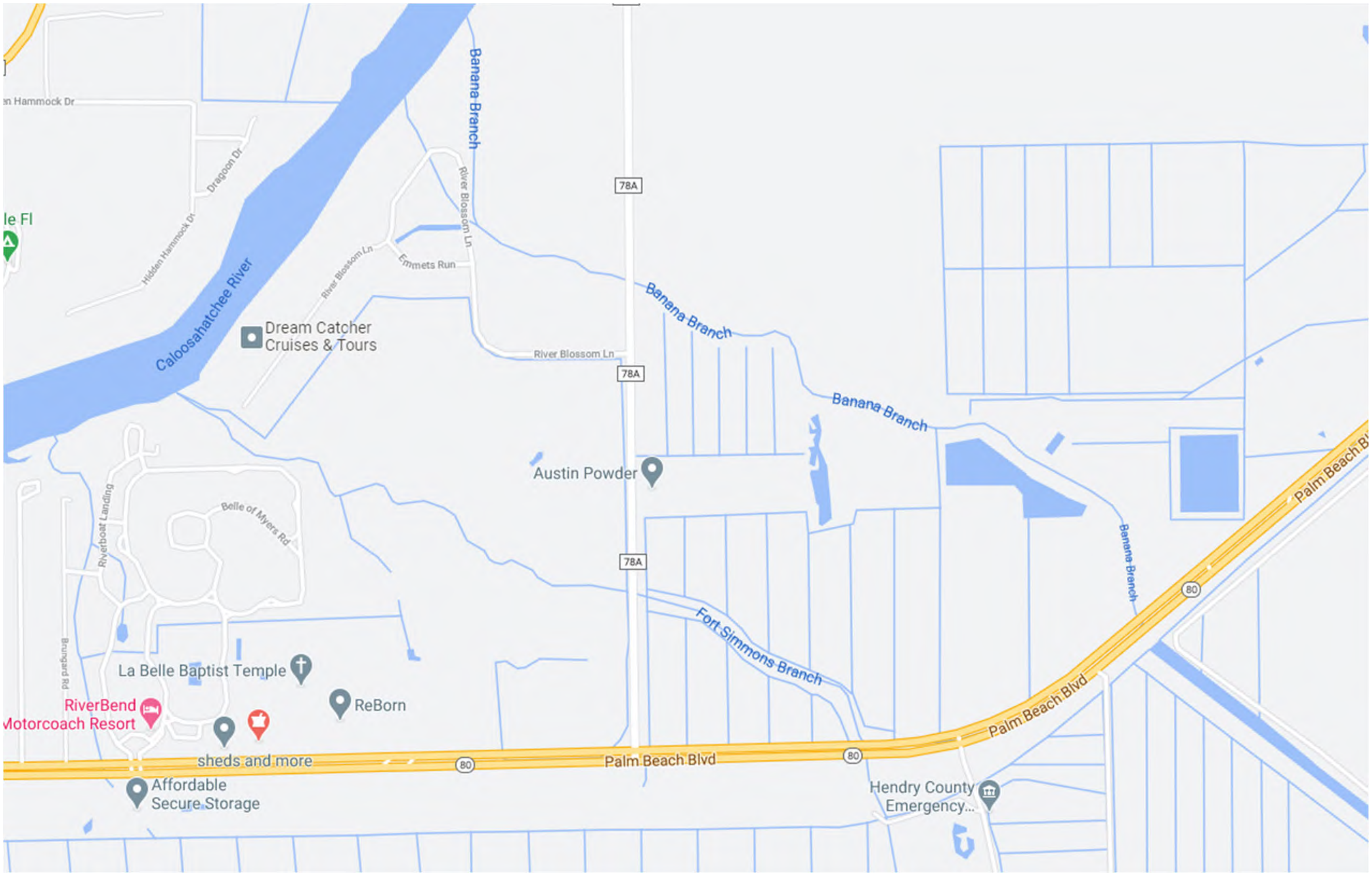

Banana Branch channel at perimeter Canal intersection looking South, (Dry Season – 2/09/21)

Banana Branch channel at perimeter Canal intersection looking East, (Dry Season – 2/09/21)

Banana Branch channel at perimeter Canal intersection looking West, February 9, 2021 (Dry Season), S381A, B & C in background

Berry Farms – Ag Ditch #2. Looking down facing the east. Ditch is overgrown and no photos of the channel were available. Location is at S381 complex, to the right in this photo. This is where S-381B will connect the perimeter canal to the Berry Farms #2 Ditch. – (2/09/21)

BANANA BRANCH CANAL DISCHARGE THROUGH OLD FORT DENAUD



Entrance to residential development near the Banana Branch Discharge into the C43. (2/9/21)

Original Banana Branch Channel (discharge). Looking NW toward the C43 in background. Channel used as residential discharge swale now. Water control structure in photo drains under road and into the new channel of the Banana Branch. – (2/09/21)

Discharge pipe from previous picture discharging into the Banana Branch. Banana Branch is a stream in this area. – (2/09/21)

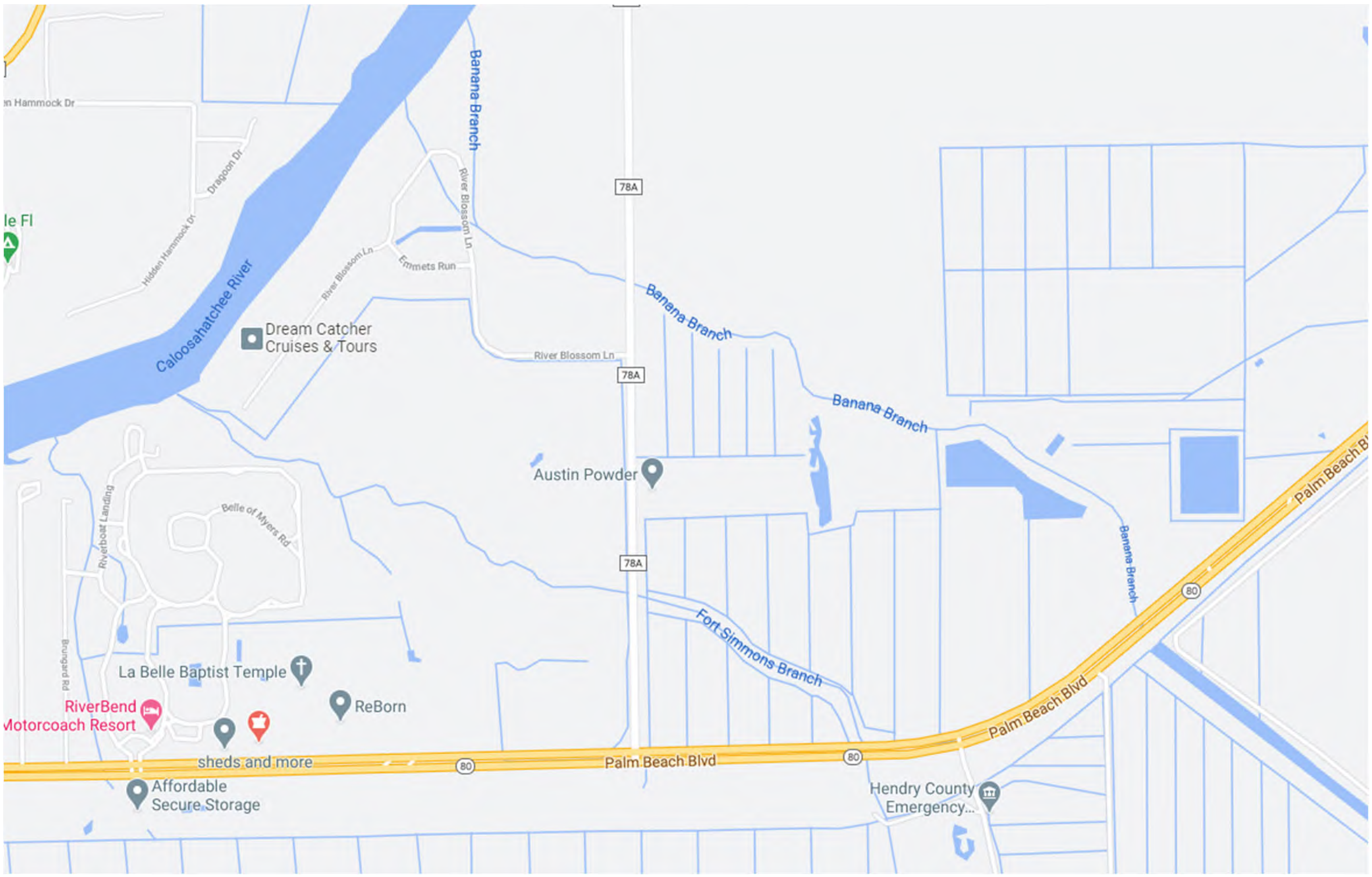
Roadside swale with catch basin looking south. Banana Branch channel in shadows in this image running across the page from right to left. – (2/09/21)

River Blossom Lane – in Old Fort Denaud development looking South. Banana Branch channel under and just left of tree canopy in this picture. – (2/09/21)

Banana Branch along River Blossom Lane in Old Fort Denaud development (2/09/21)

FORT SIMMONS BRANCH

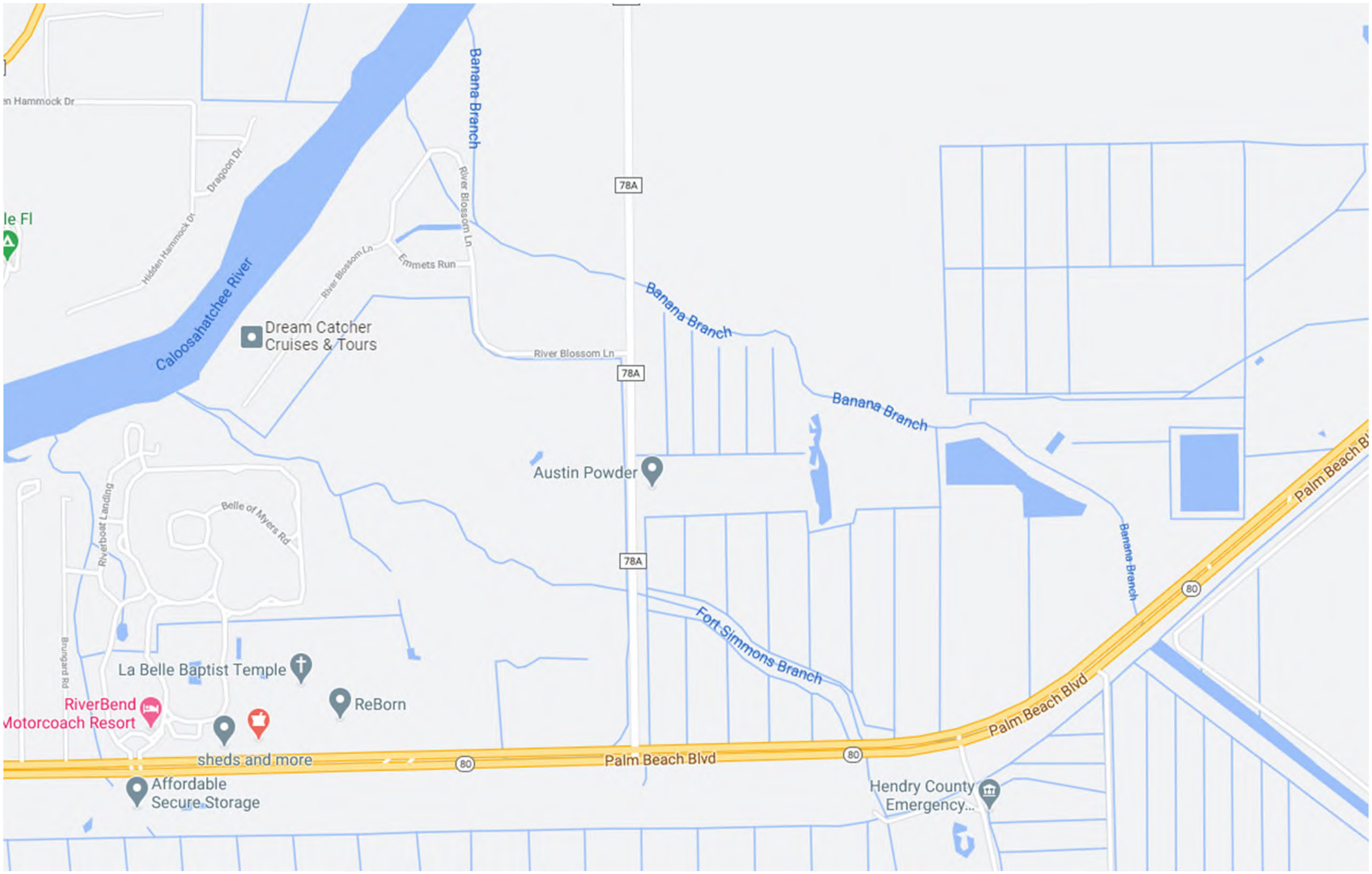
FROM BERRY FARMS CANAL UNDER FORT DENAUD ROAD



Fort Simmons Branch under Fort Denaud Road – looking East (2/9/21)

Fort Simmons Branch under Fort Denaud Road – looking West (2/9/21)

BANANA BRANCH AND SR-80



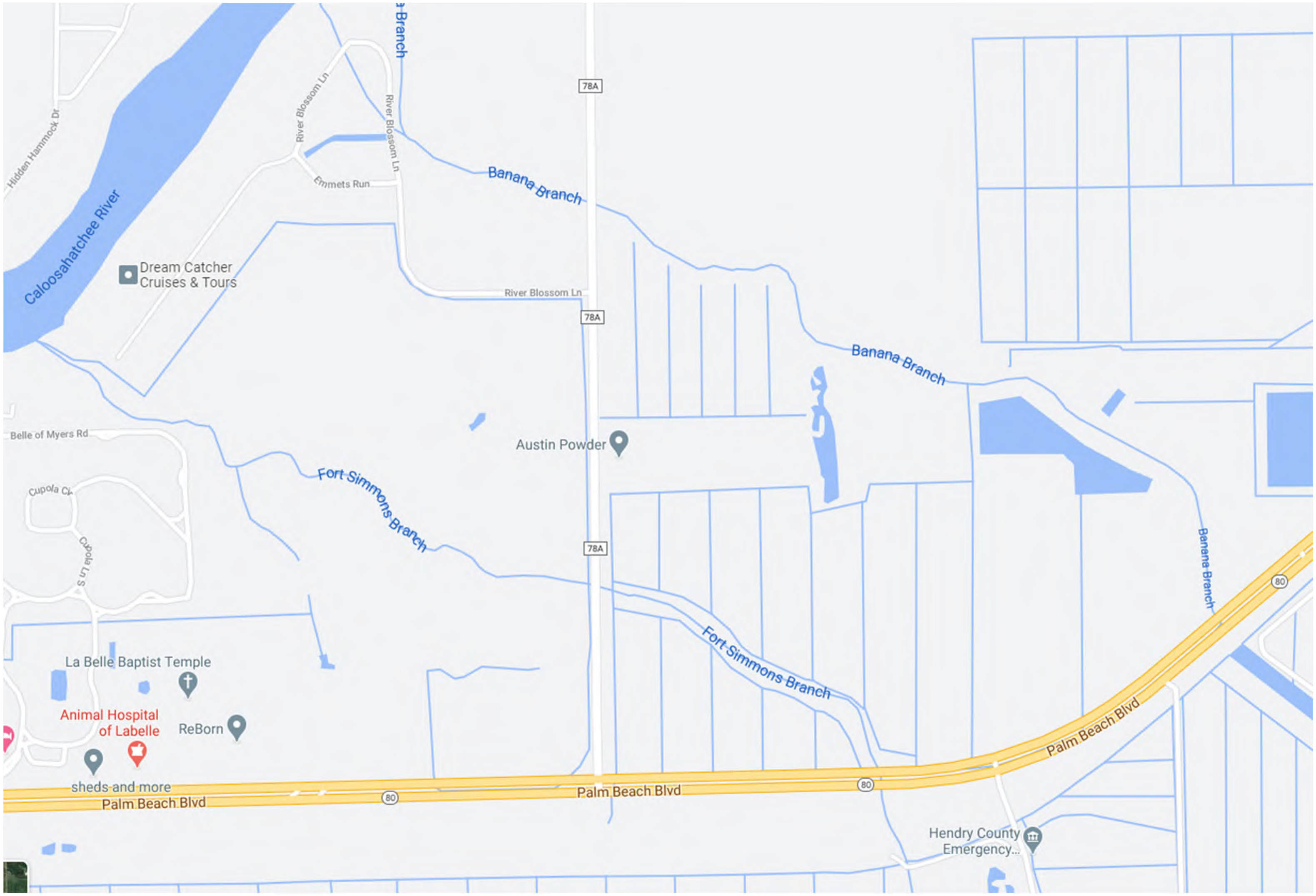
Google Earth Image – Banana Branch flowing from lower right (SE) to the upper left (NW). Image date unknown (~2019)

Banana Branch – SE bank looking NW. SR-80 Eastbound lane in foreground. – (2/09/21)

Banana Branch – SE bank looking NW. SR-80 Eastbound lane in foreground. – (2/09/21)

SR-80 Eastbound lane looking West – Banana Branch runs from Left to right in this photo – (2/09/21)

FORT DENAUD (SR-78A) CULVERT CROSSING BANANA BRANCH



Google Earth Image. Banana Branch – Fort Denaud Road Crossing

Banana Branch – Fort Denaud Road Crossing – West side of the road looking South – (2/09/21)

Banana Branch – Fort Denaud Road Crossing –East side of the road looking West at box culvert crossing – (2/09/21)

DUDA DISCHAGE AND PUMPS STATION STRUCTURES

Google earth image. Shows Duda Pump Station (main structure in center channel) and Duda discharge structure (right channel)

Duda Discharge Structure. Discharges into Townsend Canal. Looking SW. Note upstream water level (2/9/21)

Duda Discharge Structure. Discharges into Townsend Canal. Looking SW. Note upstream water level (2/9/21). Duda Pump station in background. Gate was locked – could not get to pump station

Duda Discharge Structure. Discharges into Townsend Canal. Looking SW. Note downstream water level (2/9/21)

Duda Pump Station. Intake from Townsend Canal. Looking SW. Zoomed in with camera. Did not cross the fence. (2/9/21)

NORTH RIM DITCH

6. North rim ditch

Google image of Double J Subdivision. North Rim Ditch on North side of development.

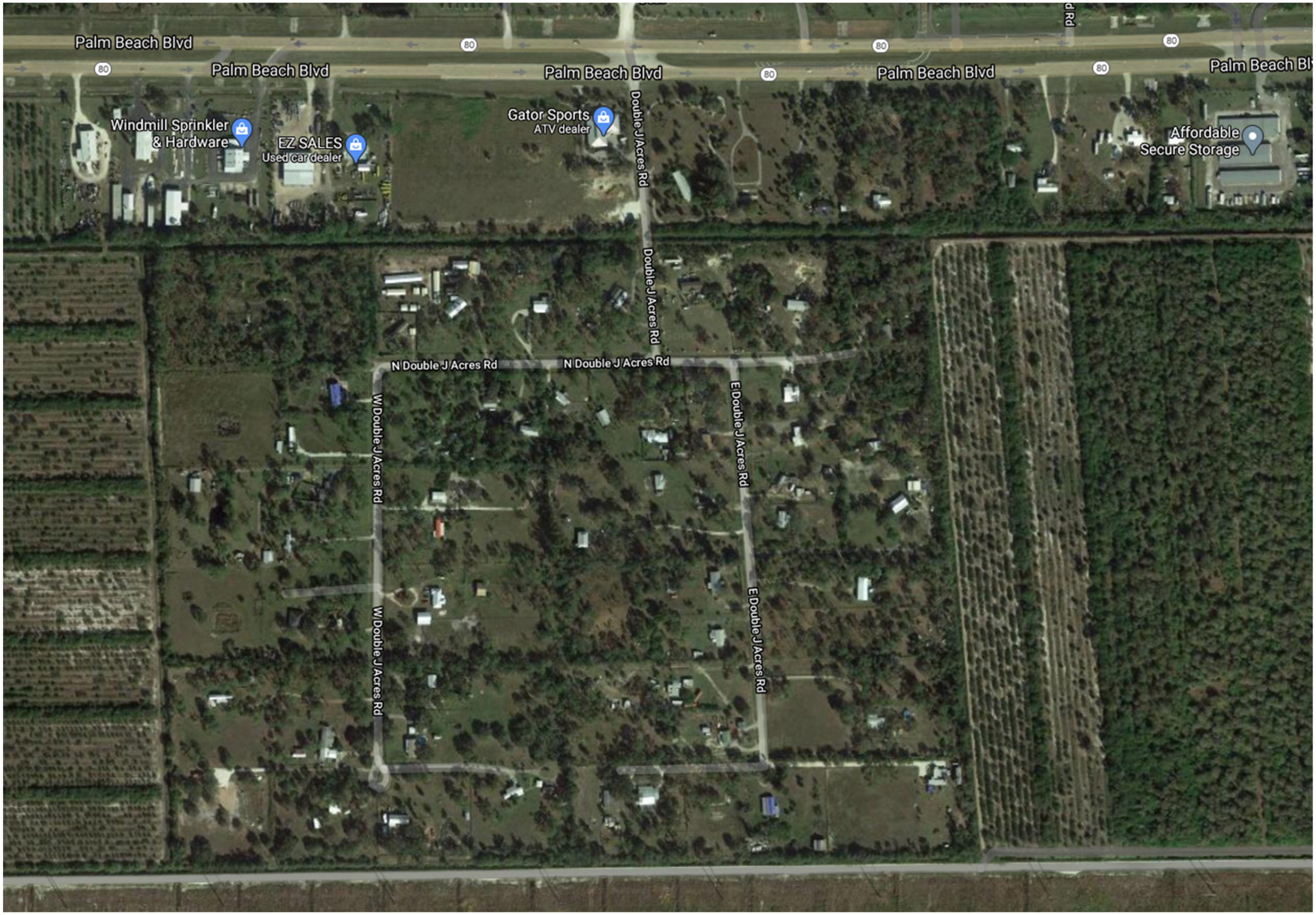
North Rim Ditch on West end of Site (2/9/21)

North Rim Ditch at Congen Road – Entrance to the project site/Reservoir complex – Looking NE, Hendry County EOC to right in this image. (2/9/21)

North Rim Ditch at Double J – Looking East – (2/9/21)

North Rim Ditch at Double J – Looking West– (2/9/21)

DOUBLE J Development



Google Image of Double J Development

Entrance onto Double J Road off of SR 80 looking South (2/9/21)

Double J Road entrance off of SR80 – Looking South (Showing street sign) - (2/9/21)

AG DITCH SOUTH BORDER OF DOUBLE J

Google Image – showing South Side of Double J. Ag ditch is located just north of the white road in this image.
If you look closely you can see the FPL transmission lines. White Rock road is service road and just north of transmission line guy wires.

Ag-Ditch just south of Double J – Residence on right side of photo is just north of the Ag-Ditch – looking West – (2/09/21)

Ag-Ditch just south of Double J – Residence in background of photo is just north of the Ag-Ditch – looking North (2/09/21). Truck shown for scale.