Information Collection Summary Report

Picayune Watershed Water Quality Feasibility Study

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Executive Summary

The South Florida Water Management District (District), Florida Department of Environmental Protection (FDEP), Collier County, and other local stakeholders have formed a Working Group to conduct this Picayune Watershed Water Quality Feasibility Study (Study) to address increased nutrient inflows for primarily Total Phosphorus (TP) and Total Nitrogen (TN). This will be accomplished through identification of potential treatment technologies based on a review of literature and other information identified by the Working Group. The Information Collection Summary Report presents the results of review of documents, web links and other information provided by the working group. The report also includes detailed descriptions of the nutrient treatment technologies found in the reviewed information and provides general recommendations regarding which technologies to focus on during the Task 4 Feasibility Study task that will follow this report.

This document summarizes the review of information provided by the Working Group, focusing on technologies identified within those resources. Overall, a total of 19 treatment options are described in detail within this report. Eleven proven technologies in common use were identified in numerous documents and are included as 'Applicable' project types below, including constructed treatment wetlands, detention areas and settling ponds, spreader swales and berms, restored wetland systems, air diffusion systems, the growth and removal of periphyton and submerged aquatic vegetation (SAV), polishing ponds, hybrid wetland treatment technology, bioreactors, iron enhanced sands, and Bold & Gold® filtration media .

Eight additional 'Non-Applicable' technologies are described below because they were identified in the reviewed documents as potential technologies for nutrient removal in previous South Florida studies. These include novel concepts that have generally only been demonstrated for smaller scale systems, including recyclable water containment areas, algal scrubbers, alum treatment systems, floating treatment wetlands, NutriGone Media™, Downstream Defender®. Aquifer storage and recovery (ASR), and deep well injection. Although these technologies appeared in the reviewed literature, none of these are recommended for additional consideration.

It is recommended that the Applicable treatment options be considered for further evaluation under the Task 4 Feasibility Study, possibly combining multiple technologies into a treatment train. It is also recommended that the operation and maintenance of treatment systems chosen for further investigation consider a sediment and or vegetative removal component. These options can prevent filtered nutrients from being re-released to downstream Outstanding Florida Waters (OFWs) through disturbance of sediments or the death and decomposition of vegetative growth. Several potential project locations are also discussed in this Study. Depending on the areas identified as potential locations for projects in Task 4, land availability for potential projects may require that the other novel technologies listed above also be considered.

1.0 INTRODUCTION AND BACKGROUND

On January 10, 2019, Florida 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 agencies to take a more aggressive approach to address some of the environmental issues plaguing the state, with a significant emphasis on south Florida and water quality. The Picayune Strand Restoration Project (PSRP) is currently under construction north of the proposed water quality feasibility study area. The PSRP will increase discharges to Outstanding Florida Waters (OFWs) within Collier-Seminole State Park, Rookery Bay Estuarine Research Reserve, and the Cape Romano – Ten Thousand Islands Aquatic Preserve. A map of the area can be found in **Appendix A**. Additionally, these downstream estuaries have been assigned estuarine specific Numeric Nutrient Criteria by the Florida Department of Environmental Protection. Given the importance of the State Park and Aquatic Preserve water resources, this proposed water quality feasibility study will review existing data, evaluate sub-regional water quality conditions of flows into Collier-Seminole State Park, Rookery Bay National Estuarine Reserve, and Ten Thousand Islands National Wildlife Refuge and develop options to address those concerns.

The South Florida Water Management District (SFWMD, District), Florida Department of Environmental Protection (FDEP), Collier County, and other local stakeholders have formed a Working Group (**Table 1-1**) to conduct this Collier County Water Quality Feasibility Study (Study) to address increased nutrient inflows (primarily Total Phosphorus (TP) and secondarily Total Nitrogen (TN)). This will be accomplished through identification of potential treatment technologies based on a review of literature and other information provided by the Working Group. The results of the review of provided documents, web links, and other information are presented in this Information Collection Summary Report. The following document includes detailed descriptions of many of the nutrient treatment technologies identified in the documents provided, and general recommendations regarding technologies to focus on in the Task 4 Feasibility Study task that will follow this report.

Table 1-1: Work Group Organizations

SFWMD	Conservancy of SW FL
FDEP	FL Wildlife Federation
FDACS	Nat. Audubon Society
USFWS	Stantec (Consultant)
Lipman Family Farms	QCA (Consultant)
Collier County	Lago (Consultant)

A summary of water quality data found in the information resources provided by the Working Group is summarized in **Appendix B**, indicating areas with higher and lower inflowing and outflowing nutrient concentrations. Based on discussions with District staff, it is expected that the projects to be implemented will be placed south of US 41, downstream of two existing culverts and one new culvert that will carry water from the PSRP to the south. It is also expected that funding source limitations will preclude any projects from being placed on privately owned lands.

2.0 DATA SOURCES/REFERENCES REVIEWED

The data sources and references reviewed were largely collected from suggestions, documents, and links provided by members of the Working Group, with a few additional sources added as they were discovered during review of the provided information sources. Information sources provided by the Working Group were aggregated into **Appendix C** of the Study Work Plan, and then converted into the Document Summary Review Table (**Appendix D**) that also includes the parameters of interest as identified in the Work Plan. Responses to specific comments made by working group members are addressed in **Appendix E**. **Appendix F** provides a regional parcel ownership map which will be further utilized in the feasibility study. Stantec personnel also performed a physical site review for accessible areas in the region. A memo summarizing site review observations can be found in **Appendix G**.

The water quality parameters of interest are addressed below when the information was included in the reviewed documents or could be inferred from knowledge of the technology type or information in the reviewed documents. Additional parameters identified by the Work Plan include: nutrient reduction, estimated level of effectiveness, potential ecological impacts, the range of literature based unit costs (e.g. cost per unit acre or cost per unit volume), operation and maintenance requirements, regulatory constraints, schedule for implementation, general land area requirements, and ancillary benefits (e.g. wildlife habitat creation).

It should be noted that specific information regarding the additional parameters was not found during the review of many of the information sources. Furthermore, nutrient removal rates, level of effectiveness, potential ecological impacts, costs, and other parameters, when provided, cannot necessarily be used to estimate water quality treatment costs in this Study area. This is because site specific factors, including but not limited to project area size, economies of scale, soils, loading rates, downstream receiving systems, and potential ecological and engineering project limitations must be considered. These site-specific factors will be included, to the greatest extent practicable, with projects selected for further analysis in the Task 4 Feasibility Study once proposed technology types and additional site-specific information are known or can be reasonably estimated.

3.0 REVIEW METHODOLOGY

The information sources were gathered from the Working Group, generally as either links to documents or actual copies of the documents and were divided for review by a team of four Stantec staff members according to their expertise. The sources provided were then divided for review by a team of four Stantec staff according to expertise. Staff included two engineers with experience in stormwater management and nutrient modeling, one environmental/soil scientist with experience in nutrient sources, cycling and management techniques, and one water quality data specialist. Each staff member reviewed documents assigned by area of expertise and provided a summary of the studies conducted to assimilate water quality data (Appendix B), treatment options, and study results that may influence the efficacy of the various treatment options.

While reviewing the documents provided by the Working Group, it was discovered that many of the documents related to studies conducted in south Florida were very site specific and could not be directly applied to the project area. Many other documents described treatment technologies currently in use by the District in south Florida, but on a much larger scale than what can be accommodated by the space limitations of this project in the ‘normal’ form in use elsewhere in the region. These technologies were noted and described and generally included as potentially viable technologies, although they would need to be constructed on a much smaller scale.

When the information was found in the reviewed materials, nutrient treatment capacities of these technologies were recorded in the review table in Appendix D; however, the information regarding treatment efficiency was not always provided, or was provided in a manner that could not be used without knowing other technologies that would be linked with this project. Costs listed in the reviewed materials, when found, are provided in Appendix D; however, due to the vast difference in scale of the existing technologies and the limited area in which technologies may be installed for this project, as well as numerous site specific factors and considerations of other technologies installed in conjunction, these costs cannot be accurately used to predict costs for projects included in this study. Additional technologies were provided following Working Group review of the draft version of this document and have been added to this final report.

Many of the documents were not descriptions of technologies, but rather studies conducted related to the technologies. General descriptions of studies that described nutrient removal factors are included in Appendix D, although most studies did not apply to this Study. Some resources provided were simply maps with no context and at times no date, and these were noted as maps in the ‘Comments’ column. Water quality data resources were reviewed and summarized in the existing conditions column, with an overall summary of the most pertinent data provided in Appendix B.

When documents reviewed included a description of a technology that had water quality treatment capacities, even if treatment was only a secondary aspect of the technology, a brief summary of the information in the report was provided in the General Description of Technology column of the table in Appendix D. Responses to the additional factors to be considered as identified in the Work Plan were provided when available, but most of the reviewed documents did not include this information. Some columns were completed based on review staff knowledge and experience, including Regulatory Constraints, Schedule for Implementation, and Ancillary Benefits.

4.0 LITERATURE REVIEW AND ANALYSIS

The information reviewed generally fell into three categories: water quality data (Appendix B), studies on factors affecting performance of existing water quality treatment systems, and descriptions of the different technologies that might be used for water quality treatment. This section describes the identified treatment options in detail. A summary of treatment options, including pros and cons of each and recommendations for future consideration are summarized in **Table 5-1** in Section 5.0. Study information regarding factors affecting treatment systems should be considered during the Task 4 Feasibility Study to follow this report.

Discussion or data related to nutrient increases related to sea level rise or climate change was not found in the information reviewed for this task. The climatological influence of major storm events was mentioned in numerous documents. Major storm events, including hurricanes, are known to affect treatment systems through large inflows of water (and nutrients) over short periods. Wind and greatly increased flow rates associated with storms are known to disturb sediments and/or cause the death of vegetation, causing a release of nutrients stored within the sediments and/or vegetation. In general, major storm events have a detrimental effect on nutrient concentrations and the function of the treatment technologies described below, at least in the immediate aftermath of a storm and possibly longer term.

A review of the links and documents provided resulted in a list of 'Applicable' technologies, defined for the purpose of this study as the most common and well-established stormwater treatment technologies already in use within south Florida, as well as technologies that are less common that have a proven track record for nutrient removal within Florida and elsewhere. Additional 'Non-Applicable' technologies were provided and defined as having uncertain effectiveness due to lack of proven efficacy for large scale projects and/or for use in the south Florida environment. The identified technologies are listed under these two group headings below; it is recommended that technologies chosen for the feasibility study be selected from the Applicable group. However, depending on project site availability and limitations (particularly land size available for projects) to be identified in the feasibility study, other technologies may be considered. Numerous studies have been undertaken by the District to determine which aspects of existing treatment wetlands improve or hinder nutrient removal capacity and some of these studies are described further in the links provided in Appendix D.

4.1 APPLICABLE SOUTH FLORIDA PROJECT TYPES

4.1.1 Constructed Treatment Wetlands

Constructed treatment wetlands are the technology behind Stormwater Treatment Areas (STAs), which dominated many of the documents reviewed; however, STAs, as constructed in the eastern Everglades restoration area, are several thousand acres in size, which would not be feasible for this project area. Treatment Wetlands, also referred to as man-made, artificial, or engineered wetlands, are highly engineered systems designed to emulate and optimize the physical, chemical, and biological removal mechanisms used in conventional treatment technologies. The treatment wetlands environment consists of a complex mix of saturated substrates, emergent and submergent vegetation, animal life and water that mimic the appearance of natural wetlands containing various sequences of open water and shallow marshes.

Constructed treatment wetlands are one of the more reliable best management practices (BMPs) used by various states to effectively remove and retain stormwater contaminants. Treatment wetlands have been used to treat runoff from agricultural, commercial, industrial, and residential areas. Stormwater wetlands are highly engineered treatment systems designed to temporarily store runoff in shallow ponds and maximize the removal of contaminants via several synergistic mechanisms, including sedimentation, filtration, adsorption, absorption/plant uptake, and microbial breakdown. Stormwater wetlands can also reduce peak discharges of infrequent large storm events to reduce the occurrence of downstream flooding.

Suspended solids are present in the waste stream will drop out as water passes through the open water segments. The shallow marshes are typically composed of an organic substrate (e.g., compost) ranging in depth between 6 and 18 inches, planted with wetland vegetation to impede flow and filter fine particles and soluble contaminants. A second open water micropool is generally located at the outlet of the shallow marshes to provide polishing prior to discharge and facilitate water reuse. The effluent micropool should be designed with sufficient depth (3-4 feet) to increase the dissolved oxygen content prior to discharge.

Wetlands have the potential to be self-sustaining ecosystems and thus may represent a long-term solution to the water quality challenge. The effectiveness of treatment wetland technologies for the removal of solids and nutrients is due to the combination and interaction of physical, chemical, and biological processes. Treatment wetlands create a spatially complex mixture of aerobic and anaerobic environments in which microbial communities catalyze various chemical processes. These biological processes are unique to wetland systems and provide the basis for a variety of control mechanisms to operate simultaneously along an extended treatment flow path. The result is that inorganic and organic constituents can be physically removed through filtration, biologically degraded to non-toxic forms, absorbed by wetland plants, adsorbed to surfaces, or chemically transformed and stored within the wetland matrix.

Wetland environments contain diverse populations of microbes and plants controlling the chemical cycling of contaminants. This diversity of wetland organisms results in the ability of the system as a whole to adapt to changing environmental conditions. The natural inundation of wetland environments provides for electrochemical reducing conditions to facilitate denitrification reactions. A key component of the denitrification equation is a continuous source of organic matter. Wetland plants provide a continuous source of organic matter through natural plant degradation, providing the driving force for denitrification. Finally, wetland substrates, consisting of oxides, carbonates, and organic matter, provide sorption sites for continuous phosphorus removal and sequestration.

Multiple wetland cells of varying hydraulic regimes can be customized in series to meet treatment needs. The treatment wetland system may also be used in conjunction with conventional technologies to attain treatment objectives. HRT (hydraulic retention time), hydraulic loading rates and constituent loading rates are dictated by the specific volumes of water and contaminant concentrations to be treated in the wetland system. Treatment wetland size is determined based upon the required HRT as well as areal and topographic considerations. Regional climatic characteristics also affect design considerations such as evapotranspiration.

Nutrients such as nitrogen and phosphorus are removed through adsorption, biodegradation, nitrification/denitrification and/or plant uptake. Adsorption of nutrients to media can be a removal mechanism for inorganics (e.g., phosphorus). With all adsorption processes, there is a finite amount of adsorption sites, so the treatment lifespan must be a consideration. Nitrogen is removed through nitrification and denitrification processes. These processes are dependent on pH, temperature, dissolved oxygen, and alkalinity and can be inhibited by the presence of other contaminants, therefore the treatment wetland must be designed to incorporate various stages and sequencing.

Figure 4-1: Typical Constructed Wetland[1]

Typical removal rates from constructed treatment wetlands range from 50-75% for sediments and phosphorus and 25-55% for nitrogen. Typical costs associated with the construction of treatment wetlands can be expected to range from $480-$570 per acre, although site specific parameters may result in higher or lower costs[2].

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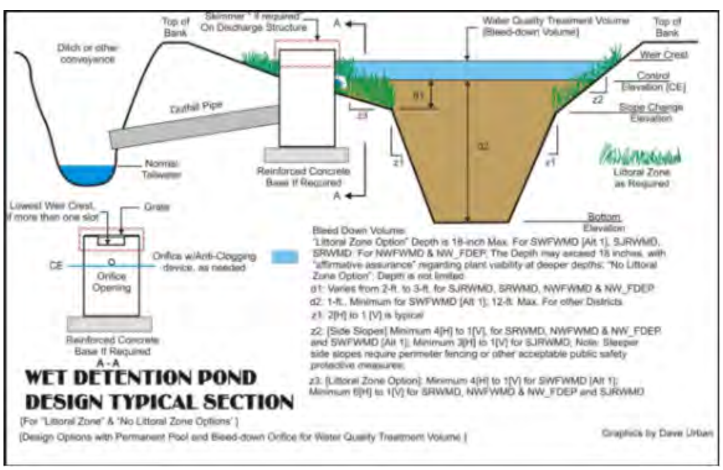
[1] Source: http://lochgroup.com/project/constructed-wetlands-for-cso-treatment/
[2] Stantec experience; Kadlec, R.H. and Wallace, S.D. 2008. Treatment Wetlands. 2nd Edition; Virginia Stormwater Design Specifications No. 13 Constructed Wetlands (2013

4.1.2 Detention Areas and Settling Ponds

Detention areas and settling ponds are designed primarily to slow peak flows from stormwater events to not overwhelm downstream water quality treatment areas (such as treatment wetlands) immediately following storms. By capturing and temporarily holding stormwater, and releasing the water at a controlled rate, flow into treatment areas are maintained at a more stabilized rate. As a result of stabilized flow rates, nutrient inputs into receiving waters downstream from detention/settling areas also enter the receiving waters at stabilized rates, without large rapid inputs immediately following storms. Stabilized flow rates into the receiving treatment area increases the ability of plants and soils in the treatment area to capture the nutrients in inflow waters. These areas have the added benefit of letting solids and associated nutrients to solids settle out as water velocities are reduced.

Stormwater detention areas and settling ponds may also uptake nutrients through plants, soils and periphyton in a manner similar to treatment wetlands, depending on design, operation, and maintenance parameters. For example, one study indicated that an existing Flow Equalization Basin (FEB - a large scale version of a detention area frequently mentioned in the documents reviewed) retained 90% of inflow phosphorus[3]; however, this should not be construed as a typical removal rate due to variability in site-specific factors, nor should this be considered a perpetual removal rate, as it is expected that at some point the system will become saturated unless plants and/or soils/sediments are periodically removed.

Figure 4-2: Typical Detention Pond Design[4]



Typical removal rates associated with sedimentation basins and wet detention ponds can be expected to be >70% for sediments, from 45-70% for phosphorus and from 30-50% for nitrogen. Typical costs of construction of these features may range from $0.50-$1.15 per cubic foot of pond, though site specific parameters may cause this cost to vary higher or lower[5].

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[3] www.sfwmd.gov/sites/default/files/documents/2020_SFER_highlights.pdf
[4] Diagram of typical detention pond design with littoral shelf of native plants
[5] Florida DOT Best Practices for Stormwater Runoff Designer and Review Manual (2015), USEPA 1999, nrcsolutions.org

4.1.3 Spreader Berms and Canals/Swales

Spreader berms and canals/swales mitigate high velocity concentrated water flow first through conveyance within wide canals/swales for initial velocity reduction and second by diffusing flow over a berm via multiple discharge locations to wide vegetated treatment area, where velocities are further reduced as the water is dispersed as sheet flow. This reduction in velocity promotes settling of suspended particulate matter and associated nutrients. Flow is dispersed from the initial spreader canal/swale to the vegetated treatment area through various methods, including, but not limited to:

- Overtopping a berm uniformly as the water rises behind the berm.
- Water flows into a canal or ditch and then overflows the downstream side of the ditch uniformly into receiving waters.
- Water may pass through a berm via multiple strategically spaced culverts.
- Water may be pumped over a berm or out of a canal in a dispersed manner into receiving waters.

Overall, this generally results in a more natural/historic sheet flow dispersal of water instead of historic channelized/point source flow, potentially restoring natural wetlands or creating new wetlands downstream of the berm or canal. Estimated costs for construction of spreader swales, using costs associated with the north Belle Meade and South I-75 Canal spreader swales range from $140,000/acre without a pump station to $240,000/acre with a pump station[6].

Figure 4-3: Spreader Berms and Canals

SFWMD Lake Hicpochee Shallow Storage with Spreader Canal. The G-726 will send stored water from the 670-acre flow equalization basin into a spreader canal for distribution into the northwest part of Lake Hicpochee[7].

[6] Collier County Watershed Model Update and Plan Development, Vol. 2, 2011, Atkins www.colliercountyfl.gov/home/showdocument?id=38451
[7] https://www.flickr.com/photos/sfwmd/40084092234

4.1.4 Restored Wetlands

Conservation and mitigation programs which invest in strategically positioned wetland restoration projects have demonstrated water quality improvements, flood abatement, habitat value and overall watershed restoration. Wetlands have long demonstrated the ability to improve water quality. Observations of water quality improvements through natural wetlands led to study and creation of treatment wetlands for a variety of waste streams. The quiescent conditions of wetland promote the settling of suspended sediment and associated contaminants. Nutrients dissolved in runoff can be adsorbed by the wetland soil and absorbed by wetland plants.

Restoration of wetland hydrology is the predominant design element for successful wetland restoration. Historically drained wetlands offer the simplest location for potential wetland restoration where drainage ditches are plugged, berms are constructed to impound water, water control structures are installed, and surface topography is manipulated to help restore target wetland hydrology. Restored wetlands perform essentially the same functions as the treatment wetlands of the STAs described above, except not with the equivalent efficiency. Restored wetlands require significantly more land area to provide an equivalent level of treatment offered by an engineered constructed treatment wetland.

It should be noted that contribution of excess nutrients into a natural wetland may adversely alter the ecology of existing hydrologically connected wetlands by promoting the growth of nuisance and/or exotic wetland plant species, which often occurs in the presence of high nutrient levels. Nuisance and/or exotic plant growth may result in a dominance of one or two non-desirable plant species, such as cattails, which can outcompete desirable native vegetation, which can be detrimental to habitat quality. Restored wetlands are also not bermed, lined or otherwise segregated from adjacent natural systems like constructed treatment wetlands. Restored wetlands can remove up to 95% of inflow sediments, although site specific factors will greatly influence this removal rate.

Figure 4-4: Restored Wetlands

Restored wetlands and wildlife usage at the Allapattah Ranch Wetland Reserve Project in Martin County[8].

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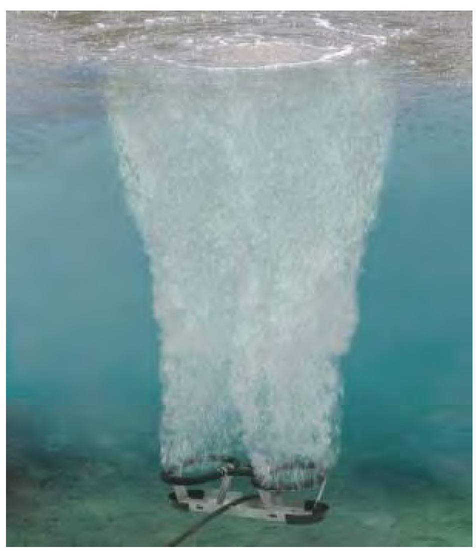
[8] https://www.sfwmd.gov/news/nr_2017_0922_allapattah_ranch_project

4.1.5 Air Diffusion System (ADS)

Aeration of stormwater ponds and/or natural lakes for nutrient removal typically involves installation of multiple air diffusers at the bottom of a pond, or possibly at the surface as a display aerator for less intense aeration. Aerating the sediments of a pond allows aerobic bacteria to work more effectively to break down sediments and decaying plant material (anaerobic bacteria work very slowly in comparison), which releases nutrients into the water column. Unless the lake is especially acidic, one of the first forms of nitrogen released from this enhanced decomposition is ammonium/ammonia. Ammonium typically dominates, though the percentage of ammonia increases as pH increases. Ammonia can leave the water column as a gas under aerated conditions. As ammonia is released, additional ammonium is converted to ammonia, which can again be released from the water as a gas. Aeration may change the form of phosphorus present within the water, but phosphorus will not leave as a gas and may only be resuspended within the water column as sediments are disturbed and organic matter within the sediments is decomposed.

These systems are useful in reducing algal growth by removing enough nitrogen from the water to prevent algal blooms, but they are not known to remove phosphorus, which does not become a gas under natural conditions. It should be noted that air diffusers placed on pond or lake bottoms can cause significant releases of phosphorus bound to bottom sediments into the water column, making the phosphorus available for downstream transport. Costs include not only the equipment and maintenance, but also electricity associated with continuous operation of pumps to run the aerators.

Figure 4-5: Air Diffusion System (ADS)



Air diffusion aeration system placed near a lake bottom[9].

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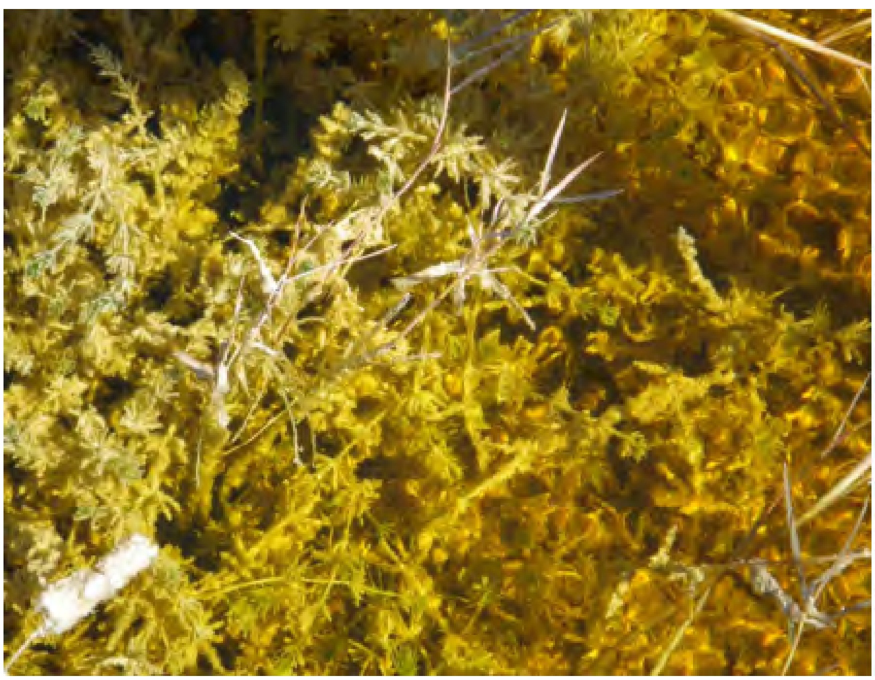
[9] http://floridalake.com/

4.1.6 Periphyton / Submerged Aquatic Vegetation (SAV) Growth and Removal

Periphyton includes freshwater organisms (e.g. algae, bacteria, and fungi) that grow attached to rocks, plants, and other objects located within the water column of a lake, pond, wetland, etc. SAV includes plants that grow beneath the water surface. In a treatment system using periphyton/SAV for nutrient removal, water flows through a system to promote the growth of biomass to uptake nutrients, after which the periphyton/SAV must be harvested and disposed of in an area where the decomposition of the material will not result in released nutrients returning to the waterbody. The periphyton or SAV may be used to create biofuels, cattle feed, crop fertilizers, soil amendments, or other bioproducts.

Periphyton growth and removal technology appears to be commonly used in the treatment of wastewater. One study[10] conducted within STA-3/4 in Southeast Florida indicated that periphyton growth in these stormwater treatment areas resulted in significant reductions in TP concentrations in water leaving the STAs; however, the information available does not indicate that the periphyton would be harvested at some point. Long term, periphyton can only permanently remove phosphorus from an aquatic system through harvest and disposal at upland sites where the nutrients can be used for other purposes. Periphyton left in a treatment system will eventually die off and potentially release nutrients back into the water column.

Figure 4-6: Periphyton[11]



[10] sfwmd.gov/sites/default/files/documents/ltp_mtg_12feb2013_psta_%20stormwater_%20periphyton_%20mesocosm_ivanoff.pdf
[11] sfwmd.gov/sites/default/files/documents/ltp_mtg_12feb2013_psta_%20stormwater_%20periphyton_%20mesocosm_ivanoff.pdf

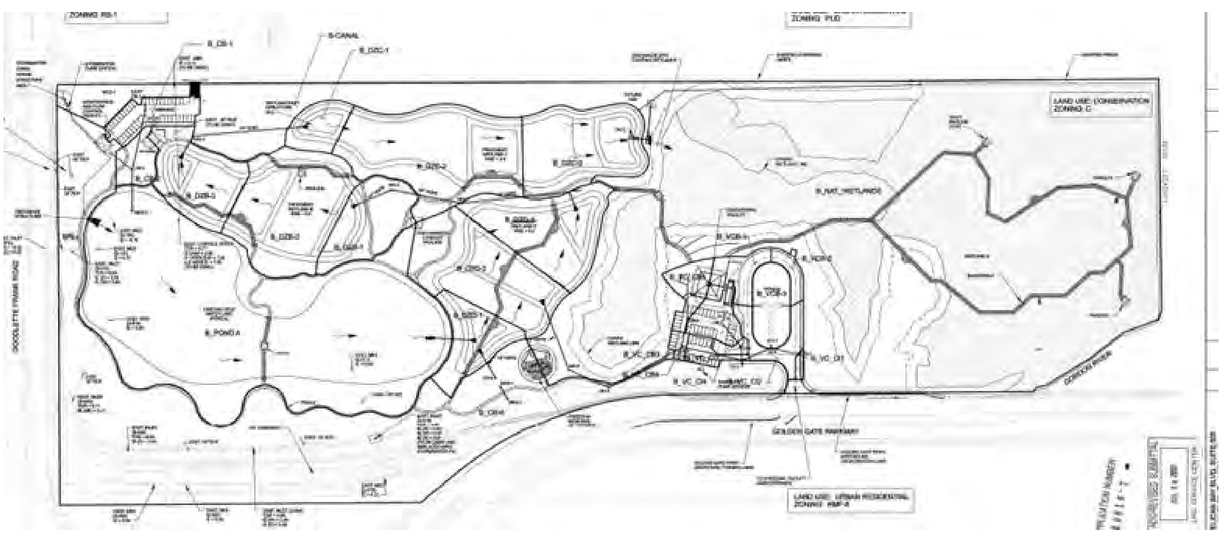
4.1.7 Polishing Ponds

Polishing ponds are generally the last in a series of settling ponds used to improve water quality. They typically follow an initial inlet deep pool or other design to cause flow dispersal and a primary treatment area. The Outlet Zone can be a deep pond to prevent re-suspension of sediments for a final 'polishing' step. There are many ways to design multiple ponds and/or wetland zone systems to accomplish this polishing, each with the Inlet Zone, Primary Treatment Area and Outlet Zone.

During the polishing treatment, the water is kept in natural condition will full exposure to air in one or many, usually compartmentalized, open water bodies (aka polishing ponds). These ponds are usually from five to ten feet deep and allow for the sedimentation of non-degraded and degraded suspended particles at the bottom of the pond is facilitated in a natural way. Further, aquatic plants, invertebrates and weed eating fish can be introduced in the polishing pond to absorb and consume remaining plant matter.

Freedom Park in Collier County has implemented a treatment train system that includes polishing ponds to treat roadway runoff with multiple basins that allow for chemical and biological treatment of water through retention time that allows sediment settling. This system was originally designed to treat stormwater runoff from Goodlette-Frank Road, with a standard wet detention system that discharged to the Gordon River via concrete weir discharge structure and grass swale to the river. The system was expanded by adding three treatment wetland zones, each with shallow and deep zones to encourage settling, prior to discharge into the existing natural wetland system. The man-made wetland zones are functioning as polishing ponds for the treatment system. This system is under further investigation for potential inclusion with treatment train technologies to be proposed in the feasibility study to follow this report.

Figure 4-7: Freedom Park Collier County – Polishing Pond Included in a Treatment Train[12]



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[12] https://my.sfwmd.gov/ePermitting/ (SFWMD ERP 11-0082-S-02, Application 060816-7)

4.1.8 Hybrid Wetland Treatment Technology

Hybrid Wetland Treatment Technology (HWTT) combines the use of wetlands and chemicals to treat water quality. The typical design includes the addition of alum at the inlet of the system as pre-treatment to remove phosphorus by forming a floc that will settle out in deep pools constructed to capture the floc. The chemically treated water then discharges to treatment wetlands where some of the floc will remain active for additional P sorption , some will settle out and sequester phosphorus in the buried sediments, and residual nutrients are removed through the treatment wetlands per the processes described above.

As described further below in Section 4.2.3 (Offline Alum Treatment), design of the alum treatment portion of the system requires initial testing of water quality parameters of incoming waters to develop a dosing rate for alum, and possible pH adjustment requirements for inflow waters. Of the study sites included in the report found at https://www.fdacs.gov/content/download/76291/file/20210_FinalReport.pdf, the largest study site had a maximum treatment flow of 25-cfs and included a 6-acre floc contact pond, a 1.5-acre SAV pond, an additional 27-acre pond, and a 65-acre isolated wetland. This technology is well suited for treatment of point sources where high nutrient concentrations and flows can be predicted.

Figure 4-8: Hybrid Wetland Treatment Technology[13]

[13] https://www.sfwmd.gov/sites/default/files/documents/ne_hybrid_wetland.pdf

4.1.9 Media Filters

Media filters utilize physical and geochemical reactions to remove contaminants, without the addition of chemical reagents, through filtration, adsorption to soil surfaces, or are chemically transformed and stored within the soil matrix. These filters adsorb and sequester various contaminants including nutrients (nitrogen and phosphorus). Filters can be designed for nutrient removal by selecting a specific media (e.g., compost, peat, or wood chips for nitrate removal and iron enhanced sands for phosphorus removal). The following sections provide an overview of three applicable filter technologies.

4.1.9.1 Bioreactors

Bioreactors are buried organic material which function in an anaerobic environment. Water flows through the anaerobic filter, where nitrate nitrogen is converted to N2 gas, which is then subsequently released to the atmosphere. The buried materials vary and may consist of permeable reactive barriers or pass through filter systems. Filters can discharge directing to groundwater or incorporate an underdrain and discharge to a surface water body. Systems with underdrains can also control the water level within the filter and thus the hydraulic retention time to ensure the level and anaerobic treatment within the filter is achieved. Bioreactors are designed to treat high contaminant/low flow conditions with bypass of larger more dilute flows. It has been observed that bioreactor materials may degrade f they are not continuously kept in anerobic conditions. The Felts Avenue bioreactor was presented as an example system for review. This bioreactor consists of pipes and wood chips buried beneath a parking lot and is shown in the figure below.

Figure 4-9: Felts Avenue Bioreactor Bonita Springs[14]

[14] http://www.cityofbonitasprings.org/cms/One.aspx?portalId=11726542&pageId=16148711

4.1.9.2 Iron Enhanced Sands

Iron enhanced sand filters (IESF), also known as Minnesota filters, incorporate filtration media such as sand, with iron particles to remove dissolved particles such as phosphate. They can be used on sites where infiltration is not feasible, such as where a site has a high groundwater table. Sources for the iron include recycled scrap iron, steel wool, or iron fillings. Several forms of phosphorus bind to the iron, and filtration basins amended with iron filings have been shown capable of removing 92 percent of total suspended solids (TSS), 71 percent of total phosphorus, and 50 percent phosphate (Minnesota Stormwater Manual).

Two common designs are iron-enhanced sand filter basins (dry ponds) or iron-enhanced sand benches in wet ponds. IESF features have been applied to various water quality designs aside from stormwater ponds, including filtration basins, rain gardens and underground storage chambers/trenches. The Spring Lake Regional Park in Scott County, Minnesota, is one example where this technology was used. Roughly four miles of new paved trails required a stormwater management system that was amenable to the sensitive wetlands adjacent to the site. The outlet control structure diverts the excess water of the wetland into the IESF, where it then filters water down through the media, removing contaminants. The iron fillings act as a magnet to the dissolved phosphorus and attach to the fillings to create a more efficient sand filter. The filtered water is captured in an underdrain system (typically required to aerate the filter bed between storms) and discharged back into the original stream bed downstream of the outlet structures.

It should be noted that iron is not appropriate for all filtration practices due to the potential for iron loss or plugging in low oxygen or persistently inundated filtration practices. Iron-enhanced sand filters may be applied in the same manner as other filtration practices and are more suited to urban land use with high imperviousness and moderate solids loads. Iron-enhanced sand filters are more suitable to conditions with minimal groundwater intrusion or tailwater effects. The exit drain from the iron-enhanced sand filter should be exposed to the atmosphere and above downstream high-water levels to keep the filter bed aerated.

Iron-enhanced sand filters may be used in a treatment sequence, as a stand-alone BMP, or as a retrofit. If an iron-enhanced sand filter basin is used as a stand-alone BMP, an overflow diversion is recommended to control the volume of water, or more specifically, the inundation period in the BMP. As with all filters, it is important to have inflow be relatively free of solids or to have a pre-treatment practice in sequence.

IESF systems have the potential to remove >90% of inflow sediment and greater than 70% of inflow TP; however, nitrogen removal as a direct result of these systems is negligible. Estimated costs range from $140 to $175 per cubic yard of treatment volume[15].

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[15] Minnesota Stormwater Manual https://stormwater.pca.state.mn.us/index.php/Iron_enhanced_sand_filter_(Minnesota_Filter)

Figure 4-10: Iron Enhanced Sands Filtration Example Schematic[16]

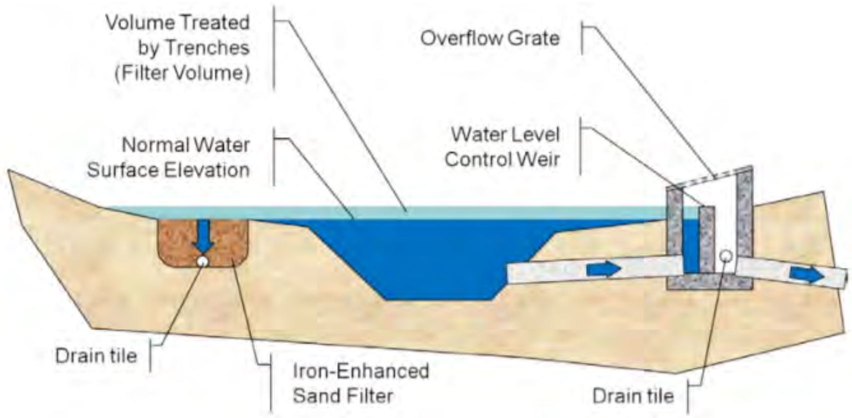


Figure 4-11: Iron Enhanced Sands Filtration Example[17]

[16] https://conservancy.umn.edu/bitstream/handle/11299/115602/pr549.pdf
[17] https://stormwater.pca.state.mn.us/images/5/50/Iron_enhanced_sand_filter.pdf

4.1.9.3 Bold & Gold®

Bold & Gold® CTS Filtration media is a Biosorption Activated Media (BAM) for stormwater treatment in conjunction with other structural or non-structural stormwater BMPs. Bold & Gold® (B&G) Filtration media is a patented product developed at the Stormwater Management Academy of the University of Central Florida. Environmental Conservation Solutions, LLC. (ECS) is the licensed manufacturer of the Bold & Gold® Filtration media.

B&G CTS Filtration media is recommended for stormwater nutrient removal to be used in low loading or slow-flow filters, either in 12-, 24- or 30-inch depth filters; after a wet pond or within a dry basin, swale and strips.

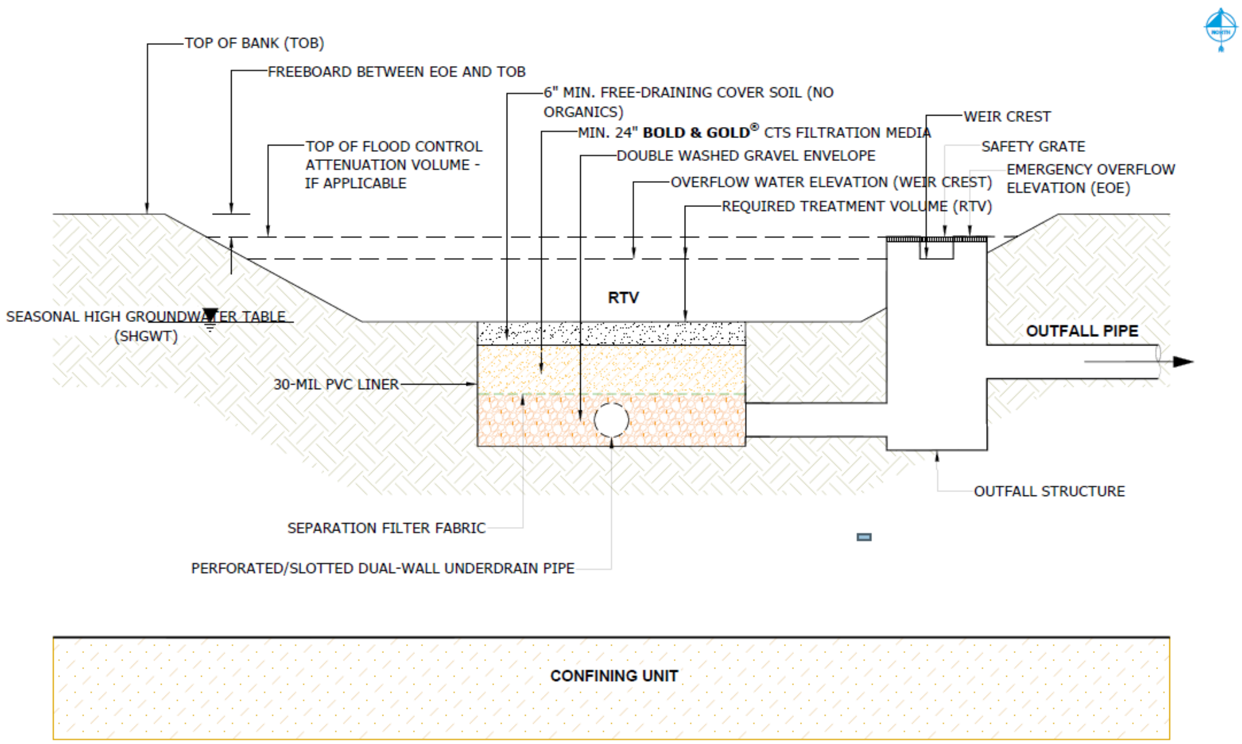
This technology uses a media that is a mixture of sand, clay, and recycled tires. According to the manufacturer, an anaerobic environment is created that converts nitrogen forms to nitrogen gas, which is then released to the atmosphere. The media also filters out particulate phosphorus and provides soil sorption sites to capture dissolved phosphorus; however, the media will eventually become saturated with phosphorus and must then be replaced. The manufacturer stated nitrogen (presumably TN but the reference document did not directly state this) removal rate in stormwater treatment applications is 75-95%, though TP removal rates are not indicated. The system is stated to have a 15-year life span, but it appears that this applies only to nitrogen removal, and media may need to be replaced more often for the system to continue removing TP for 15 years.

Maintenance requirements for the B&G CTS Filtration media shall be dependent on the proper functioning and maintenance of all components of the applicable BMP in which the filter media is used. To prevent the clogging of the voids of the B&G CTS Filtration media, there shall be installed an intermediary aggregate media that is free-draining and free of organics (clean sand, acceptable aggregates, etc.) as cover material directly above the top of the filter media surface. In addition, the cover material shall serve to control the erosion of the components of the B&G CTS Filtration media.

B&G CTS Filtration media is typically designed to last the life span of the applicable BMP. However, maintenance shall be performed if the Bold & Gold® CTS Filtration media has shown a reduction in the performance efficiencies on the reduction of Total Phosphorus (TP) below the design value before and/or at the expiration of the design service life. The maintenance procedure shall involve the removal of the cover material and B&G CTS Filtration media and replaced with new material and filter media meeting the original specifications. The spent filter media and cover material shall be disposed of at an approved landfill.

The primary control for sizing the B&G CTS Filtration media is to capture the water quality volume and pass it through the filter media with a specified hydraulic residence time (HRT) to achieve a specified drawdown time. The capture volume is dependent on the flow-through rate per available surface area of the filter media. B&G CTS has a design loading rate of five inches per hour. Assuming this loading rate, this media can be expected to remove up to 95% of TP (until the media becomes saturated, after which no additional TP would be removed until the media is replaced) and up to 75% of TN. Costs provided by the manufacturer of B&G CTS Filtration media range from $0.50 to $1.15 per cubic foot of media[18].

Figure 4-12: Bold & Gold®



BOLD & GOLD® CTS FILTRATION MEDIA USED AS A FILTER MEDIA AT THE BOTTOM OF A POND

Bold & Gold® media filtration system[19].

[18] Chris Bogdan, President of Environmental Conservation Solutions, LLC (B&G Manufacturer)
[19] https://ecs-water.com/stormwater-management/filtration-media-solutions/

4.2 NON-APPLICABLE TECHNOLOGIES

4.2.1 Recyclable Water Containment Areas

Recyclable Water Containment areas are designed to retain water on privately owned lands to control non-urban stormwater, sequester nutrients, and to improve soil quality. This technology is also commonly known as 'water farming'. Land is entered into a program to retain water for a given number of years by building a small berm around the perimeter of the participating land to retain water in depths up to 2 feet. Following the designated retention period, the land would return to agricultural use.

Water contained in these areas is likely to raise surrounding water tables on adjacent lands, possibly reducing irrigation needs, and a high amount of loss of the water to evaporation is expected. Nutrients are stored in these retention areas and can settle out to improve soil fertility, reducing future fertilizer requirements. This technology works best where there is a confining layer in the soil, such as an argillic or spodic horizon.

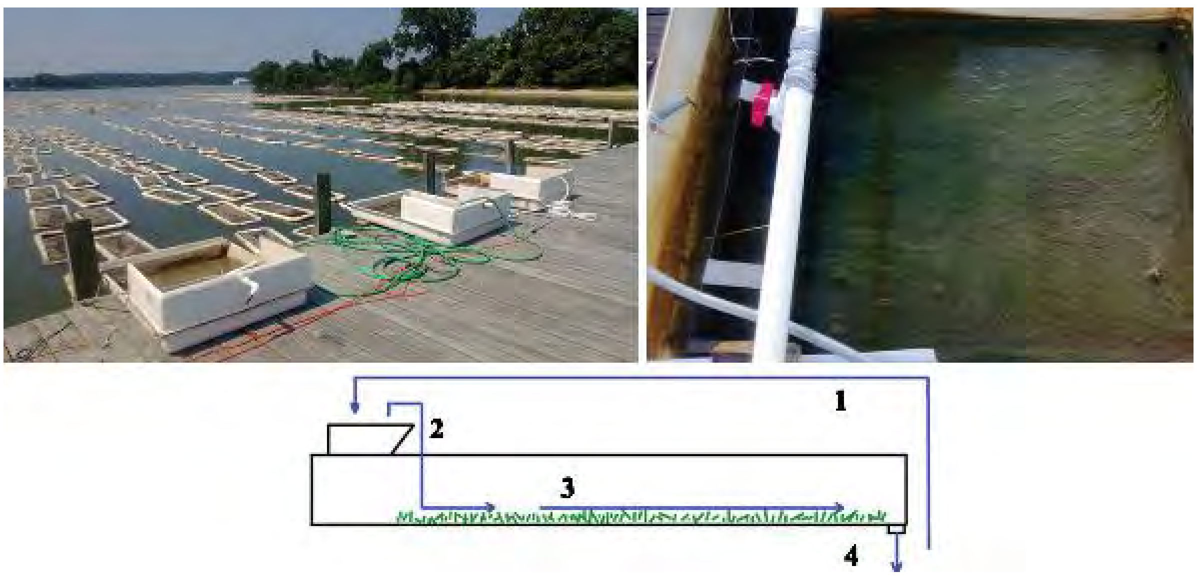
Figure 4-13: Recycled Water Containment Area – Conceptual Drawing[20]

[20] https://edis.ifas.ufl.edu/ss447

4.2.2 Algal Scrubbers

This technology involves providing a growth media for algae and intense lighting to promote the growth of algae on the media. The algae remove nutrients via absorption from the water flowing over the growth media, after which the algae are harvested. Harvested algae is then either properly disposed of in an area disconnected from receiving waters as nutrients can be released during algal decomposition, or used for biofuels, cattle feed, or other beneficial uses. This technology is O&M intensive and generally used for small scale systems, from home fish tanks to aquaculture production facilities. It is the team's professional judgment that the growth and harvesting of algae in large scale systems, as would be required for this project, would be better accomplished through the growth and removal of algae as periphyton as described in Section 4.2.3 above.

Figure 4-14: Algal Scrubbers



Algal turf scrubber components at an oyster aquaculture facility. Step 1 pumps water from the oyster aquaculture facility into the dump bucket (2). Once the dump bucket is sufficiently full the bucket tilts and dumps water across the algal turf. Water leaves the scrubber after flowing across the algae through a point (4) that re-releases water back into the aquaculture facility. This particular study is located in the Chesapeake Bay area and nutrient removal results focused on nitrogen rather than phosphorus[21].

[21] https://www.sciencedirect.com/science/article/pii/S0925857414001943

4.2.3 Offline Alum Treatment

Aluminum sulfate, or a similar aluminum compound, is added to inflow water which is directed into an offline pond. The aluminum ion binds with phosphate ions to form a floc that settles to the bottom of the pond. This aluminum phosphate floc will be periodically removed from the offline pond and disposed of appropriately. Treated water then flows out of the pond into downstream systems with reduced phosphorus concentrations.

Alum treatment is a technology that has been in use for many years, often as in-line treatment, where the produced floc settles into the natural systems. The accumulation of floc would not be desirable for the OFWs downstream of the area where treatment may occur, and therefore an offline treatment system is recommended if this option is pursued. Implementation of this technology requires advance study of inflow waters to determine required pH adjustments and alum dosing levels. Costs of these systems can vary widely depending on chemistry and volume of inflow water and include costs to periodically remove the floc.

Figure 4-15: Offline Alum Treatment

Example alum treatment system[22]

[22] https://www.florida-stormwater.org/assets/MemberServices/Conference/AC19/22%20-%20Harper%20Harvey.pdf

4.2.4 Floating Treatment Wetlands

Floating treatment wetlands are plants grown on a floating mat over open water to uptake nutrients through roots that extend into the water column. The plants might be periodically harvested if phosphorus uptake is limited and disposed of in upland areas, and possibly used for soil enrichment, to remove the nutrients from the system. These planted mats would need to cover large areas of open water to remove significant amounts of nutrients, although they are also simple additions to sedimentation basins/ponds to provide an additional level of treatment. Plant uptake of nutrients is minimal compared to the physical/chemical mechanisms for removal in ponds/wetlands. Harvesting and disposing of the plant material should also be considered before further investigation of the use of this technology.

Figure 4-16: Floating Treatment Wetlands

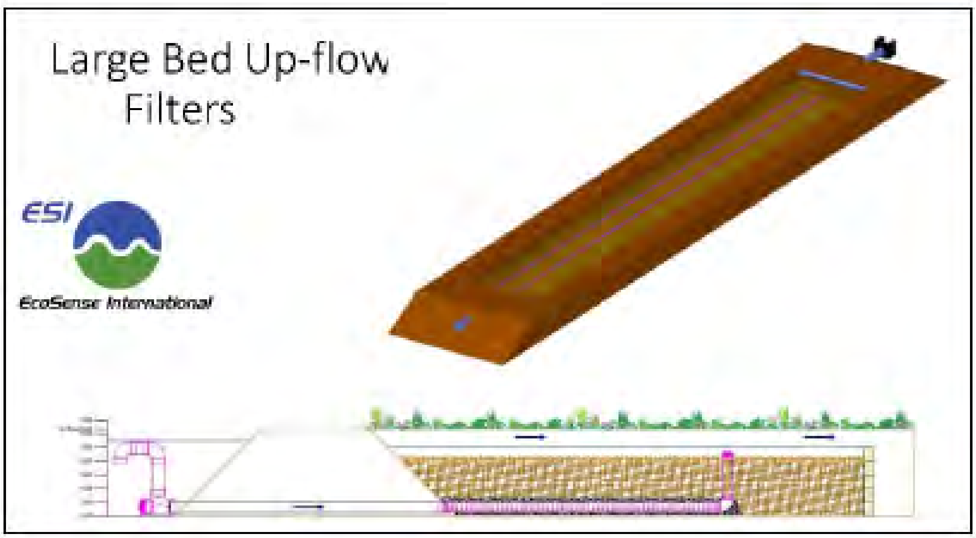
Floating treatment wetland showing vegetation growing on mats[23].

[23] Stormwater.wef.org

4.2.5 NutriGone Media™

This technology uses media comprised of organic and inorganic carbon and an ion adsorption mineral. This technology was described based on manufacturer provided data in the C-43 West Basin Storage Reservoir Water Quality Feasibility Study (2020)[9] and was recommended for testing for use in nutrient removal. It is unknown whether this technology has been used in large scale natural systems as the company website describes primarily installation of baffle boxes in stormwater collection systems. The estimated cost provided by the manufacturer to treat the C-43 basin site was $14,290,000 per 353 days.

Figure 4-17: NutriGone MediaTM



Example of NutriGone filter (EcoSense International, 2019)[24]

[24] www.sfwmd.gov/sites/default/files/C-43%20WBSR%20WQFS%20Information%20Summary%20Collection%20Report_04.03.2020.pdf

4.2.6 Downstream Defender®

This is a hydrodynamic vortex separator that is placed in-line with stormwater flows that removes sediments and any nutrients or other chemicals attached to the sediments. It appears that this separator is typically placed in-line with stormwater pipes; however, at least one example on the company's website indicates that this technology has been used on a larger scale project in Qatar, claiming that the system could remove pollutants at flows in excess of 64,000-gpm (approximately 142-cfs). Because this system only removes the solids and nutrients attached to the sediment, it is unclear how much nutrient loading could be treated in the water leaving the PSRP area, which would depend on the percentage of nutrients in dissolved form.

A study was conducted in the C-43 West Basin Storage Reservoir (former farmland) using this technology to treat runoff from a farm. It was found that the peak treatment rate was 38-cfs for a 12-foot diameter unit. Nutrient removal costs in this study were $45-$112 per lb. TP/yr. and $10-$100 per lb. ammonia-N/yr. (this is a fraction of total nitrogen).

The vendor indicates that the system may remove 70% of TP and 79% of Total Kjeldahl Nitrogen (TKN = TN minus nitrate/nitrite-N). If high levels of nutrients within the conveyed waters associated with this project are in dissolved form, the treatment might be relatively ineffective, particularly for TP removal. The need to remove and dispose of separated sediments should be considered if this technology is further investigated.

Figure 4-18: Downstream Defender®

Downstream Defender® system in Qatar[25].

[25] www.hydro-int.com/en/case-studies/unconventional-downstream-defender-system-helps-protect-gulf-waters-qatar-0

4.2.7 Aquifer Storage and Recovery (ASR)

This technology would involve injection of excess flows into a confined aquifer, to be re-pumped later to supply water for public use or for redistribution into natural systems. The appropriate geologic conditions to provide for a confined aquifer would need to exist in this region to make use of this technology, which also may require that water be treated to drinking water quality standards prior to injection. This technology would not result in nutrient removal beyond that achieved prior to injection into the aquifer. In addition, recovery rates of injected water vary widely.

Figure 4-19: Aquifer Storage and Recovery (ASR)

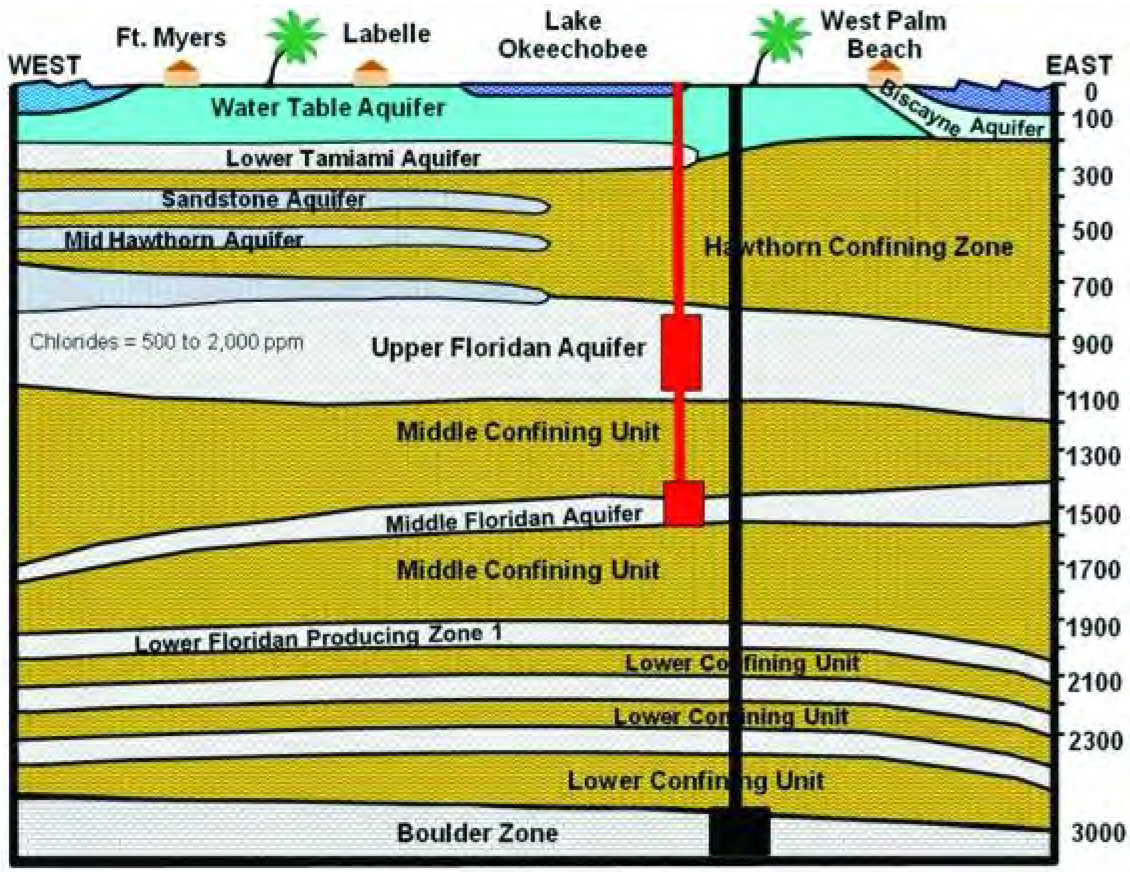
Aquifer Storage and Recovery facility for water supply in the South Florida Water Management District[26].

[26] https://www.saj.usace.army.mil/Missions/Environmental/Ecosystem-Restoration/Aquifer-Storage-and-Recovery-ASR-Regional-Study/

4.2.8 Deep Well Injection

This technology involves injecting excess water into deep aquifers from which the water will not be returned to the surface. While this permanently removes the nutrients along with the water, downstream systems may then be starved of essential freshwater flows.

Figure 4-20: Deep Well Injection



Example of deep well injection where water is injected into the 'Boulder Zone', below the Middle and Upper Floridan Aquifers normally used for water supply[27].

[27] https://lakeokeechobeenews.com/lake-okeechobee/deep-wells-reduce-discharges-estuaries/

5.0 TREATMENT OPTIONS

Table 5-1 lists the treatment options described above, pros and cons of each, and whether the option should be further investigated in the Task 4 Feasibility Study to follow this report.

Table 5-1: Treatment Options Summary Table

Treatment Option	Pros	Cons	Recommended for Feasibility Study investigation?
Applicable Constructed Treatment Wetlands	• Proven technology in South Florida • Engineered for removal of specific contaminants • Passive and sustainable treatment approach • Provides excellent and prolonged treatment of nitrogen • Aesthetically pleasing • Provides habitat • Some recreational value for wildlife viewing and hunting	• May require a large land area to provide adequate treatment • Adsorption capacity for phosphorus may become limited • Will likely require permitting	Yes
Applicable Detention Areas and Settling Ponds	• Slows stormwater flow allowing sediments and associated nutrients to settle out • Tend to promote plant growth that would provide additional nutrient uptake and possible wildlife habitat value	• May require a large land area to provide adequate treatment • May require periodic sediment removal to maintain depths for proper sedimentation • Will likely require permitting	Yes
Applicable Spreader Berms and Canals	• Slows stormwater flow • Facilitates sheet flow for nutrients to settle out • Can manage large flows passively	• Need adequate land area to treat expected flows • Will likely require permitting	Yes
Applicable Restored Wetlands	• Restoration of historically drained areas to natural wetland systems • Can provide wildlife habitat value while wetland vegetation will slow water flows and uptake nutrients	• Need adequate land area to treat expected flows • Requires well vegetated treatment area • May require sediment removal to ensure vegetation survival • Will likely require permitting	Yes

Treatment Option	Pros	Cons	Recommended for Feasibility Study investigation?
Applicable Air Diffusion Systems	• Can be retrofitting into sedimentation ponds and polishing ponds • Can remove potentially large amounts of TN • May not require permitting	• Does not really address TP removal • Requires a power source for blower • May have high maintenance requirements depending on site specifics	Possibly – may be used to supplement other technologies to enhance nitrogen removal
Applicable Periphyton and/or Submerged Aquatic (SAV) Vegetation Growth and Removal	• A natural treatment process, removed material may be used beneficially elsewhere • Has a high potential for nutrient removal	• May require a large treatment area • Requires periodic removal and transport of material • Death of biological material from extended cloudy periods or major storm events will re-release nutrients • Permitting may be required if a reservoir is constructed for growth	Yes
Applicable Polishing Ponds	• Promotes passive sedimentations of solids and associated contaminants • Provides recreational opportunities • Facilitates oxygen diffusion prior to discharge	• Requires large land area • Provides limited dissolved nutrient removal • Provides minimal wildlife habitat • Requires sediment removal on a periodic basis	Yes
Applicable Hybrid Wetland Treatment Technology	• Combination of efficient phosphorus pre-treatment and sustainable nitrogen removal	• Requires chemical addition • May require periodic sediment/floc removal	Yes
Applicable Bioreactors	• Provides efficient removal of nitrogen	• Provides limited removal of phosphorus • Can be prone to clogging (requires pretreatment for sediment removal)	Possibly – may be used to supplement other technologies to enhance nitrogen removal
Applicable Iron Enhanced Sands	• Provides efficient removal of phosphorus • Can be retrofitted into sedimentation ponds	• Can be prone to clogging (requires pretreatment for sediment removal) • May release iron • May require periodic cleaning and media replacement	Yes

Treatment Option	Pros	Cons	Recommended for Feasibility Study investigation?
Applicable Bold & Gold®	• Degrades and removes nitrogen by using sand, clay, and recycled tire material to convert nitrogen to nitrogen gas in an anaerobic environment	• Primarily for TN removal • TP removal capacity unknown and would require continual replacement of media as it becomes saturated with phosphorus • May be expensive • Unproven for project site conditions • Permitting possibly required depending on design	Possibly, only if more ‘natural’ technologies cannot be accommodated in the land area available
Non-Applicable Recyclable Water Containment Areas	• Relatively simple to construct • Can provide large treatment areas without land purchase and land removal from tax rolls	• Not a permanent solution, only provides detention and treatment for the length of the contract with the private landowner • Accumulated nutrients may be released if the land is returned to pre-containment conditions	No – would be located on private property, which is outside the scope of the current project
Non-Applicable Algal Scrubbers	• Uses growth of algae to passively remove nutrients • May not require permitting	• Not proven for large scale use • Requires more intensive maintenance of growth media and periodic removal and disposal of algae • Limited to plant uptake rates	Possibly, if more ‘natural’ technologies cannot be accommodated in the land area available
Non-Applicable Offline Alum Treatment	• Treatment can be conducted in a relatively small area • Proven technology for TP removal	• Does not remove TN • Requires site specific research to determine treatment regimen • Involves use of chemicals (offline treatment mitigates this undesirable aspect) • Expense may be very high depending on inflow TP loads • Will likely require permitting	No
Non-Applicable Floating Treatment Wetlands	• Uses growth of natural plants to remove nutrients from the water column • Can be combined with sedimentation/polishing ponds • Minimizes odors from open water systems • Roots systems promote nitrogen degradation • Possibly could provide some wildlife value	• Needs a ponded area to float on, requiring possibly large land area • Nutrient removal efficiency appears to be low as only nutrients near the water surface/root zone of the floating plants would be taken up • Lake creation would likely require a permit	Possibly in conjunction with other technologies

Treatment Options

Treatment Option	Pros	Cons	Recommended for Feasibility Study investigation?
None-Applicable NutriGone™ Treatment Media	• Previously reviewed by the District and recommended for further study	• Unproven • Only information on removal rates is from the manufacturer • Appears that it will be extremely expensive • Permitting unknown	Possibly, only if more 'natural' technologies cannot be accommodated in the land area available
Non-Applicable Downstream Defender®	• Vortex separator that removes solids and the nutrients attached to them	• System is only designed to remove solids and would not treat dissolved nutrients • May be very expensive • Large system likely to require permitting	Possibly, if more 'natural' technologies cannot be accommodated in the land area available
Non-Applicable Aquifer Storage and Recovery (ASR)	• Removes nutrients from downstream waters by temporarily removing the water itself	• Need the proper geology • Will likely need to treat water prior to injection • Injected nutrients will be returned to the surface upon use of the water • Permit required	No
Non-Applicable Deep Well Injection	• Permanently removes nutrients from the environment	• Permanently removes water from the environment • Starving downstream systems of a freshwater supply • Permit required	No

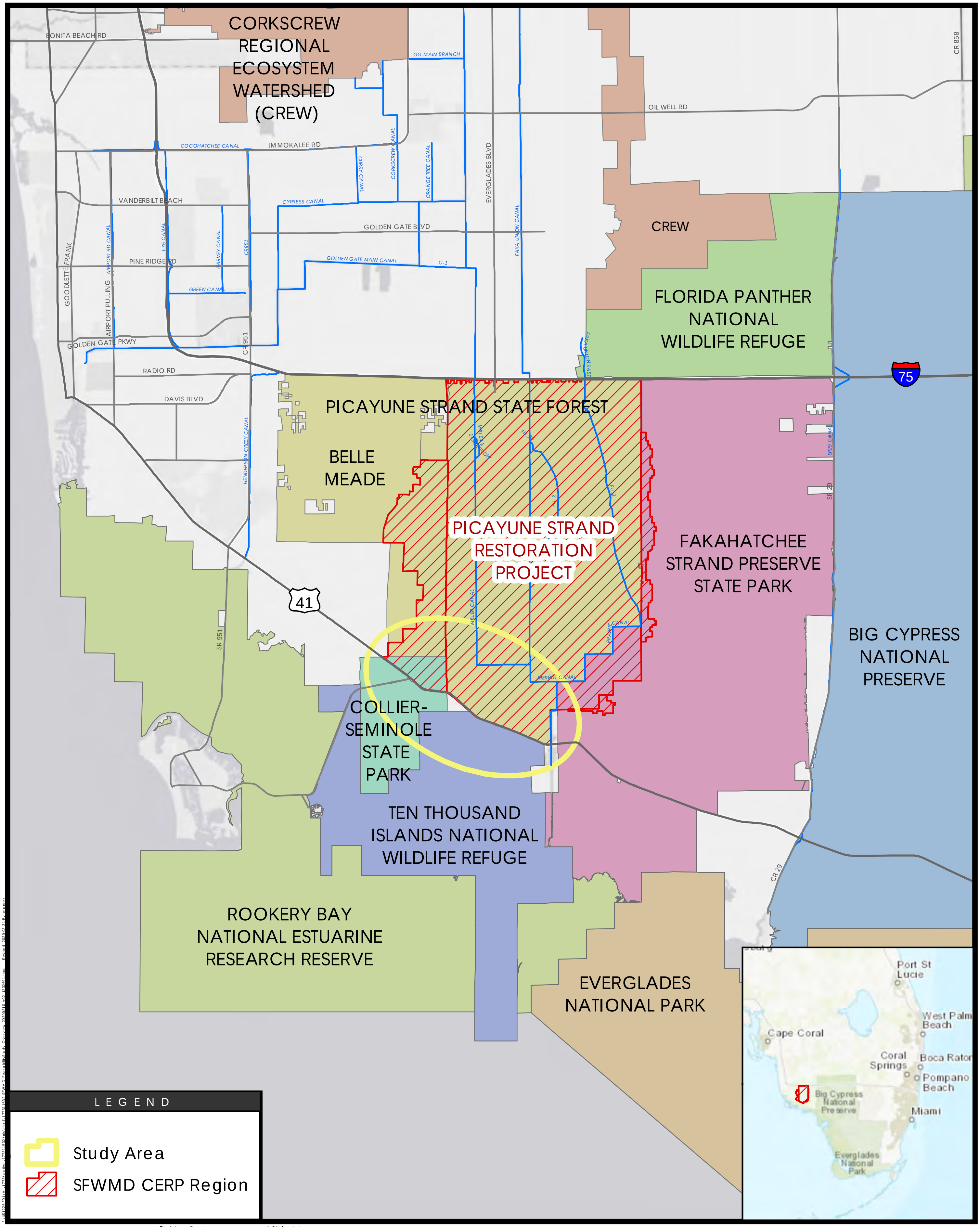
6.0 SUMMARY

The documents identified (Appendix C) by the Working Group (Table 1-1) were reviewed to identify potential technologies that might be used to treat outflow water from the region. Water quality data obtained from these documents, indicating the sources of nutrients and their relative contribution to the Study Area, are detailed in Appendix B. Based on discussions with District staff, it was determined that any project implemented would likely be located south of US 41 and designed to treat water leaving the PSRP area through culverts BR36, BR-37, and a new culvert. Projects are not anticipated to be located on private/agricultural land due to potential funding source restrictions.

A total of 19 project types were identified during this review of available literature, eleven of which are potentially applicable for further review during the Task 4 Feasibility Study. During this task, one or more treatment option(s) may be combined to provide the maximum attainable nutrient removal prior waters discharging to the OFWs to the south. The feasibility study will identify different combinations of technologies that may be used, as well as land potential treatment area availability, and will identify the maximum nutrient removal projected to be achieved given the land potentially available to be used for treatment.

These project types include constructed treatment wetlands, detention areas and settling ponds, spreader berms and/or canals, restored wetlands, aeration systems, periphyton and/or submerged aquatic vegetation growth and removal, polishing ponds, hybrid wetland treatment technology, bioreactors, Iron Enhanced Sands, and Bold & Gold®. Technologies reviewed but not recommended at this time include recyclable water containment areas, algal scrubbers, offline alum treatment, floating treatment wetlands, NutriGone Media™, Downstream Defender®, aquifer storage and recovery and deep well injection. It is recommended that periodic removal of sediments and/or vegetation be incorporated into the operation and maintenance of treatment systems to prevent these systems from becoming saturated with nutrients, as well as the subsequent release of nutrients following disturbance of sediments and/or the death of vegetation.

Appendix A PROJECT AREA SITE MAP



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Notes:
1. Coordinate System: NAD 1983 StatePlane Florida East FIPS 0901 Feet
2. Source data: FNAI, Collier County, SFWMD
3. Imagery: ESRI

SFWMD FEASIBILITY STUDY
MAJOR PUBLIC LANDS AND STUDY AREA
August 2020

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Technical Review by: M.P. 08/11/20
Independent Review by: K.G. 08/13/20

Appendix B WATER QUALITY DATA REVIEW SUMMARY

Water Quality Data Review Summary

A variety of reports and raw data files were sourced to study water quality near the proposed project area. Monitoring stations utilized by the Florida Department of Environmental Protection (FDEP), Collier County, and South Florida Water Management District (SFWMD) were reviewed to select sites for analyses. Stations containing reliable and relevant data included BR36/TAMTOM/TAMBR36 (BR36), BR37/TAMBR37 (BR37), BR39/TAMBR39 (BR39), BC20, BR49/TAMBR49 (BR49), TT175C, FAKA, Faka Union Canal, Blackwater River, TT175B, BC9, BC10, and BC11. Other stations located in proximity to these sites were considered but ultimately excluded as they did not provide unique perspectives for the analyses. Total Nitrogen (TN), Total Phosphorus (TP), Turbidity, Copper, and Iron data are included for each station when available, across all monitoring years, and used to determine the average parameter concentration within waters near each location. For sites where raw data could not be found or were believed to be incomplete, reports were used to determine summary statistics.

Compiled data were screened to remove analyzed samples containing qualifiers identifying potential inaccuracies. A conservative approach to data management was taken and included setting reported nutrient concentrations that were recorded below detection limits at the minimum detection limit (MDL). Station data that were available from multiple sources were compared to ensure consistency. The remaining number of samples were recorded (n) along with the date range associated with the data, before deriving summary information. Calculations included measures of central tendency and variability, such as average, geometric mean, median, standard deviation, minimum, and maximum. This approach to data screening and analysis was similar to the method described in the SFWMD Picayune Strand Restoration Project (PSRP) Water Quality Projections With "Southwestern Protective Levee" Feature report.

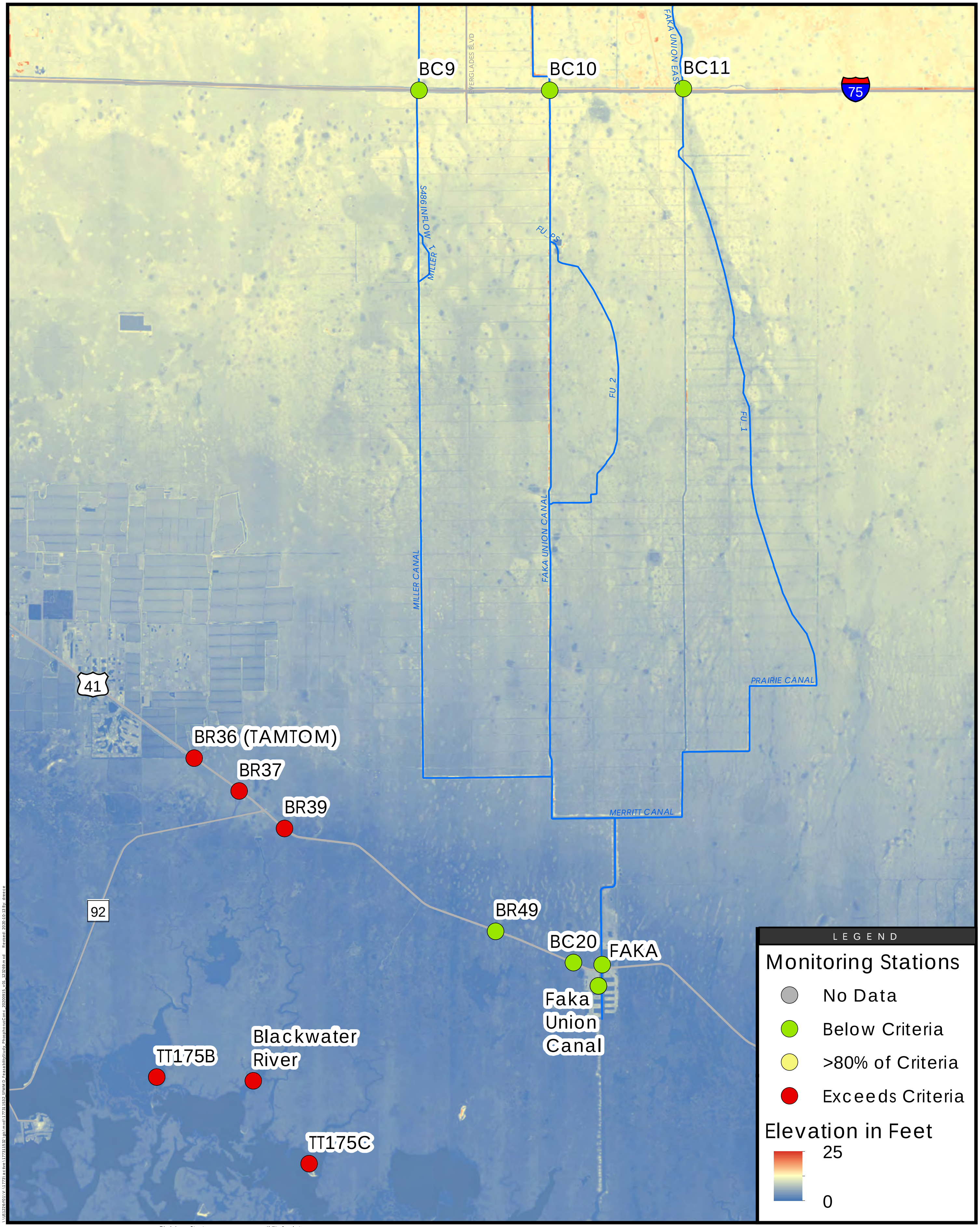
Recorded averages were compared against known criteria for each parameter across all chosen monitoring stations (FAC 62-602). The TP and TN standard narrative states that "in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna" (FAC 62-302.530 (48)(b)). To allow for nutrient comparisons between stations, and the categorization of high, moderate, and low concentrations, criteria associated with the Peninsular Nutrient Watershed Region were adopted in the absence of specific numeric TN and TP criteria (FAC 602-302.531(c)(2)). These thresholds were chosen as they were the closest geographical standards available for freshwater streams and canals. Collier County Pollution Control FY19 Surface Water Report also used Peninsular criteria (0.12 mg/L TP and 1.54 mg/L TN) for nutrient comparisons.

Stations located within downstream Outstanding Florida Waters (OFW) were identified as part of Estuary Nutrient Region E8 (ENRE8) Tidal Cocohatchee River/Ten Thousand Islands, Blackwater River (FAC 62-302.532(1)). As such, stations TT175C, Blackwater River, and TT175B were determined to have their own set of nutrient criteria thresholds (0.053 mg/L TP and 0.41 mg/L TN) used for comparison (FAC 60-302.532(1)(e)(6)). When available, turbidity and iron averages were compared against known criteria for freshwater and estuarine systems, including 29NTU turbidity and 300µg/L iron (FAC 60-302.530(23)/(70)). The copper criterion for estuarine waters is 3.7 µg/L, while standards for freshwater systems are variable. Copper data collected from stations located outside of estuaries were compared to criteria calculated from average hardness in mg/L using standard equations (FAC 60-302.530(38)). Hardness is a measurement of calcium carbonate concentration and is reflective of naturally high or low metal concentrations within a watershed. Using hardness as a means of calculating metal concentration criteria allows for site-specific standard adjustments. In compliance with Florida guidance, average hardness concentrations exceeding 400 mg/L were considered at 400 mg/L during the calculation of copper criteria.

Water quality averages derived from data recorded from each station were categorized as exceeding, within 80%, or below criteria thresholds, as a method of identifying areas with low, moderate, and high nutrient, copper, iron, and turbidity levels. Maps of stations and their associated criteria exceedances for each parameter can be found below (**Figure B-1**). Organized average water quality data can be found below (**Table B-1**). From the data available, freshwater monitoring stations BR36, BR37, and BR39 had average TP concentrations exceeding high nutrient criteria thresholds. BR36 also had a high average TN concentration, with BR37 having moderate concentrations. TN is not available for BR39. Estuarine station averages indicated high criteria threshold exceedances for both TN and TP across TT175C, Blackwater River, and TT175B. Monitoring data collected from locations north and south of the PSRP, including BC9, BC10, BC11, FAKA, and Faka Union Canal were shown to have averages below criteria. One exception to this includes BC20, which indicated waters had a moderate average TN concentration.

Turbidity averages were below threshold criteria across all monitoring stations, apart from the BR36 location, which had a moderate average measurement within 80% of the high threshold. Similarly, BR36 was the only station analyzed that had a copper average exceeding the site criterion. The iron criteria threshold was exceeded by two stations, with the most notable being BR36, which had an average concentration 3.7 times greater than the threshold value. BC9 also exceeded iron criteria with stations Faka Union Canal and BC10 having moderate average concentrations.

Turbidity, copper, and iron data were analyzed due to their potential impacts on the effectiveness of the water treatment technologies described in this report. TP and TN data were used to identify areas experiencing high nutrient levels and inform treatment train recommendations to be addressed in the feasibility report. Data included in this Appendix support the use of mitigation technologies and techniques to address high levels of nutrients, copper, iron, and turbidity near BR36, BR37, and BR39, with the goal of reducing nutrient loads impacting inland aquatic and terrestrial resources, and downstream OFWs. The feasibility of mitigation activities will be dependent on cost-benefit analyses, site-specific conditions, and subsequent land restrictions.



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Notes:
1. Coordinate System: NAD 1983 StatePlane Florida East FIPS 0901 Feet
2. Source data: Collier County, SFWMD, Stantec
3. Imagery: ESRI, Collier County

PICAYUNE WATERSHED WATER QUALITY STUDY

MONITORING STATIONS - TOTAL PHOSPHORUS CONCENTRATION

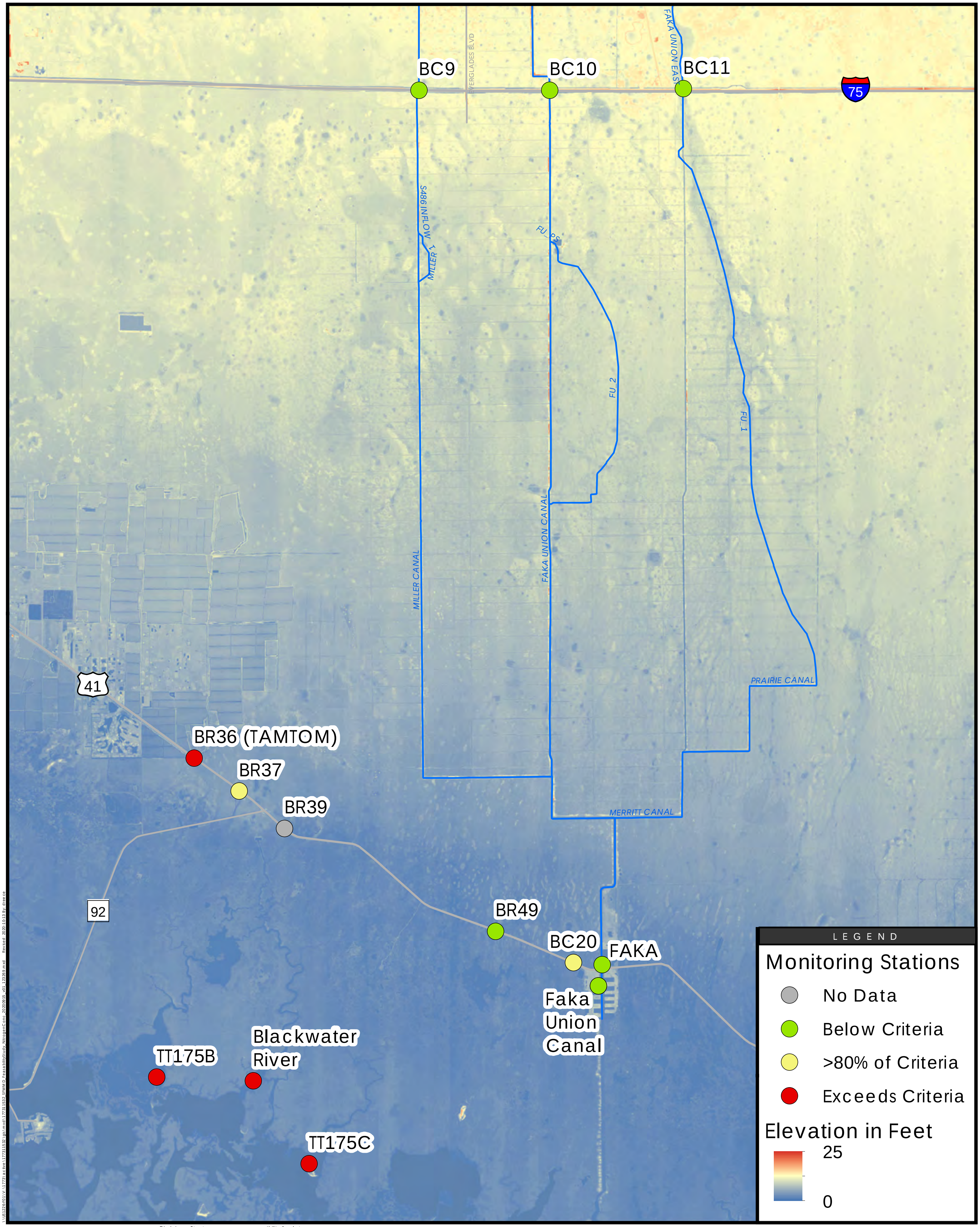
October 2020

0 5,000 10,000 Feet

N

Stantec Consulting Services Inc.
5801 Pelican Bay Blvd. Suite 300
Naples, FL 34108
tel 239.649.4040
fax 239.263.6449

Prepared by: D.A.R. 10/13/20
Technical Review by: M.P. 09/22/20
Independent Review by: B.P. 09/22/20



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PICAYUNE WATERSHED WATER QUALITY STUDY

MONITORING STATIONS - TOTAL NITROGEN CONCENTRATION

October 2020

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Prepared by: D.A.R. 10/13/20
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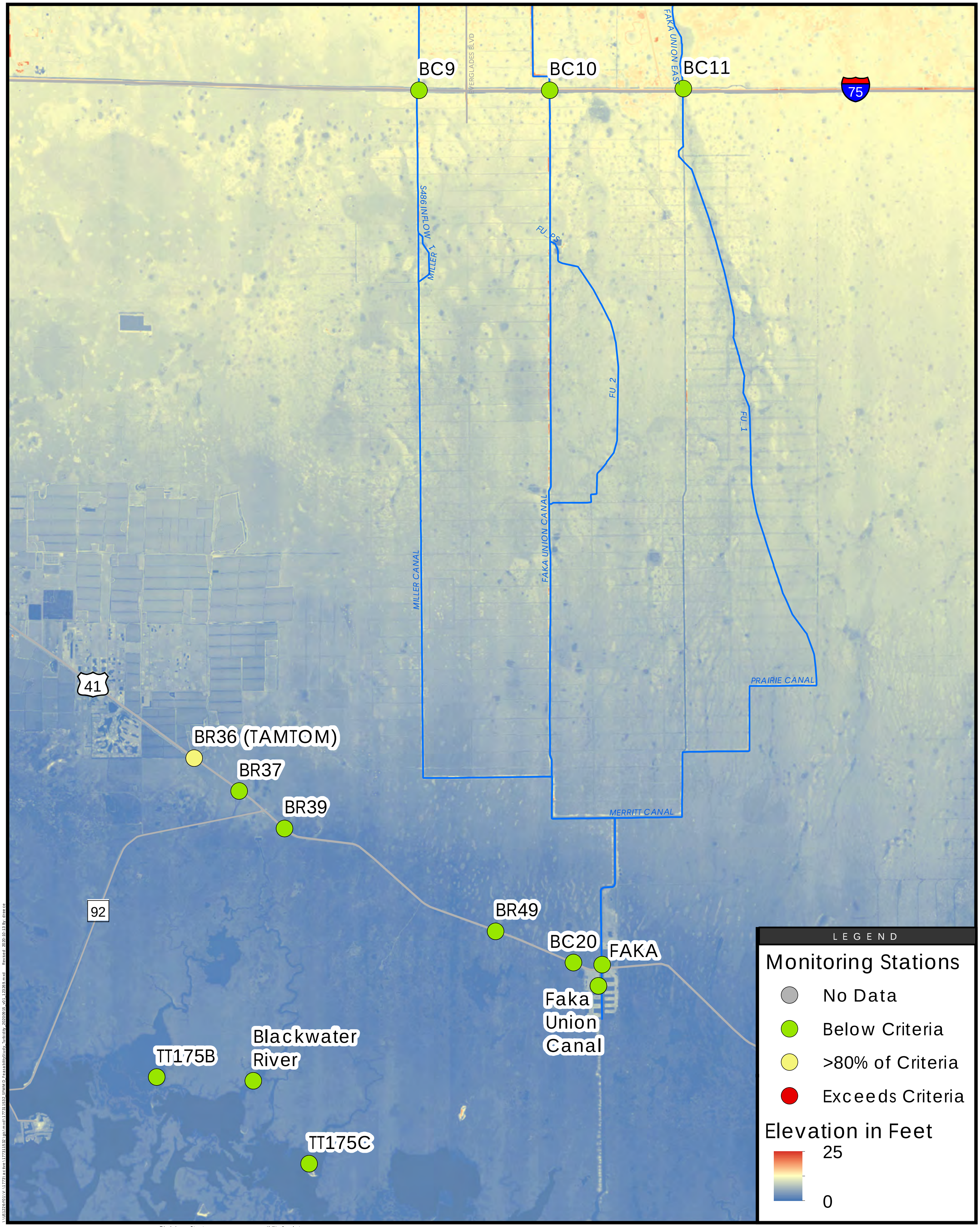

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PICAYUNE WATERSHED WATER QUALITY STUDY

MONITORING STATIONS - TURBIDITY

October 2020

0 5,000 10,000 Feet

N

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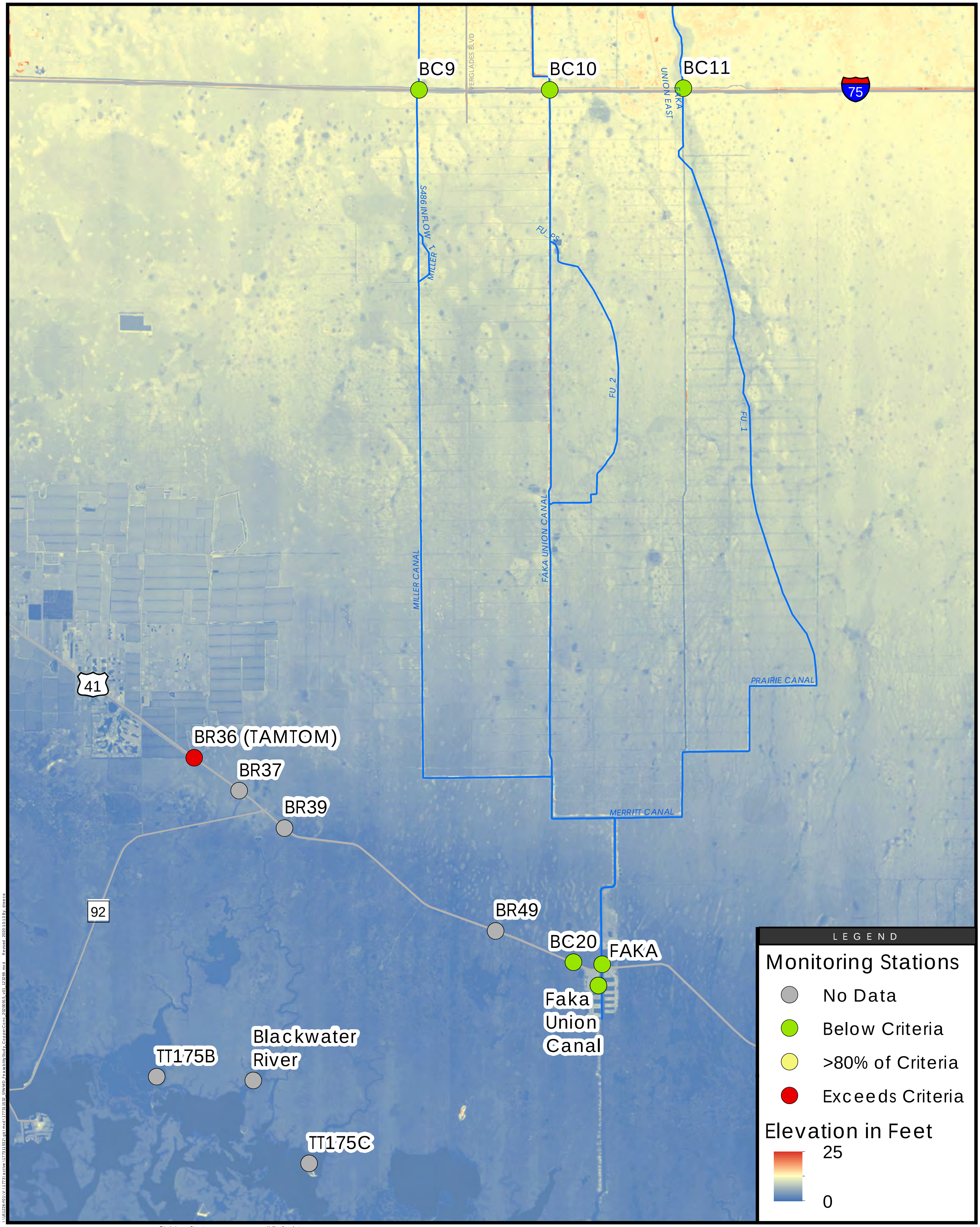

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PICAYUNE WATERSHED WATER QUALITY STUDY

MONITORING STATIONS - COPPER CONCENTRATION

October 2020

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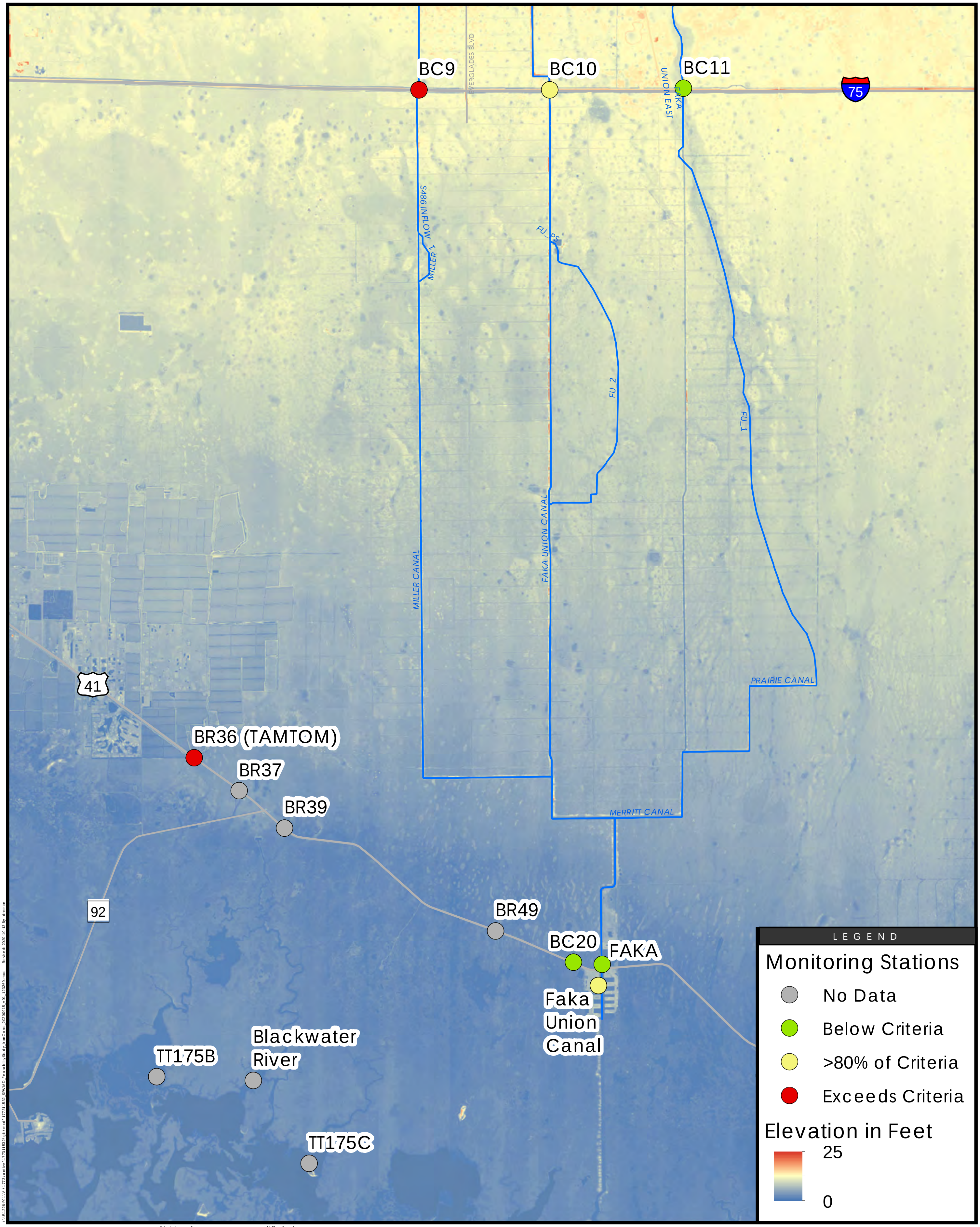

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Notes:
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2. Source data: Collier County, SFWMD, Stantec
3. Imagery: ESRI, Collier County

PICAYUNE WATERSHED WATER QUALITY STUDY

MONITORING STATIONS - IRON CONCENTRATION

October 2020

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Technical Review by: M.P. 09/22/20
Independent Review by: B.P. 09/22/20

Table B-1: Surface Water Quality Monitoring Data Summary

	Coordinates		Total Phosphorus (TP) [mg/L]										
Monitoring Stations	Latitude	Longitude	n	Mean Conc**	Standard Deviation	Geometric Mean Conc	Median	Min	Max	Date Range	Data Reference	Criteria Concentration	Criteria Reference
BR36/TAMTOM/TAMBR36	26.0057	-81.6092	88	0.362	0.306	0.303	0.276	0.106	2.428	Nov 2009-Aug 2019	1	0.12	A
BR37/TAMBR37	25.9985	-81.5982	37	0.314	0.197	0.274	0.251	0.088	1.007	Aug 2015-Oct 2019	1	0.12	A
BR39/TAMBR39	25.9903	-81.5871	8	0.162	0.063	0.147	0.191	0.056	0.214	Apr 1995-Aug 1995	2	0.12	A
BC20	25.9610	-81.5166	57	0.058	0.085	0.044	0.046	0.004	0.668	Sep 2009-Aug 2015	2	0.12	A
BR49/TAMBR49	25.9679	-81.5356	23	0.013	0.006	0.012	0.013	0.006	0.028	Sep 2016-Sep 2019	1	0.12	A
TT175C	25.9165	-81.5807	70	0.064	0.027	0.050	0.066	0.002	0.145	Feb 2016-Jul 2020	3	0.05	B
FAKA	25.9605	-81.5095	170	0.013	0.007	0.012	0.011	0.004	0.049	Oct 2001-Oct 2019	1	0.12	A
Faka Union Canal*	25.9559	-81.5105	163	0.027	0.019	0.022	0.023	0.004	0.109	Jan 2006-Feb 2020	2	0.12	A
Blackwater River	25.9347	-81.5945	24	0.072	0.025	0.068	0.067	0.040	0.134	Jan 2015-Jan 2020	2	0.05	B
TT175B	25.9354	-81.6179	70	0.057	0.022	0.046	0.059	0.002	0.112	Feb 2010-Jul 2020	3	0.05	A
BC9	26.1530	-81.5551	150	0.011	0.005	0.010	0.010	0.004	0.036	Oct 2001-Oct 2019	1	0.12	A
BC10	26.1531	-81.5232	151	0.022	0.015	0.018	0.018	0.004	0.084	Nov 2001- Sep 2015	1	0.12	A
BC11	26.1535	-81.4906	130	0.021	0.011	0.019	0.020	0.006	0.072	Nov 2001-Aug 2015	1	0.12	A

	Coordinates		Total Nitrogen (TN) [mg/L]										
Monitoring Stations	Latitude	Longitude	n	Mean Conc**	Standard Deviation	Geometric Mean Conc	Median	Min	Max	Date Range	Data Reference	Criteria Concentration	Criteria Reference
BR36/TAMTOM/TAMBR36	26.0057	-81.6092	84	1.71	0.67	1.61	1.59	0.66	5.42	Nov 2009- Aug 2019	1	1.54	A
BR37/TAMBR37	25.9985	-81.5982	37	1.34	0.61	1.23	1.21	0.61	3.79	Aug 2015-Oct 2019	1	1.54	A
BR39/TAMBR39	25.9903	-81.5871	-	-	-	-	-	-	-	-	-	-	-
BC20	25.9610	-81.5166	71	1.34	0.66	1.23	1.35	0.33	5.34	Oct 2009-Sep 2015	2	1.54	A
BR49/TAMBR49	25.9679	-81.5356	27	1.03	0.19	1.01	1.08	0.61	1.34	Sep 2015- Sep 2019	1	1.54	A
TT175C	25.9165	-81.5807	29	0.60	0.18	0.57	0.59	0.32	1.06	Jul 2014-Jul 2020	3	0.41	B
FAKA	25.9605	-81.5095	181	0.50	0.20	0.47	0.46	0.04	1.65	Oct 2001-Oct 2019	1	1.54	A
Faka Union Canal*	25.9559	-81.5105	165	0.60	0.21	0.56	0.56	0.03	2.03	Jan 2006-Feb 2020	2	1.54	A
Blackwater River	25.9347	-81.5945	24	0.60	0.19	0.57	0.57	0.31	1.03	Jan 2015-Jan 2020	2	0.41	B
TT175B	25.9354	-81.6179	30	0.54	0.17	0.48	0.53	0.02	0.81	Jul 2014-Jul 2020	3	0.41	A
BC9	26.1530	-81.5551	151	0.57	0.21	0.52	0.53	0.04	1.76	Oct 2001-Sep 2015	1	1.54	A
BC10	26.1531	-81.5232	155	0.52	0.02	0.47	0.47	0.04	1.61	Oct 2001-Sep 2015	1	1.54	A
BC11	26.1535	-81.4906	134	0.61	0.28	0.55	0.54	0.04	1.75	Oct 2001-Aug 2015	1	1.54	A

	Coordinates		Turbidity [NTU]										
Monitoring Stations	Latitude	Longitude	n	Mean Conc**	Standard Deviation	Geometric Mean Conc	Median	Min	Max	Date Range	Data Reference	Criteria Concentration	Criteria Reference
BR36/TAMTOM/TAMBR36	26.0057	-81.6092	37	24.31	15.34	19.68	24.00	4.30	65.00	Jul 2017-Feb 2020	1	29	C
BR37/TAMBR37	25.9985	-81.5982	-	-	-	-	-	-	-	-	-	-	-
BR39/TAMBR39	25.9903	-81.5871	9	1.23	0.30	1.21	1.20	1.00	2.00	Dec 1994-Aug 1995	2	29	C
BC20	25.9610	-81.5166	66	2.36	2.16	1.73	1.60	0.50	11.00	Oct 2009-Aug 2015	2	29	C
BR49/TAMBR49	25.9679	-81.5356	-	-	-	-	-	-	-	-	-	-	-
TT175C	25.9165	-81.5807	70	9.82	5.50	6.58	10.00	0.10	28.90	Feb 2010-Jul 2020	3	29	C
FAKA	25.9605	-81.5095	86	1.84	1.42	1.46	1.40	0.50	8.40	Oct 2009-Jun 2018	1	29	C
Faka Union Canal*	25.9559	-81.5105	23	3.22	1.13	3.04	3.20	1.20	6.20	Jan 2015-Jan 2020	2	29	C
Blackwater River	25.9347	-81.5945	24	7.89	3.11	7.42	7.15	3.30	18.10	Jan 2015-Jan 2020	2	29	C
TT175B	25.9354	-81.6179	70	8.93	4.42	6.45	8.25	0.10	23.10	Feb 2010-Jul 2020	3	29	C
BC9	26.1530	-81.5551	101	2.39	1.65	1.99	2.10	0.50	13.00	Oct 2009-Jun 2018	1	29	C
BC10	26.1531	-81.5232	203	2.00	1.44	1.57	1.70	0.10	9.50	Dec 2009-Feb 2020	1	29	C
BC11	26.1535	-81.4906	53	1.06	0.54	0.95	0.80	0.50	2.90	Nov 2009-May 2016	1	29	C

	Coordinates		Copper [µg/L]											
Monitoring Stations	Latitude	Longitude	n	Mean Conc**	Standard Deviation	Geometric Mean Conc	Median	Min	Max	Date Range	Data Reference	Average Hardness (mg/L)	Criteria Concentration***	Criteria Reference
BR36/TAMTOM/TAMBR36	26.0057	-81.6092	11	33.45	37.93	23.21	19.80	7.28	142.00	Jul 2017-Dec 2019	2	521	30	C
BR37/TAMBR37	25.9985	-81.5982	-	-	-	-	-	-	-	-	-	-	-	-
BR39/TAMBR39	25.9903	-81.5871	-	-	-	-	-	-	-	-	-	-	-	-
BC20	25.9610	-81.5166	16	1.13	0.96	0.82	0.75	0.15	3.35	Jul 2010-Apr 2015	2	1242	30	C
BR49/TAMBR49	25.9679	-81.5356	-	-	-	-	-	-	-	-	-	-	-	-
TT175C	25.9165	-81.5807	-	-	-	-	-	-	-	-	-	-	-	-
FAKA	25.9605	-81.5095	29	0.67	0.62	0.43	0.75	0.10	2.62	Oct 2009-Jul 2017	2	538	30	C
Faka Union Canal*	25.9559	-81.5105	12	2.57	2.40	2.01	2.05	0.88	9.74	Jan 2006-Sep 2009	2	1893	30	C
Blackwater River	25.9347	-81.5945	-	-	-	-	-	-	-	-	-	-	-	-
TT175B	25.9354	-81.6179	-	-	-	-	-	-	-	-	-	-	-	-
BC9	26.1530	-81.5551	25	0.75	0.84	0.44	0.75	0.10	3.91	Oct 2009-Jul 2017	2	290	23	C
BC10	26.1531	-81.5232	61	0.59	0.50	0.41	0.75	0.10	2.50	Oct 2009-Dec 2019	2	259	21	C
BC11	26.1535	-81.4906	18	1.12	1.94	0.58	0.75	0.10	8.61	Oct 2009-May 2016	2	253	21	C

	Coordinates		Iron [µg/L]										
Monitoring Stations	Latitude	Longitude	n	Mean Conc**	Standard Deviation	Geometric Mean Conc	Median	Min	Max	Date Range	Data Reference	Criteria Concentration	Criteria Reference
BR36/TAMTOM/TAMBR36	26.0057	-81.6092	11	1105.6	555.6	1003.6	905.0	529.0	2230.0	Jul 2017-Dec 2019	2	300	C
BR37/TAMBR37	25.9985	-81.5982	-	-	-	-	-	-	-	-	-	-	-
BR39/TAMBR39	25.9903	-81.5871	-	-	-	-	-	-	-	-	-	-	-
BC20	25.9610	-81.5166	23	186.9	138.3	143.3	141.0	35.6	547.0	Jan 2010-Jul 2015	2	300	C
BR49/TAMBR49	25.9679	-81.5356	-	-	-	-	-	-	-	-	-	-	-
TT175C	25.9165	-81.5807	-	-	-	-	-	-	-	-	-	-	-
FAKA	25.9605	-81.5095	35	112.3	88.8	80.9	85.7	11.8	341.0	Jan 2010-Jul 2017	2	300	C
Faka Union Canal*	25.9559	-81.5105	6	246.7	359.3	146.3	100.0	100.0	980.0	Oct 2006-Jul 2009	2	300	C
Blackwater River	25.9347	-81.5945	-	-	-	-	-	-	-	-	-	-	-
TT175B	25.9354	-81.6179	-	-	-	-	-	-	-	-	-	-	-
BC9	26.1530	-81.5551	36	350.7	235.0	252.4	323.0	27.4	820.0	Oct 2009-Jul 2017	2	300	C
BC10	26.1531	-81.5232	79	264.6	218.7	187.6	194.0	19.5	873.0	Oct 2009-Dec 2019	2	300	C
BC11	26.1535	-81.4906	20	189.6	90.9	168.9	176.0	38.3	431.0	Oct 2009-Jun 2016	2	300	C

Note: Red text signifies average concentrations exceed standard criteria thresholds for the given station, yellow signifies concentrations are within 80% of the standard nutrient criteria, and green signifies average concentrations are well below criteria. Cells populated with a hyphen symbolize no available data.

*Faka Union Canal station data were sourced from FDEP Run 59. Station coordinates were identical to those at FAKAUPOI, despite having containing slightly different data. As such, Faka Union Canal data were chosen to represent water quality conditions recorded from this location.

**Mean concentration is represented on the monitoring stations map.

***Copper criteria concentrations were calculated based on average hardness measured from each station. In compliance with standard methods, hardness concentrations greater than 400 mg/L were considered at 400 mg/L for the purpose of calculating copper criteria in µg/L.

1. Summary data sourced from the SFWMD PSRP Water Quality Projections With "Southwestern Protective Levee" Feature Report.

2. Raw data sourced from FDEP WBID Run 59.

3. Raw data sourced from SFWMD DBHYDRO.

A. Standard criteria based on Peninsular Standard Concentrations [FAC 60-302.531(c)(2)].

B. Standard criteria based on the Estuary-Specific Numeric Interpretations of the Narrative Nutrient Criterion table Blackwater River ENRE8 [FAC 60-302.532(1)(e)(6)].

C. Standard criteria based on the Surface Water Quality Criteria table [FAC 60-302.530(23)/(38)/(70)].

Appendix C DOCUMENT REVIEW LIST

Presentations:

Dr. Mark Clark's presentation
https://mediasite.video.ufl.edu/Mediasite/Play/b4c9df69735147edba7a186665919d3a1d

Reports:

Existing Picayune Strand Restoration Project (PSRP) design information

Existing PSRP water quality testing reports

Basin-specific feasibility studies/water quality improvement strategies

Existing MSSW / ERP near project sites

Review CERP project for applicable strategies

Parsons Stormwater Plan for Belle Meade, done well over a decade ago for Rookery Bay (Bradley Cornell may have a copy)

Described potential water re-distribution, passive/active water quality improvement projects from local stakeholders/working group – specific areas:

Collier-Seminole State Park

Rookery Bay Estuarine Research Reserve

1. Parsons. September 2006. Belle Meade Area Stormwater Management Master Plan. South Florida Water Management District
2. Rookery also did modeling of the Rookery Bay watershed as part of this examination of other plans.

Cape Romano – Ten Thousand Islands Aquatic Preserve

SFWMD Science and Data (review for opportunities / applicable project types):

1. https://www.sfwmd.gov/science-data/scientific-publications-sfer
2. https://issuu.com/southfloridawatermanagement/docs/2019_sfer_highlights_hr/2?ff
3. Big Cypress Basin
4. Estuaries
5. Restoration Strategies Science Plan – Related Documents
6. Saltwater Interface Maps by County
7. Stormwater Treatment Areas and Flow Equalization Basins
8. Water Supply – Hydrogeological Reports
9. Florida Waters Resources Manual [PDF]
10. Long-Term Plan for Achieving Water Quality Goals
11. Restoration Strategies Science Plan
12. SFWMD Formation Identification Guide [ZIP, 2.8 GB]
13. South Florida Water Management Model (SFWMM) Position Analysis – Initial Stage Values – Current Month [PDF]
14. Water Conservation
15. Water Supply Plans
16. Water Supply Reports

Data Collection Resources

Repository of pertinent studies available to use as resources for the C-43 WBSR Water Quality Feasibility Study - to access the repository, click the links below:

1. General Documents
2. Treatment Technologies Documents
3. Wetland Treatment Technology Documents
4. Basin Water Quality Study Documents
5. Blue-Green Algae Documents

Maps of proposed affected areas and locations of potential project locations

FY19 Collier County Surface Water Report

2015 Collier County Surface Water Trend Report and Appendices

Collier County Ground Water 2019 Trend Report

Florida International University's 2014 Sediment Report-Technical Report

Additional reports available at:

https://www.colliercountyfl.gov/your-government/divisions-f-r/pollution-control/water-quality-monitoring/pollution-control-water-resources-monitoring/pollution-control-water-quality-

Collier County Watershed Management Plan

https://www.colliercountyfl.gov/your-government/divisions-s-z/zoning-division/stormwater-and-environmental-planning/watershed-management-planning/wmp-development-archived-information

Collier County Comprehensive Watershed Improvement Plan (CWIP)—aka Belle Meade Flow-Way Restoration

https://www.colliercountyfl.gov/your-government/divisions-a-e/capital-project-planning-impact-fees-and-program-management/coastal-zone-management-section/collier-county-comprehensive-watershed-improvement-plan-8061

This project was also presented to the Big Cypress Basin Board at their Feb. 21, 2020 meeting which is available here:
https://www.sfwmd.gov/news-events/meetings

The PowerPoint presentation is here:
https://apps.sfwmd.gov/webapps/publicMeetings/viewFile/25422

Available Databases:

FDEPs STORET or WIN databases

FDEP's Impaired Waters Rule database and assessment tool (Run59 is the most recent)

DEP Water Quality Treatment Technologies Database

Online resources:

https://www.arcgis.com/home/webmap/viewer.html?webmap=62538b4691d64ff594e56f63791b98fd&extent=-81.9537,26.0644,-81.5794,26.3481

https://rookerybay.org/

http://cdmo.baruch.sc.edu/get/landing.cfm

Data Collection Resources

Link to DEP's mapdirect web resource:

https://ca.dep.state.fl.us/mapdirect/?map=75bb9405d73748d38f40f64f652bad59

preloaded GIS layers in the link above:

1. The IWR stations layer will be helpful for IDing where the stations are located and their station IDs/names so you can more easily pull the correct data out of either the WIN or IWR database
2. I also loaded the "waters not attaining standards" layer which indicates which waterbodies (WBIDs) are impaired and for what parameters (TN, TP, etc)
3. The CERP project boundary layer is also pre-loaded on the map

C-43 reservoir WQ feasibility study website:

https://www.sfwmd.gov/content/c43waterqualitystudy

Some of the studies are specific to the C-43 basin, but others are not. Also, the mesocosm and other associated studies for the BOMA water quality treatment and testing facility has applicability beyond the Caloosahatchee watershed:

Links to FDACS reports and information:

As part of the development of water supply plans, FDACS provides information on agricultural water use demand pursuant to sections 570.93 and 373.709, Florida Statutes. To provide the required information, FDACS utilizes the Florida Statewide Agricultural Irrigation Demand (FSAID) to identify agricultural land uses and the associated irrigation demands. FSAID is updated annually.

Information on FSAID and the annual reports are available at: https://www.fdacs.gov/Agriculture-Industry/Water/Agricultural-Water-Supply-Planning.

The 2020 FSAID report will be available at the end of August. FDACS implements a BMP program. FDACS tracks enrollment in the FDACS BMP program and the status of implementation verification site visits of those parcels enrolled in the FDACS BMP program and provides annual status reports to the Legislature and Governor that are available at: https://www.fdacs.gov/Divisions-Offices/Agricultural-Water-Policy

A statewide BMP enrollment map is available at: https://www.fdacs.gov/ezs3download/download/78962/2320452/Media/Files/Agricultural-Water-Policy-Files/Maps/Statewide-Enrollment-Map/BMP-Enrollment-Statewide-%28online-map%29.pdf.

https://rookerybay.org/wp-content/uploads/5-RookeryBayWatershedProjects.pdf

This compiles a set of watershed restoration projects in the vicinity or including areas the WQ Feasibility Study is looking for projects. They are drawn from the Parsons 2006 Belle Meade Stormwater Master Plan, Collier County Watershed Plan (2011), the Southwest Florida Watershed Master Plan (SFWMD/ACOE - former SW Fla Feasibility Study), and other sources.

Appendix D DOCUMENT REVIEW SUMMARY TABLE

Organization/Title	Link	Comments	Existing Conditions	General Description of Technology/Treatment Type	Nutrient Reduction per Unit	Nutrient Removal Efficiency	Unit Costs	O&M Requirements	Regulatory Constraints	Implementation Schedule	General Land Area Requirements	Ancillary Benefits (e.g. provides wildlife habitat)	Potentially viable for this effort? Why or why not?	Supplementary Document
Presentations:														
Dr. Mark Clark's presentation	https://mediasite.video.ufl.edu/Mediasite/Play/b4c9df69735147edba7a186665919d3a1d	Video presentation	Irrigation drainage tile for ag	Adding a structure at the drainage pipe end can improve water quality - water control structure, controls flow from pipes. Water table is held constant by outfall pipe structures. Greatly reduces excess irrigation. Increased storage capacity in field reduces runoff. Soil below surface, closer to drainage tile, still had P holding capacity - unless that becomes saturated too some day. Board height management is critical.	P concentration reduced by 24.5% and P load runoff reduced by 43.5%. N concentration reduced by 2.5% and load reduced by 31% on average. Holding water table back creates anaerobic conditions to convert NO3 to N2. Can get near complete denitrification. Board height 24-26".	Reduced runoff by an average 39.6% across four different farms; irrigation requirement reduced by 30.1%	Enhanced BMPs - need cost share funding and will need help of researchers to get operating properly.	Farmer needs to manage control structure board heights	None known, a BMP	Implemented between crop seasons, will take up to 2-3 years for farmer to get fully operationally accustomed to operation.	No, placed under crop land.	Reduces water use for irrigation	Not eligible for government funding that will be requested, funding could not be used on private land.	NA
Online Resources:														
Map of water quality conditions	https://www.arcgis.com/home/webmap/viewer.html?webmap=62538b4691d64ff594e56f63791b98fd&extent=-81.9537,26.0644,-81.5794,26.3481	Useful for viewing stations monitored by Collier County.	More detailed information and relevant findings can be found in the CC FY 2019 report. In summary, monitoring stations located south of the PSRP and South Belle Mead areas show low to moderate concentrations of nutrients and measurements of turbidity. The TAMTOM station appears to contain high levels of nutrients and turbidity relative to other monitoring stations and the peninsular standard thresholds used for comparison. See Appendix B.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	See Appendix A (doc_wq_lit_review.docx)
Florida Department of Environmental Protection:														
Link to DEP's map direct web resource, preloaded layers at this link:	https://ca.dep.state.fl.us/mapdirect/?map=75bb9405d73748d38f40f64f652bad59	Indicates there are a variety of water quality stations located throughout the project area that are not included in the CC FY19 report.	Identified 36 monitoring stations applicable to the project area. Used the WIN and IWR databases to download and analyze all available water quality data for these stations.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
A) The IWR stations layer will be helpful for IDing where the stations are located and their station IDs/names to more easily pull the correct data out of either the WIN or IWR database	See above	Compiled station info in the summary spreadsheet and notes document located in the project folder.	Station information was gathered.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	See Appendix A (doc_wq_lit_review.docx)
B) "Waters not attaining standards" layer which indicates which waterbodies (WBIDs) are impaired and for what parameters (TN, TP, etc)	See above	Useful for a preliminary review.	A variety of stations located north and south of the PSRP area are impaired with only a few indicating nutrient impairment. Further analysis is required to better understand the extent of nutrient pollution.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C) The CERP project boundary layer	See above	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FDEPs STORET or WIN databases	https://floridadep.gov/dear/watershed-services-program/content/winstoret	Raw data was downloaded and analyzed by Stantec staff to derive nutrient concentrations recorded at relevant station.	Stations experiencing Moderately to Very High TN and TP concentrations in the last 10 years included BR36, BR37, BC20, and WHITNEY RIVER. Although other stations appeared to contain varying degrees of high nutrient concentrations, available data were collected over 10 years ago and were therefore considered irrelevant to current site conditions. In 2019, the BR36 station presented an average TN concentration of 1.67 mg/L and an average TP concentration of 0.41 mg/L. BR37, located approximately 4,200 linear feet downstream of BR36, had an average yearly TN concentration of 1.04 mg/L and a TP concentration of 0.33 mg/L in 2016. Other moderate concentrations appeared at select locations near the southern border of the PSRP area; however, monitoring stations located within the PSRP canals presented nutrient concentrations below established thresholds. In addition to the aforementioned locations, the WHITNEY RIVER station data indicated consistently Very High TN and TP concentrations. This station was located near Button Wood Bay in the 10,000 Islands Park south of the PSRP area. See Appendix B.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	See Appendix A (doc_wq_lit_review.docx)
Collier County:														
Ag pumping on US 41E 6-8-20 photos	Project folder	Shows water being pumped from farm discharge pipes.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Collier County US 41 WQ sites	Project folder	Provides a graphical summary of CC WQ data recorded at the FAKA and TAMTOM stations. This data is also available in each FY report.	Document containing average TP and TN concentrations recorded from the EAGLECRK, BC22, SANDPIPE, and BR36 stations from 2016 to 2020. BR36 and FAKA stations are relevant to the water quality study because water passing through these locations will likely be influenced by or impact watershed pollution due to the PSRP project.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
A) FY19 Collier County Surface Water Report	FY19 Collier County Surface Water Report	Review conducted in documents below.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	See Appendix A (doc_wq_lit_review.docx)
B) Surface Water Quality Assessment and Trend Report for Collier County Engineering and Natural Resources	2015 Collier County Surface Water Trend Report	Review conducted in documents below.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	See Appendix A (doc_wq_lit_review.docx)
C) Collier County Ground Water 2019 Trend Report	Collier County Ground Water 2019 Trend Report	Review conducted in documents below.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	See Appendix A (doc_wq_lit_review.docx)
D) Florida International University's 2014 Sediment Report-Technical Report	Florida International University's 2014 Sediment Report-Technical Report	Review conducted in documents below.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	See Appendix A (doc_wq_lit_review.docx)
Impaired waters rule FDEP and Store, see run 59	http://publicfiles.dep.state.fl.us/DEAR/IWR/	Not useful in identifying areas of high nutrient concentrations but provides descriptions of state laws related to water quality.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Monitor sites map	https://www.arcgis.com/home/webmap/viewer.html?webmap=62538b4691d64ff594e56f63791b98fd&extent=-81.9537,26.0644,-81.5794,26.3481	Review conducted in documents below.	2019 TP data included in CC WQ report.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Organization/Title	Link	Comments	Existing Conditions	General Description of Technology/Treatment Type	Nutrient Reduction per Unit	Nutrient Removal Efficiency	Unit Costs	O&M Requirements	Regulatory Constraints	Implementation Schedule	General Land Area Requirements	Ancillary Benefits (e.g. provides wildlife habitat)	Potentially viable for this effort? Why or why not?	Supplementary Document
County watershed management plan	https://www.colliercountyfl.gov/your-government/divisions-s-z/zoning-division/stormwater-and-environmental-planning/watershed-management-planning/wmp-development-archived-information	Probably not viable. These projects were recommended in 2011 and they may already be constructed. There do not appear to be any hard numbers for nutrient reduction or removal available in this report - only existing conditions. One project is an STA located north of US 41 northwest of the project site, unknown if this was built.	Volume 1 document provides existing conditions of all Collier County watersheds and estuaries. Volume 4 contains detailed technical analysis, for example "Total Phosphorus Pollution Loads by WBID and Watershed"	Volume 2 documents the wide variety of structural BMPs considered across the County, including 24 projects for Rookery Bay, 6 of which were identified for further detailed evaluation (Table 2-1).	The report evaluates the BMPs based on "watershed score" instead of using actual scientific units (lbs, tons, acres, gallons, etc.). See Vol. 2	Cost estimates are included for the projects evaluated in detail (including 6 for Rookery Bay). See Vol. 2	NA	NA	NA	NA	NA	NA	Probably not viable. These projects were recommended in 2011 and they may already be constructed. There do not appear to be any hard numbers for nutrient reduction or removal available in this report - only existing conditions. One project is an STA located north of US 41 northwest of the project site, unknown if this was built.	NA
County Watershed improvement plan	https://www.colliercountyfl.gov/home/showdocument?id=78252	2016 plan for flow diversion from Naples Bay to Rookery Bay thru Belle Meade. The maps in the presentation (two documents below) make clear that the discharge point of this project thru Belle Meade is actually northwest of the Tamiami Trail culverts that are the focus of this study.	This is a separate project that includes many different technologies to implement a large scale diversion of water flows. The individual technologies apply to the PSRP as types of projects that may be used, but the project as a whole is specific to a region west of the PSRP site.	Freshwater flow diversion from Golden Gate Canal through the Belle Meade area using Linear Pond and Spreader Swale. Includes pump stations flow ways, culverts, spreaders, cut openings in railroad berm.	Detailed nutrient reduction calculations are included for Naples Bay improvements (due to freshwater diversion), but not specifically for discharge into Rookery Bay	NA	$32M. Detailed cost estimate is included	Many O&M requirements for many different technologies across a wide region of Collier County	Extensive permitting required	Design 2020-2023, and Construction 2023-2026	Projects spread across western Collier County	Possibly some habitat value in ponds created.	Technologies used in the project are potentially viable for this project.	NA
CWIP Presentation	https://www.sfwmd.gov/news-events/meetings	Link is to a webpage with links to all SFWMD meeting documents.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CWIP Presentation	https://apps.sfwmd.gov/webapps/publicMeetings/viewFile/25422	Same plan as "County Watershed Improvement Plan" above. The maps in this presentation make clear that the discharge point of this project thru Belle Meade is actually northwest of the Tamiami Trail culverts that are the focus of this study	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Technologies used in the project are potentially viable for this project.	NA
FY19 Collier County Surface Water Report	FY19 Collier County Surface Water Report	Good source of information for FY2019. Supports a BMP location south of BR36.	Sandpipe and BC22 are both located within the Rookery Bay (East Segment) area. Both sites had no exceedances of TN, TP, or Turbidity compared to state thresholds. Nutrient loads exceeding state thresholds are likely being discharged from sources near of the BR36 station (TN: 2.25mg/L, TP: 0.452mg/L, and Turb: 35NTU). Stations located on canals near I-75 did not have significant exceedances indicating TN, turbidity, and TP are mostly within allowable ranges moving into the PSRP. The station located south of PSRP near I-41 did not have significant exceedances of TN, TP, or turbidity, indicating water currently leaving PSRP is within allowable limits of the parameters of interest (POI).	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	See Appendix A (doc_wq_lit_review.docx)
Older reports available at:	https://www.colliercountyfl.gov/your-government/divisions-f-r/pollution-control/water-quality-monitoring/pollution-control-water-resources-monitoring/pollution-control-water-quality-	Older surface water reports not discussed below could not be located. The link only had one report detailing high nutrient concentrations. All other reports were either groundwater related or focused on trends.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2015 Collier County Surface Water Trend Report and Appendices	https://www.colliercountyfl.gov/home/showdocument?id=62700	Not useful in identifying areas of high nutrient concentrations.	Presents FAKA station loading and whether nutrient pollution was increasing or decreasing at each monitoring station. The CC FY19 is more useful in identifying current stations with high nutrient concentrations.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	See Appendix A (doc_wq_lit_review.docx)
Collier County Ground Water 2019 Trend R	Collier County Ground Water 2019 Trend Report	Not useful in identifying areas of high nutrient concentrations.	Report analyzed aquifer water quality trends throughout Collier County. Wells located near areas of interest were used to assess the Lower Tamiami and Mid-Hawthorn aquifers. Significant TN and TP water quality trends were not identified within either aquifer during the 10-year study from 2006-2016.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	See Appendix A (doc_wq_lit_review.docx)
Florida International University's 2014 Sediment Report	Florida International University's 2014 Sediment Report-Technical Report	Nutrient concentrations are measured per kg of suspended sediment and can therefore not easily be compared to Collier County data. Trends contrast with Collier County reports of areas of high nutrient concentrations. Numerical data collected from each station is required to confirm nutrient concentrations.	Water quality parameters related to sediment pollution were analyzed from collected samples in June 2014. CC028 is located south of the PSRP area, CC032 is located on the boundary between PSRP and the Collier Seminole State Park, and CC031 is located north of PSRP. Concentration data was presented graphically without tabular data for either TN or TP. As such, the presented data is only somewhat useful in locating areas of high nutrient concentrations within the areas of interest. At CC028, the 2014 TN concentration was around 1800 mg/kg and TP concentration was around 260 mg/kg. At CC032, the TN concentration was around 1000 mg/kg and TP concentration was around 280 mg/kg. At CC031, TN concentration was recorded at approximately 1,500 mg/kg and TP was recorded at around 1550 mg/kg. This data suggests moderately high concentrations of TN and high concentrations of TP are entering the PSRP area. Waters leaving the PSRP area contain lower levels of TP but higher levels of TN. Pollutant concentrations recorded near station CC032 are moderately high.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	See Appendix A (doc_wq_lit_review.docx)
Florida Department of Agriculture and Consumer Services:														
2019 Florida Statewide Agricultural Irrigation Demand Report	Information on FSAID and the annual reports are available at: https://www.fdacs.gov/Agriculture-Industry/Water/Agricultural-Water-Supply-Planning.	As part of the development of water supply plans, FDACS provides information on agricultural water use demand pursuant to sections 570.93 and 373.709, Florida Statutes. To provide the required information, FDACS utilizes the Florida Statewide Agricultural	Does not list projects; ag projections do not show any increased acreages in the vicinity of the project area; some ag lands to the west projected to be removed from ag by 2045; some ag areas have already been sold for development. Note - ag land adjacent to NW corner of CSSP is owned by FCC Preserve LLC.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2015 Water Quality/Quantity Best Management Practices for Florida Vegetable and Agronomic Crops	https://www.fdacs.gov/content/download/77230/file/vegAgCropBMP-loRes.pdf	FDACS implements a BMP program. FDACS tracks enrollment in the FDACS BMP program and the status of implementation verification site visits of those parcels enrolled in the FDACS BMP program and provides annual status reports to the Legislature and Governor	Link to row crop BMP manual. Farmer is enrolled in BMP program but which BMPs are being implemented are unknown. Site is already farmed under a stormwater permit with maintenance requirements.	Many different BMPs are available but will not be discussed further here because BMPs chosen for the project will not be placed on privately owned lands.	Varies	Varies	Varies	Varies	Possible permit mod required if permitted features are altered, most BMPs would not require permits	Immediately up to a year or two depending on the BMP	Would be implemented on existing ag land	Unknown	No - Funding sources being sought will prohibit use of funds for projects on private lands.	NA
BMP enrollment map	https://www.fdacs.gov/ezs3download/download/78962/2320452/Media/Files/Agricultural-Water-Policy-Files/Maps/Statewide-Enrollment-Map/BMP-Enrollment-Statewide-%28online-map%29.pdf.	NA	Adjacent farm is enrolled in the program	Farmer pledges to implement water and nutrient BMPs practices, keep records of soil and fertilizer management	Varies	Varies	Varies	Varies	Gives state presumption of water quality compliance, subject to audit by FDACS	Varies	Varies	Unknown	No - Funding sources being sought will prohibit use of funds for projects on private lands.	
Collier Seminole State Park:														
2020 PRSP SWPF Project Area Estuarine Effects CSSP	Project folder	PowerPoint with 5 slides; shows flow direction, culvert locations	Slide 3 map shows existing culvert locations and proposed/possible culverts	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rookery Bay:														

Organization/Title	Link	Comments	Existing Conditions	General Description of Technology/Treatment Type	Nutrient Reduction per Unit	Nutrient Removal Efficiency	Unit Costs	O&M Requirements	Regulatory Constraints	Implementation Schedule	General Land Area Requirements	Ancillary Benefits (e.g. provides wildlife habitat)	Potentially viable for this effort? Why or why not?	Supplementary Document
Rookery Bay Website	https://rookerybay.org/	Requested data for monitoring stations located south of PSRP and south Belle Mead.	All three monitoring locations had turbidity concentrations within state thresholds (<29 NTU above background measurements). All three stations had average yearly measurements between 10 and 24 NTU apart from abnormally high turbidity values in 2014 and 2019. Analyzed data was collected between 2000 and 2020 with two of the three monitoring locations beginning in 2002. Monthly turbidity data indicated frequent spikes in turbidity during fall and winter months across all three stations. High turbidity values likely correspond with storm events.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	See Appendix A (doc_wq_lit_review.docx)
Rookery Bay Compilation of Projects	https://rookerybay.org/wp-content/uploads/5-RookeryBayWatershedProjects.pdf	NA	NA	Restoration of natural flow ways	Unknown	Unknown	Unknown	Varies	Would probably require ERP permitting for filling of canals	1+ years	Fill in canals	Rehydrates area to restore wetlands which would probably provide wildlife habitat.	Possible if the PSRP site has canals that need filling.	NA
A) Chapter 2.1 North Belle Meade St	NA	NA	NA	Storage reservoir	Unknown	Unknown	Unknown	Varies	Reservoirs require extensive design and permitting	2+ years	Typically 1000+ acres, would need to determine what is available in this region	Aquatic wildlife and bird foraging habitat	Not likely, water storage reservoirs are primarily for water supply rather than nutrient treatment.	NA
B) Chapter 2.2 North Belle Meade Re	NA	NA	NA	Wetland restoration - alterations to accept flows coming out of a reservoir	Unknown	Unknown	Unknown	Varies	Would need an ERP, wetland restoration ERPs are somewhat easier to obtain but modeling will be required to 'get the water right'.	1-2+ years to design, permit and construct	Unknown	Rehydrates area to restore wetlands which would probably provide wildlife habitat.	Possibly if a site with previously impacted wetlands can be obtained.	NA
C) Chapter 2.3 Golden Gate Canal Diverter Structure	NA	NA	NA	Diverter structure	Unknown	Unknown	Unknown	Varies	Changing the current flow of water, would need an ERP for pump stations, etc., could be done as environmental restoration, somewhat restoring natural historic flows	1 + years	Would occur in existing canals	None expected	Flow may need to be diverted depending on where land for projects is available.	NA
D) Chapter 2.4 Henderson Creek Off-Line Storage Reservoir	NA	NA	NA	Off-line storage reservoir: captures wet season flows to be released in a more natural hydrologic regime	Unknown	Unknown	Unknown	Varies	Needs an ERP, wetlands in the area may complicate permitting	2-3+ years	Typically large tracts of land are required for reservoirs	Possible foraging for birds, fish and aquatic life habitat	Not likely, water storage reservoirs are primarily for water supply rather than nutrient treatment.	
E) Chapter 2.5 Sabal Palm Road Spreader System	NA	NA	NA	Spreader system: multiple culverts under the road so water crosses in many places instead of a concentrated point	Unknown	Unknown	Unknown	Varies	Permitting will most likely be required	2-3+ years	Varies	None expected unless spreading water promotes growth of wetland vegetation, which may result in wading bird habitat	Possible - should be considered.	
F) Chapter 2.6 Tamiami Trail & Manatee Road Stormwater Treatment	NA	NA	NA	Stormwater Treatment: diverts water to slow flow to a more natural hydrologic regime	Unknown	Unknown	Unknown	Varies	Permitting will most likely be required	2-3+ years	Varies	None expected	Yes - slowing water flow rates will result in sediment deposition and nutrients attached to sediment will be removed from the water as well.	
G) Chapters 3.3 and 3.4 Belle Meade Agricultural Flow-way South of US 41	NA	NA	NA	Agricultural flow-way: located in triangle area owned by farmer - Only possible if land can be purchased	Unknown	Unknown	Unknown	Varies	Most likely needs an ERP permit but there do not appear to be wetlands on this ag land triangle; need to fill in historic ag canals.	1+ years for design, permitting, construction	Limited by what's available, would need to determine what this triangle parcel can treat	May result in wading bird foraging habitat	Potential - if farmer is willing to sell the triangle parcel	This project is located immediately south of US 41/Tamiami Trail and east of the Royal Palm Estates Development. The natural hydrology of the area has been heavily impacted by agricultural activities. This project involves the creation or restoration of a flow-way focused on accepting flows from the south side of US 41/Tamiami Trail and transmitting them to the estuarine interface outfalls and into adjacent public lands such as the Rookery Bay National Estuarine Research Reserve and Collier-Seminole State Park. The project would include agricultural land restoration and planning for, and the installation of culverts, spreader swales, and control structures, as well as removing berms and roadways at strategic locations in order to re-establish flows from north to south. The project could be implemented as part of ongoing agricultural best management practices or could occur if agricultural land-uses convert to development and would then be implemented during planning or permitting efforts.
H) Chapter 3.5 Tomato Road Diversio	NA	NA	NA	Diversions: installation of a swale south of 41	Unknown	Unknown	Unknown	Unknown	Most likely needs an ERP permit but there do not appear to be wetlands on this ag land triangle; need to fill in historic ag canals.	1+ years for design, permitting, construction	Land needed to construct a swale along US 41 - water may need to be pumped, requiring land for a pump station as well.	None expected	Potential - may need to divert water to available land for projects.	The project involves the construction of a new swale south of US 41/Tamiami Trail and then connecting the swale to existing culverts under US 41 within the approximate vicinity of Tomato Road in order to increase the efficiency of the culverts to carry flow to the south and east. Prior studies of the area revealed a north-to-south creek that intercepts stormwater and natural sheet flow as it flows southeasterly within the Tamiami Canal. This creek directs the water south. The cypress swamp has a dense shrub layer indicative of impacted hydrology. The interface of the pine flatwoods/cypress swamp and creek to the south contains an elevated jeep trail which is also known as the original "Road to Marco." The jeep trail is approximately 20 feet wide and two to three feet above the wetland's natural grade therefore it impedes flow to the south and adversely impacts water flows in the area. An historic agricultural ditch discharges south into a degraded 24 inch corrugated steel culvert under the jeep trail at the apparent low-point in the cypress swamp. It appears that the road is overtopped during flood events and these facilities need to be reconstructed.

Organization/Title	Link	Comments	Existing Conditions	General Description of Technology/Treatment Type	Nutrient Reduction per Unit	Nutrient Removal Efficiency	Unit Costs	O&M Requirements	Regulatory Constraints	Implementation Schedule	General Land Area Requirements	Ancillary Benefits (e.g. provides wildlife habitat)	Potentially viable for this effort? Why or why not?	Supplementary Document
I) Chapter 6.2 Henderson Creek Development Best Management Practices Retrofit	NA	A general description of algal turf scrubbers can be found at en.wikipedia.org/wiki/Algal_turf_scrubber	NA	An algae scrubber filters water by moving water rapidly over a rough, highly illuminated surface, which causes algae to start growing in large amounts. As the algae grow, they consume nutrients such as nitrate, phosphate, nitrite, ammonia, ammonium and even metals such as copper from the water.	Unknown	Unknown	Unknown	Unknown	Unknown	1+ years for design, possible permitting, construction	Unknown	None expected	Not likely - this technology is generally used for small scale systems.	
J) Chapter 6.5 Fiddler's Creek Spread	NA	NA	NA	Spreader system: breaching a road or berm in multiple places to spread water flow to more closely mimic natural sheet flow	Unknown	Unknown	Unknown	Unknown	Probably needs an ERP	1+ years for design, possible permitting, construction	Varies	Potential creation or enhancement of wetlands if water is spread to mimic sheet flow	Yes - need to find the right area to implement the technology though	
K) Chapters 6.7 and 6.8 County Road 951 and 92 Cross Drain Culverts	NA	NA	NA	Cross drain culvert: additional culverts under S R 92 to improve flow, possibly plugging canal, would cause water to sheet flow and nutrient uptake would be greater than if water flows through canal only	Unknown	Unknown	Unknown	Unknown	Probably needs an ERP	1+ years for design, possible permitting, construction	Varies	Potential creation or enhancement of wetlands if water is spread to mimic sheet flow	Yes -a known technology, would need to determine impacts downstream.	
Fiddler's Creek Mitigation PowerPoint Slide	Project folder	Proposed preserve areas	Appears to be owned by a developer, FCC Preserve LLC, which also owns the area to the NW. Plans for this area are unknown but the west half of the SE site and all of the NW site are covered in wetlands, which would cause permitting issues for any projects.	Map shows potential preserve locations. No technology was stated, nothing to review.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FCC Preserve LLC ERP	Project folder	Permits located that show construction to the north but none of the permits reviewed included the easternmost FCC Preserve LLC block in planned construction or mitigation.	Copy of permit placed in project folder (additional time extension permits were issued that are not in the folder) - this eastern area is included in the polygon for the development permit to the NW, but the permit plans do not include this area - preserve areas are all within the development to the north	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Paul Julian Calculation Email	Project folder	Calculation of land area needed for treatment for the PSRP. Well over 300 acres of treatment will be needed if removal capacity is similar to STA 5.	None	STA	Outflow of approx. 50 to 100 TPFWM (µg/L) with a inflow concentration of 334 µg/L at 1056 Ac-Ft/Yr	Unknown for this project site	Unknown for this project site	Unknown for this project site	Will require a permit	2-3+ years for design and permitting	Well over 300 acres based on STA 5 removal rates estimate	Would provide wetland habitat for wading birds and aquatic animals.	Yes - technology is know to be effective, need to determine site specific land requirements and whether enough land can be obtained.	NA
N Collier Seminole Crucie Lakes RBNERR Restoration	Project folder	Map only	NA	Shows proposed culverts - i.e. spreader culverts under SR 92 and under bike path, both in CSSP, from 2004	NA	NA	NA	NA	NA	NA	NA	NA	Yes it's viable but would need agreement from CSSP.	an
Possible Stormwater Infrastructure Map	Project folder	Only shows parcel ownership	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rookery Bay Data NERR Data	https://cdmo.baruch.sc.edu/get/landing.cfm	Water quality data available	Turbidity data shows relatively consistent average yearly turbidity measurements, indicating there have been no major changes in watershed turbidity. Seasonally, there are large spikes in turbidity every year, most likely corresponding with tropical storms and hurricanes.	No project info	NA	NA	NA	NA	NA	NA	NA	NA	NA	See Appendix A (doc_wq_lit_review.docx)
Parsons 2006 Belle Meade Stormwater Master Plan, Collier County Watershed Plan (2011), the Southwest Florida Watershed Master Plan (SFWMD/ACOE - Former SW Fla Feasibility Study), and Other Sources	https://rookerybay.org/wp-content/uploads/5-RookeryBayWatershedProjects.pdf	Compilation of a set of watershed restoration projects in the vicinity of the PSRP. One conceptual project in the area of interest will treat residential development discharge before entering Rookery Bay.	Royal Palm Estates and Auto Ranch Outfall: Existing lake servicing the development is adjacent to undeveloped land close to the Rookery Bay Reserve. The outfall is working poorly and the discharge path is undefined and maintained. Proposed project would include properly designed outfall to allow for water quality treatment and attenuation.	Existing wet detention system not functioning properly	Varies	Varies	Varies	Periodic inspections of control structure.	NA	1+ years, need to go though design and permitting before construction can begin	Varies	NA	Does not directly treat the water from the PSRP but does treat water quality that flows from residential areas of interest. Possible supplemental project if lands can be obtained.	NA
United States Fish and Wildlife Service (USFWS):														
FWS BO 4.04.2017	Project folder	USFWS document describing species concerns for Oyster Bay golf course community nearby, may be referenced for similar concerns on projects for the PSRP but no there are no treatment projects listed in the document.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
South Florida Water Management District (SFWMD):														
03010-2116 B US 41 at project	Project folder	US-41 Right-of-Way Map survey drawings. No project location or WQ information	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CR 92 FDOT ROW Map 03060-2102	Project folder	SR-92 Right-of-Way Map survey drawings. No project location or WQ information	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PRSP SFWMD WQ Summary Report 2020	Project folder	Includes water quality, flow rate and loading data.	Describes the techniques used to restore the PSRP area to include the construction of pump stations, tie-back levees, spreader berms, and canal plugs. The objectives of the report were to evaluate and determine TP and TN concentrations that could be expected in the PSRP restored flows, and evaluate changes in surface flows and nutrient concentrations before and after restoration. Stations included in this nutrient analysis includes TAMTOM, TMBR37, FAKA, S488, BC9, BC10, and BC11. Included data was sources from CC from 2001 to 2019. Note, monitoring data was previously discussed in reviews of other sources to include for the FDEP and CC 2019 surface water report. Results largely mimicked data previously discussed. In summary, the TAMTOM station had the highest mean nutrient concentration of all stations analyzed with TMBR7 and TMBR49 being the second and third highest, respectively.	Spreader berms, pump stations, levees, canal plugs	Installed for control of water quantity.	Unknown	Unknown	Varies	These technologies are also described elsewhere and generally require permitting	2-3+ years	Varies	If water detention creates wetlands may create aquatic fauna and wading bird habitat.	Yes - common technologies, would need to find the correct locations and enough land for each to be cost effective.	See Appendix A (doc_wq_lit_review.docx)
PSRP Conveyance Features Att A 12-4-19	Project folder	Discuses design build of culverts under road, did not see flow rates, includes culvert specs	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PS Culverts Map Book	Project folder	Map showing preliminary culvert locations from 8/2019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C-43 reservoir WQ feasibility study website	https://www.sfwmd.gov/content/c43waterqualitystudy	The 18 month Study began on July 3, 2018 and will be completed by December 2020. Multiple water quality treatment technologies are being studied to reduce nutrients on former agricultural lands	Final Information Collection Summary Report (4/3/2020) provides a list of 25 Technologies Recommended for Further Evaluation https://www.sfwmd.gov/sites/default/files/C-43%20WBSR%20WQFS%20Information%20Summary%20Collection%20Report_04.03.2020.pdf; this list was narrowed to the technology most applicable for this study	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Organization/Title	Link	Comments	Existing Conditions	General Description of Technology/Treatment Type	Nutrient Reduction per Unit	Nutrient Removal Efficiency	Unit Costs	O&M Requirements	Regulatory Constraints	Implementation Schedule	General Land Area Requirements	Ancillary Benefits (e.g. provides wildlife habitat)	Potentially viable for this effort? Why or why not?	Supplementary Document
A) Air diffuser Systems (ADS)	https://www.sfwmd.gov/sites/default/files/C-43%20WBSR%20WQFS%20Information%20Summary%20Collection%20Report_04.03.2020.pdf	Table ES-1	NA	Technology includes a fine bubble aeration system for domestic and industrial installations. Information from ADS states that they have a clog-free design that requires minimal power input to provide aeration within the reservoir with little maintenance required. The fine bubble aerators create mixing and oxygen diffusion within the reservoir (ADS, 2020a).	Varies	Performance data provided by ADS indicate a 90% BOD reduction and 50% to 75% reduction of TN and TP	Varies	ADS technology is for in-reservoir treatment and does not produce residuals for maintenance. System lifespan is estimated at 20 years, and some systems have been fully functioning after 40 years of operation. Maintenance includes checks of compressors, air leak testing of supply piping and visual inspection of disc modules (ADS, 2020b).	NA	NA	For use within a reservoir or other open water area.	Improves fish habitat by reducing anoxia.	Yes, if a pond or other water feature is proposed this could provide an additional benefit when added to the system. Creating a lake solely for installation of an ADS would not be effective.	
B) Alum Treatment	https://www.sfwmd.gov/sites/default/files/C-43%20WBSR%20WQFS%20Information%20Summary%20Collection%20Report_04.03.2020.pdf	Table ES-1	NA	Aluminum Chloride/ Aluminum Sulfate - Flocculation/Coagulation	Varies	Varies	Varies	Varies	May require permitting	1+ years to study system to determine treatment needs	Applications typically fall under one of three types of applications: sediment separation, injection into the inflow, and in-reservoir treatment	NA	Potential as a supplement to other technologies, not likely as a stand-alone project.	NA
C) Bold & Gold	https://www.sfwmd.gov/sites/default/files/C-43%20WBSR%20WQFS%20Information%20Summary%20Collection%20Report_04.03.2020.pdf	Table ES-1	NA	A biosorption activated media formulated to remove nitrogen species, phosphorus species, algal toxins, algal mass, Escherichia coli, and per- and poly-fluoroalkyl substances (University of Central Florida, 2019). The media can be used in many different applications including up flow filters, side-bank filters within wet detention ponds, dry detention systems, infiltration basins, rain gardens, pervious pavers, vegetated filter strips, drain fields, and rapid infiltration basins. Bold & Gold is a mixture consisting of primarily mineral (Florida-based sand and Florida mined clay) and relatively slow degradable recycled materials (tire crumb) (Bogdan, 2020).	Varies	Performance data in applications treating stormwater state a nitrogen removal rate of approximately 75% to 95%.	The cost per pound of nitrogen removed is estimated at $10.23 for the 15-year lifespan (University of Central Florida, 2019).	The filters are estimated to be in service for 15 years with a TN treatment rate of0.05 gpm/ft2 (University of Central Florida, 2019). Materials supplied by the vendor do not discuss the handling of residuals. Media must be replaced more often if the technology is used to remove TP.	Unknown	Unknown	Varies	None expected	Probably not - Treats primarily TN with little TP treatment unless media is replaced frequently, possibly at great cost.	NA
D) Hybrid Wetland Treatment Technology (HWTT) - Alum	https://www.sfwmd.gov/sites/default/files/C-43%20WBSR%20WQFS%20Information%20Summary%20Collection%20Report_04.03.2020.pdf	Table ES-1	NA	Includes design, construction, and operation of a facility that combines wetland and chemical treatment approaches to reduce phosphorus (DeBusk, 2009). The treatment uses chemical coagulants added to the front end of a wetland treatment system, containing one or more deep water zones to capture the resulting floc material. The passive treatment of the wetlands partnered with the active coagulant sorption results in the reduction of phosphorus. The coagulant used for the HWTT is aluminum sulfate or alum (SFWMD, 2009).	Varies	Varies	Estimated operating costs range from $19 to $301 per pound of phosphorus removed, depending on the flow capacity and the phosphorus concentrations introduced.	Residuals management was not discussed in detail, but floc will be collected in the deep zone of the wetlands. Residual management will be minimal given proper design of wetlands. Energy is needed to power the alum feed pump. Site specific considerations may also arise.	May require permitting	1+ years to study system to determine treatment needs	Varies	NA	Potential as a supplement to other technologies, not likely as a stand-alone project.	NA
E) NutriGone™	https://www.sfwmd.gov/sites/default/files/C-43%20WBSR%20WQFS%20Information%20Summary%20Collection%20Report_04.03.2020.pdf	Table ES-1	NA	Primarily used in the removal of bio nutrients from stormwater prior to discharge, intercepting groundwater near surface water interfaces and filtering surface water from ponds and swales. NutriGone™ media sorbs the nutrients to the media.	Varies	50% TP removal efficiency stated by manufacturer	The cost estimate for a facility at the C-43 WBSR given a flow of 695 cfs is approximately $14,290,000 per 353 days. This includes the cost of the media and a media production center amortized over 20 years. Given a 50% TP removal rate, the cost is estimated at $108 per pound of TP removed (Burden, 2020).	The vendor expects the media will last 353 days before being at maximum capacity for phosphorus. The media will need to be removed and new media added. The vendor suggests construction of a media production facility near the filter site. Vendor materials indicate that the media is capable of being sold as a soil amendment after being used in the filter at roughly 50% of the original price (Burden, 2020).	Unknown	Unknown	Room for in-line filter systems with the media	NA	Not likely - may be too costly. Technology is not proven beyond small scale systems.	NA

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F) Downstream Defender® (DEP Number 1756)	https://www.sfwmd.gov/sites/default/files/C-43%20WBSR%20WQFS%20Information%20Summary%20Collection%20Report_04.03.2020.pdf	Table ES-1	NA	Uses a hydrodynamic vortex separator to remove fine and coarse particles, oils, and floatable debris.	Varies	Performance indicated by the vendor indicate 70% TP removal with up to 79% TKN removal. Downstream Defender® was implemented as a BMP for agricultural effluent (Moffa & Associates, 2002). Peak treatment flow rate is 38 cubic feet per second (cfs) for a 12-foot-diameter unit (Hydro International, 2020b). Downstream Defender® captures and stores sediment and oil within the chamber.	The cost of Downstream Defender® for treating the active farm effluent was approximately $45 to $112 per pound of TP removed per year and $10 to $100 per pound of ammonia-N removed per year (Moffa & Associates, 2002).	A sump-vac is used to remove captured sediment and floatables through the access ports located at the top (Hydro International, 2020b). Sediment disposal is needed after removal. Downstream Defender® is designed to be used in a surface water runoff treatment system using the flow from the storms, meaning there is no need for power input.	NA	NA	Unknown	NA	Potential - it removes fine and course particles, oils and floating debris (physical removal only); may be combined with other technologies, particularly if land space is limited.	NA
G) Treatment Wetlands	https://www.sfwmd.gov/sites/default/files/C-43%20WBSR%20WQFS%20Information%20Summary%20Collection%20Report_04.03.2020.pdf	Table ES-1	NA	Capable of achieving low TN and TP concentrations	Summary of Treatment performance in STAs for WY2018 provide an average TP load retained of 77%. TN % removal varies, ranging from 15% to 45% from 2001 to 2016	The lowest TP concentrations practically achievable in any type of treatment wetlands were in the range of 10 to 15 ppb. The lowest TN outflow concentrations observed were essentially all in the reduced forms (total organic nitrogen and ammonia-nitrogen) and equal to about 0.7 mg/L.	Varies	Varies	Permitting will most likely be required	2-3+ years for design and permitting	Significant land area may be needed	Wetland would provide wildlife habitat	Yes, if sufficient property can be acquired in the downstream location of the culverts	
SFWMD Publications and data	1. https://www.sfwmd.gov/science-data/scientific-publications-sfer	Highlights projects related to environmental modifications and protection within South Florida.	https://www.sfwmd.gov/sites/default/files/documents/2020_SFER_highlights.pdf	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
A) C-43	NA	NA	NA	C-43 reservoir: regulates water quantity	May have some ancillary benefits but nutrient reduction is not the primary purpose of a reservoir	Varies	Varies	Varies	Reservoirs require extensive permitting	Years for permitting and construction.	Varies	Aquatic wildlife and bird habitat	Probably not - reservoirs are primarily for water storage not water treatment, a large area of land would be needed for a low treatment efficiency.	NA
B) C-44	NA	NA	NA	C-44 Reservoir and STA	Unknown	Will remove nutrients, amount unknown	Varies	Maintain berms. structures, pumps, vegetation, etc.	May be difficult to permit if there are wetlands upstream or downstream where the hydrologic regime of existing wetlands would have to be addressed.	2-3+ years	Varies - but likely large land requirements	Aquatic wildlife and bird habitat	Partially - would be best to construct the STA without a large open water reservoir given land availability limitations.	NA
C) S-333	NA	NA	NA	Gated spillway: regulates water flows	Not for water quality though may have some benefits	Unknown	Unknown	Unknown	Will need design and permitting	1+ years for design and construction	Generally small for the spillway itself, but larger areas behind the spillway are needed, as are downstream receiving areas	None expected	May be a component of other technologies but not a standalone project	NA
D) C-111	NA	NA	NA	Spreader canal: regulates flow rates, design capacity 1150 cfs	Not for water quality though these often have some water quality benefits	Unknown	Unknown	Unknown	Will need design and permitting	1+ years for design and construction	Varies	May provide wading bird habitat if wetlands are restored by spreading water	Yes if a suitable location can be found	NA
E) L8 FEB	NA	NA	NA	Placed in front of an STA can enhance TP removal by STA, stores 48,000 ac-ft of water	Varies	Varies	Varies	Varies	Will need design and permitting	1+ years for design and construction	Varies	If water is backed up wading birds and aquatic wildlife may use the area	Yes if a suitable location can be found	NA
F) WCA 3	NA	NA	NA	Decompartmentalization: controls flow	NA	NA	NA	NA	NA	NA	NA	NA	No - no existing area to decompartmentalize	NA
G) Ten Mile Creek Water Preserve Area	NA	NA	NA	Previous year net inflow of 3800 ac-ft of water	Reduced TP by 80%	Reduced TP by 80%	Varies	Varies	Varies	Varies	Varies - generally requires large tracts of land	Can provide aquatic wildlife and bird foraging habitat	Probably not - typically a large land requirement that is unlikely to be available here.	NA
H) A1FEB	NA	NA	See here for details: https://www.sfwmd.gov/sites/default/files/documents/a1_feb_seepage_study_final.pdf - seepage study does not address nutrients though	A1 FEB	Retained 90% of inflow P	45.2 metric tons over 15,000 acres, stores 60,000 ac ft	Varies	Varies	Permitting will most likely be required	Varies	Varies	If water is backed up wading birds and aquatic wildlife may use the area	Yes - if the right area can be found	NA
I) Taylor Creek	NA	NA	NA	Taylor Creek STA	118 ac removed up to 2 metric tons TP/yr	Varies	Varies	Varies	Permitting will most likely be required	Varies	Varies	Can provide aquatic wildlife and bird foraging habitat	Yes - if the right area can be found	NA
J) C-139	NA	NA	NA	Annex restoration: restore ag land to wetlands, backfill 2.9 miles of canal	Unknown	Varies	Varies	Varies	Permitting will most likely be required	1-2+ years to design, permit and construct	Varies	Probably none unless wetlands and native areas are restored	Not likely unless ag land can be purchased	NA
K) Periphyton STA Study	https://www.sfwmd.gov/sites/default/files/documents/ltp_mtg_12feb2013_psta_%20stormwater_%20periphyton_%20mesocosm_ivanoff.pdf	NA	Study conducted in existing STA3-4	100 ac cell: high TP removal, 12th consecutive yr that outflow was 13 ppb or less TP	Unknown	Unknown	Unknown	Varies	Unknown	Unknown	Varies	Probably if wetlands and native areas are restored	Possible - additional research into technology specifics needed to determine if they are suitable for this site	NA
SFWMD Publications and data	1. Big Cypress Basin	https://www.sfwmd.gov/sites/default/files/documents/naplesbayreconfinal_2006.pdf	First link is to a page with many studies and other documents that are not relevant to this work. Second link includes some projects on pages 79-84. Relevant information is described here.	Gordon River Water Quality Park described here - 50 acres of ponds, polishing marshes and wetlands serve as a filtration system while recreational opportunities are provided - See also Orlando Wetlands Park (not described here) for mixed recreation and water quality treatment.	Unknown	Unknown	Unknown	Unknown	Permitting will most likely be required	Unknown	Unknown	Recreation and wildlife habitat likely	Yes - combines a number of technologies already identified as likely candidates for this project if land can be found.	NA

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SFWMD Publications and data	2. Estuaries	Describes mostly biological studies, mention but not description of wetlands flow ways	Caloosahatchee area	Wetland flow ways used to attenuate and treat stormwater runoff	Varies	Varies	Varies	Varies	Permitting will most likely be required	Varies	Varies	May provide wading bird and aquatic wildlife habitat	Yes - wetland treatment in various forms is recommended for this project if sufficient land to provide adequate treatment can be obtained.	NA
SFWMD Publications and data	3. Restoration Strategies Science Plan – Related Documents	Items here only include project related information and only projects not already described elsewhere in this table	STA 1 discharge canal P treatment study	Treatment of TP as water flows through STA treatment canal - saw significant reductions in TP, primarily due to settling of particulate P.	NA	Yearly TP reductions between canal inflow and outflow ranged from 8.3-49.7% between 2003-07; canal acted as a TP source between 2008-13; canal acted as TSS sink over whole period	NA	NA	Included in permitting of STA	1+ years	Varies	Probably provides wildlife habitat, depends on depth and vegetation present.	Yes, if an STA is created there may be a discharge canal.	NA
SFWMD Publications and data	3. Restoration Strategies Science Plan – Related Documents	Items here only include project related information and only projects not already described elsewhere in this table	Soil Amendment/Management Literature review	Lists dozens of potential soil amendments that might be tested in an STA to control P, including installation of a lime rock cap. Costs provided are estimates to conduct studies in existing STAs (2015)	NA	NA	NA	NA	NA	NA	NA	NA	No - This information is provided to describe costs and needs for studies, the silt amendments have not been tested in an STA.	NA
SFWMD Publications and data	3. Restoration Strategies Science Plan – Related Documents	Items here only include project related information and only projects not already described elsewhere in this table	STA Inflow Basin Canal Study	The inflow canal acted as a source of P to the STA, especially when flows were high after a storm event, apparently associated with resuspension of canal sediments.	NA	NA	NA	NA	NA	NA	NA	NA	No - An inflow canal for an STA may be needed but should not be considered a treatment technology.	NA
SFWMD Publications and data	4. Saltwater Interface Maps by County	Saltwater interface maps, does not include projects	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SFWMD Publications and data	5. Stormwater Treatment Areas and Flow Equalization Basins	List of Everglades studies	Majority of studies included in this page are not relevant to the Project area, as they are focused on the Everglades STAs, and do not provide relevant data or lessons learned as they are too specific to the particular projects, or are too broad to glean useful information when assessing treatment technologies	Stormwater Treatment Area management and water budgets	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SFWMD Publications and data	6. Water Supply – Hydrogeological Reports	Geology/aquifer investigation docs, not relevant to the project unless ASR or deep well injection are pursued (and these are not recommended)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SFWMD Publications and data	7. Florida Waters Resources Manual [PDF]	General reading, no project information	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SFWMD Publications and data	8. Long-Term Plan for Achieving Water Quality Goals	Applies to Everglades Protection Area. List of 27 documents since 2003. Executive Summary and Full Report downloaded.	Pre-2003 conditions are analyzed in detail	STAs with Submerged Aquatic Vegetation (SAV)	Exc. Summary Table ES.3, and Figure ES-2 contain broad nutrient reduction values for the entire long range plan. More detailed WQ data in the full report	NA	Cost in Executive Summary Table ES.4 for the entire long range plan. More detail in the full report	NA	NA	NA	NA	NA	Yes - STAs are a recommended treatment technology f sufficient land can be found.	NA
SFWMD Publications and data	9. Restoration Strategies Science Plan	Studies to evaluate different factors affecting P uptake and release	Studies on existing STA factors and how they affect P uptake, no new technologies described	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	an
SFWMD Publications and data	10. SFWMD Formation Identification Guide [ZIP, 2.8 GB]	Cannot open zip file, appears to be a geology document	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
SFWMD Publications and data	11. South Florida Water Management Model (Fwd.) Position Analysis – Initial Stage Values – Current Month [PDF]	3 page 2D model stage values exhibit. No WQ information. No project information	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SFWMD Publications and data	12. Water Conservation	Water quantity related information, does not address water quality or quantity issues related to this situation.	Does not apply to this project	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SFWMD Publications and data	13. Water Supply Plans	Mostly does not apply, report at link to the right addressed here.	https://www.sfwmd.gov/our-work/restoration-strategies	General discussion of use of Flow Equalization Basins (FEBs) and Stormwater Treatment Areas (STAs)	Preliminary estimates made by Paul Julian from FDEP would need 300 acres or more based on P removal rates in STA 5; this site is approximately 300 acres.	Depends on inflow concentrations and outflow rates	Unknown	Similar to existing STAs	Need land area available for STA use - then need to permit; will be additional regulatory constraints if the land already has wetlands on it.	2-3+ years	300+ acres based on Paul Julian calculations	Would likely provide extensive aquatic wildlife and bird foraging habitat.	Yes, if sufficient land is available.	NA
SFWMD Publications and data	14. Water Supply Reports	Weekly reports describing water levels, not projects	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Repository of pertinent studies available to use														
General Documents	1. General Documents	Multiple Studies done in FL, some relevant to this project	Studies conducted on former agricultural land	C-43 Efficacy of a Large-Scale constructed wetland to remove phosphorous and suspended solids from Lake Apopka, FL (Marsh Flow-way) which was constructed on former ag lands	Varies	Depends on inflow concentrations and outflow rates	$42 / kg TP and $0.03/ kg TSS	Similar to existing STAs	Permitting will most likely be required	2-3+ years	Large	NA	Yes - constructed wetlands (such as STAs are recommended for consideration for this project if sufficient land can be found.	NA
General Documents	1. General Documents	Multiple Studies done in FL, some relevant to this project	Studies conducted on former agricultural land	C-43 Large Constructed Wetlands for Phosphorous control: This review shows that large constructed wetlands all remove phosphorus. They do so more efficiently than the population of smaller counterparts, as measured by concentration reduction (median 71%) or removal rate coefficients (median 12.5 m¨year´1) for the entire period of record. However, large systems display lesser P load reductions (median 0.77 gP¨m´2¨year´1) than the larger general population of wetlands, in part because the large systems typically operate at lower incoming P loads (median 1.22 gP¨m´2¨year´1).	Varies	Median concentration reductions were 71%;	Varies	Similar to existing STAs	Permitting will most likely be required	2-3+ years	100 acres+	Vegetative biodiversity; protection and production of fauna; aesthetic, recreational, commercial and educational human uses	Yes, if sufficient land is available.	NA

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General Documents	1. General Documents	Evaluation of Total Nitrogen Reduction Options for the C-43 Water Quality Treatment Area Test Facility	Compares performance of various wetland plant community alternatives	Emergent Macrophyte Vegetation (EMV) would be most likely to achieve the lowest TN, TP, and TSS concentrations with the smallest footprint and the lowest construction cost. Pros: Highly complex microbial community, high TON mineralization, high denitrification, moderate P removal, high TSS removal, lowest cost, wide experience and applicability. Cons: limited aerobic zone	Varies	Varies	$38,000 cost per HA w/o land costs	Similar to existing STAs	Permitting will most likely be required	2-3+ years	Large	Would likely provide extensive aquatic wildlife and bird foraging habitat.	Yes, if sufficient land is available.	NA
Treatment Technologies Documents	2. Treatment Technologies Documents	Lake Hancock Water Quality Study	Reviewed other treatment technologies for possible use in Lake Hancock in central Florida	Various treatment systems throughout Florida reviewed for effectiveness, including a Water Conservation Area and multiple STAs	Varied by STA	Varied by STA	Varied by STA	Varied by STA	Permitting will most likely be required	2-3+ years	Varies	Would likely provide extensive aquatic wildlife and bird foraging habitat.	Yes, if sufficient land is available.	NA
Treatment Technologies Documents	2. Treatment Technologies Documents	FGCU Thesis by Dana Dettmar 2015	NA	Algae Control Using In Lake Floating Treatment Wetlands	Discussion about microbes rather than nutrient removal	Unknown	Unknown	Unknown	Probably few constraints	Unknown	Needs open water to float on	Unknown	No - This has limited ability to remove nutrients from the water column.	NA
Wetland Treatment Technology Docu	3. Wetland Treatment Technology Documents	Study information only	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Basin Water Quality Study Document	4. Basin Water Quality Study Documents	All information relates to the Caloosahatchee River. Not useful in identifying areas of high nutrient concentrations within Collier County.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	See Appendix A (doc_wq_lit_review.docx)
Blue-Green Algae Documents	Blue-Green Algae Documents		C43/Lake Okeechobee documents	ASR	Probably minimal	Water is intended to be repumped to the surface at some point, nutrients that don't migrate from storage area will be returned to the ecosystem when water is withdrawn; anaerobic conditions may turn Nitrogen forms to N2 gas that could be released to the atmosphere, but phosphorus is likely to remain.	Varies	Maintain well - may need to treat water prior to injection	Unknown if geology in the area is appropriate, may need to treat water prior to injection, water use permitting issues	Varies	Small land area for well and possible treatment facility	None	No - pre-injection treatment probably needed, unknown if geology is correct for use in this area, will not treat water quality, especially for P.	NA
			C43/Lake Okeechobee documents	Deep well injection	Unknown	Removes water permanently, including any nutrients in the water	Varies	Maintain deep well	Well permitting	Varies	Small land area for well	If the water is permanently removed from the system it will not provide desired restoration of freshwater flows to downstream waters	No - removes freshwater flows permanently, does not meet goals of restoring freshwater flows into systems to the south.	NA
PSRP ideas and map June 2019	Project folder - Numbers refer to locations on map	Ideas from 2019	1. This area is a mitigation site for the Eagle Lakes development to the north. An option would be to have Eagle Lakes donate this mitigation site to SFWMD and build an STA here. Water would have to be conveyed from the Tomato Road discharge site under US 41 to this area via a canal then discharged to the southeast into Collier-Seminole State Park.	STA	Preliminary estimates made by Paul Julian from FDEP would need 300 acres or more based on P removal rates in STA 5; this site is approximately 300 acres.	Depends on inflow concentrations and outflow rates	unknown	Similar to existing STAs	Area is already a mitigation area, would need to consider in permitting and maintain success criteria - need to look at permit to determine exactly where the mitigation is and the treatment/success criteria required.	Years for permitting and construction.	300+ acres based on Paul Julian calculations	Would likely provide extensive wildlife habitat for birds, alligators, turtles, etc.	Yes, if land is available for purchase and permitting considerations can be dealt with	NA
PSRP ideas and map June 2019		Ideas from 2019	2. The "bicycle seat" area can be used as an STA. Water would need to be conveyed from the Tomato Road discharge site under US41 to this area via a canal then discharged to the south into Collier-Seminole State Park.	STA	Preliminary estimates made by Paul Julian from FDEP would need 300 acres or more based on P removal rates in STA 5; this site is approximately 50 acres.	Depends on inflow concentrations and outflow rates	Unknown	Similar to existing STAs	Would need to obtain an ERP to construct the STA, does not appear to be wetlands in the area under existing conditions, if wetlands are present permitting will be slightly more complicated	2-3+ years	300+ acres based on Paul Julian calculations, about 50 acres available	Would likely provide extensive wildlife habitat for birds, alligators, turtles, etc.	Yes, if state park will allow the land to be used. Will still need other projects/technologies as this is probably not enough area to provide full treatment.	NA
PSRP ideas and map June 2019		Ideas from 2019	3. This is an old railroad bed that is now used as a hiking trail. This structure can be used as a type of spreader structure. Water would be conveyed from the Tomato Road discharge site to the spreader via a canal. The spreader would distribute water over this area of the State Park. The natural forested area should remove nutrients from the agricultural discharge.	Spreader swale to allow P uptake from water spread across a broader region	unknown	unknown	unknown	Would need to maintain the berm and any structures	May be difficult to permit if there are wetlands upstream or downstream where the hydrologic regime of existing wetlands would have to be addressed	years to permit and construct	Unknown	May increase wet area providing additional wading bird habitat	No - State park does not want projects outside the area for item 1	NA
PSRP ideas and map June 2019		Ideas from 2019	4. A farm discharge pipe can be built into the SWPF levee and pumped to the north. The water can be released on the northern end of the SWPF into the PSRP natural forested area via a spreader canal. The forested area should naturally remove some nutrients that are in the agricultural discharge. The amount of phosphorus a forest removes from water is not known but generally accepted to be much less than an STA. This water will then flow south and be conveyed under US41 via the proposed culverts and bridges to Collier-Seminole State Park. This option will also prevent water from stacking up between the farm's levee and the SWPF.	Projects need to be south of 41 and not ag related	NA	NA	NA	NA	NA	NA	NA	NA	Prospective funding limitations are expected to prohibit use for projects on private lands	NA
PSRP ideas and map June 2019		Ideas from 2019	5. This area is in the project footprint. The area outline is approximately 380 acres but could be increased if needed. This area could contain an FEB for attenuation of flows with some emergent vegetation to help reduce phosphorus concentrations before moving the water to Collier-Seminole State Park to the south.	Cannot build projects in the PSRP area without USACE revisions and congressional approval	NA	NA	NA	NA	NA	NA	NA	NA	No, cannot build new projects in this area without CERP modification	NA
PSRP ideas and map June 2019		Ideas from 2019	6. Improve or widen the Tamiami Canal to convey more water to the existing Bridges 37 and 39. A culvert under CR92 will be placed south of Bridge 37 to move water through the park. In this option, the project will not build a new opening through US41.	Not clear	Unknown	Unknown	Unknown	increased canal maintenance	Unclear if this could be permitted, unknown if land is available to widen canal.	years to permit and construct	Unknown without knowing canal widening width	None likely	No- it does not appear that this would treat water quality issues	NA

Organization/Title	Link	Comments	Existing Conditions	General Description of Technology/Treatment Type	Nutrient Reduction per Unit	Nutrient Removal Efficiency	Unit Costs	O&M Requirements	Regulatory Constraints	Implementation Schedule	General Land Area Requirements	Ancillary Benefits (e.g. provides wildlife habitat)	Potentially viable for this effort? Why or why not?	Supplementary Document
PSRP ideas and map June 2019		Ideas from 2019	7. Build a small canal from the Tomato Road discharge area west to the northeast corner of the mitigation area then south to Rookery Bay. Rookery Bay managers have stated that they need water and would take the water from the project.	Assuming referring to Area 1 on map. It appears that this would resolve the additional water issue but would do nothing to address water quality prior to water entering Rookery Bay	Minimal?	Not effective to remove nutrients by building a canal to convey water without a treatment area	Unknown	Basic canal maintenance to control vegetation - spraying cattails and other plants would result in releases of large quantities of nutrients following chemical treatment.	Would need to permit the canal including modeling	tears to permit and construct	Land to excavate to construct canal - unknown without knowing canal width.	None likely	Probably not - does not provide a water quality treatment function prior to entering Rookery Bay	NA
Henderson Creek Diversion Project	HCDP in project folder	NA	NA	Project looks at diverting water from Naples Bay to Henderson Bay - project dropped as not feasible, not applicable to PSRP area	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hydraulic Assessment for Henderson Creek	Final Draft Henderson in project folder	NA	NA	Engineering assessment for the terminated Henderson Creek Diversion Project	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other:														
Maps of proposed affected areas and locations of potential project locations	To be identified in reviews of above information													
Basin-specific feasibility studies/water quality improvement strategies	Need to identify basins and search for plans													
Existing MSSW / ERP near project sites	https://ca.dep.state.fl.us/mapdirect/?focus=standard		There are both ag and residential ERPs adjacent to this property. One currently vacant land owned by a developer south of the Eagle Lakes golf club was reported to have mitigation on it for another project but no permits found in the SFWMD database show this as anything other than an old ag permit area.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Review CERP project for applicable	Covered in SFWMD links above	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Parsons Stormwater Plan for Belle Meade	Cannot locate document	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Existing Picayune Strand Restoration Project (PSRP) design information	https://www.saj.usace.army.mil/Missions/Environmental/Ecosystem-Restoration/Picayune-Strand-Restoration-Project/	Webpage with links to all assorted documents about the PSRP, presentations, meeting minutes, overviews, but no information on WQ technical information. Some of surface water modeling data, no WQ modeling found	Canals run throughout state forest, associated with development plans from decades ago	Described above	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Existing PSRP water quality testing reports	Water quality summary report provided as document listed above	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
FCC Creek and FCC Oyster Harbor consultation letter dated April 4, 2017	This is the same as the FWS-BO-4.04.2017 document listed above	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Collier-Seminole State Park	https://floridadep.gov/sites/default/files/2004%20Collier-%20Seminole%20State%20Park.pdf	Start with management plan, search for other documents; reviewed MGMT Plan, could not locate any other documents related to Park	2004 Report: MGMT plan calls for hydraulic restoration to restore the hydraulic regime nearly as possible to its original state, and to "reverse and obliterate" all biological changes brought on by known hydrological disruptions. No water quality projects or technologies proposed in report.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rookery Bay Estuarine Research Reserve	Link provided is same as compilation of proposed projects in Rookery Bay watershed listed above	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Rookery also did modeling of the Rookery Bay watershed as part of this examination of other plans.	Link provided is same as compilation of proposed projects in Rookery Bay watershed listed above	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Cape Romano – Ten Thousand Islands Aquatic Preserve	https://myfwc.com/media/11888/ten-thousand-islands.pdf	NA	This report primarily focuses on seagrasses within Cape Romano. Supplemental optical physical water parameters were measured at 30 sites throughout the project area. Nutrient sampling was conducted by Florida International University until 2008. This data was analyzed and reported by the National Park Service separate from this document. Not relevant to this project.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	See Appendix A (doc_wq_lit_review.docx)
Proposed Numeric Nutrient Criteria for South Florida Estuaries and Coastal	https://www.nps.gov/ever/learn/nature/upload/ENP-NNC-Report-Revised-05-12.pdf	Document is unavailable	Referenced in the ten thousand islands summary report above.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Harvey Harper presentation on alum treatment	https://www.florida-stormwater.org/assets/MemberServices/Conference/AC19/22%20-%20Harper%20Harvey.pdf	ppt	NA	Use of Alum to remove TP from inflow water to a lake	0.12 kg/ac ft-yr	85% removal of TP	$386/lb TP removed - 175.1 ac drainage basin, treating 156 ac ft/yr	maintain equipment - cost will vary by size; periodic removal of floc from pond	need offline treatment	1-2 years	depends on inflow loading	none expected	maybe - alum treatment not always well received	NA
Additional Resources Reviewed Following Draft Report:														
Constructed Wetlands for Pollution Control	https://www.sfwmd.gov/sites/default/files/documents/02-constructed%20wetlands%20for%20pollution%20control%20IWA%202000.pdf	Design considerations for constructed wetlands	NA	Constructed treatment wetlands - general overview, not a description of a specific project	Varies	Varies	Varies	Varies	Permit likely required	1-2 years	Varies	Would likely provide extensive aquatic wildlife and bird foraging habitat.	Yes - constructed wetlands are recommended for consideration for this project if sufficient land can be found.	SRWQFS technologies and design considerations
Evaluation of Current Stormwater Design Criteria within the State of Florida	http://www.erd.org/ERD%20Publications/EVAL%20OF%20CURRENT%20SW%20DESIGN%20CRITERIA%20WITHIN%20THE%20STATE%20OF%20FLA-2007.pdf	Design criteria and nutrient removal information for stormwater ponds	NA	Stormwater pond design	Varies	Varies	Varies	Varies	Permit likely required	1-2 years	Varies	Would likely provide aquatic wildlife and bird foraging habitat.	Not included, not direstly designing stormwater ponds	SRWQFS technologies and design considerations
Hybrid Wetland Treatment Technology	https://www.sfwmd.gov/sites/default/files/documents/lowpp_tcns_000_mm10_sheet.pdf	Technology combines alum treatment with constructed wetlands	SFWMD fact sheet discussing HWTT	Combination of alum treatment and constructed wetlands	Varies	Varies	Varies	Varies	Permit likely required	1-2 years	Varies	Would likely provide aquatic wildlife and bird foraging habitat.	Not included, not direstly designing stormwater ponds	
Implementation of Hybrid Wetland Treatment Technology in the Northern Everglades Watershed	https://www.fdacs.gov/content/download/76291/file/20210_FinalReport.pdf	Technology combines alum treatment with constructed wetlands	Report discusses use of HWTT at numerous sites in the Northern Everglades Watershed	Combination of alum treatment and constructed wetlands	Varies	Varies	Varies	Varies	Permit likely required	1-2 years	Varies	Would likely provide aquatic wildlife and bird foraging habitat.	Not included, not direstly designing stormwater ponds	

Appendix E RESPONSES TO WORKING GROUP COMMENTS ON DRAFT REPORT

CCSR WQFS Draft Information Summary Report Comment and Response Memo

The following includes summary of comments made by the stakeholders of the CCSR WQFS project. General edits to the text of the report are not included in the following memo. Similar comments are combined, and the respective reviewers are referenced for each comment with superscript. Critical comments or those made by at least 3 separate editors are presented in bold font.

Narrative Comments

1. Recommend showing small scale projects instead of district large scale regional projects. Focus on something like the Lely canal spreader berm, polish ponds like Freedom Park, the use of Bold & Gold or some other medium for nutrient uptake as well as looking at the City of Bonita Springs water quality projects (bio reactor). [B]

   Answer: Staff have added the bioreactor technology as a treatment option for this project. Treatment train options will be developed from known technology and will be presented within the feasibility study.

2. Address and recommend the use of technologies that address treatment of BOTH TN and TP so as to not cause cyanobacteria dominance. [A]

   Answer: Technology presented in the document review is intended to discuss all technologies included within reviewed documents. Treatment trains presented within the feasibility study will address both TN and TP mitigation.

3. Provide treatment options that prevent nutrients from entering the environment, as this is more cost effective than treatment. [A]

   Answer: Treatment options will be investigated to reduce pollution entering the watershed. South Florida Water Management District staff will provide guidance on restrictions associated with source treatment options.

4. Will further evaluations consider hydraulic modeling that was done for the PSRP since the project will likely be downstream of the new conveyances associated with the PSRP project? [C]

   Answer: Yes, modeling will be considered when investigating the hydraulic and nutrient removal capacities of the proposed treatment trains during the feasibility study.

5. Was the Hybrid Wetland treatment technology (HWTT) considered in this evaluation of potential treatment technologies? [C]

   Answer: This technology has been added to this report.

6. Section 4.1.1. There are several examples of constructed treatment wetlands that are much smaller in scale than the Everglades STAs. Key factors to consider when designing and sizing a constructed treatment wetland are treatment columns and hydraulic loading rates, inflow nutrient concentration and outflow nutrient concentration targets. A treatment wetland that compares in size to the EAA STAs is not feasible in this area, but likely not necessary either, depending on the treatment goals and anticipated treatment volumes. Examples of smaller scale treatment wetlands include: Ten Mile Filter Marsh (Lee County), Powell Creek Filter Marsh (Lee County), Orlando Easterly Wetlands (treats reclaimed water, but successful in reducing nutrient concentrations over 1,200 acres. [C]

   Answer: The document review was based upon all provided and discovered documents, which primarily focused on large scale projects; however, the technology behind STAs (constructed treatment wetlands) and FEBs (spreader berms and swales) are applicable to this study and will be included in the Task 4 feasibility study as options to the extent that land is available for their use.

7. Section 4.2.2. Air Diffusion System (ADS) does not seem promising in this area with high TP. ADS may be beneficial as part of treatment train to supplement technology that removes TP at a greater efficiency than TN, but may require more intense operator involvement, maintenance, and monitoring to ensure there is no export of phosphorus. [C]

   <u>Answer</u>: All technologies contained within the presented or discovered documentation were investigated, including ADS. This is however not a reflection of recommendation. Recommended treatment trains designed to target both TN and TP pollution will be presented in the feasibility study. The treatment trains may include multiple technologies, some of which address only one nutrient or the other, but in combination the treatment train technologies will address both nutrients to the greatest extent practicable.

8. **Work with agencies to establish clear nutrient removal targets the project will attempt to achieve based on concentrations within downstream OFWs. Maximum attainable nutrient removal is not sufficient. [D, F, G]**

   <u>Answer</u>: Staff will present removal targets within the feasibility study based on treatment area restrictions. These targets may be based on downstream OFWs and/or achieving a certain level of efficacy for the proposed treatment trains within the feasibility study report.

9. **The sources of pollution should be addressed in the feasibility study and should be included in the suite of treatment options. The feasibility study should not exclude technologies and treatment areas based on costs. All treatment options and areas should be considered, especially those options that treat the source of pollutants directly. There are funding sources, such as FDACS cost-share programs, that are tailored specifically for projects on privately owned land. The feasibility study should include an evaluation of projects on both publicly and privately owned land. [D, F, G]**

   <u>Answer</u>: The current scope of services does not allow for recommended treatment options to be located on private land. The feasibility study will provide considerations for future studies on pollutant sources and direct load reduction strategies from a regulatory perspective.

10. Consider the use of IFAS research supported Recyclable Water Containment measure in researching BMP treatment options for source controls. [G]

    <u>Answer</u>: This treatment option has been included in the revised report.

11. Consider incorporating the long-discussed private land parcels for consideration: a) the triangular Lipman field south of US41, and b) the permitted preserve managed by Fiddlers Creek development. These have been discussed in several meetings. [G]

    <u>Answer</u>: The current scope of services does not allow for recommended treatment options to be located on private land. The feasibility study will provide considerations for future studies on pollutant sources and direct load reduction strategies from a regulatory perspective.

12. Need to provide additional studies on alum treatment to ensure that it's use would not impact downstream areas, even if floc wasn't an issue because it's been removed or regulated to offline treatment (changes in pH, methylation of mercury, etc.). [D, F]

    <u>Answer</u>: Alum treatment is included in this report as a technology identified by multiple resource documents; however, at this time it will not be recommended for treatment trains.

13. Suggest removal of alum treatment from consideration given this is a natural system where studies on the efficacy of this method is unknown. [E, F]

    <u>Answer</u>: Alum treatment is included in this report as a technology identified by multiple resource documents; however, at this time it will not be recommended for treatment trains.

14. Removal of Floc is also a cost associated with alum treatment. [D]

    <u>Answer</u>: Alum treatment is included in this report as a technology identified by multiple resource documents; however, at this time it will not be recommended for treatment trains.

15. Bold & Gold treatment does not address phosphorus and would need to be applied outside the sensitive wetland and upland areas of CSSP and RBNERR due to the uncertain long-term effects on natural systems. Suggest removal from consideration. [E, F]

    <u>Answer</u>: All potential treatment technologies identified as part of the document review are included in the report. In the feasibility study, it is unlikely that single technologies will be recommended for sole use in mitigation. A variety of treatment trains will likely be proposed to include multiple technologies and techniques to address both TN and TP loads. Concerns regarding the efficacy and impacts of various treatment options will be considered while developing the feasibility study.

16. NutriGone media technology is problematic and suggest removal from consideration given this is a natural system where studies on efficacy of this method is unknown. [E, F]

    <u>Answer</u>: All potential treatment technologies were investigated as part of the document review. In the feasibility study, it is unlikely that single technologies will be recommended for use in mitigation. A variety of treatment trains will likely be proposed to include multiple technologies and techniques to address both TN and TP loads. Concerns regarding the efficacy and impacts of various treatment options will be considered while developing the feasibility study.

17. **Aquifer storage and recovery (ASR) technology recovery rates can vary widely. Recommend removal from consideration. [D, E, F]**

    <u>Answer</u>: All potential treatment technologies identified during document review are included in this report. ASR is included as an identified technology but is not recommended for use in this project.

18. Deep well injection requires permanent disposal of freshwater needed for natural systems restoration and is contrary to the overall watershed restoration goals. Treatment options should be focused on surface water. Recommend removal from consideration. [D, F]

    <u>Answer</u>: All potential treatment technologies identified during document review are included in this report. Deep well injection is included as an identified technology but is not recommended for use in this project.

19. Address not only how the quantity of flow will impact water quality but also historic habitats and endangered species. [E]

    <u>Answer</u>: Nutrient load estimates and increases to flow as a result of the PSRP will be considered when developing treatment trains. Specifications regarding the proposed mitigation project options will be described in accordance with the scope of services.

<u>Appendix A</u>

1. The general boundary should include the farms for which the Southwest Protection Feature is being built. These large farms must be included as they have been shown to be the primary source of nutrient pollution that may threaten water quality in the OFWs. [G]

    <u>Answer</u>: Maps will be updated as needed given the existing scope of services.

<u>Appendix B</u>

1. **Can the data table include data sources and periods of record for determining the average concentration of TN and TP? [A, C, D]**

    <u>Answer</u>: Yes, this is included in the updated Appendix B.

2. Include averages across multiple years vs a single year. [A]
   <u>Answer</u>: Yes, this is included in the updated Appendix B.

3. When determining average, how were results handled that were below detection limit? [A]
   <u>Answer</u>: A conservative approach was taken to samples that were labeled with qualifiers indicating values below Minimum Detection Limits (MDL). These data values were considered at the MDL for the purpose of this study.

4. How were qualified data handled? [A]
   <u>Answer</u>: Qualified data were handled differently for the updated Appendix B. The revised Appendix B includes an explanation of how qualified data was handled and updated summary data given these changes. In general, data that contained qualifiers indicating some level of mismanagement or inaccuracy were removed from the dataset prior to analysis.

5. **Refer to station BR36 as TAMTOM/BR36 or TAMTOM in the table. [A, D, F]**
   <u>Answer</u>: All stations will be referred to in the water quality summary table by all known names (e.g. BR36/TAMTOM/TAMBR36) with shortened naming within the report text and mapping.

6. Consider copper, iron, and/or chlorophyll in the analysis. [A]
   <u>Answer</u>: Copper and iron will be considered in the updated analyses due to their potential impacts on future proposed mitigation. Since there is TN and TP data available and these are the primary parameters of interest in recommending treatment option, Chlorophyll will not be included as it is a response variable to these parameters.

7. Mention the numeric criteria of the receiving waters and list sources for all standards. [A]
   <u>Answer</u>: Numeric criteria associated with each station in listed in the updated Appendix B along with source information.

8. Update the TN/TP concentrations for Whitney River. [A]
   <u>Answer</u>: The Whitney River station data has been replaced with data collected from TT175C, which was sourced from the SFWMD DBHYDRO. This change in sourcing was determined to provide a more complete view of the pollutants leaving Whitney River than the previous station provided.

9. Support why the Peninsular standards were used and if they are appropriate in this region. [C]
   <u>Answer</u>: Support for using the Peninsula region nutrient standards is provided in the updated Appendix B. The standards represent the nearest geographical numeric criteria available for freshwater streams and canals. Specific numeric TN and TP criteria for the inland water monitoring stations do not exist for this region.

10. **Create a map to display the locations of the various monitoring stations referenced in Appendix B for those who are less familiar with the area. [C, D, F]**
    <u>Answer</u>: Maps are now provided to show both the locations of the various stations and whether their averages exceeded the established numeric concentration criterion for each parameter of interest.

11. Why were values exceeding 80% used? Clarify 80% vs 70% as a moderate concentration. [C, D]
    <u>Answer</u>: Values exceeding 80% were used as a method of identifying areas with average parameter concentrations below but near the established numeric criteria. These stations were considered to have moderate concentrations for comparative purposes.

12. Do not use threshold criteria at each monitoring station to determine success but rather state clear nutrient reduction targets the project will attempt to meet within the receiving waters (OFWs). [D]

Answer: Staff will present removal targets within the feasibility study based on treatment area restrictions. These targets may be based on downstream OFWs and/or achieving a certain level of efficacy for the proposed treatment trains within the feasibility study report.

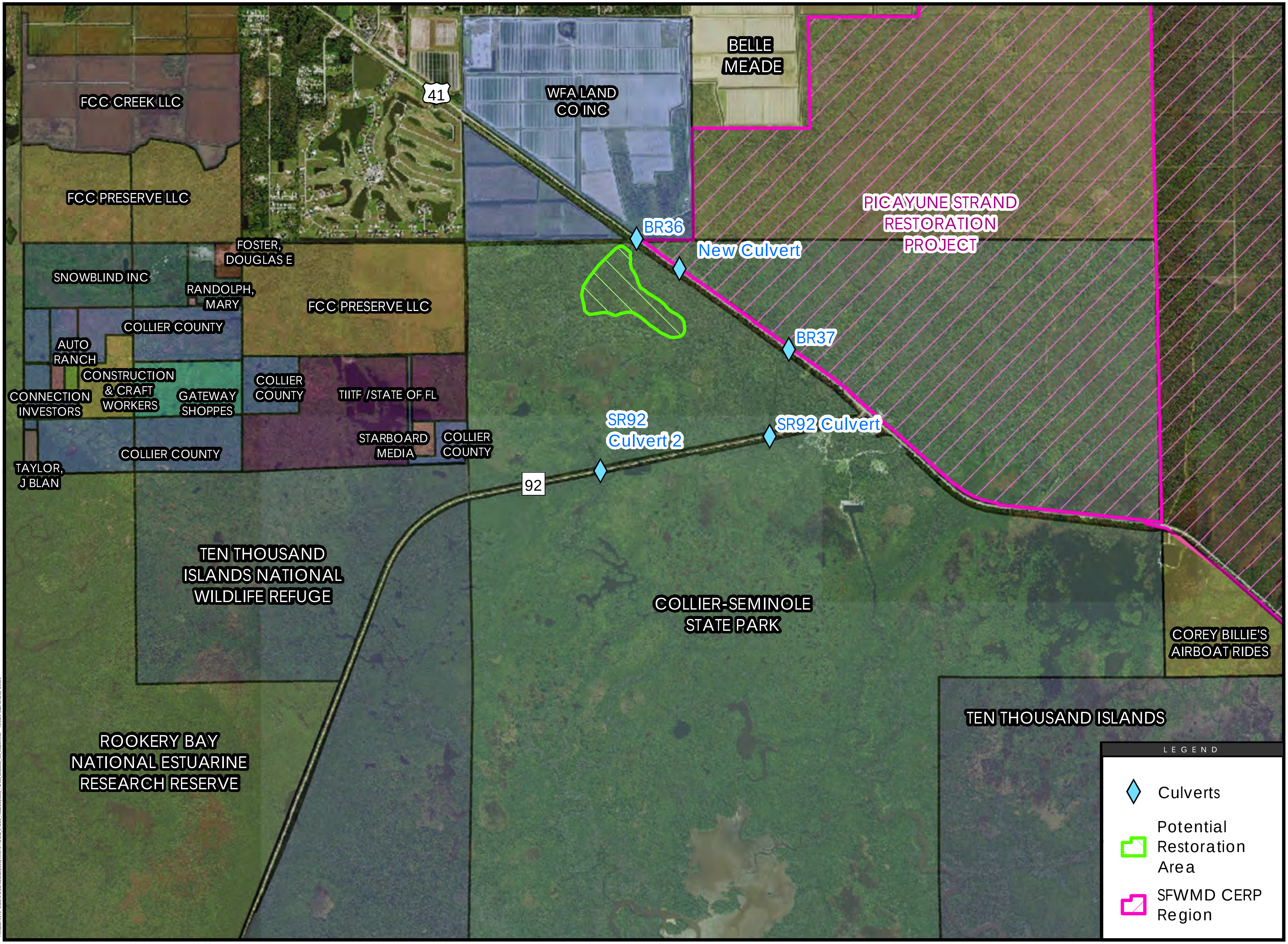
Appendix D

1. Refer to Paul Julian's comments on considering treatment area sizing based on modeled data. [C]
   Answer: This information will be reviewed while preparing aspects of the feasibility study.

Reviewers

A. Rhonda Watkins, Collier County
B. Lisa Koehler, SFWMD
C. Dr. Paul Julian, FDEP
D. Marisa Carrozzo, Conservancy of Southwest Florida
E. Kathy Worley, Conservancy of Southwest Florida
F. Meredith Budd, Florida Wildlife Federation
G. Bradley Cornell, Audubon Western Everglades

Appendix F AREA PARCEL OWNERSHIP MAP



Stantec

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Notes:
1. Coordinate System: NAD 1983 StatePlane Florida East FIPS 0901 Feet
2. Source data: FNAI, SFWMD, Stantec
3. Imagery: Collier County

COLLIER COUNTY WATER QUALITY STUDY
AREA PARCEL OWNERSHIP
September 2020

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N

0 1,500 3,000 Feet

Prepared by: D.A.R. 09/30/20
Technical Review by: X.X.X MM/DD/YY
Independent Review by: J.B. 08/19/20

Appendix G SITE REVIEW MEMO

Collier County Water Quality Feasibility Study
Site Review Memo
October 5, 2020

A site review was conducted by Stantec staff to field assess potential water quality treatment areas located north of San Marco Road (C.R. 92) and west of Tamiami Trail East (U.S. 41).

1.Curcie Road-Collier County Property

The Collier County-owned property is located west of Curcie Road and in the southeast corner of an abandoned rock quarry. The perimeter of the subject property contains mangroves, buttonwood, and scattered amounts of Brazilian pepper. The interior of the property contains large areas of cattails, spikerush, juncus, small open water areas, and scattered amounts of melaleuca. This property could be used to receive pumped water, attenuate the pumped water for water quality treatment before being discharged. Water quality could be enhanced by the treatment/removal of exotic and nuisance vegetation on the property. Water quality could also be enhanced by re-planting nuisance/exotic vegetation removal areas with desirable native plant species. Water quality treatment ponds/cells could be constructed on the property to provide additional water quality treatment before discharge.

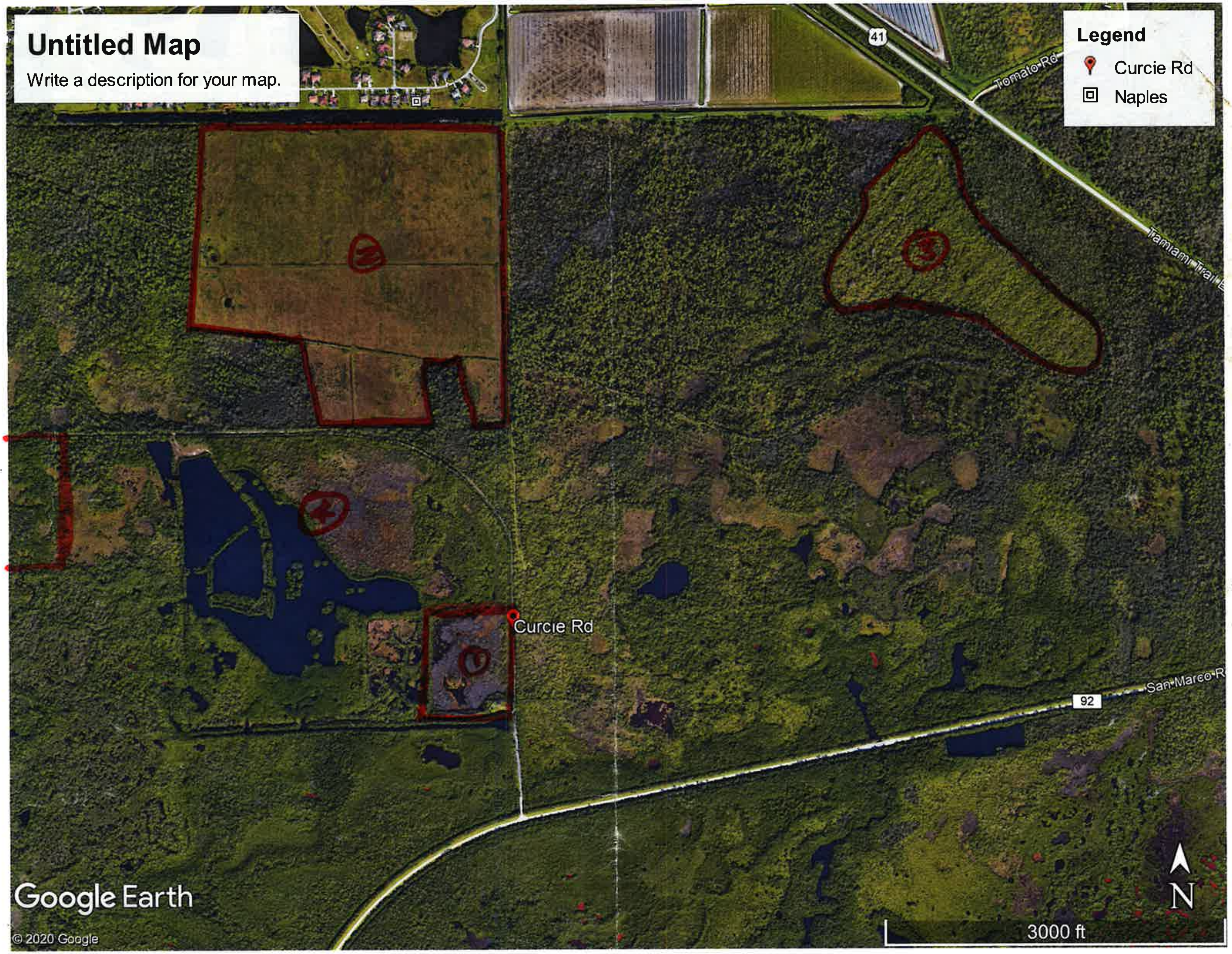
2.Fiddler's Creek Agricultural Property

Stantec was not able to gain access to the Fiddler's Creek agricultural property but staff was able to use binoculars from Curcie Road and view some of the vegetation occurring on the site. The property does not appear to be in active agricultural production and would be considered fallow agricultural lands. The property contained standing water and appeared to be dominated by freshwater plant species including spikerush, juncus, torpedograss, and sawgrass, with scattered melaleuca, wax myrtle, and Brazilian pepper. This property could be used to receive pumped water, attenuate the pumped water for water quality treatment before being discharged. Water quality could be enhanced by the treatment/removal of exotic and nuisance vegetation within the property, and further enhanced by re-planting nuisance/exotic vegetation removal areas with desirable native plant species. Water quality treatment ponds/cells could be constructed on the property to provide additional water quality treatment before discharge.

3.Fallow Agricultural Area

A fallow agricultural area was observed occurring west of Tamiami Trail East (U.S. 41) and southwest of Tomato Road. The fallow agricultural area appears to have been abandoned many years ago. A perimeter berm surrounds the fallow agricultural area and the interior contained large amounts of primrose willow (exotic) and Carolina willow. Scattered cypress trees were also observed within this area. Pumped water could be directed into this system, attenuated for water quality treatment, and then discharged. Water quality could be enhanced by the treatment/removal of exotic and nuisance vegetation within this system, and further enhanced by re-planting nuisance/exotic vegetation removal areas with desirable native plant species. The native habitats adjacent to the fallow agricultural area contained varying amounts of Brazilian pepper, Java plum, melaleuca, Old World climbing fern, Caesar-weed, and other nuisance/exotic plant species. The treatment/removal of exotic/nuisance plant species from surrounding habitats could also improve regional water quality. Water quality treatment ponds/cells could be constructed on the fallow agricultural property to provide additional water quality treatment before discharge. According to the NRCS Soils Survey, there may be scattered upland habitats located between the Fallow Agricultural Area, Curcie Road, and the Fiddlers Creek Agricultural property. Upland areas could be converted to water quality treatment systems if approved by local, state, and federal permitting agencies. Additional field review will be required to assess the subject area for potential upland habitats.

4.The Rookery Bay-owned Curcie Road rock quarry property contains mangrove/buttonwood habitats, open-water areas, and freshwater habitats. Water quality could be enhanced on the site by the treatment/removal of exotic and nuisance vegetation. Water quality could also be enhanced by re-planting nuisance/exotic vegetation removal areas with desirable native plant species. If water could be pumped into the property, additional water quality treatment could occur before discharge. Pumped water could be directed into this system, attenuated for water quality treatment, and then discharged. Water quality treatment ponds/cells could be constructed on the property to provide additional water quality treatment before discharge.



Untitled Map
Write a description for your map.
Legend
Curcie Rd
Naples
41
Tomato Rd
Tamiami Trail E
Curcie Rd
San Marco Rd
92
N
3000 ft
Google Earth
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