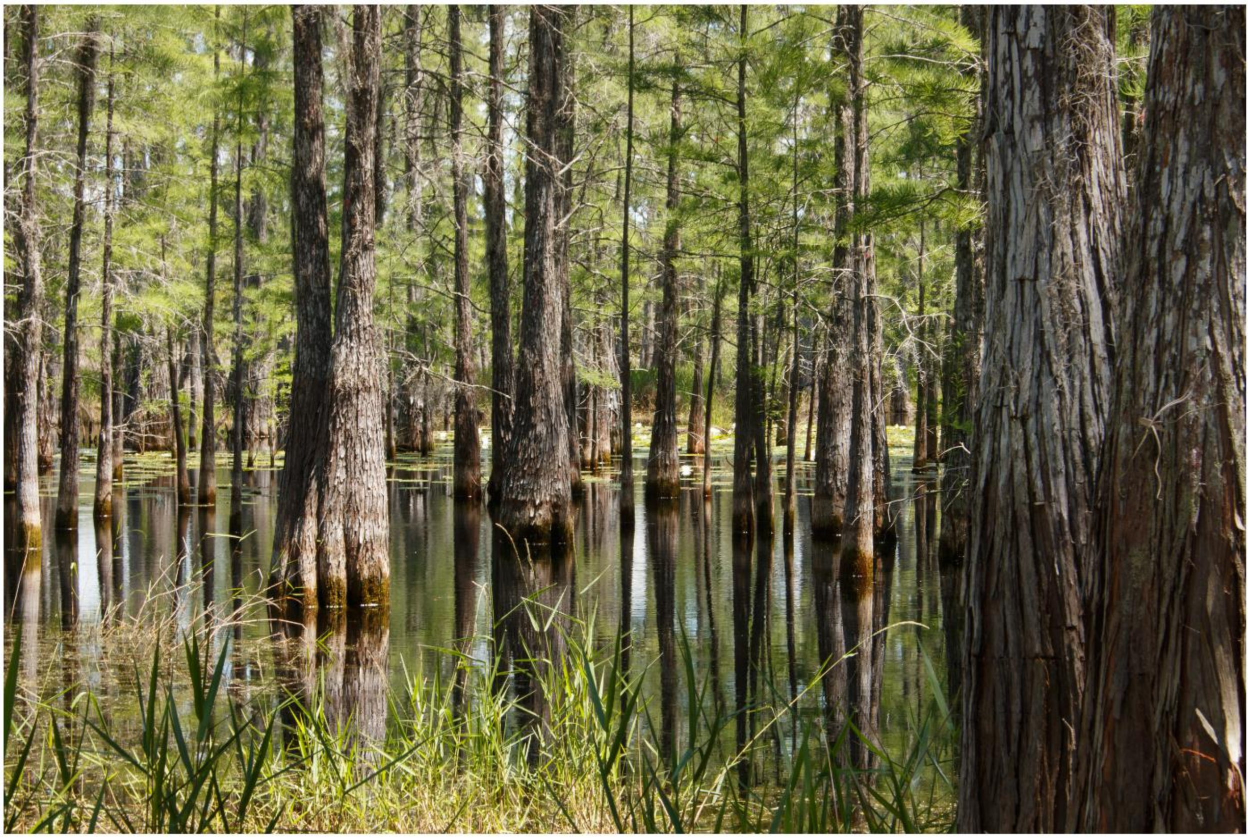

Tampa Bay Water Recovery Assessment: Final Report of Findings

Final Report
Consolidated Water Use Permit
September 29, 2020

Warren Hogg, P.G.
Erin Hayes, MEM
Doug Keesecker, M.S
Whitney Kiehn, PhD, PWS
Christopher Shea, PWS

Professional Geologist Certification

The geological evaluations and interpretations contained in the Recovery Assessment Plan Final Report of Findings have been prepared or reviewed by a licensed Professional Geologist in the State of Florida in accordance with Chapter 492, Florida Statutes.

R. Warren Hogg
R. Warren Hogg, P.G.

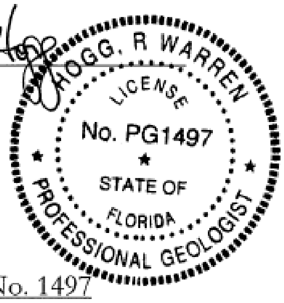

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Table of Contents

List of Tables

List of Figures

List of Appendices

Executive Summary

Meeting the public need for a clean, safe, and reliable water supply is a challenging task. The population of the three-county Tampa Bay area has grown exponentially, from 125,000 people in 1920 to approximately 2.9 million people in 2018, creating a continually increasing demand for potable water. Adaptive management in developing and managing the local water resources has been necessary as the region developed first into an area dominated by agriculture and then into an expanding urban center. Early groundwater supplies near the coastline were abandoned due to saltwater intrusion into the aquifer and subsequent pumping from inland wellfields contributed to low water levels in lakes and wetlands north of Tampa Bay. The importance of balancing all water use needs, including those of the environment, was acknowledged by the state legislature with the passage of the Water Resources Act of 1972. It was clear that the region needed to find solutions that would provide for the growing drinking water demand of the Tampa Bay area and protect the environment.

In 1998, the leaders of the state and region came together and created Tampa Bay Water, reforming the former West Coast Regional Water Supply Authority into a true regional water utility. The six member governments, the Authority, and the Southwest Florida Water Management District (District) entered into a Partnership Agreement with three main objectives: 1) to develop new water supplies to meet future water demands; 2) to reduce the permitted pumping rate from the 11 wellfields north of Tampa Bay and allow area lakes and wetlands to recover; and 3) to end the existing and avoid future litigation between the parties to the agreement. In the 22 years since the agreement was signed, Tampa Bay Water developed multiple alternative water supplies to meet the current and future water needs of the Tampa Bay area. The new regional water supplies allowed Tampa Bay Water to reduce pumping from the 11 wellfields by approximately 50%, in order to promote the recovery of the environment. By working collaboratively with state and local governments, the region was able to allow environmental recovery and meet increasing water demand without any new water use litigation.

With all of these regional successes, one significant question remained: would the environment around the wellfields fully recover with the reduction in regional wellfield pumping? Tampa Bay Water and the District had documented historical lake and wetland impacts near the wellfields that were primarily due to wellfield pumping and periods of drought, compounded by impacts related to urbanization and changes in surface water flow patterns. The reduction in wellfield pumping began in late 2002 as the new alternative water supplies were introduced into the regional supply system. As groundwater pumping was reduced, less surface water leaked into the underlying aquifer through clay confining beds. This allowed area lakes and wetlands to retain more water which promoted their long-term health. In the areas of the 11 wellfields, retaining more water in lakes and wetlands allowed them to recover from past stress due to pumping. Tampa Bay Water and the District documented improving environmental conditions around the wellfields in the years following the reduction in wellfield pumping. However, it took lengthy and rigorous scientific studies to determine if the environment around the wellfields had fully recovered.

The District issued a Consolidated Water Use Permit to Tampa Bay Water in 1998 that authorized the pumping from the 11 northern (Central System) wellfields. This permit was renewed in 2011 with an annual average permitted withdrawal limit of 90 million gallons per day (mgd) from these wellfields. This renewed permit also required Tampa Bay Water to complete a Permit Recovery Assessment Plan to 1) evaluate the recovery of water resource and environmental systems attributable to reduction of the groundwater withdrawals from the Central System wellfields to a long-term average of 90 mgd, 2) identify any remaining unacceptable adverse impacts caused by pumping the Central System wellfields at a long-term average rate of 90 mgd, and 3) identify and evaluate potential options to address any remaining unacceptable adverse impacts at the time of the Consolidated Permit renewal in 2020. The goals of this Recovery Assessment Plan were to answer the question "has the environment fully recovered from pumping impacts" in a thorough and scientific manner and to form the basis for the renewal of the Consolidated Permit.

Tampa Bay Water developed a multi-year investigation of environmental health and recovery around the 11 wellfields to address the permit requirement for a Recovery Assessment Plan (Plan). The first step in 2011 was to develop a work plan and schedule to guide the technical work. Staff met with District staff for several months as this Plan was developed and agreement was reached on several fundamental points. Both parties agreed that the Plan would focus on the recovery of wetlands and lakes and that the recovery of wetland and lake water levels would be the basis for assessing environmental recovery, not the recovery of wetland vegetation. There is a significant lag in time between the recovery of water levels in a surface water system and the recovery of the wetland plants; however, if water levels recover to normal levels, the wetland vegetation will reestablish over time. Tampa Bay Water and District staff also agreed that scientific and quantitative metrics of hydrologic recovery were necessary for different wetland types and committed to establish these new metrics.

Tampa Bay Water and the District worked together in an open and collaborative manner to accomplish the work of this Plan. The responsibility for documenting recovery lies with Tampa Bay Water as the permittee but the District staff have devoted an exceptional amount of time and energy to evaluate data and site conditions, review and comment on the technical analyses, and work through the complex and interrelated investigations. Between 2012 and 2020, Tampa Bay Water and District staff completed more than 130 technical meetings and field reviews to complete the work under this Plan. All of the technical analyses performed to complete this Plan were discussed with District staff during technical coordination meetings and suggested improvements have been incorporated into the final results. Tampa Bay Water submitted each process, recovery metric, and preliminary analysis to the District in writing as they were developed and requested review and written approval or concurrence from the District. This process ensured that the District staff was fully informed on a continual basis and has avoided disputes and substantial analytical changes at the end of the process. It also allowed District staff to review voluminous technical material as it was developed, which will facilitate their review of these documents during the 30-day statutory review period following the submittal of the Consolidated Permit renewal application.

Tampa Bay Water and the District have collected an abundance of environmental data from hundreds of lakes, wetlands, and monitor wells throughout the Tampa Bay area. The oldest monitoring sites have data that extend back to the 1930's. These data are essential to the determination of lake and wetland recovery and considerable time was devoted to assuring that the data is of the highest quality. District and Tampa Bay Water staff agreed to share these collective data so there will be no discussion about the validity or quality of the data at the end of the assessments. The Plan contains lists of sites for which recovery is assessed and includes 378 monitored wetlands and 137 monitored lakes. Water Use Permitting rules require that an applicant demonstrate that pumping will not cause adverse impacts to the water resources of the area, not just monitored lakes and wetlands. A modeling analysis was completed of potential impact in the surficial aquifer based on the wellfield pumping at 90 mgd and Tampa Bay Water agreed to assess the health/recovery of all unmonitored wetlands within these defined areas. This resulted in assessment of an additional 845 wetlands and lakes for which there is little or no available site-specific data. Likely environmental conditions in these unmonitored wetlands and lakes were assessed, to the extent possible, from extrapolation and interpolation of available data. In total, the Recovery Assessment Plan contains some level of assessment for 1,360 individual lakes and wetlands.

In order to make a scientific assessment of recovery at a wetland or lake, water level data must be compared to a numeric metric that is based on the ecological health of that wetland type. The District has established Minimum Levels or Management Levels for most of the lakes in the Plan and these levels were used as the metrics for the lakes. The District also had an established metric for isolated cypress wetlands as part of the Minimum Level program for wetlands. This metric was incorporated for all isolated cypress wetlands in a mesic soil setting. The remaining wetlands were classified into other types (isolated wetlands in a xeric soil setting, marshes, connected or flowing wetlands) and scientific metrics of ecological health were established for each wetland type using available ecological data from these sites. These new metrics of wetland health were used in the subsequent analyses; if a wetland meets the appropriate metric of health, it can be considered “recovered.”

The Tampa Bay area has experienced average to slightly above-average annual rainfall during the past 10 years except for 2015 which recorded well above-average rainfall. The analytical methods that were developed within the Plan were designed to factor out the effect of rainfall on wetland water levels as much as possible so that the results assess the recovery due to the reduction in wellfield pumping. A weight-of-evidence approach was employed through all recovery analyses to use the wealth of available historical data from monitored lakes and wetlands. The 50 percent reduction in wellfield pumping since 2002 is significant enough for the analyses to detect a recognizable response in the environmental data collected before and after the pumping reduction. For wetlands not meeting their recovery metric, the weight-of-evidence approach considers the multiple factors that influence water levels and environmental health by examining all available lake and wetland data using multiple assessment techniques. This assessment method weighs all available lines of information and examines the current environmental condition in light of actual pumping, rainfall and drainage alterations that have occurred on and near the wellfields. This approach, while acknowledging the uncertainty present in all analytical methods, ameliorates this concern by relying on multiple analyses and data types. Multiple lines of available evidence, including field assessments, were evaluated for lakes and wetlands during the preliminary and final technical analyses before making the final determination of recovery and environmental health.

Tampa Bay Water has assessed the environmental recovery and health of 1,360 individual lakes and wetlands due to the reduction in wellfield pumping to a long-term average of 90 mgd as part of this Recovery Assessment Plan. Staff completed rigorous analyses of hydrologic and ecological conditions at the 515 monitored lakes and wetlands and completed qualitative assessments of health for the 845 unmonitored lakes and wetlands near the 11 wellfields. Only qualitative assessments of the unmonitored sites were possible because no direct data is available for those sites and because of uncertainty in the statistically interpolated datasets used in the analyses. The final determination of environmental recovery on and near the wellfields has been made for the 515 lakes and wetlands that Tampa Bay Water and the District have monitored for many years. The final recovery assessment was based on analysis of long-term datasets that include the most recent 12-year period of 2008 to 2019. This period of time captures years of above and below-average rainfall and the 12-month running average pumping rate from the Consolidated Permit wellfields has been below 90 mgd since late 2009.

The final recovery analyses demonstrate that 85% of these monitored sites meet their numeric metrics of recovery. An additional 13.5% of these sites (70 lakes and wetlands) did not meet their numeric metric of recovery but did exhibit significant improvement in water levels since Tampa Bay Water reduced the wellfield pumping rates. Most of the improved wetlands missed their specific numeric water level target by less than one foot on a long-term basis and field review of many of these improved sites revealed that they do not show signs of adverse environmental impact. Changes to the landscape adjacent to several wellfields have influenced the degree of recovery that can be achieved due to persistent flooding concerns in recent years. Residential developments, some served by individual septic tank systems, were constructed adjacent to the property boundaries of several wellfields when the pumping rates were higher and drawdown in the water table was greater than today. Additional hydrologic improvements on these wellfield properties would exacerbate high water table conditions in the residential developments adjacent to the wellfield property boundaries.

Only eight wetlands across the 11 wellfields were identified as not fully recovered with a continued impact related to wellfield pumping. Environmental conditions at two of these wetlands, both associated with the Cypress Bridge Wellfield, will be addressed by a change in the Optimized Regional Operations Plan (OROP). The other six wetlands were assessed to determine if mitigation is required by Tampa Bay Water. Only one wetland requires mitigation in accordance with the baseline protocol developed by Tampa Bay Water and approved by the District. This single wetland is located on the property boundary of the Cypress Creek Wellfield, half on the wellfield/public property and half on private property containing a home and septic tank system. Since this wetland cannot be directly mitigated due to flooding concerns, Tampa Bay Water will propose to use existing wetland mitigation credits at our Model Dairy Wetland Mitigation Project to satisfy this mitigation requirement.

The technical analyses completed for this Plan demonstrate that environmental recovery has been achieved at the Consolidated Permit wellfields following the reduction of annual average pumping below 90 mgd. There are no remaining adverse environmental impacts related to the continued wellfield pumping at this long-term average rate. The successful completion of the Recovery Assessment Plan and resolution of the one wetland for which mitigation was required provide reasonable assurance to the District that the continued annual average pumping rate of 90 mgd from the ten remaining wellfields does not cause harmful hydrologic alterations to the lakes, wetlands, and surface water resources on and near the wellfields. This assessment will provide much of the basis for the Consolidated Permit renewal in late 2020.

The Consolidated Permit Recovery Assessment Plan is the culmination of many years of scientific study to evaluate environmental recovery following the reduction in pumping from Tampa Bay Water’s 11 northern wellfields. This environmental recovery is directly attributable to the regional cooperation that created Tampa Bay Water, the cooperative agreements that funded the construction of multiple alternative water supply projects, and the significant $1.7 billion financial investment to create a fully interconnected regional water supply system. The remaining question from 22 years ago has now been answered. Tampa Bay Water has continued providing reliable drinking water supply for Tampa Bay area residents while protecting the environment on and around the wellfields. This is a story where in the end, everyone wins.

1: Introduction

1. Introduction

Two words that define the history of Florida are growth and change. The landscape of this state has continually changed since the passage of the Swamp and Overflowed Lands Act of 1850. This Act of the United States Congress ceded "swamp and overflowed lands" to multiple states, including Florida, for the purpose of reclaiming the lands for agricultural purposes (Dovell, 1947). As documented in "Swamp and Overflowed Lands in the United States, Ownership and Reclamation" (Wright, 1907), over 22 million acres of swamp land were claimed by the State of Florida by 1906, the most of any state in the nation. This report by the U.S. Department of Agriculture stated that drainage of these lands was a public function that would provide fertile lands for crops and land on which people could build homes. Large tracts of land were cleared, and wetlands drained for the development of citrus groves and cattle ranches beginning in the late 19^{th} century. Agriculture quickly became a major economic driver for the state's economy with food products shipped throughout the country and the world.

As more and more people moved into the state, some of these groves and ranches began to transition into large development communities, notably near urban centers such as Tampa Bay. The construction of houses, infrastructure, and corresponding amenities became another major economic driver for the state as the state population grew to approximately 18.8 million people by 2010 (based on U.S. Census data). These two economic sectors are very land-intensive, and many wetlands were drained and/or cleared in order to provide the land needed for crops and homes. The growth of agriculture and development have greatly changed the spatial coverage and health of wetlands over the past century. This statement is not made in condemnation or concurrence; it is simply an observation – growth leads to change. Where wetlands were once viewed as a nuisance that should be converted to a higher use, it is now understood that they are of vital importance to the health of the local community. The citizens of Florida began to understand that the protection of wetlands should be balanced with continued development in the state. The influx of residents into Florida and the growing awareness of the importance of wetlands brought another concern, the conflicting needs for water.

People need water; it is a basic necessity of life. Without a safe and reliable water supply, population and economic growth are not sustainable. The demand for potable water in the Tampa Bay region grew at a rapid rate from the mid-1950's through the mid-1990's commensurate with the population increases. Coastal groundwater sources became too saline to drink and new wellfields were developed inland, away from the coastline. As the inland wellfields reached their capacities, new wellfields were developed to meet the ever-growing demand for water. Pumping from the inland aquifer system continued to increase to levels where the effects were observed in lakes and wetlands on and near the wellfields. Low or absent water levels were documented at individual wellfields in the past but during an extended drought period in the mid-1990's, water levels in wetlands and lakes across the region were very low or absent. The environment also needs water; without it, ecological systems will change and can ultimately perish. Persistent low water levels or the absence of water in a lake or wetland causes a change in vegetation from wetland-dependent plants to upland species. Fish and other species that rely on water can die or be forced to migrate to other areas. Additional effects of water deficits include treefall, soil subsidence and the increased risk of wildfire. There are multiple reasons for wetland and lake water level impacts, including excessive groundwater pumping, drought or climate cycles, and drainage system changes related to land development or land management for agriculture. During the mid-1990's, the high level of pumping from the wellfields north of Tampa Bay combined with the very low annual rainfall over successive years were the two primary causes of adverse water level impacts in many lakes and wetlands on and near the wellfields.

Water resource managers in the Tampa Bay region needed to find a balance between meeting the potable water needs of the population and ensuring that water was also available to sustain healthy lakes and wetlands. An historic agreement between local governments, the water supply authority, and the Southwest Florida Water Management District (District) called for the reduction in pumping from 11 wellfields north of Tampa Bay from an average annual permitted capacity of 192 million gallons per day (mgd) to 90 mgd over a period of ten years. To offset this reduction in water supply and to provide water to meet future water demand, the agreement provided capital investment for the development of new alternative water supplies. The alternative water supplies included surface water withdrawals from two local rivers, a 15-billion gallon off-stream reservoir, and a seawater desalination facility. These new supplies were built and brought on-line and the average annual pumping rate from the 11 wellfields was dramatically decreased and has remained below the 90 mgd permitted limit since the beginning of 2010.

1.1 Statement of Issue

Local and state officials agreed to this significant reduction in groundwater pumping north of Tampa Bay to promote recovery of the environment on and around the 11 wellfields. Staff of Tampa Bay Water and the District estimated that at an annual average pumping rate of approximately 90 mgd, impacts to lakes and wetlands would be greatly reduced and perhaps eliminated. This was an estimated quantity based on the best-available information at the time: a reduction in concentrated groundwater pumping for environmental recovery at this scale had never before occurred. Both agencies continued their extensive environmental monitoring programs to track improvement in environmental conditions and gage the actual degree of recovery.

Tampa Bay Water and the District have documented significant increases in lake and wetland water levels since the pumping rate was reduced at the Consolidated Permit wellfields. During this period of environmental improvement, the Tampa Bay region has also experienced more normal rainfall conditions. Even though monitoring data shows that environmental conditions have improved, a fundamental question remained: “have environmental conditions improved enough or to the appropriate level?”. This study and report were developed to determine if area lakes and wetlands have fully recovered or recovered to the extent possible given the land-use changes that have occurred adjacent to the wellfields up to the present time.

1.2 Purpose and Objective

The current Consolidated Water Use Permit for the 11 northern wellfields requires Tampa Bay Water to answer this question through the development and implementation of a Recovery Assessment Plan. The permit specifically requires Tampa Bay Water to evaluate the recovery of water resources and environmental systems that is attributable to the reduction of wellfield pumping to an average of 90 mgd and to identify and address any remaining unacceptable adverse impacts related to wellfield pumping at an average of 90 mgd. The objective of this study is to define recovery in terms of specific environmental features and apply robust scientific analyses to quantify the degree of environmental recovery achieved since Tampa Bay Water reduced the wellfield pumping rate.

1.3 Format of the Recovery Assessment Plan Report

This report is a summary of the technical investigations that lead to the final documentation of environmental recovery for the 11 wellfields of Tampa Bay Water's Consolidated Water Use Permit. The assessment of recovery and quantification of these results will play a central role in the renewal of the Consolidated Permit in late 2020. The key to the successful renewal of this permit will be documenting recovery at all of the wellfields. If any adverse impact remains due to the current level of wellfield pumping, Tampa Bay Water will identify a remedy to address that impact.

This final Recovery Assessment Plan Report is a comprehensive examination of the myriad of factors that influence environmental health in the northern Tampa Bay area. The hydrogeologic and environmental settings of west-central Florida, the water supply development history of the Tampa Bay region, and a description of Tampa Bay Water's regional system are presented early in the report (Chapters 2 through 4) as they provide the framework and context to fully understand the assessment results. The second segment of this report (Chapters 5 through 7) details the technical and regulatory issues of this study, the mechanics of how metrics of lake and wetland recovery/health were established, the methods developed to apply the metrics, and tools developed to track the multiple assessments of recovery. The final assessments of each individual lake and wetland are presented in Chapters 8 through 10 and the hydrologic improvement within the underlying Upper Floridan Aquifer are discussed in Chapter 11.

The final recovery assessment results are presented for each of the Consolidated Permit wellfields in Chapter 12 along with a discussion of the data used to assess recovery and factors that may limit or constrain the degree of local environmental recovery, such as unique geologic features or changes within the surrounding drainage basins. Recovery is presented on a regional scale in Chapter 13 including a discussion of a new environmental baseline condition that balances the needs of the environmental systems, the water supply needs of the region and the needs of the communities adjacent to the Consolidated Permit wellfields. The end of the report is a final accounting of recovery, the identification of any remaining adverse impacts, and the actions or projects that Tampa Bay Water proposes to mitigate those impacts (Chapters 14 and 15). The report closes in Chapter 16 with a discussion of how the final Recovery Assessment Plan results will be used to support the renewal of the Consolidated Permit in late 2020.

Tampa Bay Water and the District have been assessing environmental conditions for decades and have published many technical reports on this subject. Some of these reports have been used to support this analysis of environmental recovery and are included in this report as technical appendices. The work that Tampa Bay Water has performed specific to this Recovery Assessment Plan has been documented over the past nine years; the relevant reports and documents are included with this report as appendices and are available in electronic format from Tampa Bay Water. This final assessment report does not include period of record hydrographs for all of the lakes, wetlands, or monitor wells included in this document. These graphics were simultaneously prepared and included in annual compliance reports for each of these 11 wellfields. Tampa Bay Water chose not to include these graphs for the hundreds of lakes, wetlands, and monitor wells in this report as this effort would be duplicative and would have greatly increased the size of this report. The annual wellfield reports will be included as supporting material in the Consolidated Water Use Permit renewal application package and are available in electronic format upon request.

2: Hydrogeologic and Environmental Setting of and History of West Central Florida

2. Hydrogeologic and Environmental Setting of and History of West Central Florida

The surface and subsurface water resources of West-central Florida are interconnected and dependent upon each other. The surface water features rely on rainfall and in turn, some of the water in these lakes, wetlands, and streams seeps downward to recharge the underlying aquifers. The surface water features are supported by and, in some cases, recharged from the underlying aquifers. The geologic history of Florida is complex; the geology and hydrogeology of West-central Florida are important to understanding the surface water features discussed in detail in this report and how they interact with the local ground water system. This chapter presents a summary of the geology and hydrogeology of the Northern Tampa Bay area, describes the wetlands present in the region, and changes that have occurred to wetland systems.

2.1 Geology - Regional

Tampa Bay Water has diversified the regional water supply sources to include surface water and desalinated seawater; however, the largest percentage of the drinking water the Agency produces comes from groundwater. The groundwater in the Tampa Bay area comes from rock aquifers deep below land surface. The way these sediments were deposited and lithified developed a variety of characteristics including porosity, bedding planes, caverns and karst features from dissolution of carbonate rock, and numerous fractures, that allow for both the storage and flow of water. Many of these features are the result of changes in sea level.

Much of the state of Florida lies on the Florida Platform. The platform is approximately 400 miles long from north to south and is about 400 miles across at the widest point (Scott, 1992). In the present day, over half of the platform is under water. The basement rocks found on the platform were part of the African plate that remained behind after a collision with the North American plate over 200 million years ago (MYA) (Scott, 1992). The layers of sediment which have been deposited on top range in age from 145 million years old to the present day. Many of the layers were defined based on the extent of sea level at the time.

In a 1970 report, White classified the state into several Geomorphic Provinces, which are areas that have a similar geology and were shaped at the surface by similar processes. Under this classification system, most of the Consolidated Permit wellfields are part of the Gulf Coastal Lowlands province. This area has sandy, loamy soils and terrace scarps, which mark the extents of ancient seas as ocean levels rose and fell. A portion of the Cross Bar Ranch Wellfield is considered part of the Brooksville Ridge province. This is an upland area characterized by karst topography with sink features as well as lakes and wetlands (ERM-South Inc., 1995). A portion of the Morris Bridge Wellfield is considered part of the Zephyrhills gap, which has been largely shaped by the Hillsborough River (Geurink and Basso, 2013).

Recent work, however, has looked at reclassifying the physiographic provinces, and offers an alternative to those developed by White in 1970. A portion of this new work, published in 2018 (Williams et al, in prep, as cited in Upchurch et al., 2018), places the Consolidated Permit wellfields within the Land O' Lakes Karst Plain province amidst the overarching Ocala Karst Geomorphic District. This district is a series of individual provinces spanning from the top of Tampa Bay nearly to the Florida/Georgia state line. The geology and surface structures of this district were largely affected by their proximity to the Ocala Uplift, which is an area of increased elevation running parallel to the coast, through the north-central area of the state (Williams et al, in prep, as cited in Upchurch et al., 2018).

For much of its recent geologic history, the Florida Platform existed under a warm, shallow sea. As a result, carbonate rocks, including limestone (calcium carbonate) and dolostone (calcium carbonate with magnesium), formed in these waters from the settlings of shells of organisms which were composed of calcium carbonate (Upchurch et al., 2018) and the development of reef systems (Scott, 1992). Influxes of siliciclastic sediments (those containing silica, or silica-based minerals) were sourced from erosion of the Appalachian Mountains and changes in fluxes for siliciclastic sediments correspond to changes in their uplift and erosion patterns. Most of the siliciclastic sediment deposited on the Florida Platform has occurred since the Oligocene, approximately 28 MYA (Arthur et al., 2008).

The large-scale geology surrounding the Florida Platform affected how the rock units were deposited and developed in this area. These features include structures such as arches, basins, faults, and lineaments. The oldest feature which may have impacted the units which make up Florida's aquifer system is known as the "Florida Lineament" (Christenson, 1990 as cited in Arthur et al., 2008). This feature was more recently characterized as a rift zone and reclassified as a lineament, but the location coincides with previous works characterizing it as a fault (Pindell, 1985 as cited in Arthur et al., 2008) and a fracture zone (Klitgord et al, 1983, as cited in Arthur et al., 2008).

Prior to the Cenozoic Era more than 66 MYA, sediment deposition in the northern Tampa Bay Area was impacted by the presence of an uplifted feature known as the Peninsular Arch to the Northeast, and the South Florida Basin (Applin and Applin, 1965 and Winston, 1971, as cited in Arthur et al., 2008) to the Southeast. According to Arthur et al. (2008), the South Florida Basin, "contributed to southward thickening of Mesozoic and Early Cenozoic lithostratigraphic units in the Southern Florida Peninsula."

During the Cenozoic through recent eras, the Ocala Platform to the northeast was the most dominant structure affecting deposition in this area. Additionally, Arthur et al., 2008 also demonstrates evidence of multiple groups of faults around the Ocala Platform, which may penetrate the rock units of the Avon Park Formation, the Ocala Limestone and the Suwannee Limestone.

From parts of the Cretaceous Period (approximately 70 MYA) through the Miocene Period (23 MYA), a feature known as the Gulf Trough (Scott, 1992), or the Georgia Channel (Arthur et al., 2008) was an area of deeper water with a moving current that existed over the Florida panhandle approximately near present-day Tallahassee. This trough prevented a significant buildup of siliciclastic sediments, leading to the deposition of more pure carbonate rocks. As sediments continued to build and filled in the trough by the early Miocene, siliciclastic sediments became more prominent in the rock and sediment record, through the present-day (Scott, 1992).

Above the basement rock lies the Cedar Keys Formation. This unit is a dolomite, which alternates with beds of evaporite minerals, gypsum ($CaSO_4 \cdot 2H_2O$) and anhydrite ($CaSO_4$). The evaporite minerals effectively preclude the flow of water between the rocks above and below. Porosity of this unit increases from the bottom of the unit to the top (Scott, 1992). The presence of evaporite minerals are generally indicative of restricted circulation of water. A decrease or cessation of inflow can lead to an increase in mineral concentration in water, eventually causing them to precipitate out of solution. Changes in evaporation and temperature can also affect precipitation, as well as changes in sea level associated with subaerial exposure (Scott, 1992).

Above the Cedar Keys Formation is the Oldsmar Formation. This unit was deposited during the Early Eocene (Miller, 1986, as cited in Arthur et al., 2008) beginning approximately 56 MYA. This unit contains interbedded layers of limestone and dolostone (Arthur et al., 2008 and Scott, 1992), with dolostone being the more dominant feature closer to the Cedar Keys Formation. The limestone varies in color from white to gray, while the dolostone is gray to light brown (Arthur et al., 2008), crystalline and vuggy, (Scott, 1992) meaning that it contains cavities within the rock which are lined with minerals that developed after the rock was formed. Evaporite beds of anhydrite have been noted in this formation, along with gypsum-filled pore spaces (Arthur et al., 2008 and Miller, 1986, as cited in Scott, 1992).

The Avon Park Formation was deposited next, during the Middle Eocene (Arthur et al., 2008 and Scott, 1992), between approximately 47.8 and 38 MYA. The Avon Park Formation contains both limestone and dolostone (Scott, 1992, and Miller, 1986, as cited in Arthur et al., 2008). This limestone contains abundant fossils (Scott, 1992). Within the Avon Park Formation lies a section with pore spaces and vugs filled with evaporite minerals such as gypsum and anhydrite (Hutchinson, 1985; Tihansky, 2005 and Arthur et al., 2008) and in interbedded layers, which decrease permeability and impede water flow between the two sections (Scott, 1992 and SWFWMD, 1996a). The limestone is mainly a wackestone to grainstone (Arthur et al., 2008), meaning that fossils and shell fragments are present, but varied in their amounts, and in between them can be a lime mud or calcite crystals. The limestone ranges in color from cream to brown (Sinclair, 1982 and Arthur et al., 2008) and is variably indurated and fossiliferous (Arthur et al., 2008). Induration refers to the hardness of the rock, and how easily it can be broken up. Fossils present can include corals, mollusks (Sinclair, 1982), and seagrasses (Cander, 1991 as cited in Tihansky, 2005), among others. The dolostone can be gray to tan to dark brown in color, and can be of fine-grained micritic, or sucrosic texture. It is hard, massive, vuggy and fossiliferous (SWFWMD, 1996 and Arthur et al., 2008). Multiple studies have also noted the presence of thin layers of lignite or peat (Sinclair, 1982; SWFWMD, 1996; Tihansky, 2005 and Arthur et al., 2008).

The carbonate sequences of the Avon Park Formation suggest a marine depositional environment in warm shallow water (Arthur et al., 2008). The presence of dolomite and evaporite minerals in voids would suggest periods of either restricted ocean circulation or tidal flats with low water levels (Scott, 1992). Coupled with peat and seagrass fossils, the water was shallow enough for both evaporative or precipitative conditions and organic matter development: however, these conditions were not long lasting (Tihansky, 2005). Alternating layers reflect repeating changes in sea level that represent regressive and transgressive cycles (Randazzo et al, 1990, as cited in Arthur et al., 2008). Thicknesses of the Avon Park Formation vary. Miller (1986) characterized the Avon Park Formation in northern Hillsborough and Pasco Counties to range from 1300 to 1500 feet thick, while studies covering southwest Florida and specifically the Cross Bar Ranch Wellfield have provided thicknesses of 300 to 500 feet (SWFWMD, 1996) and 50 to 500 feet (ERM-South, Inc., 1995), respectively.

Atop the Avon Park Formation lies the Ocala Limestone. The Ocala Limestone was also deposited during the late Eocene (Sinclair, 1982; Hutchinson, 1985; ERM-South Inc., 1995 and Arthur et al., 2008), between approximately 41 and 34 MYA, from calcium carbonate deposition in warm, shallow seas (Carter and others, 1989, and Loizeaux, 1995, both cited in Tihansky, 2005). A disconformity between the Avon Park Formation and the Ocala Limestone (Tihansky, 2005 and Arthur et al., 2008) suggests that the Avon Park Formation was exposed subaerially to some degree allowing for erosion of the surface prior to deposition of the Ocala Limestone sediments (Tihansky, 2005). In some locations, a color change is evidence of the difference, as well as the disappearance of peat layers found in the Avon Park Formation (Arthur et al., 2008).

While considered to be one unit, the Ocala Limestone properties differ between the upper and lower sections (Scott, 1992 and Arthur et al., 2008). The lower limestone can vary in color from cream to white to gray (ERM-South Inc., 1995 and SWFWMD, 1996) and while fairly fossiliferous, can be classified as a grainstone or packstone, meaning it can contain crystalline calcite or lime mud matrix, respectively (Scott, 1992; Tihansky, 2005 and SWFWMD, 1996). Scott (1992), ERM-South Inc. (1995) and Tihansky (2005) made observations of dolomite lenses or dolomitized limestone in the lower portion of the Ocala Limestone. This may be more common in areas where the upper Avon Park Formation was also dolomitized (Arthur et al., 2008). The lower part is also observed to be semi-indurated, (ERM-South Inc., 1995; SWFWMD, 1996 and Tihansky, 2005) meaning that it is moderately hard, but still friable.

The upper portion can be white to light orange (SWFWMD, 1996 and Arthur et al., 2008), and is described as a packstone, wackestone, or bioclastic limestone meaning it is mostly composed of fossil fragments and foraminifera (SWFWMD, 1996). In the upper Ocala Limestone, these abundant fossils are bound together in a mud, not by crystalline grains, and are generally chalky, soft and friable (Scott, 1992; ERM-South Inc., 1995; SWFWMD, 1996; Tihansky, 2005 and Arthur et al., 2008). The upper portion of the Ocala Limestone does not contain much silica (Arthur et al., 2008), however chert is present (Scott, 1992 and Arthur et al., 2008).

Overall, this unit is approximately 150-170 feet thick in the northern Tampa Bay area (ERM-South Inc., 1995 and Tihansky, 2005) but exhibits thicknesses between 90 and 300 feet across the Florida Platform (Miller, 1986, as cited in SWFWMD, 1996). The transition in the Ocala Limestone from grain-supported to mud-supported fossils indicates that the sea level deepened over time (Randazzo et al, 1990, as cited in Arthur et al., 2008), which would correspond to the marine transgressions, or sea level rising relative to shore, that occurred during the time period (Loizeaux, 1995, as cited in Arthur et al., 2008). The top of the Ocala Limestone is marked by karst topography, erosion, and dissolution (Scott, 1992), which may indicate a drop in sea level after the Ocala Limestone sediments were deposited (Loizeaux, 1995, as cited in Tihansky, 2005).

The Suwannee Limestone is directly above the Ocala Limestone. The carbonate grains making up this unit were deposited during the Oligocene, as early as 33 MYA. Like the Ocala Limestone, it was also formed in shallow marine waters (Cander, 1994, as cited in Arthur et al., 2008, and Tihansky, 2005); however, changes in sediment characteristics suggest multiple cycles of fluctuating sea level (Hammes, 1992, as cited in Tihansky, 2005). These include increasing grain sizes toward the top of each cycle, and karst activity demonstrating erosion, dissolution, and subaerial exposure (Scott, 1992, and Hammes, 1992, as cited in Tihansky, 2005).

The Suwannee Limestone is a relatively pure carbonate rock because a channel system separating the Florida peninsula from Georgia prevented the deposition of siliciclastic sediments from the Appalachian Mountains (Scott, 1992 and Arthur et al., 2008). The limestone is observed to be white or cream to tan in color (SWFWMD, 1996; ERM-South Inc., 1995; Sinclair, 1982 and Tihansky, 2005). It has been described as highly fossiliferous (ERM-South Inc., 1995; Sinclair, 1982; and SWFWMD, 1996), although some reports characterize the upper portion as containing more prominent fossil evidence than the lower (SWFWMD, 1996 and ERM-South Inc., 1995). Fossils include foraminifera, gastropods, bivalves, and echinoids, among others (SWFWMD, 1996). It is often characterized as a vuggy limestone (SWFWMD, 1996; Tihansky, 2005 and Scott, 1992), which is believed to be due to invertebrate molds (Tihansky, 2005).

It is a fine-grained limestone, which has been characterized as both a packstone and a grainstone (Scott, 1992; Tihansky, 2005 and Arthur et al., 2008), suggesting that this fossil-rich sequence is both mud and grain supported. In 1996, the Southwest Florida Water Management District (SWFWMD) described the upper and lower portions of the unit separately and characterized the upper portion as a crystalline matrix supporting fossils, and the lower portion as a crystalline matrix with micrite pellets and foraminifera. Additionally, small amounts of sand and clay have been found throughout this unit (Sinclair, 1982; Tihansky, 2005 and Arthur et al., 2008), and layers of dolomite have been characterized as interbedded with the limestone (Scott, 1992 and Arthur et al., 2008).

The thicknesses of the Suwannee Limestone have been characterized as between 150 and 300 ft. (Miller, 1986, as cited in SWFWMD, 1996), and an average thickness of approximately 160 ft. in West-central Florida (Tihansky, 2005). At the Cross Bar Ranch Wellfield, the maximum thickness was found to be approximately 250 ft (ERM-South Inc., 1995). Faults or other structures are believed to play a role in the observed variability (Tihansky, 2005).

The Hawthorn Group lies unconformably above the Suwannee Limestone. (Arthur et al., 2008). An unconformity exists when there is a gap in the depositional record. The presence of an unconformity between the Suwannee Limestone and the sediments of the Hawthorn Group indicates that some level of erosion or dissolution occurred, and sediments would have filled in any karst features in the Suwannee Limestone which existed at the time of deposition. In the northern Tampa Bay area, this group of rock units consists of the Tampa Member of the Arcadia Formation, followed by undifferentiated sediments, meaning they are not separated by changes in depositional environment. For the entire unit, sediments range in age from the mid-Oligocene (Brewster -Wingard et al., 1997, as cited in Arthur et al., 2008) approximately 27 million years old, to the early Pliocene (Scott, 1988; Covington, 1993; Missimer et al, 1994, as cited in Arthur et al., 2008), approximately 3.6 million years old. The undifferentiated sediments appear to be variable in and around the J.B. Starkey and North Pasco Wellfields, and their northern extent can be found within the Cross Bar Ranch Wellfield. Additionally, they thicken from north to south in West-central Florida (Arthur et al., 2008). Hawthorn Group sediments contain siliciclastics, phosphates, carbonates, clays and sands (Hutchinson, 1985 and Arthur et al., 2008).

This group was likely deposited in a shallow marine system which was impacted by a river and delta system which moved seaward onto the carbonate platform (Arthur et al., 2008). In all, the Hawthorn Group sediments are generally on the order of 0-15 ft. thick; however, in the Tampa Bay area, measurements have been recorded up to 200 feet (SWFWMD, 1996; Tihansky, 2005 and Arthur et al., 2008).

The Arcadia Formation was deposited during the upper Oligocene to middle Miocene (Brewster-Wingard et al., 1997, as cited in Arthur et al., 2008), between approximately 27 and 13 MYA. It is characterized mainly as a dolomite; however, some limestone is present and varies in color from a yellow gray to white.

It can contain some quartz sand and phosphorite, and the carbonate layers are sometimes interbedded with siliciclastic sediment (Arthur et al., 2008). Grain size is also variable, containing everything from microcrystalline sediments to sand. Clays and chert have also been found in this unit (Upchurch et al., 1982; Scott, 1988, as cited in Arthur et al., 2008). Around this time period, the influx of siliciclastic sediments eroding from the Appalachian Mountains began to overwhelm the Gulf Trough (Scott, 1992)/Georgia Channel (Arthur et al., 2008), introducing more siliciclastic sediment into the rock record.

The Tampa Member is the named unit of the Arcadia Formation present in the northern Tampa Bay area. It is a limestone which can vary in color from white to a light-yellow/gray (Sinclair, 1982; SWFWMD, 1996; ERM-South Inc., 1995 and Scott, 1988, as cited in Arthur et al., 2008). This unit is a fairly soft limestone (Sinclair, 1982 and SWFWMD, 1996) which is fine-grained, contains sand and clays, and is locally fossiliferous (SWFWMD, 1996; ERM-South Inc., 1995; Sinclair, 1982; Tihansky, 2005 and Arthur et al., 2008). It is characterized as a wackestone to packstone (Scott, 1988, as cited in Arthur et al., 2008), containing gastropod and bivalve molds and casts and foraminifera (SWFWMD, 1996 and Arthur et al., 2008). Phosphate is present, though less so than in the Hawthorn Group, as well as chert (SWFWMD, 1996; Sinclair, 1982; Tihansky, 2005 and Arthur et al., 2008). In multiple studies, clays and pebbles were observed in separate beds or lenses (Sinclair, 1982 and Arthur et al., 2008). Reported thicknesses vary, with studies reporting 0-200 ft. (SWFWMD, 1996) and 50-100 ft. (Sinclair, 1982), although ERM-South Inc. (1995) reconciles these, stating that “This thickness of the Tampa Member…is variable because both the top and bottom surfaces are irregular, erosional surfaces” (Williams, 1985, as cited in ERM-South Inc., 1995). In Pinellas and northwest Hillsborough counties, the Tampa Member appears directly overtop the Suwannee Limestone (Arthur et al., 2008). According to King (as cited in Arthur et al., 2008), the fine-grained sediment of the Tampa Member indicates it was formed from sediments deposited in a lagoon.

Above the carbonates of the Tampa Member lie the undifferentiated sediments of the Hawthorn Group. In parts of Pasco and northern Hillsborough counties, an unconformity exists between the Hawthorn Group sediments and the Tampa Member below (Arthur et al., 2008). Additionally, these sediments can be very discontinuous throughout the wellfield areas, and especially north in the Cross Bar Ranch Wellfield area (ERM-South Inc., 1995). These sediments generally contain a larger amount of clay than the Tampa Member below them, including minerals smectite, illite, kaolinite, and palygorskite (Scott, 1992). According to Sinclair (1982), this clay-rich layer is often calcareous, and the carbonate sediments present are commonly dolomite (Scott, 1992). Additionally, these sediments tend to include quartz sand grains and phosphorite (Arthur et al., 2008). The Hawthorn Group sediments may be interbedded with some limestone near the Tampa Member, or there could be some limestone mixed in due to erosion in the previous layer (Sinclair, 1974 and Carr and Alverson, 1959 both cited in Sinclair, 1982). The top of the Hawthorn Group sediments shows evidence of karst features and erosion (Scott, 1992). This, coupled with the clay minerals which are formed as a result of weathering, would suggest that that the undifferentiated sediments present are weathered remnants of the eroded Hawthorn Group sediments (ERM-South Inc., 1995).

The surficial sands lie on top of the clay-rich sediments of the Hawthorn Group and were generally deposited during the Pliocene to Pleistocene, ranging in age from approximately 5.3 million years old to 12,000 years old (Scott, 1992). They are mainly composed of unconsolidated quartz sands but can vary in the amounts of fossils and clays (Hutchinson, 1985 and Scott, 1992). According to Sinclair (1982), these sands are usually white to tan in color, but Scott (1992) has noted the observation of orange and blue-green grains as well. Due to the presence of sands and clays, these unconsolidated sands can range in grain size from coarse to fine-grained (Scott, 1992). Given the local variability in the sediments of the Hawthorn Group, the surficial sands may sit above the Hawthorn Group, or directly on the Tampa Member limestone. The surficial sands have a maximum thickness of approximately 35 feet (Sinclair, 1982 and Hutchinson, 1985).

Figures 2.1, 2.2, 2.3 and 2.4 are cross sections produced by the Florida Department of Environmental Protection and the Florida Geological Survey within the northern Tampa Bay area. Figure 2.1 documents the location of the cross sections through northern Tampa Bay. Figure 2.2 displays cross section B-B', which traverses the middle of Pasco County from west to east. This cross section approximately passes through the North Pasco and Cypress Creek Wellfields. Figure 2.3 contains cross section C-C', which crosses the northern half of Hillsborough county, west to east, approximately between the Cosme-Odessa and Northwest Hillsborough Regional Wellfields, and just south of the Section 21 and Morris Bridge Wellfields. Figure 2.4 presents cross section E-E' which runs from north to south through the inter-wellfield area, and through a portion of southern Cross Bar Ranch Wellfield and close to the Section 21 Wellfield.

The geology of the Florida Platform is well documented in many other resources as well, including Health and Smith, 1954; Menke et al., 1964; Steward, 1968; Cherry et al., 1970; Mann, 1972; Sinclair, 1974; Geraghty and Miller 1976; Hutchinson et al., 1981; Hutchinson, 1984; Miller, 1986; CH2M Hill, 1988; Dames and Moore, 1988; Scott, 1988 (SWFWMD, 1996), and Williams and Kuniansky, 2016, among others.

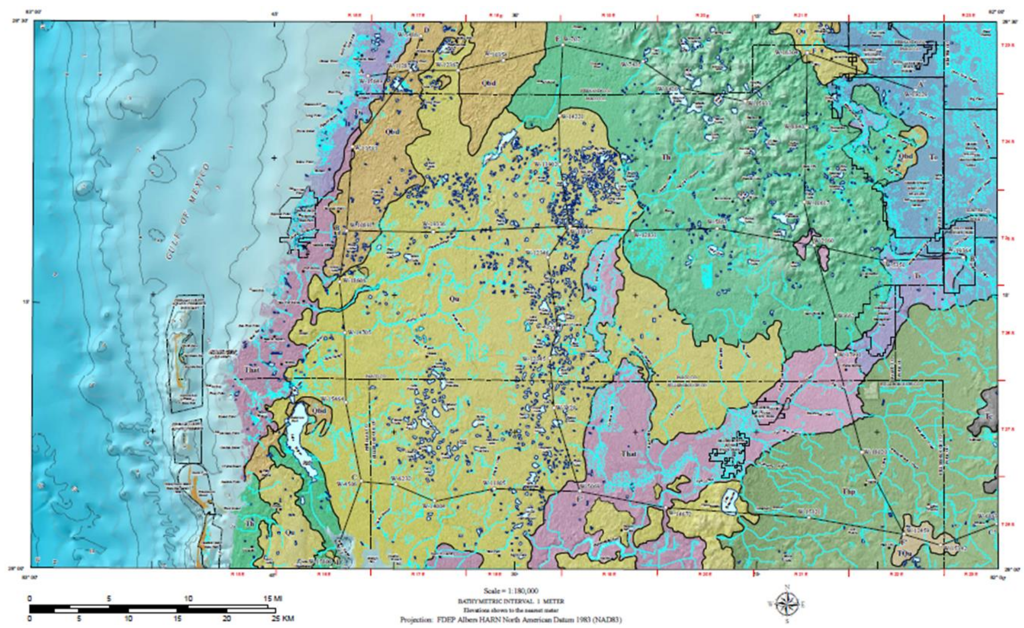

Figure 2.1: Map of Cross-section Transects in Northern Tampa Bay. Source: FDEP/FGS.

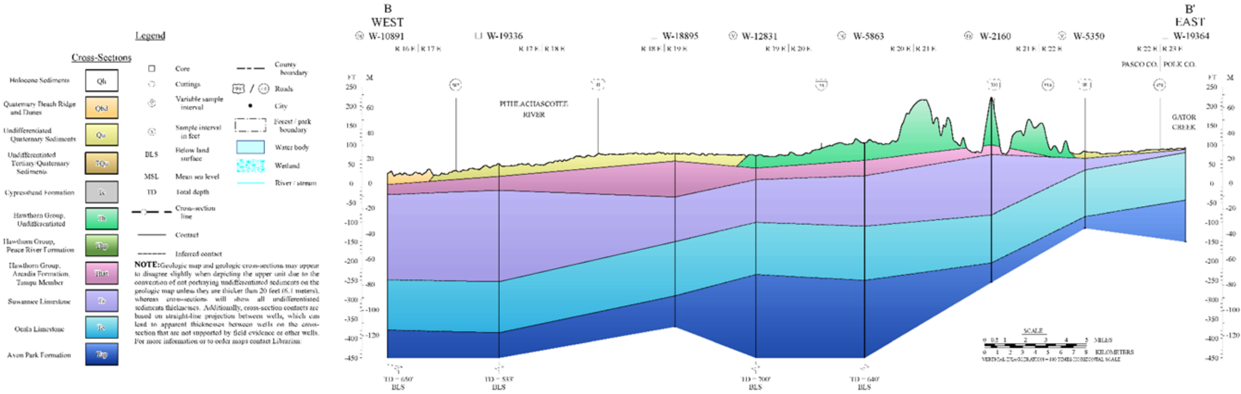

Figure 2.2: Cross-Section of Geologic Units Across Pasco County Along Transect B-B'. Source: FDEP/FGS.

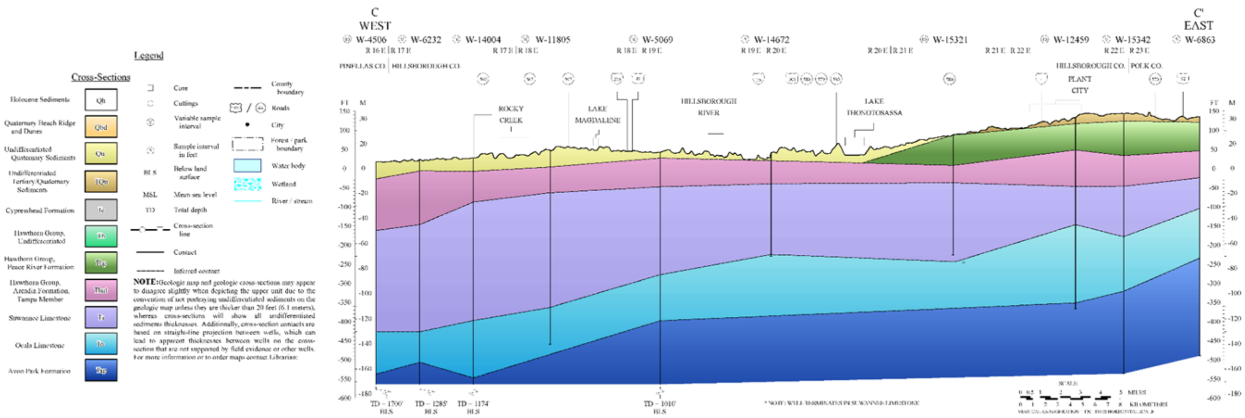

Figure 2.3: Cross-Section of Geologic Units Across Northern Hillsborough County Along Transect C-C'. Source: FDEP/FGS

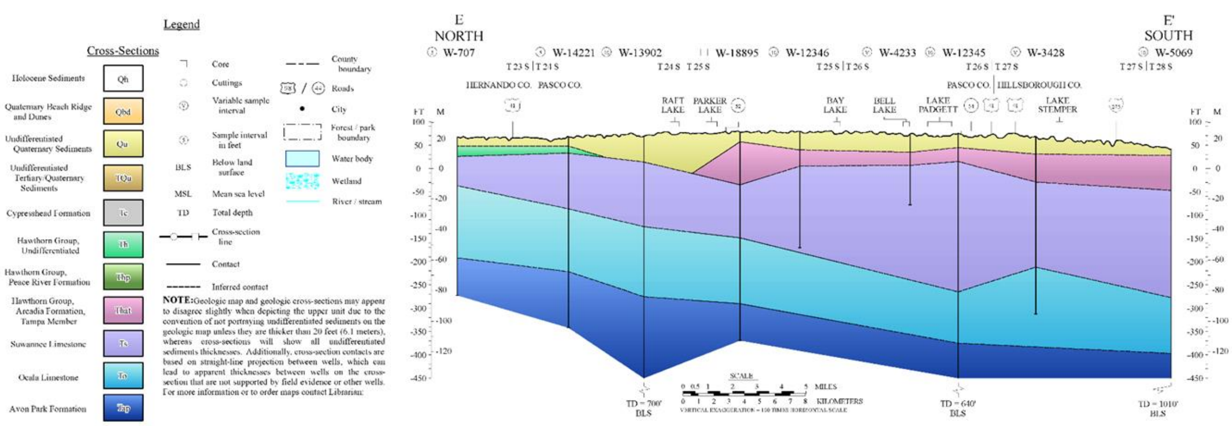

Figure 2.4: Cross-Section of Geologic Units Through Pasco and Hillsborough Counties Along Transect E-E'. Source: FDEP/FGS.

2.2 Hydrogeology - Regional

In his 1986 report, Miller characterized the Floridan Aquifer System as,

"a vertically continuous sequence of carbonate rocks of generally high permeability that are mostly of middle and later tertiary age and hydraulically connected in varying degrees, and whose permeability is, in general, an order to several orders of magnitude greater than that of those rocks that bound the system above and below (Fretwell, 1988)."

As discussed in the previous section, many of the rock units which make up present-day Florida are carbonates, and many characteristics of carbonate rocks allow them to move and store water (SWFWMD, 1996). Carbonate rocks are susceptible to dissolution and erosion from wave action and sea water chemistry, as sea levels rise and fall, and to wind and rain when exposed to the atmosphere. Fractures and faults have been observed in Florida carbonate rocks, and unconformities between bedding planes can act as conduits for preferential flow. Highly fossiliferous beds can often contain larger pore spaces than a homogeneous fine-grained limestone. The presence of pore spaces may indicate the ability to hold water; however, it does not always mean that water can easily move through the carbonate layer. Pore spaces and paths for preferential flow through rock can lead to increased connectivity and the development of karst features, often present as sink features or the elaborate cave systems for which Florida is known. Large karst features at depth allow for movement and storage of large volumes of water where present and connected. The hundreds of feet of rock naturally filter out many water quality constituents in the rain and surface waters that percolate downward, making the beds with low salinity very useful sources of drinking water, in what is called an aquifer (Bates and Jackson, 1987, as cited in Scott, 1992).

There are several aquifers present in the Northern Tampa Bay Area. The Floridan Aquifer System is by far the most productive. It is split into the Upper and Lower Floridan Aquifers by a middle confining unit which reduces vertical transmissivity or flow (Fretwell, 1988). The Lower Floridan Aquifer System (LFAS) is typically saline and is not used as a source of drinking water in the Tampa Bay Area (Arthur et al., 2008). The Upper Floridan Aquifer System (UFAS) is used as a drinking water source. Above the UFAS lies an Intermediate Confining Unit (ICU) which typically contains abundant clays which serve to prevent or slow flow from the surficial sands to the Floridan Aquifer rock layers. This unit does not exist in entirety over the Northern Tampa Bay Area, as evidenced by numerous sinkholes which are often direct connections between the surficial and Floridan aquifers. In some areas in the state, the ICU can be quite thick and can be a source of water known as the Intermediate Aquifer System (IAS) (Arthur et al., 2008). Above the ICU/IAS lies the Surficial Aquifer System (SAS). Where present, this layer is closest to the surface and is comprised of the quaternary sands with some clays. It receives water directly from rain and overland flow, and the water in the SAS flows downward through the ICU to recharge the UFAS. While the SAS contains water, it is not useful for large-scale water production (SWFWMD, 1996). Water in this aquifer can often be used for individual private wells for drinking water and irrigation (SWFWMD, 1996): however, it is often subject to water quality concerns given the lack of filtration and can often go dry during periods of drought. The SAS can act as a recharge system for the UFAS (SWFWMD, 1996 and Arthur et al., 2008).

2.2.1 Floridan Aquifer System

The LFAS is comprised of the Cedar Keys Formation, the Oldsmar Formation and the lower Avon Park Formation. The Cedar Keys formation contains beds of the evaporite minerals gypsum and anhydrite which designate the base of the aquifer system (Scott, 1992 and Arthur et al., 2008). The LFAS is enriched in calcium and sulfate from these dissolved minerals (Tihansky, 2005).

The base of the UFAS begins in the Avon Park Formation. Within the Avon Park Formation are interbedded layers of gypsum and anhydrite minerals, which also fill the pore spaces in the surrounding limestone and dolostone layers (Scott, 1992; Arthur et al., 2008; Hutchinson, 1985; Ryder, 1981, 1985, Miller, 1986, SWFWMD, 1996a, b, 2001 as cited in Tihansky, 2005). Gypsum and anhydrite are evaporite minerals, which were likely deposited in a tidal flat or subaerial environment or precipitated out of solution as a result of overlying seawater being trapped in a closed basin. These rock units, known as the Middle Confining Unit or MCU, keep the more saline waters of the LFAS at depth (SWFWMD, 1996 and Arthur et al., 2008).

Many studies consider the extent of the UFAS in northern Tampa Bay to include the Avon Park Formation, the Ocala Limestone, the Suwannee Limestone, and the Tampa Member of the Arcadia Formation (Fretwell, 1988; Tihansky, 2005; Scott, 1992; and Arthur et al., 2008). In mapping the upper geologic unit of the Floridan Aquifer System, Miller (1986) characterized northern Hillsborough County and most of southern Pasco County to include the Tampa Member of the Hawthorn Group, and the remainder of Pasco County to include up through the Suwannee Limestone.

The Avon Park Formation above the MCU is a very productive section of the UFAS. This part of the formation is highly dolomitized, which is characteristically very fractured (Ryder and Mills, 1978; Ryder, 1985; CH2M Hill, 1990a and 1990b; and HydroGeologic Inc., 1992, as cited in Tihansky, 2005) which increases secondary porosity and the flow of water (SWFWMD, 1996).

The Ocala Limestone, as a unit, tends to be less permeable than the Avon Park Formation below or the Suwannee Limestone above which is why some studies characterize it as more of a confining layer (SWFWMD, 1996 and Tihansky, 2005). Other reports acknowledge that the Ocala Limestone does not have many of the features that are characteristic of a more indurated dolomite, or weathered beds, and relies on primary porosity as the mechanism to move and store water. It is more fine-grained and fossiliferous (Loizeaux, 1995, as cited in Tihansky, 2005). Where local fractures through the Ocala Limestone extend into the layers above or below, there is increased permeability and the concept of a confining layer no longer applies (SWFWMD, 1996). The Ocala Limestone is considered a fairly pure limestone, with vugs. If the Ocala Limestone has become dolomitized near the contact with the Avon Park Formation, it may be considered the Ocala Limestone/Avon Park Formation producing zone (Tihansky, 2005). This could be relevant if fractures which have increased secondary porosity of the Avon Park Formation continue up into the base of the Ocala Limestone (SWFWMD, 1996; Gee and Jenson, Inc., 1981a, as cited in Tihansky, 2005).

Another major water producing zone exists in the Suwannee Limestone/Tampa Member. The Suwannee Limestone, as stated previously, is a fine-grained fairly pure carbonate which was deposited in warm shallow waters (Scott, 1992 and Arthur et al., 2008). However, during the time these sediments were deposited, sea levels cycled up and down leading to periods of exposure to the atmosphere. This repeated exposure caused dissolution and erosion including karst features, creating the unconformity between the

Suwannee Limestone and the Tampa Member of the Arcadia Formation. The karst features have increased the secondary porosity of this unit, resulting in the Suwannee Limestone developing into a major water producing zone (Hammes, 1992, as cited in Tihansky, 2005).

The Tampa Member of the Arcadia Formation makes up the bottom layer of the Hawthorn Group sediments and is considered the final unit of the UFAS (Scott, 1992; Hutchinson, 1985, and Arthur et al., 2008). The top of the UFAS is often defined as the uppermost consolidated carbonate section (Southeastern Geological Society, 1986, as cited in Arthur et al., 2008). The Hawthorn Group sediments were deposited during the Miocene through early Pliocene (Scott, 1992 and Scott, 1988, Covington 1993 and Missimer et al., 1994, as cited in Arthur et al., 2008). The Tampa Member is a limestone, and while carbonate deposition was still occurring from the Miocene through present, there is increased influence of siliciclastic sediments in the stratigraphic record at this time (Scott, 1992 and Fretwell, 1988). In addition to the increased siliciclastic sediments, the Hawthorn Group sediments are also characterized by the presence of chert and phosphate. (Scott, 1992). The remainder of the Hawthorn Group sediments, which contain increased silicates and clays, form the ICU, where present (Fretwell, 1988).

2.2.2 Intermediate Confining Unit (ICU)

In the northern Tampa Bay area, the upper Hawthorn Group/Arcadia Formation sediments, and in some areas post-Hawthorn Group sediments, are classified as the ICU (Arthur et al., 2008). These layers above and sometimes including part of the Tampa Member have a higher clay content than the layers above (SAS) and below (UFAS) them which effectively restricts the flow of water between the two sections (SWFWMD, 1996 and Tihansky, 2005). The ICU thins out towards the north and is not present in the northern third of the Cross Bar Ranch Wellfield (Scott, 1992 and SWFWMD, 1996). In southern Hillsborough county, the Hawthorn Group sediments are sufficiently thick and since they are composed of fine-grained sediments with small pore spaces, can hold enough water that it is known as the IAS (Scott, 1992). In the northern portion of the Cross Bar Ranch Wellfield, the lack of a confining unit means there is a direct connection between the SAS and UFAS, such that all consolidated and unconsolidated units behave as one aquifer (Scott, 1992 and SWFWMD, 1996). Where fractures or dissolution have eroded away the Hawthorn Group sediments in other areas of Tampa Bay, there can be a local connection between the two aquifers (Scott, 1992, SWFWMD, 1996, and Sinclair and others, 1985, Green and others, 1995 and Diodato, 1999, as cited in Tihansky, 2005).

2.2.3 Surficial Aquifer System (SAS)

The SAS is an unconfined aquifer composed of unconsolidated sediments (Scott, 1992) from the Late Pliocene through the Holocene, from approximately 3.6 MYA through present day (Arthur et al., 2008). These unconsolidated sands are largely siliciclastic (Scott, 1992 and Fretwell, 1988) with clays and phosphates (SWFWMD, 1996 and Arthur et al., 2008). The SAS has an average thickness of about 30 feet (SWFWMD, 1996 and Arthur et al., 2008) and is approximately 35 feet thick at the Cross Bar Ranch Wellfield (Hutchinson, 1985). In total thickness, it can vary from around 25 feet thick to 200 feet or more along platforms and ridges (Scott, 1992). These sediments are found above the undifferentiated clay-rich sediments of the Hawthorn Group, which make up the ICU in the northern Tampa Bay area (SWFWMD, 1996 and Scott, 1992). Where the Hawthorn Group is not locally present, there can be a direct connection between the SAS and the UFAS.

There are many sources of information regarding the Floridan Aquifer System. The SWFWMD 1996 Northern Tampa Bay WRAP report identifies several additional references , but are not limited to the following: Cherry et al., 1970, CH2M Hill, 1988, Dames and Moore, 1988, Geraghty and Miller, 1976, Heath and Smith, 1954 Hutchinson et al., 1981, Hutchinson, 1984, Mann, 1972, Menke and others, 1964, Miller, 1986, Sinclair, 1974, Steward, 1968, Swancar and Hutchinson, 1992, and Wetterhall, 1964. Additional sources include USGS publications: Ryder, 1985; Wolansky and Corral, 1985; Metz 1995; Yobbi, 1996; Knochenmus, 2006, and SWFWMD hydrogeological studies including Barcelo and Basso, 1993; Hancock and Basso, 1993; Basso 2002, Basso 2003, Arthur et al., 2008, and Geurink and Basso, 2013.

2.3 Cross Bar Ranch/Northern Pasco County

The Cross Bar Ranch Wellfield is located in north-central Pasco County, situated between US 41 to the west and Interstate 75 to the east. This area has been the subject of several studies because of the complex geology which exists here. The Cross Bar Ranch Wellfield encompasses two different physiographic units according to White (1970): 1) The Gulf Coastal Lowlands and 2) The Brooksville Ridge Province. The Gulf Coastal Lowlands Province covers the northern area of the wellfield. It contains karst and dune features and pastureland with scrub oaks; however, it does not contain many wetlands. The southern portion of the wellfield is in the Brooksville Ridge Province, which is characterized as a karst upland. Sinkholes in this area can be deep, and lakes and wetlands are also found in this area (White, 1970 and Gilboy and Moore, 1982, as cited in ERM-South Inc., 1995). Groundwater generally flows from a potentiometric high called the “Pasco High” in Eastern Pasco County (Hutchinson, 1985), north and west across the wellfield and into the Pithlachascotee River system (ERM-South Inc., 1995).

Several studies identify marine terraces throughout the wellfield area, which mark the edges of ancient shorelines and various sea levels. They are called the Talbot Terrace, the Penholoway Terrace and the Wicomico Terrace, located between 25 to 42 feet above sea level, 42 to 70 feet above sea level, and 70 to 100 feet above sea level, respectively (Cooke, 1945, as cited in ERM-South Inc., 1995). Each of these was formed during a regression of sea level, or a period when sea levels were decreasing. Situated approximately at the 70-foot contour, the boundary between the Penholoway and Wicomico Terraces is considered a hydrologic anomaly (Cooke, 1945, Gilboy and Moore, 1982, and Hutchinson, 1985, as cited in ERM-South Inc., 1995).

As was stated in the previous sections, the competent rock layers located at the Cross Bar Ranch Wellfield are a series of limestone and dolomite units formed in the warm, shallow waters of the Florida Platform (ERM-South Inc., 1995; Scott, 1992; SWFWMD, 1996 and Arthur et al., 2008) The lowest unit which makes up the bottom of the UFAS is the Avon Park Formation. This unit is highly fossiliferous and contains both limestone and dolostone. The limestone is white, chalky, and friable, while the dolostone section is darker in color and much more crystalline (ERM-South Inc., 1995). Fractures in the dolostone provide the increased transmissivity in this section of the aquifer (Williams, 1985, as cited in ERM-South Inc., 1995). Above the Avon Park lies the Ocala Limestone. The bottom section contains more dolomite and is sometimes considered a part of the major transmissive zone of the UFAS. It is harder than the limestone units, can be cream to gray in color, and is highly fossiliferous. The upper portion of the Ocala Limestone is soft and white to tan in color. This section is considered a bioclastic limestone and contains foraminifera in a calcareous matrix (ERM-South Inc., 1995). The limestone matrix decreases the permeability compared to the lower Ocala, the Suwannee Limestone above, and the Avon Park Formation, below. Locally, sinks and fractures can result in increased flow through this section; however regionally, this portion of the Ocala is often considered a confining zone (ERM-South Inc., 1995).

Above the Ocala is the Suwannee Limestone. It is highly fossiliferous and cream to tan in color. The uppermost of the competent rock units is the Hawthorn Group, which in this area contains the Tampa Member of the Arcadia Formation. Units in the Hawthorn Group contain carbonates, phosphates, siliciclastic sediments, and fine-grained clays. The Tampa Member is found to vary in color from white to gray and may be fossiliferous. Above the Tampa Member at the Cross Bar Ranch Wellfield lie unconsolidated sediments which contain sand and clays (Gilboy and Moore, 1982, as cited in ERM-South Inc., 1995). These sediments are believed to be eroded from the upper layers of the Hawthorn Group (Williams, 1985, as cited in ERM-South Inc., 1995). Near the Cross Bar Ranch Wellfield, the Tampa Member marks the upper extent of the UFAS.

The surficial aquifer (SAS) is composed of unconsolidated sediments above the competent rock which constitutes the UFAS, except for the clay layer of the Intermediate Confining Unit, which effectively separates the two aquifers, where present. The SAS is present in the southern and central wellfield areas (Hutchinson, 1985 and ERM-South Inc., 1995). The SAS is not present in the north as there is no confinement separating the surficial sands from the lithified strata. Fractures and karst features including sinkholes provide a conduit to the underlying UFAS (ERM-South Inc., 1995). Core samples in the southern wellfield area suggest that the SAS is between 5 and 30 feet deep (Leggette, Brashears and Graham, Inc., 1979, as cited in ERM-South Inc., 1995). The variation in thickness is explained by the fact that erosion of the carbonate rock was occurring with changes in sea level, creating karst features. At the time of erosion and deposition of Hawthorn Group sediments, if these features were present, they would have been filled in (ERM-South Inc., 1995). While not considered a separate aquifer, the unconsolidated sediments in the northern wellfield area appear to vary in thickness from about 5 feet to about 40 feet (Leggette, Brashears and Graham, Inc., 1979, as cited in ERM-South Inc., 1995).

As stated previously, the geology of the Cross Bar Ranch Wellfield is very complex in that there exists a hydrologic anomaly within the wellfield (Figure 2.5). The anomaly is a marker for several interesting transitions. For one, it marks a change in the gradient of the potentiometric surface in the UFAS. Monitor wells have shown the potentiometric surface of the UFAS to be higher to the south of the anomaly than to the north (Hutchinson, 1985). Also, pumping of production wells on one side of the anomaly has been shown to have little to no effect on water levels in monitor wells on the other side (Hutchinson, 1985). The clay layer in the Hawthorn Group which separates the SAS and the UFAS pinches out or is eroded away at the anomaly and north.

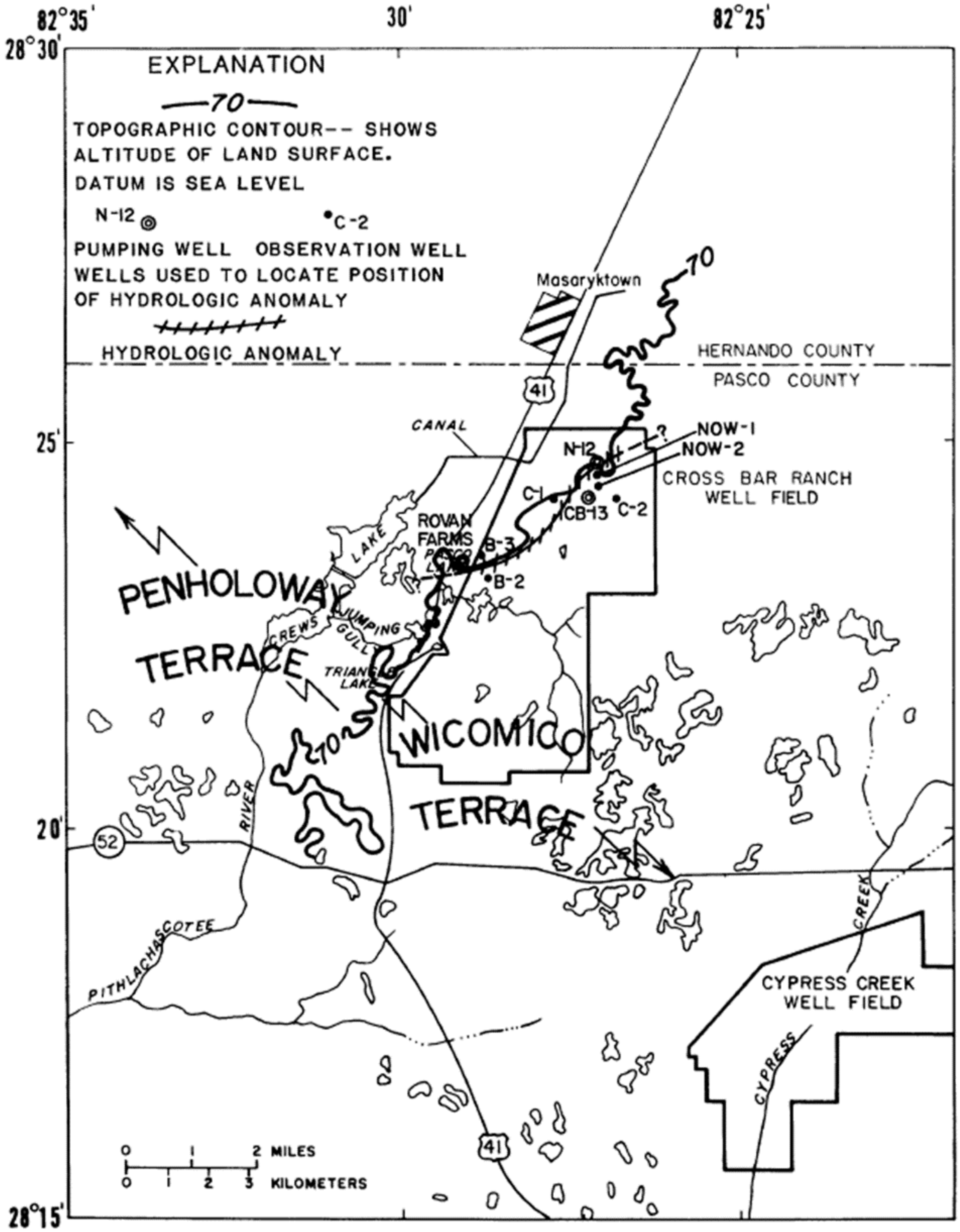

Figure 2.5: Approximate Location of the Hydrologic Anomaly at the Cross Bar Ranch Wellfield (Hutchinson, 1985)

Additionally, studies of the depth to competent rock have also found on average a difference of 60 feet between the land south and north of the anomaly (Leggette, Brashears and Graham, Inc., 1979, as cited in ERM-South Inc., 1995). This may be the result of a historical buildup of water near the anomaly, increasing the recharge to the UFAS and dissolving some of the limestone rock as well (Upchurch and Lawrence, 1984, as cited in ERM-South Inc., 1995). Two monitoring wells, CBR-NOW-1 and CBR-NOW-2 both have cavities between the surficial sands and the limestone, and they are in the approximate location of the anomaly (ERM-South Inc., 1995). Crews Lake, which is located to the west of the wellfield, has several sinkholes within it which are also thought to be evidence of this anomaly.

One explanation for these findings stems from the fact that the location of the anomaly corresponds to a change from the Penholoway to the Wicomico terrace. Within the Penholoway terrace, north of the anomaly, dunes and karst features present are indicative of proximity to the coastline, and the presence of clays on the other side of the anomaly indicates a marine depositional environment (ERM-South Inc., 1995). The terrace suggests a change in sea level which was fairly consistent for a period of time such that the dunes to the north could develop and marine sediments could be deposited (ERM-South Inc., 1995).

Another hypothesis for the features which exist here is the presence of a fault (Hutchinson, 1985). A fault could be responsible for displacing beds, explaining the disappearance of the clay layer between sides. Faulting often results in a zone of brecciated or granulated rock, which could increase the transmissivity within that zone (Moore and Stewart, 1983, cited in Hutchinson, 1985). There also could be increased siliciclastic sediments which would also affect the transmissivity within this area (ERM-South Inc., 1995). A fault or a change in sea level could have created a karst escarpment, which
Photolineaments are common in the area of the Cross Bar Ranch Wellfield and can be explained by a fault or karst escarpment. Photolineaments are considered a karst feature, and they can have a direct relationship to rock, soil, vegetation, streamflow, fractures, faults, and sink features (ERM-South Inc., 1995). A report by Miller (1977, as cited in ERM-South Inc., 1995) noted that the wellfield area north of the hydrologic anomaly did not have "readily recognizable sinkholes which could be attributed to any photolinear features." The opposite was found true of the wellfield south of the anomaly, where sinkholes and streams could be attributed to photolineaments. In this case, the presence of a water table close to the surface was helpful in detecting deep water-filled sinks (ERM-South Inc., 1995). In 1985, Williams studied photolineaments at the Cross Bar Ranch Wellfield, finding trends in these features to the northwest/southeast, which coincides with fracture traces found by Miller (ERM-South Inc., 1995). Miller also found fractures trending perpendicular at northeast/southwest, and both sets ranged in length from less than 1 km to about 5 km in length. According to Miller, one fracture did match the approximate location of the anomaly. Williams also found fractures south of the hydrologic anomaly which matched the orientation of fractures that Miller found north of the anomaly (ERM-South Inc., 1995).
Overall, the fact that wells on either side of this area do not show much of an effect of pumping from the other side of the anomaly would suggest that it represents a low permeability zone. ERM-South Inc.'s Cross Bar Ranch Wellfield Water Resource Evaluation Report also offered an explanation how the transmissivity or permeability can change spatially. With a fault zone, different-sized pieces of rock filling in the fault would both increase (larger rock pieces) and decrease (smaller grains/gravel) the transmissivity within this area. Additionally, a wider fault zone could effectively hinder horizontal water flow, leading to increased recharge and dissolution features. A narrower feature may not yield as much vertical movement as more water could likely move horizontally through the rock units. The

width of this fault zone is unknown and may fluctuate throughout its extent, including in the Cross Bar Ranch Wellfield.

The absence of a confining, clay-rich layer, north of the anomaly zone also increases the permeability of the rock units down to the UFAS. This is evident in the flashier nature of the potentiometric surface north of the anomaly area with rainfall or groundwater pumping. Water in this area is not capable of being stored in an SAS prior to filtering down to the UFAS, and for this reason there are very few wetlands present compared to the rest of the wellfield.

2.4 Section 21 Wellfield/Northern Hillsborough County

The Section 21 Wellfield is located in northern Hillsborough County, and began production in 1963. By May of the following year, the wellfield was averaging approximately 14 mgd and 64 sinkholes were reported within one mile of the wellfield (Frank Crum, personal comm. as cited in Sinclair, 1982). Several sinks were reported near production well 10 (Sinclair, 1982) which was pumped nearly double that of the other Section 21 production wells at the time. According to Sinclair (1982), the clay layer between the surficial and Floridan aquifers has been shown to be fairly sporadic throughout the southeastern portion of the wellfield, which could explain the formation of sinkholes in that area. Of the reported sinkholes, a three–year study following their formation only found two which had any further subsidence (Sinclair, 1982), while the wellfield remained operational. Cutbacks in wellfield pumping began in October 2005, and the 12-month running average pumping dropped to below 6 mgd for the wellfield.

In 2015 a “drop out” occurred in Lake Park on the Section 21 Wellfield. The cause was characterized to be due to sinkhole formation processes (Ardaman and Associates, 2015). The previous 12-month running average pumping rate for the wellfield was 3 million gallons per day, and no wells on the wellfield itself were pumped in the three months prior. Except for four days, the wellfield remained inactive from November 2015 through October 2016. Since that time, there have been no additional sinkholes reported to Tampa Bay Water, nor were there any in at least the decade prior.

2.5 Regional Ecological Features

The southwest Florida region is ecologically diverse, with a large variety of habitat types ranging from estuarine marshes and barrier beaches to hardwood cypress swamps and pine flatwoods. Coastal features known as estuaries are unique interfaces where freshwater and saltwater mix. The largest estuary in the region is Tampa Bay, a 400 square mile area where freshwater from the Hillsborough River, Sweetwater Creek, Rocky/Brush Creek, and the lake Tarpon Outfall Canal meet the Gulf of Mexico. Other sizable estuaries in the region include the Anclote River, Pithlachascotee River, and Weeki Wachee River (SWFWMD, 1996a). Hardwood cypress swamps, forested flow-through systems, cypress domes, and marshes form a mosaic of wetlands throughout the southwest Florida landscape providing critical habitat for wetland-dependent plants and animals.

2.5.1 Wetland Functions and Value

Wetlands are considered some of the most ecologically valuable ecosystems on Earth and occupy 7-9 million km^2 of the planet. They serve as critical habitat to many threatened and endangered species, support rich food webs, rich biodiversity, and transform chemical, biologic, and genetic material.

Wetlands provide storm and flooding protection as well. They store surface water, helping to ameliorate impacts of flooding and drought. They protect coastlines by reducing storm surge energy and dissipating flooding. Wetlands also serve the environment by acting as “the kidneys of the landscape,” cleaning received waters of pollutants and performing chemical transformations critical in the cycling of important nutrients (Mitsch & Gosselink, 2000).

The freshwater wetlands of central Florida vary in depth between a few inches to several feet. The depth of an individual wetland combined with geological characteristics and weather and climate patterns affect the hydroperiod of individual wetlands. Hydroperiod refers to the amount of time that a wetland contains surface water during a defined period of time, usually measured on a seasonal or annual basis. Seasonal rain patterns bring heavy rainfall to the region between June and September, a period known as the rainy season. Isolated wetlands are most densely vegetated during this period from summer to early fall (Haag and Lee, 2010).

Lower rainfall between October and May means that wetland water levels decrease, and wetland vegetation dies back. The rhythm of seasonal flooding and drying of central Florida’s isolated wetlands is critical for the life stages of many wildlife and plant species. Herpetofauna rely on wetland hydroperiods long enough to lay eggs, for the eggs to hatch, and for the larva to complete metamorphosis through the tadpole stage. The timing of inundation is important, as the seasonal requirements for reproduction of anurans (i.e. frogs and toads) vary (VHB, 2019). Flooded wetlands attract dragonflies and damselflies as they feed on mosquitoes and other flying insects. These species also require standing water for breeding and to complete their life cycle. Many shorebirds rely on central Florida wetlands for overwintering. Not only do wetlands provide important resources to many species of birds including food, nest-building materials, and shelter from weather and predation, but wetlands are also required breeding grounds for about 75 percent of all waterfowl (Haag and Lee, 2010).

2.5.2 West-Central Florida Wetland Types and Abundance

Ninety percent of Florida’s wetlands are freshwater wetlands, while the other 10 percent are coastal (Dahl, 2005). In 1996, 98 percent of these freshwater wetlands were vegetated, and the remaining 2 percent were open water (Dahl, 2005). Central Florida is distinct from the rest of the state; the majority of wetlands are small and numerous, widely distributed, and contribute to a mosaic of habitat types. In many cases, these isolated wetlands are flanked by uplands and often adjacent to residential and commercial development (Haag and Lee, 2010).

The majority of wetlands in central Florida are the Palustrine type, which are non-tidal wetlands that are dominated by trees, shrubs, persistent emergent plants, emergent mosses and lichens (Figure 2.6). Central Florida Palustrine wetlands may also be open-water and lack vegetation, but also must be less than about 20 acres with a water depth no greater than 6.6 ft. with a salinity less than 0.5 ppt. This classification includes hardwood swamps, cypress domes, hydric hammocks, and wet pine flatwoods (Haag and Lee, 2010).

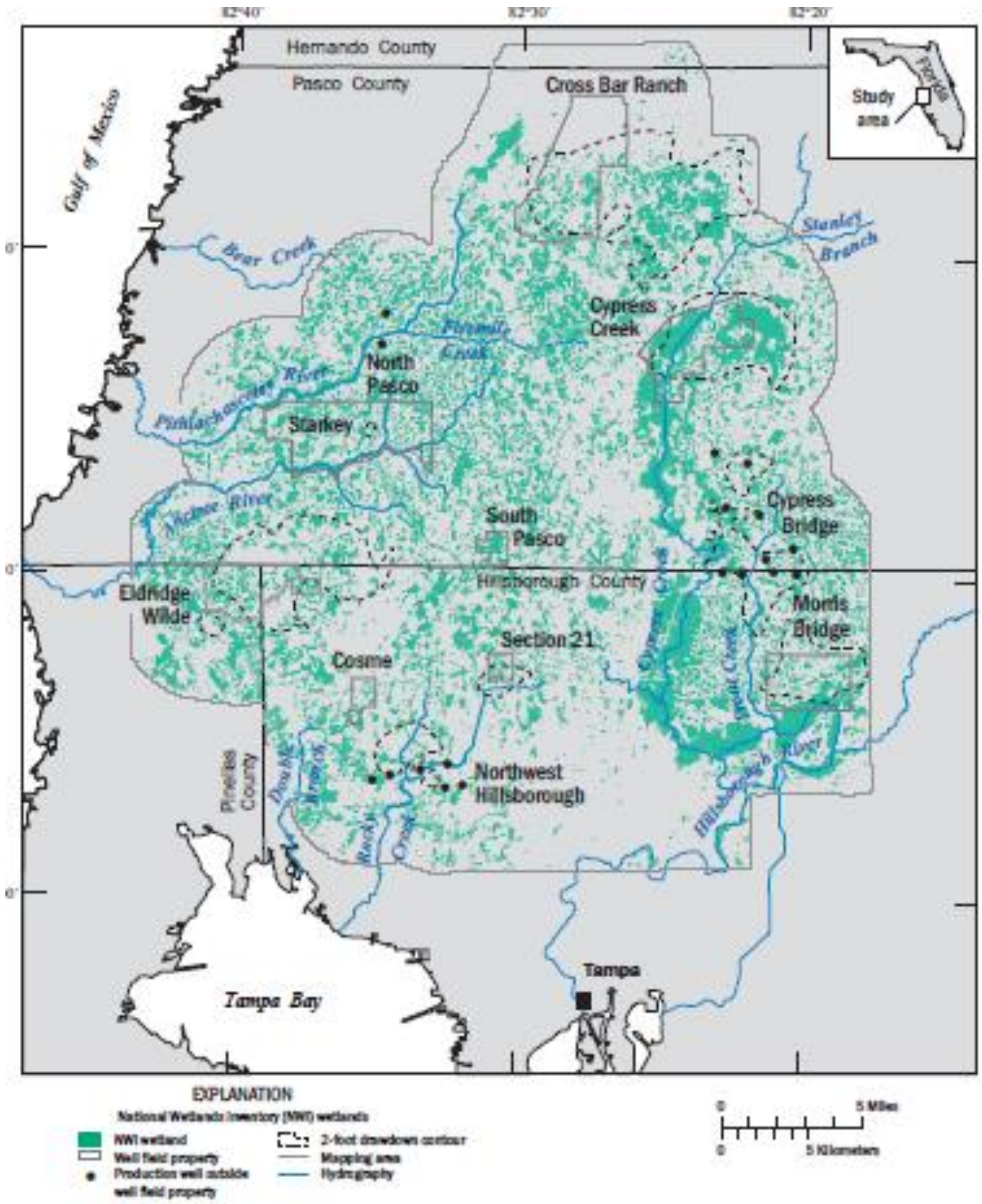

Figure 2.6: Distribution of Freshwater Palustrine Wetlands in the Northern Tampa Bay Area (from HSW 2018)

Other wetland types found in Central Florida are Lacustrine and Riverine Wetlands which are associated with deep water habitats. Lacustrine wetlands typically lack vegetation and are greater than 6.6 ft. deep. These wetlands are typically lake-fringing wetlands. Riverine System wetlands are channelized with periodically or continually moving water with a salinity less than 0.5 ppt. Floodplain wetlands are not part of this Riverine classification (Haag and Lee, 2010).

2.5.3 Historical Loss of Wetland Acreage

Until the mid-20th century, wetlands were routinely drained across the country to make land suitable for agriculture, dredged for navigation, and "maintained" for optimal conditions for fish or waterfowl populations (Mitsch & Gosselink, 2000). Between the 1780s and the 1980s, total wetland area was reduced from around 221 million acres to around 104 million acres in the conterminous United States, a 53% loss (Dahl, 1990). Wetland benefits such as values for flood control and water quality improvement were only recognized relatively recently. President Jimmy Carter issued two executive orders in May 1977 that adopted wetland protection as official federal policy: Executive Order 11900, Protection of Wetlands, and Executive Order 11988, Floodplain Management. Federal agencies such as the U.S. Environmental Protection Agency and the Soil Conservation Service established wetland protection policies soon thereafter. Although laws protect and preserve precious wetlands, coastal wetland loss still occurs in areas such as Louisiana where coastal wetland subsidence and sea level rise outpace wetland growth through delta sediment deposition (Mitsch & Gosselink, 2000).

Florida wetlands were historically viewed as nuisance lands that were of no use or value, and obstacles to agriculture. These wet and mucky environments were seen as providing refuge for pests such as mosquitoes, snakes, and alligators that should be eliminated. The need for additional lands for citrus cultivation and cattle grazing that began in the late 1800s furthered the desire to convert wetlands to usable land. Urbanization of increasingly populated areas in the state has also had significant impacts on wetland coverages with approximately 72% of the net wetland loss in the state being attributed to the building of homes, resorts, golf courses, industry, and infrastructure. The overall impact has been a loss of approximately 46% of Florida's wetland coverage which has been reduced from about 20.3 million acres to about 11.0 million acres between about 1780 and the mid-1980s (Dahl, 1990).

2.5.4 Wetland Impacts and Changes

2.5.4.1 Land Management Activities

Historical land management activities such as diking, ditching, and draining wetlands for agricultural activities have had lasting impacts on wetlands in the central Florida region. When wetlands are drained, the abundance of oxygen availability results in increased decomposition rates and subsidence (lowering) of the wetland bottom. Often these are permanent structural changes that greatly diminish or eliminate wetland function completely. Other land management activities such as silviculture, logging, and livestock grazing disturbs wetland edges and interiors, making way for invasive and non-native plant and animals to establish and replace native species (Haag & Lee, 2010).

Groundwater production has also impacted the health and hydrology of wetlands in the region. The growing reliance on groundwater pumping from the Upper Floridan Aquifer as the primary drinking water source for west-central Florida residence increased dramatically between 1950 and 2000. High pumping rates lowered the potentiometric surface of the Upper Floridan Aquifer, increasing the downward leakance of the overlying surficial aquifer system and contributing to depressed water tables. Wetland and lake hydrology were impacted by lowering water levels and shortening hydroperiods. As the regional water supply utility, Tampa Bay Water committed to reducing groundwater withdrawals beginning in 2002. The effect of these regional cutbacks has been a rebound in aquifer levels and the water table, as evident in the hydrologic recovery of wetlands and lakes in the region.

Modern land management of wetland systems and the surrounding areas has also evolved to benefit wetland health and native plants and animals. Prescribed fires are used to manage the accumulation of natural flammable material such as leaf litter, mimic natural fire patterns, and benefit fire-dependent plant species. Periodic fire is required to maintain the community type of some wetlands, such as marshes and cypress domes, by limiting shrub and hardwood invasion (Myers and Ewel, 1990). Herbicide spraying, chopping, and mowing are other methods used to control invasive plants such as melaleuca (*Melaleuca quinquenervia*), Brazilian pepper (*Schinus terebinthefolius*), and water-hyacinth (*Eichhornia crassipes*). Increased disturbance of wetland transition zones, elevated nutrient runoff and habitat fragmentation have also increased the need for active management of wetlands to preserve their health. This challenge has become increasingly complex as the central Florida human population continues to grow and residential and commercial development continues.

2.5.4.2 Wetland Fragmentation and Surface Water management Systems

Urbanization of west central Florida has had undeniable impacts on the health and structure of the regional ecology. Habitat fragmentation due to residential and commercial development, as well as the development of supporting infrastructure, has resulted in the dramatic decline of some wetland-dependent amphibian populations (Dodd and Smith, 2003). Reduction in permeable surfaces and redirection of flood waters to storm water ponds has altered hydrology of the region and reduced surface water and groundwater recharge of wetlands. These rapidly-urbanizing areas stand in stark contrast with many of the large wellfield areas that are maintained in a mostly-natural state. Wellfield properties are not only important for water supply, but also provide critical habitat and refuge for the region’s wildlife populations. These properties are maintained by the Southwest Florida Water Management District, local governments and Tampa Bay Water and include the Cypress Creek, Cross Bar Ranch, Morris Bridge, Starkey, Eldridge-Wilde, South Pasco, Section 21, and parts of the Cosme-Odessa Wellfield.

2.6 Land-Use and Land-Cover Change

Land-use and land-cover changes over time characterize modifications to the landscape which affect the quality and number of area wetlands and influence the interaction between the surface features and groundwater system as previously described. As land is converted from natural to urbanized land-uses, storm-water management systems are necessary to convey the additional run-off from rainfall away from the new structures to prevent flooding. In turn, this can reduce the amount of natural recharge of water to the groundwater system. Figure 2.7 shows approximate USGS land-use and land-cover data for the northern Tampa Bay area, encompassing the Consolidated Permit Wellfields. Data used in this map was collected between 1970 and 1983, with minor edits from the U.S. EPA and the USGS. The land-use from this time period is largely dominated by cropland and pasture, which is present on lands that in part, overlap at least six wellfield areas. Other wellfield areas are dominated by a combination of forested wetlands, herbaceous rangelands, and evergreen forested land. While the crop and pasture lands have been modified for human use, they are more natural land-uses and do not have the same degree of impacts to water resources as residential, commercial or industrial land-uses.

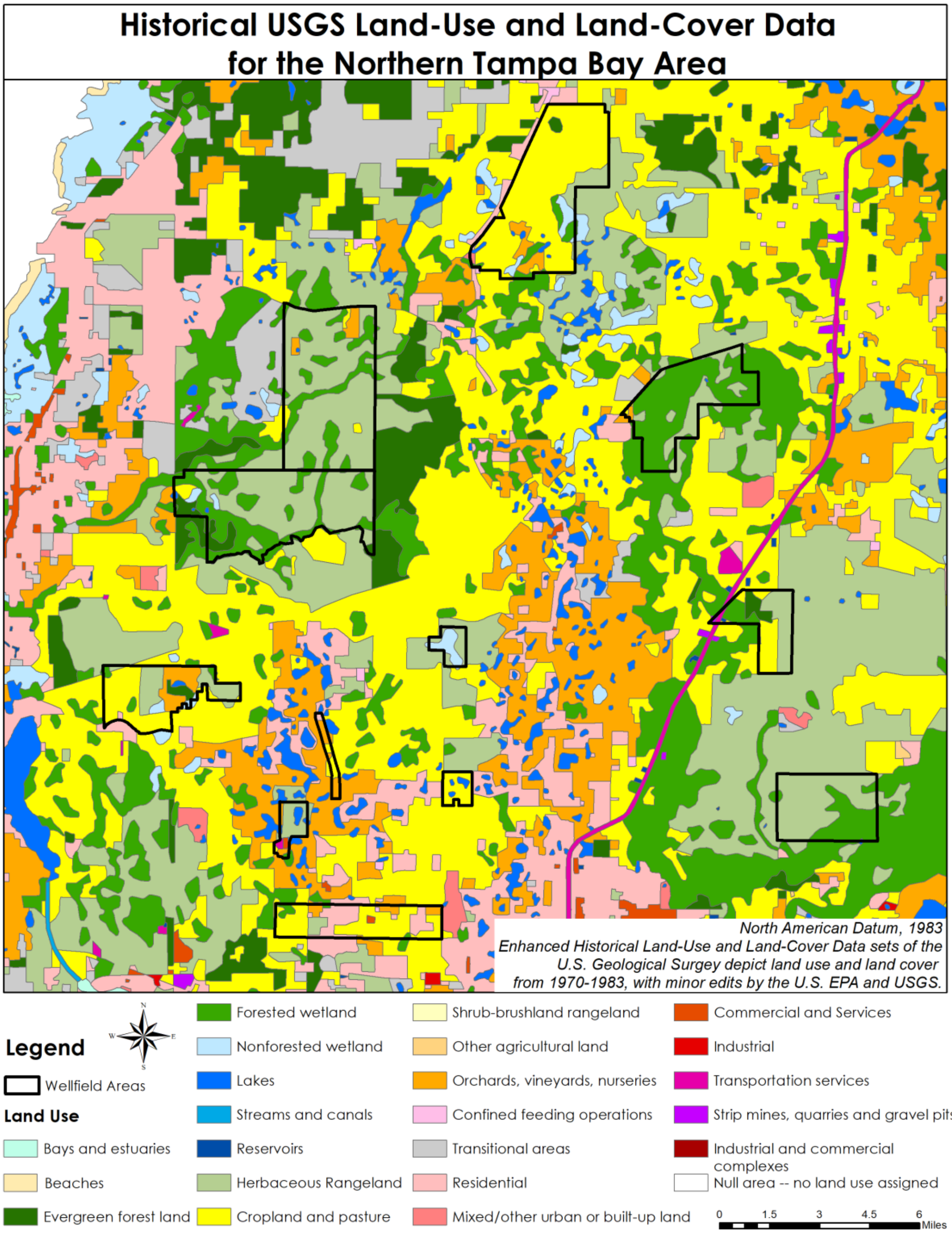

Figure 2.7: Historical USGS Land-Use and Land-Cover Data for the Northern Tampa Bay Area from 1970 – 1983.

Figure 2.8 shows an updated land-use and land-cover using 1990 data, obtained from the Southwest Florida Water Management District. While this map contains more land-use categories, comparisons can be made to the previous map. There are increases in urban and residential areas to the west, along the coast, and to the south, especially around the Northwest Hillsborough Regional Wellfield. More land-use distinctions were made from the previous dataset to specify wetlands and lakes, especially within areas largely defined as crop and pastureland and are most evident at the Eldridge-Wilde and Cross Bar Ranch wellfields. In the inter-wellfield areas, which were previously dominated by orchards and tree crops, there was increasing encroachment of urban and residential land-use. Wellfields including Starkey, North Pasco, Cypress Creek, South Pasco, Cross Bar Ranch, and Morris Bridge were still largely vegetated spaces; however, the increase in land-use categories have allowed for more specificity in the types of wetland and upland areas that each encompasses.

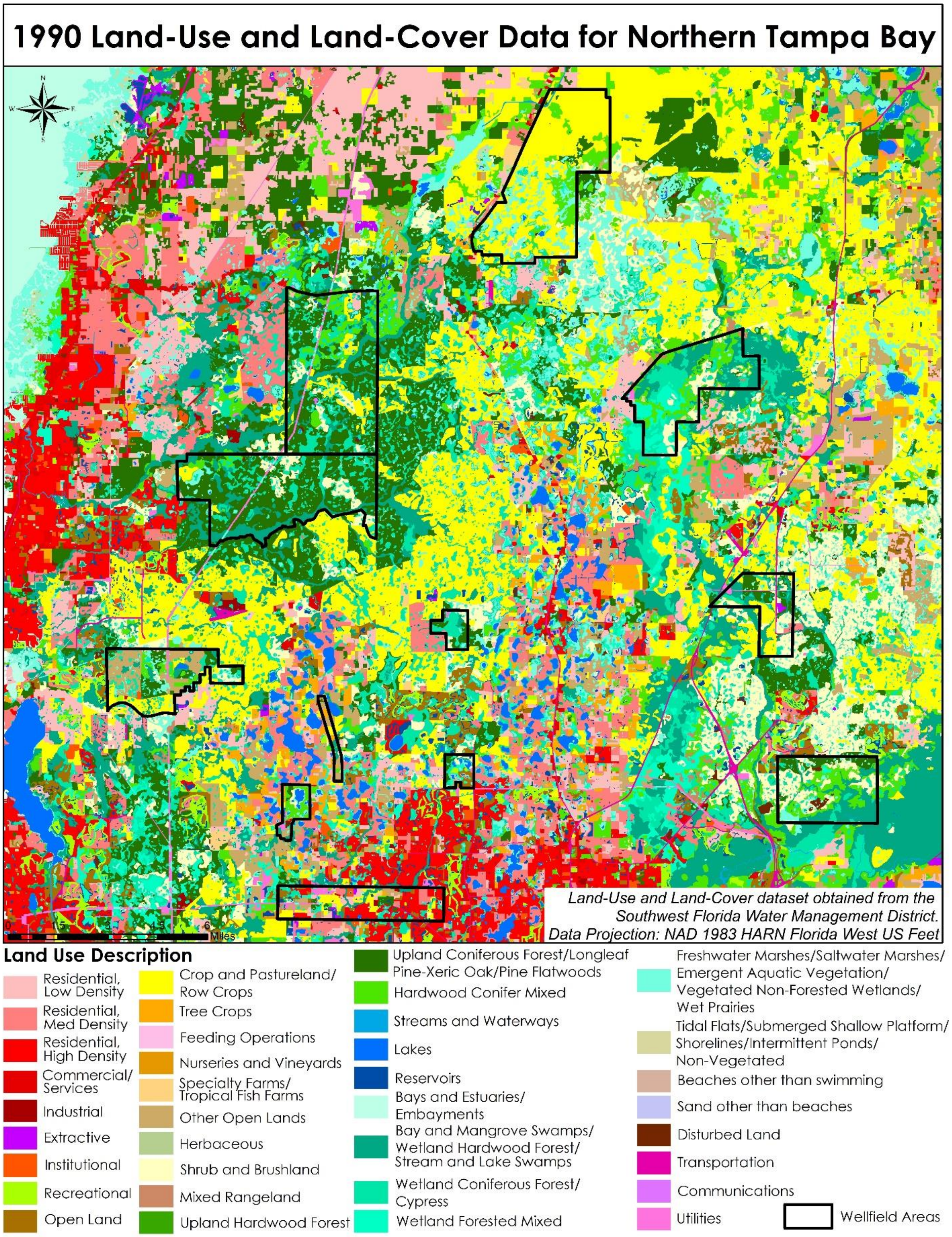

Figure 2.8: 1990 Land-Use and Land-Cover Data for the Northern Tampa Bay Area.

Figure 2.9 shows the 2017 land-use and land-cover data from the Southwest Florida Water Management District. The red colors on this map represent various levels of residential, commercial, and industrial spaces, which have largely encompassed the Cypress Bridge and Northwest Hillsborough Regional Wellfields and now surround much of the Section 21, Cosme-Odessa, Eldridge-Wilde and South Pasco Wellfields, the north side of the Morris Bridge Wellfield, and the southeast portion of the Cypress Creek Wellfield. The land-use transition from 1990 to 2017 is marked by decreases in land previously characterized as crop, pastureland, tree crops, and orchards, much of which has been replaced by high-density residential areas. Areas east of the Morris Bridge Wellfield which were previously categorized as wetland hardwood forest/stream and lake swamps, cypress and wetland coniferous forest, and mixed wetland forest in 1990 were largely reclassified as wetland hardwood forests and stream and lake swamps.

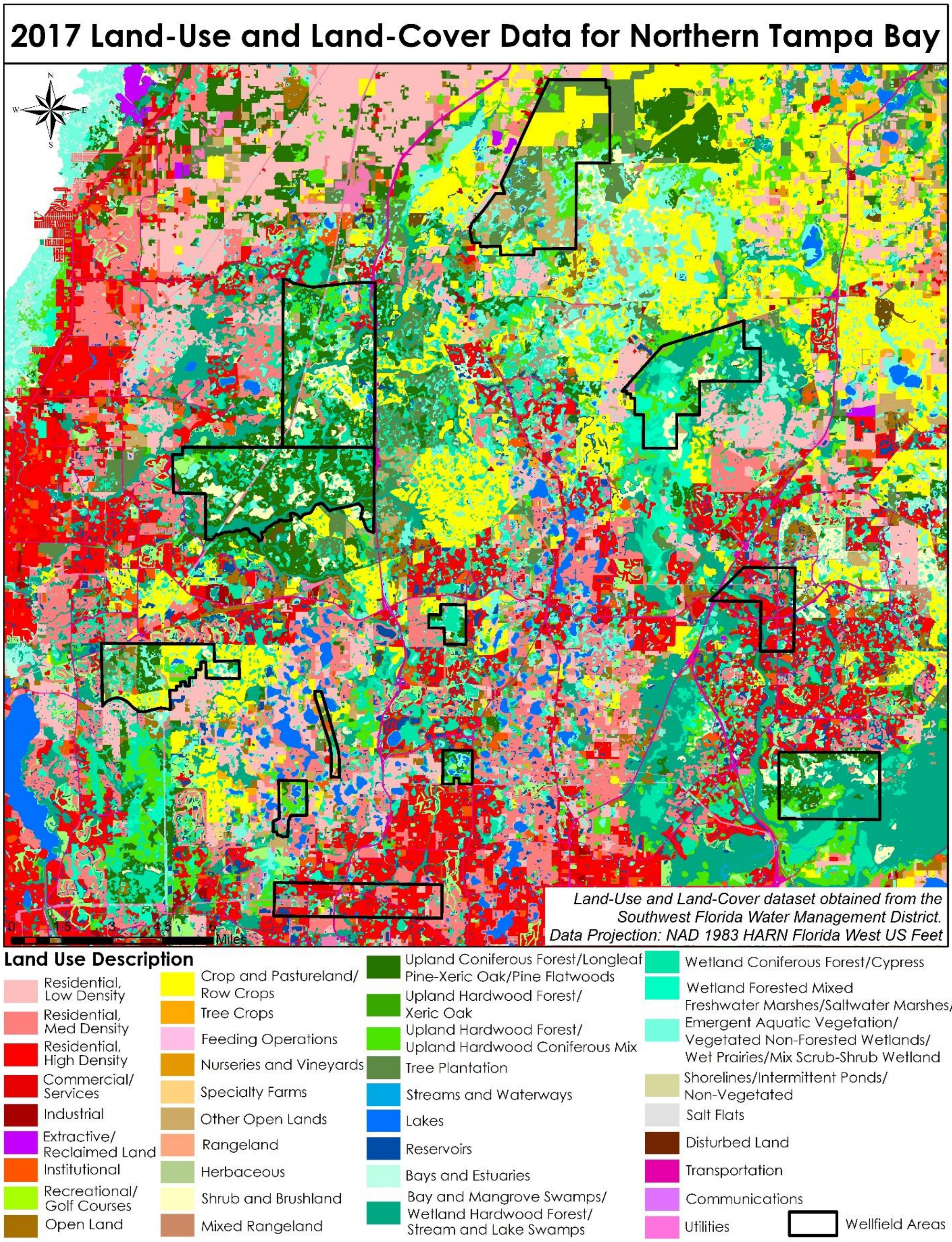

Figure 2.9: 2017 Land-Use and Land-Cover Data for the Northern Tampa Bay Area.

These changes can be quantified over the study area through time. Percentages of acreage were calculated for several key land-use categories across the spatial extent of the mapped area as displayed in Table 2.1 and Figure 2.10.

Table 2.1: Selected Land-use and Land-cover Changes Through Three Time Periods.

LULC Category	1970/ 1980	1990	2017
Residential	10.44%	17.97%	27.90%
Commercial and Industrial	1.21%	2.42%	4.16%
Crop and Pasture	27.94%	17.31%	11.06%

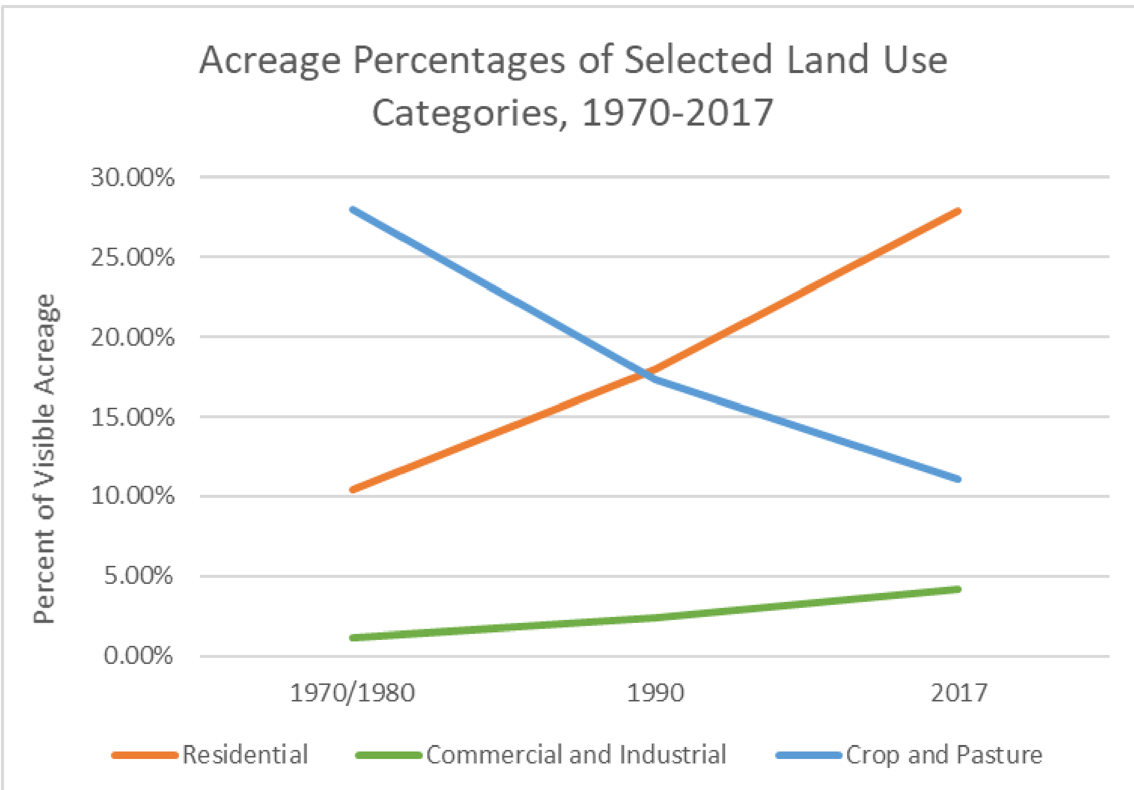

Figure 2.10: Graph of Percent Acreage Changes for Three Selected Land-Use/Land-Cover Categories in Three Time Periods

For the 1970/1980 data, the categories of Industrial and Commercial Complexes and Urban or built-up land were included in the summation of Commercial and Industrial land-use to avoid underestimating the acreage attributed to those classes for this time period. For the 1990 and 2017 data, the separate land-use category for Institutions was included in the summation of Commercial and Industrial land use. The change in percentage of the major land use classifications over time are informative. While there are many additional categories not accounted for in this summary table and graph, the data show that as land-use for crop and pastureland has decreased over time while both residential and commercial/industrial land-uses have increased.

As the geology of this region is important in characterizing the presence and movement of groundwater throughout this region, land-use and land-cover data provides a broader understanding of how the landscape has been altered to meet the needs of a rapidly-growing region. The population change data and historical aerial photographs contained in Chapter 3 further explain why and how the Tampa Bay area environment has changed.

3: Water Supply History of West Central Florida

3. Water Supply History of West Central Florida

The history of water supply in west-central Florida is a story of adaptive management. As people moved to the Tampa Bay area during the 1900's, each local government developed their own water supply and distribution systems to meet the potable water demand of their citizens. The initial water supplies soon encountered problems with water quality and local governments had to find replacement supplies. The demand for water increased with population growth, creating the need for more supply sources that, because of water quality issues, were located further and further away from the coastal population. Later in regional history, as ground water pumping from inland wellfields increased, there was public outcry about damage to local lakes and wetlands because of the reliance on groundwater. It seemed that each time a new water supply source was built, there were eventual problems that required changes as to how the water supply resources were managed. The Tampa Bay region had always found ways to satisfy the regional need for potable water, but eventually the region had to deal with the unanticipated consequences of these actions.

Floridians have always struggled with the environment and natural resources. From the early days in Florida's history, people constantly altered the landscape to carve out places to grow crops and space to live. Draining and filling wetlands and swamps created the usable land that the growing population required but then, it was necessary to continuously develop new water supplies for the ever-expanding population. The environmental effects of draining wetlands and the regional lowering of the water table caused by large ditching projects near the coast are still very evident today. These effects were compounded as groundwater wellfields were developed in areas with many lakes and wetlands, creating drawdown in the underlying aquifers. The drawdown of the surficial aquifer by groundwater pumping in turn further lowered wetland water levels and eventually impacted their health. As is often the case, harm to the environment is not recognized until the environment has been pushed to its limits and beyond.

The state made necessary adjustments through time as to how water resources are managed but history shows that these changes are not easy or rapid. Two actions occurred in the early 1970's that laid the foundation for water management in west-central Florida. First was the passage of the Water Resources Act of 1972 which provided the legislative authority to regulate water use through a permitting process which aimed to balance the need for water for many uses, including the environment. The second was the creation of the West Coast Regional Water Supply Authority as a single entity responsible for water supply development to meet the growing potable water demand of the Tampa Bay area. The Authority built new wellfields to meet the public demand, but the environmental concerns remained. Regulatory changes, litigation over water issues, and continuing environmental damage marked the late 1980's and 1990's; it was clear that further changes were needed.

The struggles of the Tampa Bay area have highlighted the need to balance the growing water requirements of people and the environment while finding solutions that protect both. Tampa Bay Water was created in 1998 from the West Coast Regional Water Supply Authority to address the growing water supply needs of the six member governments and to reduce groundwater pumping levels to restore and protect the wetlands and lakes that provide essential ecological benefits to the community. These ambitious goals have been achieved through the cooperation of local, regional and state governments. Tampa Bay Water created a single regional water supply system by purchasing all the groundwater wellfields owned by its member governments and interconnecting these facilities with wellfields owned by Tampa Bay Water. This allowed the management of these water supply facilities based on current environmental conditions. By diversifying supply sources and relying less on the groundwater resources, regional groundwater pumping has been dramatically reduced. Because of cooperation, the region has achieved the necessary balance of providing water for its citizens while ensuring environmental recovery. Details of the regional water supply history and how this balance has been achieved are presented in this chapter. Latter chapters of this report will continue the discussion of balancing water needs into the future. Key questions that will be addressed are how to balance environmental recovery with development that occurred during a time of high pumping and low water levels while preserving the environmental recovery that has been realized to date.

3.1 Historical Population

The total population of the three-county Tampa Bay area was 42,047 people in 1900. To put this in perspective, the Raymond James Stadium in Tampa holds 65,890 people. Imagine going to a football game at the stadium with every resident of the three-county area in attendance and about one-third of the seats are empty! The population density at that time was far less than current levels; just over 15 people per square mile lived in the current boundaries of Hillsborough, Pasco, and Pinellas counties in 1900. The latest available estimate of regional population (2018) is 2,894,473 people with an average of 35,501 new people added every year between 2010 and 2018. Regional growth has been exponential, not linear, and has doubled every one to two decades since 1900 (U.S. Department of Commerce 2010 and the Florida Legislature Office of Economic and Demographic Research 2016). Regional population information from 1890 to 2018 is delineated by county and the regional population as a whole and is presented in Table 3.1 and Figure 3.1.

Table 3.1: Tampa Bay Area Historical Population

Year	Hillsborough County	Pinellas County	Pasco County	Tri-County Total		Tampa	St. Petersburg	Clearwater	New Port Richey
1890	14,941	NA	4,249	19,190		5,532	273		
1900	36,013	NA	6,054	42,067		15,839	1,575	343	
1910	78,374	NA	7,502	85,876		37,782	4,127	1,171	
1920	88,257	28,265	8,802	125,324		51,608	14,237	2,427	
1930	153,519	62,149	10,574	226,242		101,161	40,425	7,607	758
1940	180,148	91,852	13,981	285,981		108,391	60,812	10,136	920
1950	249,894	159,249	20,529	429,672		124,681	96,738	15,581	1,512
1960	397,788	374,665	36,785	809,238		274,970	181,298	34,653	3,520
1970	490,265	522,329	75,955	1,088,549		277,714	216,159	52,074	6,098
1980	646,939	728,531	193,661	1,569,131		271,515	238,647	85,528	11,196
1990	834,054	851,659	281,131	1,966,844		279,766	238,629	98,669	14,044
2000	998,948	921,495	344,768	2,265,211		296,598	248,232	108,789	16,117
2010	1,229,226	916,542	464,697	2,610,465		335,709	244,769	107,685	14,911
2018	1,408,864	970,532	515,077	2,894,473		378,531	266,076	155,589	15,863

Data: U.S. Department of Commerce: U.S. Census Bureau
Website: https://www.census.gov/programs-surveys/decennial-census/decade/decennial-publications.2010.html
2018 Population Estimate - Florida Legislature, Office of Economic and Demographic Research, October 24, 2018

Pinellas County was organized from part of Hillsborough County in 1912.
Pasco County was organized from part of Hernando County in 1887; part annexed to Polk County between 1890 and 1900.

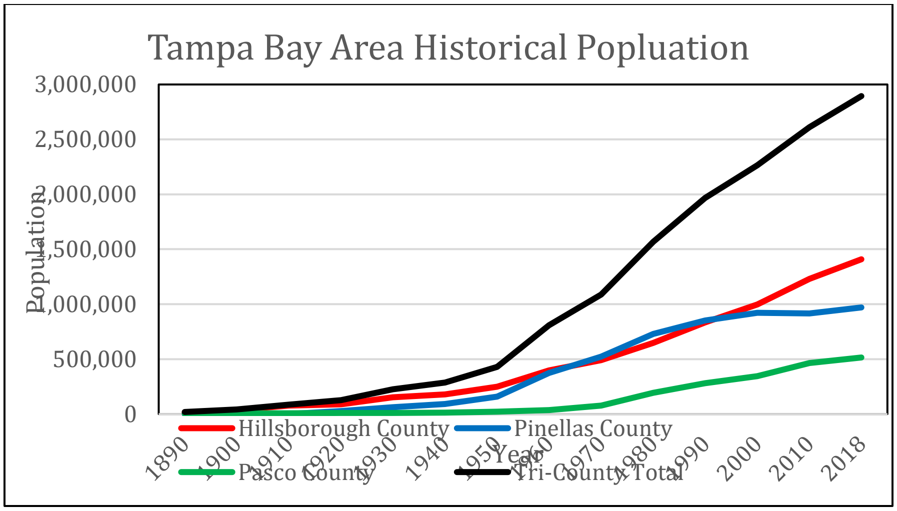

Figure 3.1: Tampa Bay Area Historical Population

The driver behind public water supply demand is people. The equation is simple; as the population increases, so also does the demand for water. Conversely, if the population became smaller, the demand for water would decrease. However, declining populations have not been observed at any time in the history of Florida or the Tampa Bay region. The Southwest Florida Water Management District calculated a fiscal year 2018 gross per capita water use rate of 104 gallons per person for the 16-county area which includes the Tampa Bay area (Southwest Florida Water Management District, 2019). Given the three-county population of 2,894,473 people in 2018, approximately 300 million gallons per day (mgd) of water would have been needed for that year. The 2018 total water demand within the service area of Tampa Bay Water's six member governments was 247.8 mgd (Hazen and Sawyer, 2018). This reported value does not include cities with their own water supply sources (e.g. Plant City, Temple Terrace, Zephyrhills, Dade City, Oldsmar, Tarpon Springs, Clearwater, and Dunedin). With rapid population growth and corresponding water demands, it is clear that water supply sources had to be developed in relatively short periods of time to avoid public health issues or an adverse impact to the regional economy. Regional changes in population are the underlying reason for the when, where, why and how the regional water supplies have been developed.

3.2 Original Water Supply Sources – Tampa and St. Petersburg

The history of the Tampa Bay region is similar to many places in the world; people tend to settle along the coastline and along waterways. In the late 1800's, the regional population centered in the cities of Tampa and St. Petersburg. The City of Tampa was chartered in 1887 and became a major port in the 1890s following the development of phosphate mines. Henry B. Plant extended railroad lines to Tampa in 1884, bringing businessmen and visitors to the growing city (City of Tampa, a). General John Williams moved from Detroit in 1875 and purchased 2,500 acres of land on Tampa Bay in the area now known as St. Petersburg. Railroad lines were extended to St. Petersburg in 1888 and the city was incorporated in 1903. It is in these two locations, the cities of St. Petersburg and Tampa, that the Tampa Bay history of water supply development began.

The Tampa Water Works Company drilled 45 wells north and west of Tampa's downtown area for water supply beginning in 1891. No construction details are available for the wells; they were described as artesian and relatively close to the coastline. The wells had poor quality water from the beginning (City of Tampa, b) with very high total hardness (>700 parts per million) and chloride concentrations that often reached 1470 parts per million (ppm). The Tampa Water Works Company abandoned about half of these wells and used the remainder to serve general household purposes. Because of quality, much of the demand for drinking water was met by bottled water companies. The City of Tampa began searching for a long-term water supply source in 1922 and chose the Hillsborough River. The City purchased the Tampa Water Works Company in 1923 and built a water treatment plant and pumping station along the Hillsborough River, just upstream of the Tampa Electric Company dam. In 1923, the City population had grown to 73,500 people. The average daily water demand was 7.66 mgd by 1924 and was met entirely with surface water from 1923 until the late 1970's when additional water supplies were needed.

The City of St. Petersburg initially relied on water from Reservoir Lake (now known as Mirror Lake) to meet their demand for water (Grismer, 1948). A new waterworks pumping plant at the lake began providing water in 1899 to the downtown area and was soon extended to the surrounding residential areas. The population of St. Petersburg in 1900 was 1,575 people and at that time, the lake supply was adequate to meet the demand of this population. During the winter of 1905-1906, water consumption began depleting the lake and the City began drilling deep wells into the aquifer to supplement the water supply. By 1923, six ground water production wells were installed near Mirror Lake. They too quickly reached their production limits. To meet growing demand, three additional wells were drilled at Crescent Lake, less than one mile north of Mirror Lake. In 1925, these combined supply sources produced an average of 3.4 mgd. The City of St. Petersburg population grew from 14,237 in 1920 to 40,425 people in 1930; by the late 1920's, the increasing use of groundwater resulted in saltwater intrusion in Mirror Lake and the nearby supply wells (Camp Dresser & McKee, 1982). The City needed a new water resource to replace both the supply from Mirror Lake and their coastal wells as well as to meet the growing demand for water.

The first municipal water supply attempts in the region were adequate for approximately 30 years before each city had to find new supply resources. The cities adapted by changing water resource types or moving inland to find adequate fresh water supplies.

3.3 Development of Initial Wellfields

3.3.1 Cosme-Odessa Wellfield

The City of St. Petersburg looked inland for a replacement water supply. The City signed a contract in 1929 with the Layne-Southeastern Company to provide water to the City from the Cosme area of northwest Hillsborough County (Figure 3.2). Construction of a pipeline was expedited, and six production wells were drilled by September 1930. The water supply system was also completed and began operation in late September 1930 (Grismer, 1948). The Layne-Southeastern Company turned the supply system over to a subsidiary company, the Pinellas Water Company, who continued to supply water to the City until December 1940 when the water supply system was purchased by the City (Southwest Florida Water Management District, 1984a). Seven more production wells were added to the wellfield between 1941 and 1948 to meet the increasing water demand of City customers. In the mid-to-late 1950's, the wellfield was expanded with ten additional production wells along the Seaboard Airline Railroad right-of-way toward Odessa. The last production wells were drilled in 1957 and the wellfield became known as the Cosme-Odessa Wellfield. The total depths of the production wells at the wellfield range from 300 to 500 feet below land surface with casing depths that ranged from 80 to 125 feet.

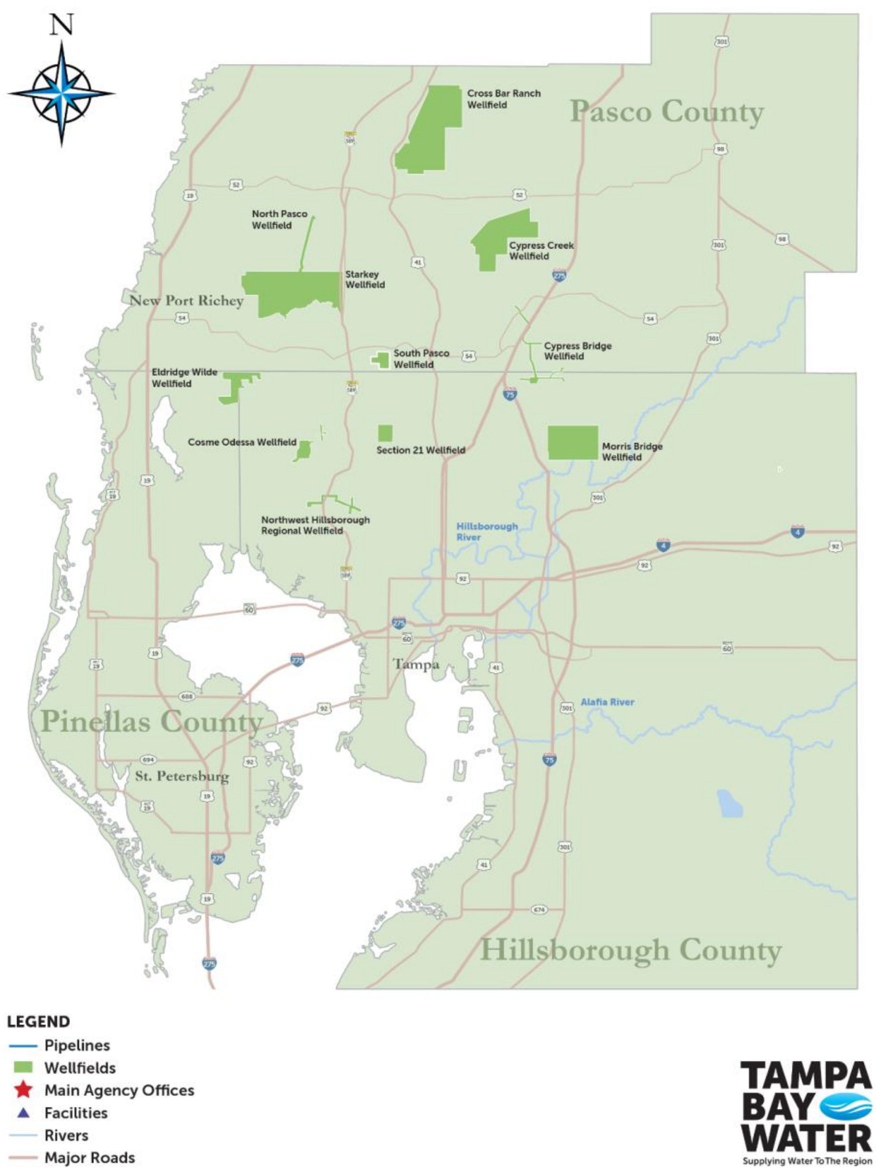

Figure 3.2: Map of the 11 Consolidated Permit Wellfields

The City added these production wells to the wellfield to serve a population that more than quadrupled from 40,425 to 181,298 people over a 30-year period (1930 – 1960). During the decade between 1950 and 1960, the City population almost doubled, increasing by 87%. Historical aerial photography of the wellfield area (Figure 3.3) showed few homes in the Cosme-Odessa area in the late 1930's and an abundance of citrus groves (Leggette, Brashears & Graham, 1995). The land use had shifted to primarily agriculture by the late 1950's and the wellfield pumping rate was almost 20 mgd by 1962. Lower water levels in some area lakes were noted by the City and area residents beginning in the 1950's (Southwest Florida Water Management District, 1996a) and these declines in lake water levels became more pronounced following the very high rainfall years of 1959-1960 (Southwest Florida Water Management District, 1984a). Lower lake water levels were likely a combination of drawdown from wellfield pumping, land use and drainage changes related to citrus groves and home construction around the lakes combined with several years of substantially below-average rainfall. Engineering studies conducted for the City in 1959 and 1960 indicated that large-scale increases in pumping at the Cosme-Odessa Wellfield would potentially cause salt-water intrusion problems in the area (Leggette, Brashears & Graham, 1966), the very problem that prompted the City to develop this wellfield. In response to the growing water demand of City customers, the risk of salt-water intrusion, and an awareness of pumping-related impacts at the Cosme-Odessa Wellfield, the City began developing the Section 21 Wellfield in 1961 as their next potable water supply source.

Figure 3.3: Aerial Photograph of the Cosme-Odessa Wellfield Area from 1938

Figure 3.4: Aerial Photograph of the Cosme-Odessa Wellfield Area from 1967 - 1969

Citrus acreage in the wellfield area continued to increase and home construction continued; both are visible in aerial photography from 1967. Numerous homes surrounding the lakes are shown in Figure 3.4. The land in northwest Hillsborough County where the Cosme-Odessa Wellfield is located has remained mostly rural although much of the former agricultural land use has transitioned to residential use (Figure 3.5). Homes have been constructed surrounding most of the lakes in the region with small residential developments along county roads. Citrus production has largely left the area with only a few groves remaining; small blueberry farms and plant nurseries have moved into the community.

Figure 3.5: Aerial Photograph of the Cosme-Odessa Wellfield Area from 2018 - 2019

3.3.2 Eldridge-Wilde Wellfield

Pinellas County also faced an increasing demand for water and saltwater intrusion concerns. Through the year 1940, most of the citizens of Pinellas County lived within the City of St. Petersburg and Clearwater (20,904 county-wide residents as compared to 70,948 residents in the two largest cities combined). The end of World War II in 1945 marked an era of rapid growth within Pinellas County with population increases in Belleair, Clearwater, Dunedin, Gulfport, Largo, Pinellas Park, and St. Petersburg. The total county population increased from 91,852 people in 1940 to 159,249 in 1950 and increased further by 135% to 374,665 people by 1960. Much of the growth between 1945 and 1960 was in the southern part of the Pinellas peninsula, with dense development along the coastal beach areas. The amount of developed land as a percentage of total land in the county increased from 9 percent in 1943 to 39 percent in 1963 with urban development replacing citrus groves (Pinellas County, 2008).

The Pinellas County Water System was created by special act of the Florida Legislature in 1935 to serve a growing customer base located in the unincorporated areas of the county, the cities of Largo and Seminole, and the incorporated area of the beach communities (Camp, Dresser & McKee, Inc., 1986). The first water supply for the new system consisted of surface water stored in the McKay Creek Basin with water first delivered to customers in 1937. This first water supply system used the Walsingham Reservoir and began operating in 1937. It served less than 200 customers with approximately 1.5 million gallons of water per day (Pinellas County Utilities, unknown). The growth and increasing water demand within the county were met by adding more treatment plant capacity, groundwater production wells (unidentified locations in the southern and western part of the peninsula) and an additional impounding reservoir. By 1951, the County recognized that their surface water reservoirs and water supply wells would soon be inadequate to meet demand in the developing beach communities (Black, Crow and Eidsness, Inc., 1970). Increasing salinity in the coastal wells prevented the County from expanding their production capacity and they began to look inland for a new water resource to replace their existing water supplies.

The Pinellas County Water System drilled test wells and conducted a pumping test in 1952 in the northeast corner of Pinellas County (Figure 3.2). Results indicated that adequate water could be obtained from that area. The land where the wellfield would be constructed was undeveloped and contained extensive coverage of wetlands and a large lake as can be seen in an aerial photograph of the area from the late 1930's (Figure 3.6). Development of the new wellfield was hampered by delays in financing and the County had to construct three interim ground water supplies to meet demand and replace the coastal wells experiencing saltwater intrusion. These three interim wellfields in the Coachman area of the County met the Pinellas County Water System demands until the Eldridge-Wilde Wellfield was constructed and began supplying water to the county (Black, Crow and Eidsness, Inc., 1970). The Eldridge-Wilde Wellfield began producing water from nine ground water production wells in 1956. The wellfield was essentially continually expanded in phases to meet the increasing water demand of the Pinellas County Water System. By 1960, 21 production wells were providing water to county customers and all of these production wells were constructed in the southwest portion of the wellfield, along Tarpon Springs/Keystone Road. These wells typically had shallow casing depths of less than 100 feet below land surface and total depths ranging from 140 to 405 feet. Aerial photography from the late 1960's show that the property contained some citrus and the coverage of wetlands had decreased with exposed edges in many wetlands and low water levels in Lake Dan (Figure 3.7). Ditches are also visible in this photograph that connect many of the wetlands, especially on the north and south sides of the wellfield property.

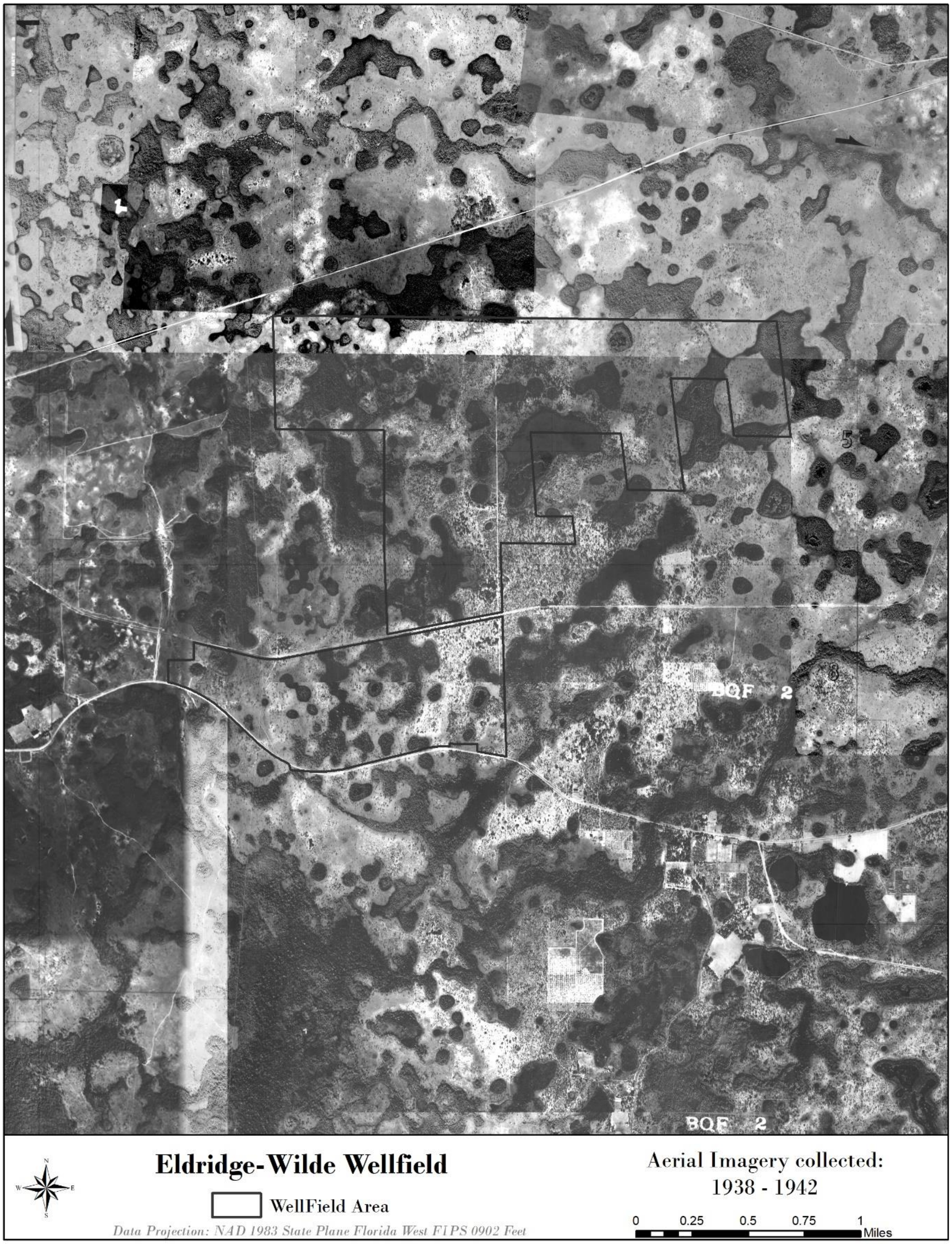

Figure 3.6: Aerial Photograph of the Eldridge-Wilde Wellfield Area from 1938 – 1942

Figure 3.7: Aerial Photograph of the Eldridge-Wilde Wellfield Area from 1967 – 1969

The county continued to add new water customers to their system and the number of connections reached 35,000 by 1969. The population of Pinellas County grew to 522,329 people by 1970 with the majority of the growth in the unincorporated portions of the county which was served by the Pinellas County Water System. In 1970, there were a total of 58 active production wells in the Eldridge-Wilde Wellfield extending north to the Pasco County line with nine of these wells on the Hillsborough County portion of the wellfield. The additional production wells were constructed to similar specifications as the initial 21 wells. The County's consultant recommended that production from this wellfield be limited at that time to an average annual quantity of 33 mgd pending the implementation of an extensive monitoring program and analysis of the results. The monitoring program was intended to better understand the hydrogeology of the wellfield area and define the risk of saltwater intrusion into the aquifer underneath the wellfield. The county's consultant also recommended that an additional water supply source be developed to the northeast to meet the anticipated growth in Pinellas County (Black, Crow and Eidsness, Inc., 1970).

Increasing chloride concentrations were observed in the southwestern portion of the wellfield during the 1970's as the annual average pumping quantity from the wellfield ranged from 28 to 35 mgd. The increasing chloride trends became more pronounced after wellfield pumping was redistributed in 1983 due to the removal of 13 production wells from service due to alleged contamination (Southwest Florida Water Management District, 1989a). Between 1981 and 1986, the county modified 21 of the existing production wells by deepening these well bores into the Avon Park Formation (between 650 and 800 feet below land surface). This work was performed in response to declining well yields. Even with the modifications made to the production wells and changes in pumping rotation, the potential for saltwater intrusion was identified in deep regions below the wellfield and in areas south and east of the wellfield (HydroGeoLogic, Inc., 1992). The U.S. Geological Survey (Tihansky, 2005) completed an extensive investigation into the water quality changes in some of the wellfield production wells. Tihansky concluded that the changes were due to a combination of both saltwater mixing (horizontal movement) and upward migration of older water from within the Floridan Aquifer (vertical movement), depending on the location and depth of the production wells.

Potential saltwater intrusion into the aquifer was not the sole environmental issue related to pumping at the Eldridge-Wilde Wellfield. The District staff report for the renewal of the Water Use Permit for the wellfield (Southwest Florida Water Management District, 1989a) describes field surveys of wetlands on and near the Eldridge-Wilde Wellfield that were completed in 1972/73, 1982, and 1989. The initial and subsequent investigations found that wetlands "within one to three miles from the wellfield were in good condition with respect to vegetation when compared to the poor vegetational condition of non-augmented wetlands sites in the well field". The District staff attributed the dry conditions and heavily impacted vegetation on the wellfield property to pumping from the wellfield production wells. The District staff report continued saying that "Nearly all cypress and marsh wetlands in the Eldridge-Wilde Well Field have been moderately to severely impacted by fire, soil subsidence and a general elimination of wetland plants. A relatively small wetland area in the well field area, roughly 15 percent, is in good condition apparently as a result of surface water augmentation in the vicinity." Pinellas County had begun augmentation of Lake Dan sometime in or before the 1970's to maintain lake water levels primarily to support cattle ranch operations on the property. These wetland impacts reported by District staff included several feet of subsidence in some wetlands on the wellfield with subsequent treefall due to soil subsidence.

Wetland impacts and low water levels on the wellfield were documented prior to the initial Consumptive Use Permitting process and subsequent issuance of the first permit for this wellfield in April 1978.

The Pinellas County total population expanded by 206,202 people between 1970 and 1980 and by another 123,128 people in the next decade. In addition to the Eldridge-Wilde Wellfield, Pinellas County also developed the East Lake Road Wellfield, a small facility intended for peaking purposes (Camp Dresser & McKee, 1982). This wellfield was located about two miles south of the Eldridge-Wilde Wellfield and limited pumping began in late 1974. Eight production wells produced an annual average quantity of 3 mgd and a maximum day quantity of 5 mgd. The eight production wells were shallow, ranging in depth between 125 and 235 feet (Southwest Florida Water Management District, 1989b). The annual average quantity from this small wellfield never exceeded 2.3 mgd before it was abandoned in 1995 due to saltwater intrusion that began prior to 1978 (Pinellas County Utilities, unknown). In addition to these two county wellfields, Pinellas County began to receive regional wellfield water in 1976 as will be described in Sections 3.5 and 3.6 to meet the water needs of their citizens.

The Eldridge-Wilde Wellfield has remained in a natural setting since development in the 1950's with cattle ranching operations on-site until recent years. The land surrounding the wellfield in Hillsborough County has remained rural with low-density residential land use. The largest residential development in the wellfield area is the Trinity Development, located on the north property boundary of the wellfield in Pasco County (Figure 3.8). Initial construction of this development began between 1990 and 1995; the residential areas on the northern boundary of the wellfield were essentially completed by 2008. The Trinity community continues to develop to the present time with the development of East Trinity and commercial infill throughout the community. This community has experienced significant flooding in recent years with Pasco County and the District continuing to work on solutions to manage flooding through the Duck Slough system which runs through the middle of the Trinity Development.

Figure 3.8: Aerial Photograph of the Eldridge-Wilde Wellfield Area from 2018 – 2019

3.3.3 Section 21 Wellfield

The City of St. Petersburg developed the Section 21 Wellfield to supplement the water supplied by the Cosme-Odessa Wellfield. According to a summary timeline document obtained from the University of Florida Levin College of Law, this 600-acre parcel was acquired by the City when they purchased the Pinellas Water Company in 1940 (Unknown, 1979). An aerial photograph from 1938 shows the property and undeveloped surrounding area with (presumed) dirt roads on the east and north sides (Figure 3.9); the area wetlands and lakes were full of water at the time of the photograph. In 1961 and 1962, the City drilled ten production wells on this property which is located approximately 4 miles to the east of the Cosme-Odessa Wellfield (Figure 3.2). Initially, six of the ten production wells were placed into service. Wells 21-1 and 21-3 were never activated but were capped and available for use if needed (designated as standby wells). Two production wells, 21-4 and 21-7, were never placed into service. The total depths of the six active production wells ranged from 411 to 601 feet below land surface with casing depths between 71 to 116 feet. The Section 21 Wellfield came online in 1963 and produced an average of 3.3 mgd during that initial year. However, within three years, the annual average wellfield pumping rate quickly increased to 17.5 mgd. The City population continued to increase during the 1960's but at a slower pace than in the prior decades. The Section 21 Wellfield provided two benefits to the City: it allowed for reduced pumping from the Cosme-Odessa Wellfield and provided more water to meet the needs of City residents.

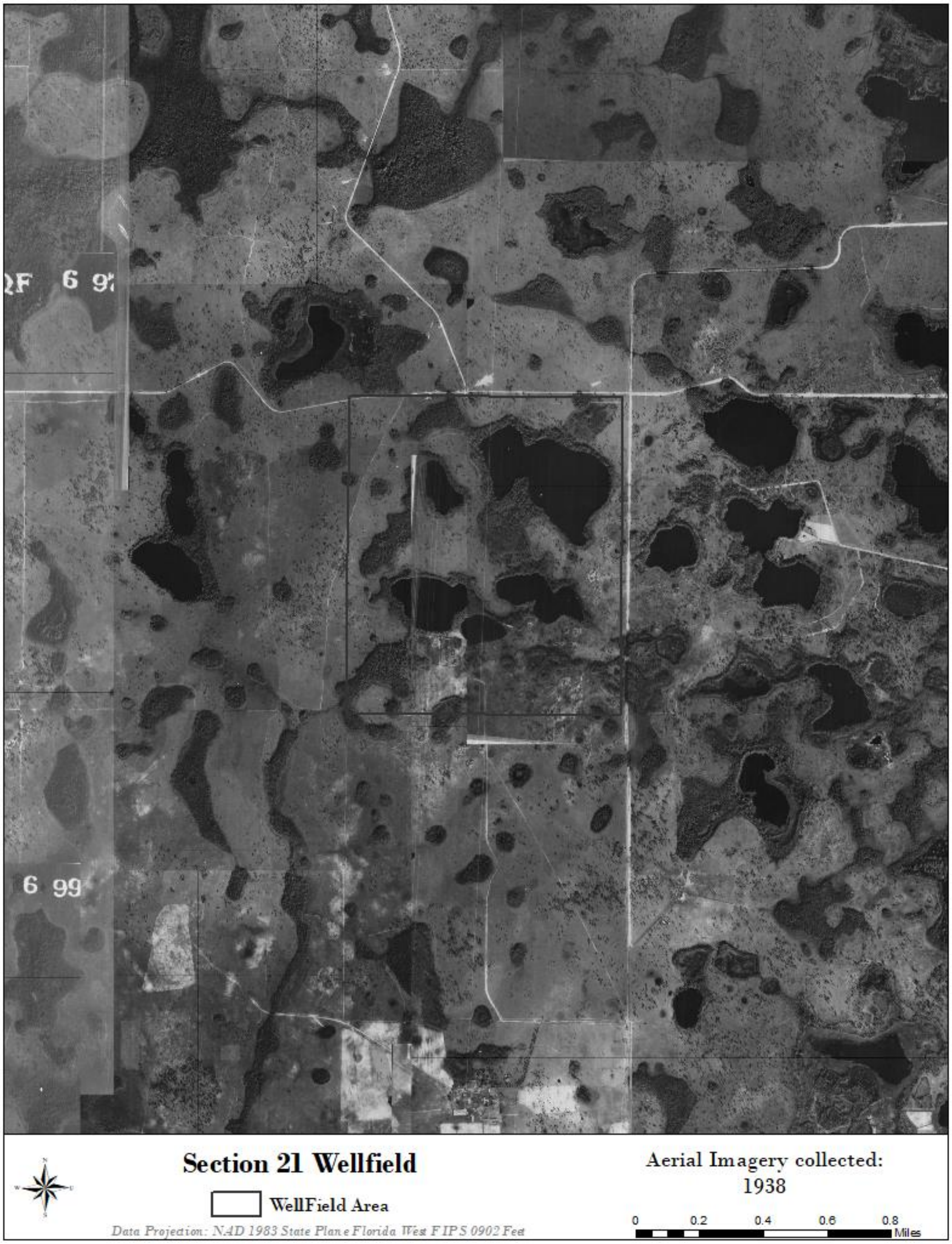

Figure 3.9: Aerial Photograph of the Section 21 Wellfield Area from 1938

The rapid increase in pumping from the Section 21 Wellfield caused the formation of sinkholes that became a concern for local residents. In May 1964, wellfield personnel and adjacent property owners reported the occurrence of 64 new sinkholes within a 1-mile radius of the wellfield (Sinclair, 1982), mostly south and south-east of the wellfield. Additional sinkholes were not observed and the sinkholes that occurred in 1964 did not appear to increase in size and depth. The Southwest Florida Water Management District (1984b) concluded that the large increase in pumping in the spring of 1964, along with declines in the water table and potentiometric surface of the Upper Floridan Aquifer accelerated the development of these sinkholes that most likely would have occurred naturally over time. Sinclair also reported that sinkholes had occurred in conjunction with the development of the Cosme-Odessa and Eldridge-Wilde Wellfields but little attention was paid at the time due to the sparse population in those areas.

Lower water levels in lakes on and near the Section 21 Wellfield became a significant concern as pumping continued through the 1960's. These lower lake levels were generally attributed to wellfield drawdown and lower rainfall (Southwest Florida Water Management District, 1984b). Wetlands on the wellfield property also experienced lower water levels after the wellfield production began although there was no formal wetland monitoring program until much later. Lower water levels eventually led to soil desiccation and subsidence, tree fall, and the migration of upland plant species into some wellfield wetlands. The District evaluated the health of wetlands in this area using aerial photography and concluded that healthy wetlands existed in this area in the 1940's but underwent considerable deterioration in wetland health a few years after pumping began at the Section 21 Wellfield (Southwest Florida Water Management District 1996a). The lower wetland and lake water levels on the wellfield property are visible in an aerial photograph from 1967 – 1969 (Figure 3.10) with Starvation Lake having separated into two pools due to low water levels. Dale Mabry Highway and Van Dyke Road were present at the time of this photograph and the surrounding area was rural with agriculture and a few single-family homes to the west of the wellfield property.

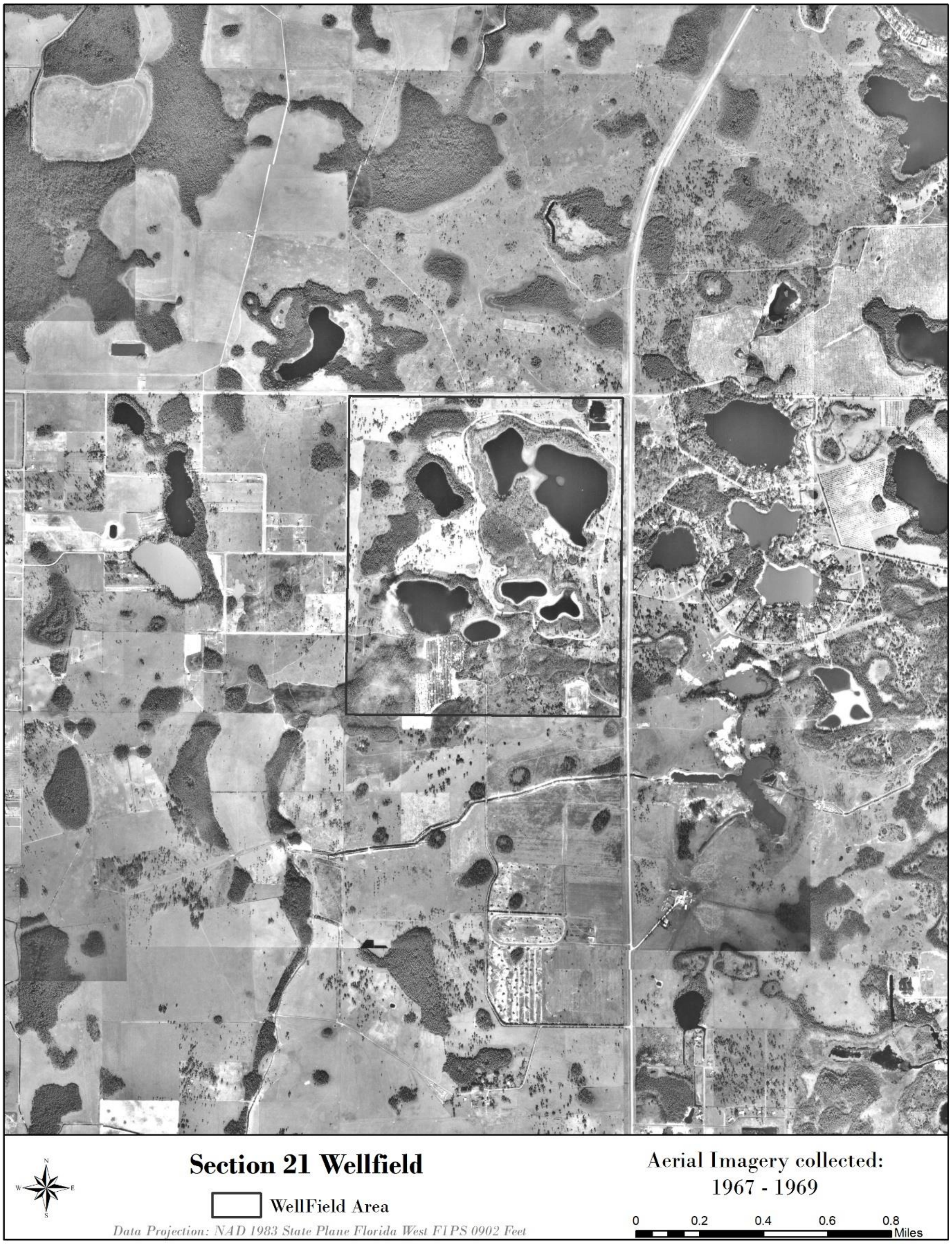

Figure 3.10: Aerial Photograph of the Section 21 Wellfield Area from 1967 – 1969

Other factors associated with lowered lake and wetland water levels over time are development and drainage modifications in a rapidly urbanizing area (Leggette, Brashears & Graham, 1995). Notable landscape changes near the Section 21 Wellfield include the widening of Dale Mabry Highway on the east border of the property and Van Dyke Road on the north border of the property. These and other roads have caused an unquantified change in surface water flow to Starvation Lake and other features on the wellfield. The residential and commercial development in the surrounding area and roads adjacent to the wellfield are part of stormwater management systems which have changed the flow of surface water to the wellfield property. The largest stormwater management feature near the wellfield is the Interceptor Canal which was constructed by Hillsborough County in the mid-1960's. The canal extends from Lake Heather to Brushy Creek to allow the water level in interconnected upstream lakes to flow out of the area during high rainfall events. This feature was constructed to alleviate flooding of lakefront homeowners to the east and northeast of the wellfield. The District concluded that the canal has a minimal direct effect on Starvation Lake within the wellfield (Southwest Florida Water Management District, 1996a); however, the potential impacts to other environmental features has not been quantified. The canal is visible in Figure 3.10 and an aerial photograph from the late 1980's shows that urban development had covered the landscape south and east of the wellfield and a new development was under construction to the north of the property Figure 3.11.

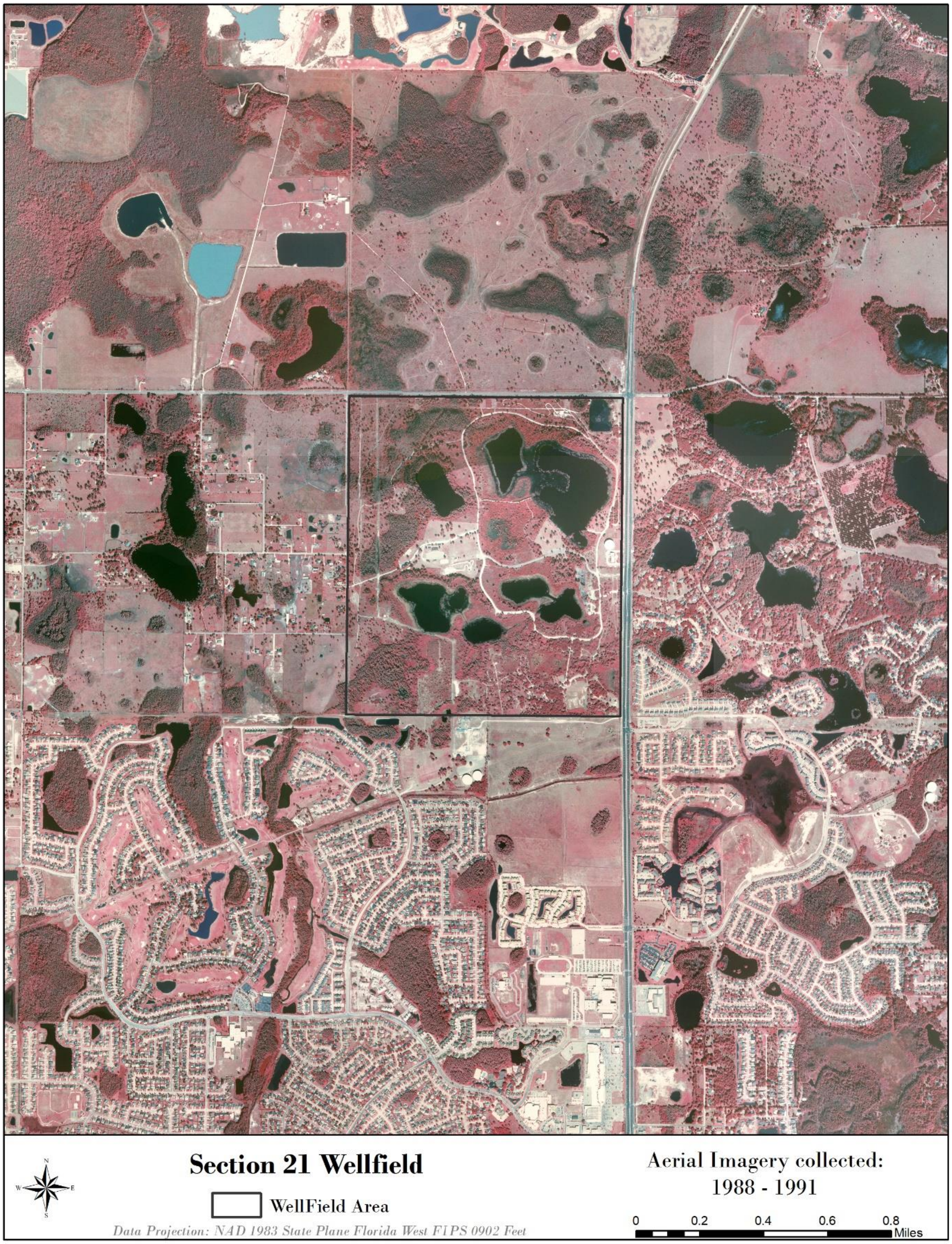

Figure 3.11: Aerial Photograph of the Section 21 Wellfield Area from 1988 – 1991

Tampa Bay Water modified four of the six active production wells in 2003 and 2004 by deepening the total depth of the wells into the Avon Park Formation (between 663 and 700 feet below land surface). The production casings of three of these wells were extended to depths of approximately 200 feet below land surface. The production casings in wells S21-8 and S21-10 could not be deepened due to physical restrictions in these two wells and S21-10 could not be deepened due to other well construction difficulties (Leggette, Brashears & Graham, 2005). These well modifications were made to increase the well productivity and decrease the flow into the wells from the shallow zones within the aquifer. These changes were expected to result in less pumping-related impact to the lakes and wetlands on the wellfield property and reduce the probability of bacteriological issues in the production wells. The pumping capacities increased in the four wells that were deepened and surface water levels have been higher since the wells were returned to service in 2005. It is unknown what portion of the improved lake and wetland water levels on the wellfield are due to the well modifications and what portion is due to the reduction in wellfield pumping that began in 2005. A recent aerial photograph of the wellfield area (Figure 3.12) shows that dense urban development now covers the area with residential developments, retail, and support infrastructure (schools, hospitals, and sports fields).

Figure 3.12: Aerial Photograph of the Section 21 Wellfield Area from 2018 – 2019.

3.3.4 South Pasco Wellfield

By 1970, the Section 21 Wellfield annual average pumping rate had increased to almost 18 mgd and the combined Cosme-Odessa and Section 21 annual pumping had increased to 27.6 mgd. To meet the projected water demands, the City of St. Petersburg acquired a 589-acre parcel in Pasco County, approximately four miles north of the Section 21 Wellfield (Figure 3.2) and began development of the South Pasco Wellfield. The area surrounding the wellfield property was undeveloped with limited residential and commercial properties on and near Dale Mabry Highway to the east (Figure 3.13). Eight production wells were drilled in 1970 and 1971 with total well depths of just over 700 feet below land surface and casing depths between 60 to 126 feet.

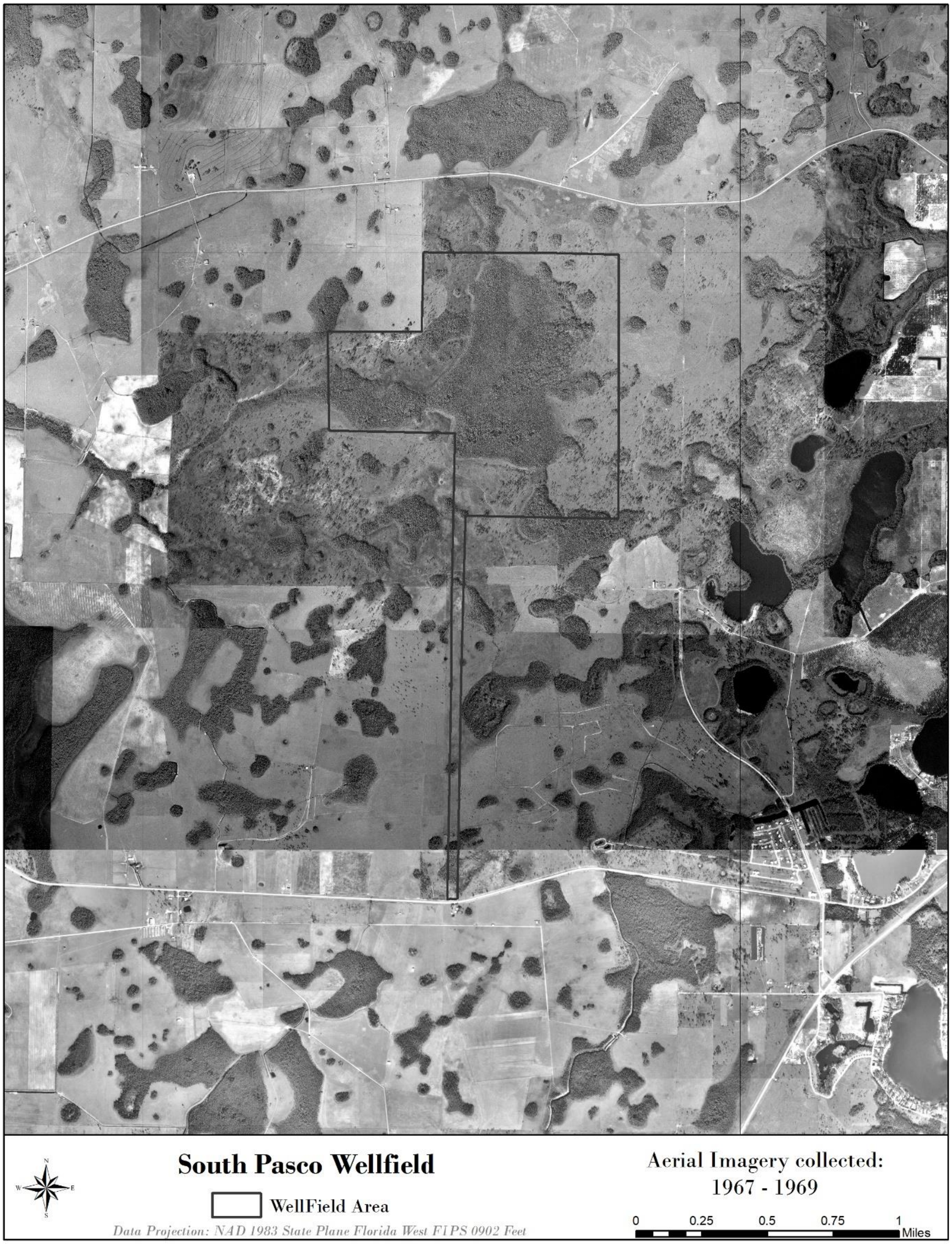

Figure 3.13: Aerial Photograph of the South Pasco Wellfield Area from 1967 – 1969

The South Pasco Wellfield came online late in 1973 (Southwest Florida Water Management District, 1982). Water Year 1974 was the first full year of operation at the wellfield with an annual average pumping rate of 16.6 mgd. With production from the South Pasco Wellfield, the City was able to reduce pumping from the Section 21 Wellfield. The combined average pumping rate from the Cosme-Odessa and Section 21 Wellfields was 17.84 mgd during Water Year 1974, slightly more than the average pumping rate at the South Pasco Wellfield. Between 1974 and 1978, the South Pasco Wellfield supplied about 45% of the water produced by the City of St. Petersburg. Between 1970 and 1980, the City's population increased by about 12 percent to a total of 238,647 residents; total population then remained essentially the same through 2010 (Section 3.1).

Three sinkholes were documented near the wellfield property in 1973 (Southwest Florida Water Management District, 1982) and about 30 small sinkholes were noted about 1-mile north of the South Pasco Wellfield in 1974 following the initiation of pumping from this wellfield (Sinclair, 1982). As with the Section 21 Wellfield, the number and extent of sinkholes did not increase after the initial ones were observed. District staff began monitoring wetland vegetation in the South Pasco Wellfield in 1973 to study the effects of pumping on wetland health. The Southwest Florida Water Management District (1982) reported that impacts to wetlands were observed in the years following initiation of pumping at the South Pasco Wellfield due to lowering of the water table. The effects of the lower water table and reduced wetland hydroperiods were most pronounced in the cypress heads on the north and east side of the wellfield that are not directly connected to the wetlands in the center and west of the property that make up the headwater of the South Branch of the Anclote River. The impacts to the isolated cypress wetlands on the wellfield included lowered water levels, reduced hydroperiod, fire damage, treefall, and the invasion of weedy, upland plants into the wetlands. These impacts took several years to develop but were not unanticipated by District staff; however, the wetland impacts were not as serious as seen in the other wellfields (Southwest Florida Water Management District, 1982).

The South Pasco Wellfield was in a rural setting when the wellfield was developed by the City. The first development in the immediate area of the wellfield was the Sierra Pines neighborhood located immediately west of the property. Historical aerial photography shows that the roads for this single-family home neighborhood were being constructed in 1974 which was the first of five consecutive years where the wellfield pumped an average of approximately 15 to 16 mgd. Aerial photography shows that this subdivision was built-out by 1985. Additionally, another subdivision, Meadowbrook Estates located north of Sierra Pines and south of State Road 54, was developed. These developments can be seen in the aerial photograph from 1998 (Figure 3.14) along with a large residential development (Cheval) under construction south of Lutz-Lake Fern Road. The land immediately south of the wellfield began developing in late 1998 with initial construction of Heritage Harbor and Villa Rosa in 1999. Both subdivisions were complete by 2004. Development on the east side of the wellfield began in 2001 with the excavation of a large oblong pond. This land sat idle until 2012 when construction began on the Long Lake Ranch development. By 2017, construction was complete at the Long Lake Ranch development and the extension of Sun Lake Boulevard was complete, now stretching from Van Dyke Road to and across State Road 54. The extension of this road lies on the eastern property boundary of the South Pasco Wellfield. These developments and features can be seen in the aerial photograph from 2018 – 2019 (Figure 3.15). The property to the north of the wellfield was cleared during 2019 and 2020 and will likely become commercial property along State Road 54.

Figure 3.14: Aerial Photograph of the South Pasco Wellfield Area from 1988 – 1991

Figure 3.15: Aerial Photograph of the South Pasco Wellfield Area from 2018 – 2019

This was the last of four wellfields developed north of Tampa Bay by the City of St. Petersburg and Pinellas County during a time when there were no regulations in existence governing the withdrawal and use of water. In response to a growing demand for water supply and low water levels associated with ground water pumping throughout Florida, the State was preparing to develop the first regulations to be applied to the consumptive use of water.

3.4 Onset of Regulations and Permits

The Florida Legislature historically addressed water-related issues within the State by creating single-purpose districts to focus on the specific issue of concern (e.g. irrigation, sewer, aqueduct, mosquito-control, and drainage districts). These districts were limited in their authority to the single purpose for which they were created. The first major multi-purpose water management district was the Central and Southern Florida Flood Control District, established in 1949 under the Flood Control Act of 1949. This district was created to comply with federal requirements for expending flood control funds to prevent a recurrence of the disastrous South Florida flood of 1947. A number of multi-purpose districts were created by the State Legislature in the 1950's including water conservation and sanitary districts; however, there was no formal state-wide oversight of their work (Maloney, et al., 1980).

Challenges with management of water resources in Florida were highlighted during a dry period between 1954 and 1956. The 1955 Florida Legislature created the Florida Water Resources Study Commission with the charge to study the water resources of the state. This commission was to determine whether or not there was a need for a comprehensive water law in the State that would be administered by a board to manage these multiple issues, and if so, to determine the extent of jurisdiction of the board. The result of these studies led to the enactment of the 1957 Florida Water Resources Act which established a state-wide administrative agency to oversee the development of Florida's water resources. The agency was established within the State Board of Conservation and was authorized to issue permits for the capture and use of excess surface and ground waters. This agency was also authorized to set rules for the conservation of water in areas of the state where over-withdrawal of water was endangering the state water resources. This agency was established but implementing water regulatory districts proved to be a cumbersome process (Maloney, et al., 1980).

Hurricane Donna caused widespread flooding and damage in southwest Florida in the summer of 1960. The Southwest Florida Water Management District (District or SWFWMD) was created in 1961 by a special act of the Florida Legislature for the purpose of flood control and management in west-central Florida (Parker, 1973). The District covers all or part of 16 counties from Levy County in the north to Charlotte County in the south and inland from the Gulf of Mexico into central Florida, including parts of Polk and Highlands counties. The newly formed District was the local sponsor of the "Four River Basins, Florida Project" which was a major flood control project of the U.S. Army Corps of Engineers. This project included all or portions of the drainage basins of the Hillsborough, Withlacoochee, Oklawaha, and Peace Rivers and three smaller watersheds, the Pithlachascotee River, Anclote River, and Lake Tarpon (U.S. Army Corps of Engineers, 1973). The project included flood control structures, water detention areas, and encompassed a 6,000-square-mile area. The project consisted of a series of canals, reservoirs, and water control structures designed to prevent a recurrence of disastrous flooding while allowing for beneficial water storage. Implementation of this plan was a joint effort between the U.S. Army Corps of Engineers and the District.

Multiple years of below-average rainfall in the 1960's and the increasing level of pumping from wellfields in the Tampa Bay Area led to a greater emphasis on water supply issues and the regulation of large groundwater users in the area (Camp Dresser & McKee, 1982). During the 1960's, legal scholars continued their analysis of Florida water law and state-wide water resource management issues and developed a new regulatory framework for managing the state's water resources. This new framework, documented in the 1972 "A Model Water Code", outlined a regulatory approach based on the best features of the prior appropriation system and the riparian system of water law. The Model Water Code stated that "the waters of the state are the property of the state and are held in public trust for the benefit of its citizens" and that the people of the state are the beneficiaries of this trust and have a right to have the waters protected for their use (Maloney, et al., 1972). This document also recognized the interrelationship of water in all stages of the hydrologic cycle and the importance of protecting all waters of the state. The document acknowledged that the maximum beneficial use of water should be obtained for the people of the state but that adequate provision shall be made for the protection of fish and wildlife and the maintenance of proper ecological balance.

The Florida Legislature enacted Chapter 373 of the Florida Statutes entitled the Water Resources Act of 1972 based on the Model Water Code of 1972 (Klein, C.A. et al, 2009). The Water Resources Act provides two levels of administration for water use regulation; the statewide responsibility was initially given to the Department of Natural Resources and the regional responsibility was assigned to the five water management districts. The legislature reassigned the state responsibility to the Department of Environmental Regulation in 1975 giving them regulatory control over both water quality and quantity (Maloney, et al., 1980). The five water management districts are based on the five major surface water hydrologic basins in the state. The Water Resources Act and Chapter 373 of the Florida Statutes established that each water management district has the sole responsibility for regulating the consumptive use of water within their boundaries. As each district had different water management issues, each of the districts have the authority to create their own administrative rules adopted under the Florida Administrative Code to accomplish the directives of Chapter 373, Florida Statutes. Common to all of the consumptive use permitting rules of the five districts is the three-prong test; in order to obtain a permit for the use of water, an applicant must demonstrate that (1) the proposed use of water is reasonable and beneficial, (2) will not interfere with any existing use of water, and (3) is in the public interest (Chapter 373.223, Florida Statutes). Permits for consumptive uses of water are issued for fixed periods of time and must be renewed to continue using the authorized quantity of water.

The responsibilities of the Southwest Florida Water Management District (District) expanded in 1972 with the passage of the Water Resources Act and the adoption of Chapter 373, Florida Statutes. The District transitioned from strictly a flood-control district to a broad-based resource management agency with four areas of responsibility: water supply, water quality, natural systems, and flood protection. The initial consumptive use permitting rules of the District were drafted between 1972 and 1974, becoming effective on January 1, 1975. The initial permits were viewed as an inventory of the existing water uses within the District and the rules were relatively minimal. The initial rules only addressed offsite environmental impacts; environmental impacts were allowed on property owned or controlled by the permittee. Impact determinations during the permitting process within the District were based on 1) the "water crop theory" and 2) the "5-3-1 Rule".

The "water crop theory" allowed a specified amount (1000 gallons per day/acre) to be withdrawn from the ground based on the amount of recharge to the aquifer. This provision was deleted from the District's

Consumptive Use Permitting rules in 1980 as the 1000 gallons per day/acre estimate was found to be arbitrary. The "5-3-1 Rule" stated that a withdrawal of water cannot cause 5 feet of drawdown in the potentiometric surface under lands not owned or controlled by a permittee, cannot cause drawdown in the water table greater than 3 feet under lands not owned or controlled by a permittee, and cannot cause 1 foot of drawdown in lakes located on properties not owned or controlled by the permittee. It was presumed that if the model-predicted drawdown from a permitted water use was less than these presumed limits, there was no adverse impact associated with the permittee's use of water. Under these initial consumptive use permitting rules, a permittee could cause adverse impacts to wetlands or lakes on their property but not on adjacent properties.

The Water Resources Act of 1972 afforded an opportunity to those who had existing consumptive uses of water prior to the passage of the Act to obtain a consumptive use permit under the new system for their existing water use. The District was already working on water resource and allocation questions for the wellfields in the Tampa Bay area that were in existence prior to 1972. The water use from the Cosme-Odessa and Section 21 Wellfields was reviewed during public hearings held in December 1971 and January 1972 by the District Governing Board (Southwest Florida Water Management District, 1984a and 1984b). District Order 72-1 established regulatory levels for the three Upper Floridan Aquifer monitor wells at the Cosme-Odessa Wellfield and the two regulatory wells at the Section 21 Wellfield. This order also established regulatory levels for three Upper Floridan Aquifer monitor wells at the South Pasco Wellfield which was in development but not yet producing water. In November 1973, Order 73-6R established a gallonage cap of 168 million gallons per week from the Cosme-Odessa and Section 21 Wellfields. The next year, the District Governing Board issued Order 74-10R which established regulatory levels in four Upper Floridan Aquifer monitor wells at the Eldridge-Wilde Wellfield in November 1974. These aquifer regulatory levels and wellfield limits were established as the first measures by the District to regulate the quantity of water withdrawn from area wellfields and reduce or stabilize the environmental impacts of concentrated groundwater pumping.

The initial consumptive use permits (CUPs) were issued by the District following the implementation of the new regulatory framework in 1975. The District issued CUP No. 7500004 to the City of St. Petersburg in August 1976 for the Cosme-Odessa Wellfield under Order No. 76-2 by the Governing Board. The average annual permitted quantity for the Cosme-Odessa Wellfield was 19 mgd with a maximum daily quantity of 22 mgd (Southwest Florida Water Management District, 1984a). In August 1976, CUP No. 7500003 was issued to the City for the Section 21 Wellfield under Order No. 76-2 by the Governing Board. The average annual permitted quantity was 18 mgd with a maximum daily quantity of 22 mgd (Southwest Florida Water Management District, 1984b). The Consumptive Use Permits for the Cosme-Odessa and Section 21 Wellfields would be reduced to an annual average quantity of 13 mgd and a maximum daily rate of 22 mgd in 1984. The District issued CUP No. 7602673 to Pinellas County in April 1978 for the Eldridge-Wilde Wellfield with an average annual quantity of 35.2 mgd and a maximum day quantity of 55 mgd. This permit had a short duration and expired on December 31, 1980 but it was renewed for a six-year term with no change in quantities in March 1982; the original permit remained in effect during the permit application review process. The District issued permit No. 277003647 to the City of St. Petersburg for the South Pasco Wellfield with an initial expiration date of December 31, 1981, an annual average quantity of 16.9 mgd and a maximum daily quantity of 24 mgd.

The City renewed the initial permit in September 1982 for a 10-year term at the existing permitted quantities. The permitted quantities for these wellfields remained until the issuance of the Consolidated Permit in 1998.

3.5 Formation of the West Coast Regional Water Supply Authority

These Orders issued by the District Governing Board and the initial Water Use Permits for the four existing wellfields placed limits for the first time on the amount of available water for the City of St. Petersburg and Pinellas County. In 1970, the population of the three-county Tampa Bay area had grown to 1,088,549 people and this was expected to rapidly increase. The existing water supply issues and the growing need for additional water supply created an awareness that water supply issues in the Tampa Bay area required intergovernmental cooperation. The District, Pasco County, Pinellas County, and the City of St. Petersburg agreed to develop the Cypress Creek area in central Pasco County for the purposes of flood control, water storage, water supply, wildlife refuge, and outdoor recreation space (Camp Dresser & McKee, Inc., 1982). The City of St. Petersburg, Pasco County and Pinellas County empowered the Cypress Creek Management Board on August 30, 1973 to guide the development of the proposed Cypress Creek Wellfield. The intent was for this to be the first regional water supply facility for the Tampa Bay area and would satisfy regional water needs through 1980.

The Florida Legislature recognized the need for regional cooperation in the development of water supplies and passed legislation in 1974 enabling the formation of regional water supply authorities (Chapter 74-114, Laws of Florida, later Chapter 373.1962, Florida Statutes). This legislation was sponsored by Representative Guy Spicola and Senator Louis de la Parte, both representing Hillsborough County. At the local level, legal counsel Alan Sunderberg (representing the City of St. Petersburg), John Allen (representing Pinellas County), and Jake Varn (representing Pasco County) helped to negotiate and promote this legislation. This Statute states that “regional water supply authorities may be created for the purpose of developing, recovering, storing, and supplying water for county or municipal purposes in such a manner as will give priority to reducing adverse environmental effects of excessive or improper withdrawals of water from concentrated areas.” The Statute further clarifies that these authorities have the power to acquire water and water rights and to develop, store, and transport water, and to provide, sell and deliver water for county or municipal uses and purposes; however, authorities are not to engage in local water distribution. The authorities were to be regional in nature, acting on behalf of their members, and delivering water to the members for distribution within their local service areas. Water supply authorities are also directed to design, construct, operate, and maintain water supply facilities necessary to ensure that an adequate water supply will be available to all citizens within the geographic boundary of the authority.

The West Coast Regional Water Supply Authority (Authority) was created on October 25, 1974 as a special district in the State of Florida consistent with the Chapter 373 enabling legislation. A five-party Interlocal Agreement was signed on this date between Hillsborough, Pasco and Pinellas Counties and the Cities of St. Petersburg and Tampa and the agency’s jurisdiction covered the three counties that signed the agreement (West Coast Regional Water Supply Authority, 1974). Through this Interlocal Agreement, the members acknowledged that it was in the best interest of the citizens to create the Water Supply Authority and that cooperative effort was needed to meet the future water supply needs of this rapidly urbanizing area. This founding document also specified that the member governments would be allowed to continue operating their own water production and transmission facilities while contracting with the Authority for additional water supply. The authority operated on a subscription basis for the development of new water supply sources. The cost of developing each new source of water was recovered by apportioning the cost of each facility to the specific member governments that were entitled to receive water from that facility. This led to a wide range of water rates depending on the cost to construct and operate each water supply facility (West Coast Regional Water Supply Authority, 1998). This meant that each member government paid a different price for water depending on from which of the Authority's supply facilities they received water.

The City of New Port Richey joined the Authority as a non-voting member in 1982 when the City transferred its ownership rights in the Starkey Wellfield to the Authority but continued to use this wellfield as its source of water. This structure of five members with voting rights on the Board of Directors and one non-voting member of the Board continued until 1998 when the Authority was reformed into Tampa Bay Water (Section 3.10).

3.6 Regional Wellfield Development

The formation of the Authority began the development of regional water supply wellfields in the Tampa Bay area. Individual member governments of the Authority no longer developed wellfields for themselves, but either developed them jointly with the Authority or received water from one of the regional wellfields that would be constructed in the 1970's and early 1980's. Additional water was needed to supply the phenomenal growth that the Tampa Bay area would experience in the next two decades. The population of the three-county Tampa Bay area was 1,088,549 in 1970 but grew to 1,569,131 people in 1980. By 1990, the area population was 1,966,844 people, almost double the number of residents that lived in the three counties 20 years before. During this 20-year period, the population of the cities of St. Petersburg and Tampa remained relatively stable but rapid growth occurred in Hillsborough, Pasco, and Pinellas counties (Table 3.1). The counties grew outward from the city boundaries and those areas that had been rural and agricultural began to transition to single-family and commercial developments. Five new wellfields would be developed by the Authority or a member government in the 1970's and early 1980's to meet the increasing water demand.

3.6.1 Starkey Wellfield

The City of New Port Richey is located along the southwest coastline of Pasco County. The City's water supply historically came from a small wellfield very close to the coast. The wellfield contained nine production wells that ranged from 65 to 270 feet in depth and produced an average of 0.87 mgd in 1969 (Black, Crow & Eidsness, Inc., 1970). Poor water quality from this City wellfield caused increased complaints from customers; the total dissolved solids concentration (TDS) from all but one of the production wells exceeded 500 mg/l with some wells exceeding 1,000 mg/l (Camp Dresser and McKee, 1986). Due to water quality and hydraulic problems, consulting engineers for the City recommended the construction of a new wellfield with eight production wells with a total wellfield capacity of 4 mgd. The proposed location for this new wellfield was east of the City of New Port Richey. The last production from the downtown New Port Richey Wellfield was in September 1977 (Camp Dresser and McKee, 1982).

The District purchased approximately 8,200 acres in west Pasco County in the mid 1970's from Mr. J.B. Starkey to create the Starkey Wilderness Park. The property and surrounding area were predominantly rural with very limited roads and homes visible in the aerial photograph from 1967 – 1969 (Figure 3.16). The purchase contract for the Starkey Wilderness Park included a provision that allows the land to be used for water management purposes, including the withdrawal of potable water, in reasonable amounts as determined by the District (Southwest Florida Water Management District, 1988). The property deed stipulates that wellfield pumping and other land uses must be conducted in a manner that is complementary with the natural character of the property. In keeping with the deed stipulation, the District allowed the City of New Port Richey to construct and operate water supply production wells on the west side of the Starkey Wilderness Park (Southwest Florida Water Management District, 2005b). Five production wells were constructed between 1974 and 1976 with the initial water production beginning in 1974. The City constructed a sixth production well in 1979.

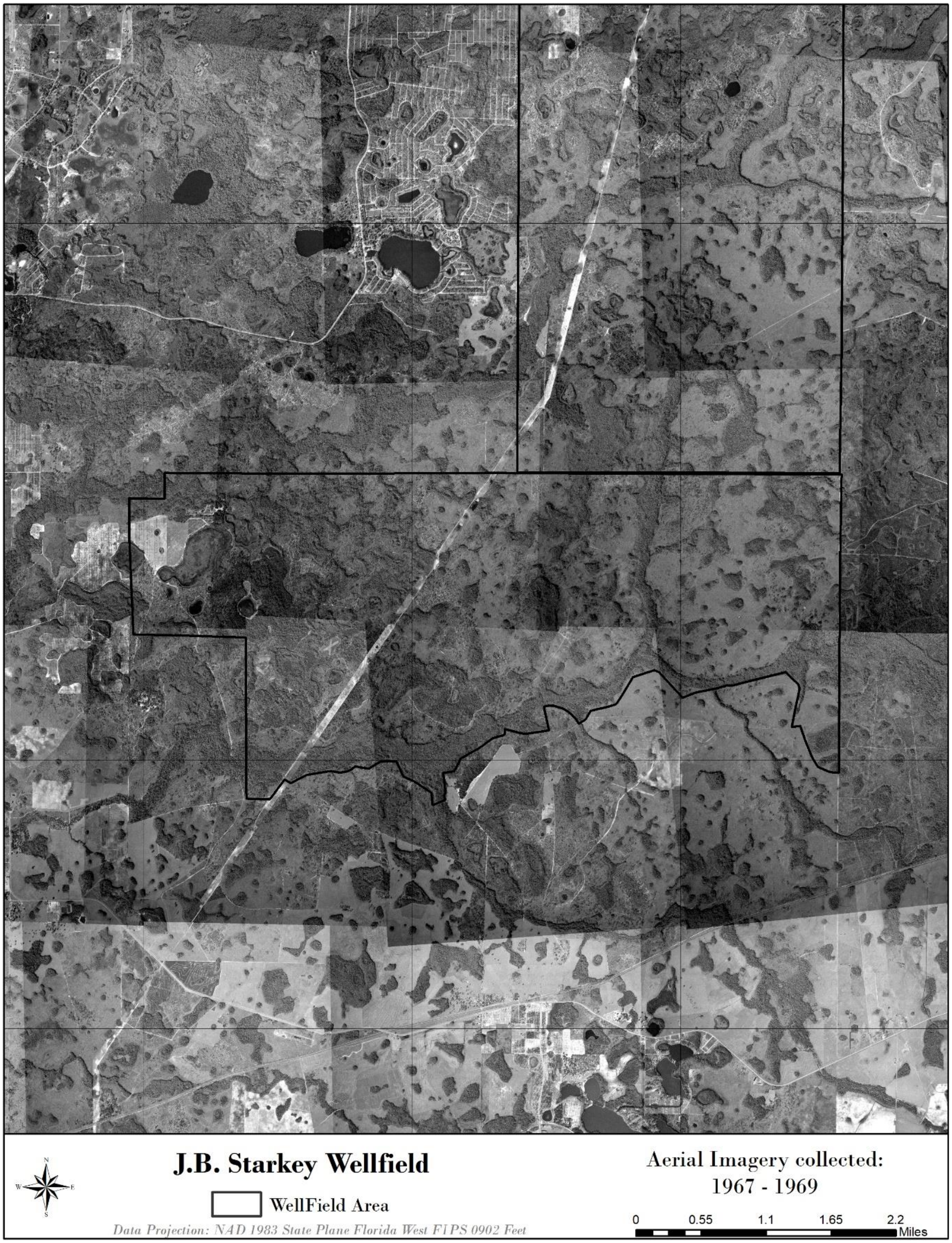

Figure 3.16: Aerial Photograph of the Starkey Wellfield Area from 1967 – 1969

The Authority entered into a water transfer and management agreement with the City of New Port Richey and the District in November 1981 to transfer the ownership and operation of the Starkey Wellfield (Figure 3.2) to the Authority (KPMG, 1997). This agreement specified that the Authority would operate the wellfield for the water supply needs of the City of New Port Richey and Pasco County and that all additional wells and water supply infrastructure would be the responsibility of the Authority. The City retained production well No. 5, located at their Maytum Water Treatment Plant, for their water supply use. The water supply from this well was transferred to a separate Water Use Permit held solely by the City of New Port Richey.

The first Consumptive Use Permit was issued to the City of New Port Richey in 1976 for an annual average of 3 mgd. A test well was constructed and tested in 1977 to explore the water supply potential for an expanded wellfield (CH2M Hill, 1983a). The Consumptive Use Permit was renewed in December 1979 and authorized an annual average of 8 mgd and a maximum daily quantity of 15 mgd from 14 existing and proposed wells (Southwest Florida Water Management District, 1988). Water Use Permit No. 204446 was issued to the Authority, New Port Richey and Pasco County in 1982 for an average annual quantity of 8 mgd and a maximum day quantity of 15 mgd. This permit was issued to facilitate the phased development of the Starkey Wellfield. In Water Year 1982, the average annual production from these initial production wells had increased to approximately 3.3 mgd. Five new production wells were constructed in the Starkey Wellfield in 1982 and early 1983 giving the Authority ten production wells generally aligned west to east across the Starkey Wilderness Park. The production quickly increased when all production wells were equipped and connected to the transmission main with the average annual production nearly reaching 8 mgd by 1984.

The next phase of wellfield development was completed over several years. Production wells ST-12 and ST-15 were constructed to the east of the existing wells by early 1984 and testing of these wells demonstrated higher transmissivity and lower leakance values than in the central and western part of the wellfield (CH2M Hill, 1982). Production wells ST-13 and ST-14 were completed along the Florida Power right-of-way in 1988 and connected to the wellfield collection main. The wellfield roads and well sites are visible in the aerial photograph from 1988 – 1989 (Figure 3.17) and by this time, urban development had occurred to the west and north of the wellfield property. The Water Use Permit for this second phase of the Starkey Wellfield was reissued in 1988 for an annual average quantity of 15 mgd and a maximum day quantity of 25 mgd. In Water Year 1989, the annual average pumping rate from the wellfield increased to 13.26 mgd to meet the increasing demand in the New Port Richey and Pasco County service areas. Since this wellfield was the primary water supply source for the City and the West Pasco Service Area, pumping rates remained high until the end of 2007 when the Starkey Wellfield was connected to Tampa Bay Water's Regional System and pumping rates could be significantly reduced.

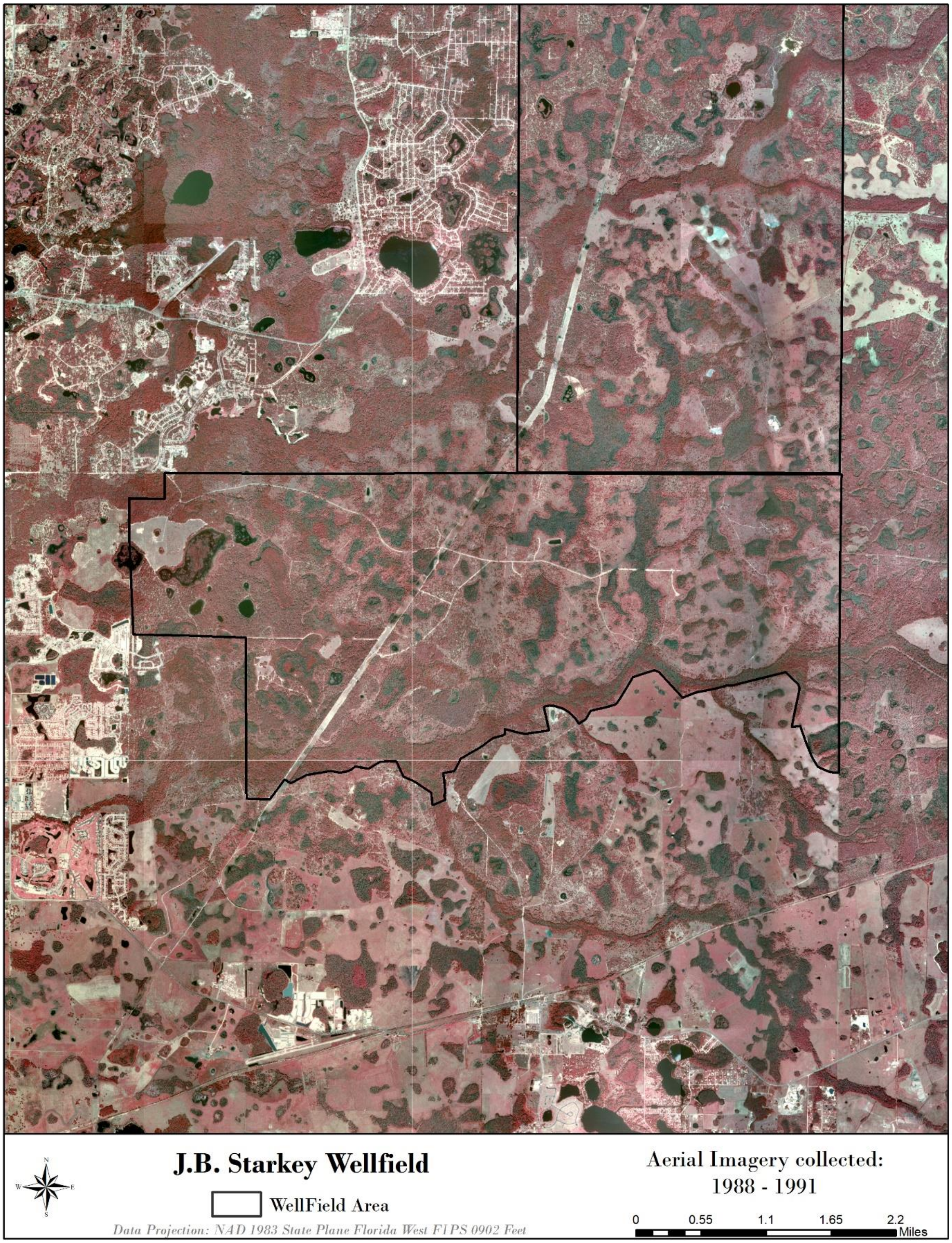

Figure 3.17: Aerial Photograph of the Starkey Wellfield Area from 1988 – 1991

The Starkey Wellfield is located within the Starkey Wilderness Park with residential development on the western and northern edges of the wellfield. New development to the south of the wellfield is visible in the aerial photograph from 2018 – 2019 (Figure 3.18). Since this wellfield is in an isolated setting with surrounding natural lands, any impacts documented in wetlands on the wellfield are due to a combination of only two factors, pumping and rainfall. Environmental monitoring reports from the 1980's show that water levels in wetlands on the western part of the wellfield were typically low, likely reflecting a greater rate of leakage of water into the surficial aquifer and underlying Upper Floridan Aquifer. Wetlands in the center of the wellfield showed the greatest water level decrease (an average of 2.3 feet of water level decline since Water Year 1983) as reported in the Water Year 1989 Starkey Wellfield Annual Report. In the late 1980's, severe subsidence occurred within wetland S-44 (also known as the "Widowmaker"); other sinkholes were documented on the Starkey Wilderness Preserve between (1982 and 1989). The wetlands on the eastern side of the wellfield showed relatively little water level changes as compared to other parts of the wellfield and regional control sites (CH2M Hill, 1990). Other historic impacts to wetlands included soil subsidence, changes in vegetational community structure, fire damage from wildfire or prescribed fire events, and tree fall due to soil loss and high-wind events (CH2M Hill, 1991).

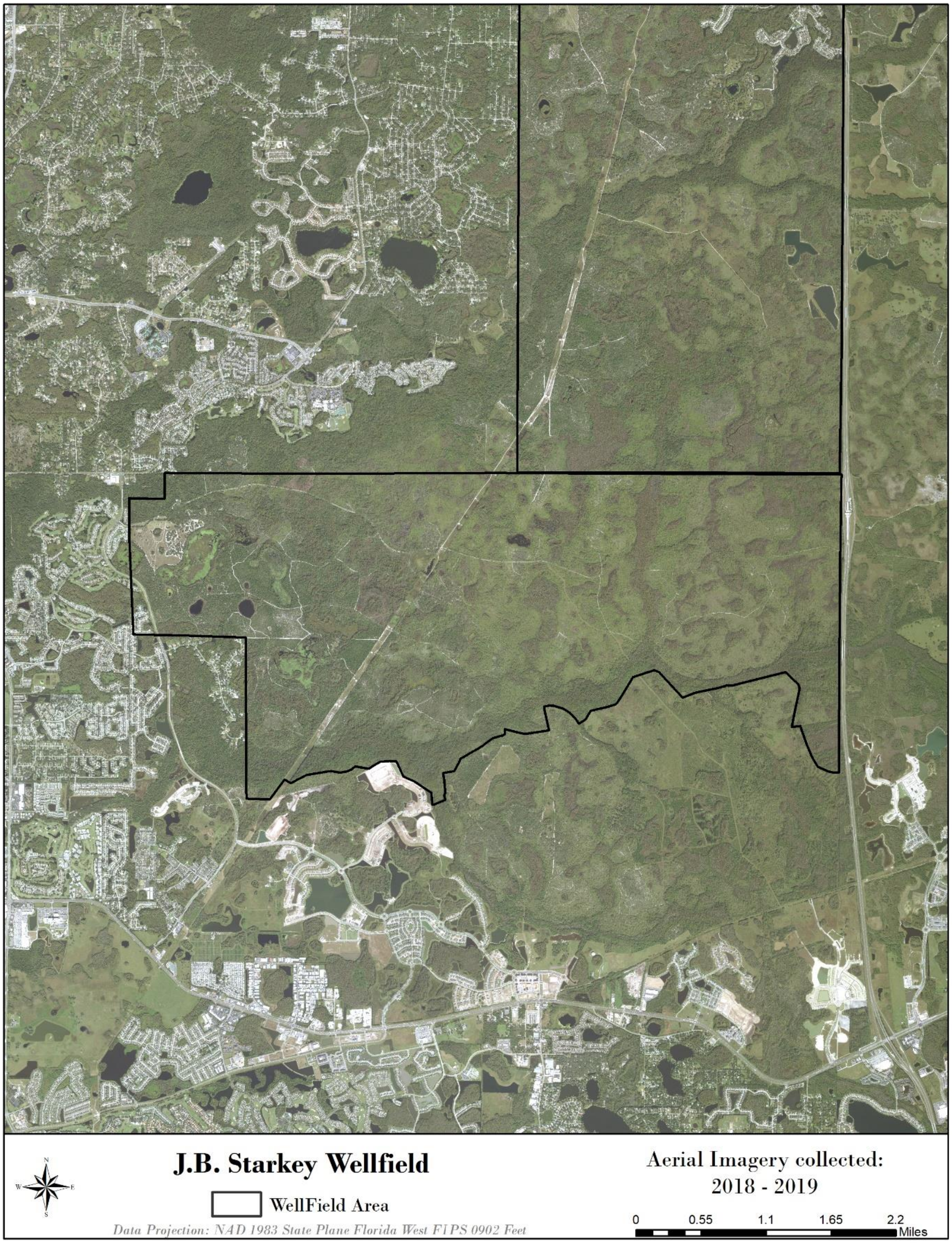

Figure 3.18: Aerial Photograph of the Starkey Wellfield Area from 2018 – 2019

3.6.2 Cypress Creek Wellfield

The need to meet the water demands of the growing Tampa Bay area through intergovernmental cooperation led the District, Pasco County, Pinellas County, and the City of St. Petersburg to begin development of the Cypress Creek Wellfield in central Pasco County. These governments worked together on this project for flood control and water storage, water supply development, wildlife refuge areas, outdoor recreation and open space (Camp Dresser & McKee, 1982). Origins of this water supply wellfield can be found in the Four River Basins Project authorized by the Flood Control Act of 1962 (Southwest Florida Water Management District, 1975). The Four River Basins plan provided for a flood detention area with water conservation reservoirs to reduce flood levels in the lower reaches of Cypress Creek and the Hillsborough River when combined with other project components. The District began work on the flood control functions of the project in 1972 as part of the multi-purpose plan for the Cypress Creek Basin area in central Pasco County. The wellfield property and surrounding area was generally undeveloped as visible in an aerial photograph from 1967- 1969 (Figure 3.19).

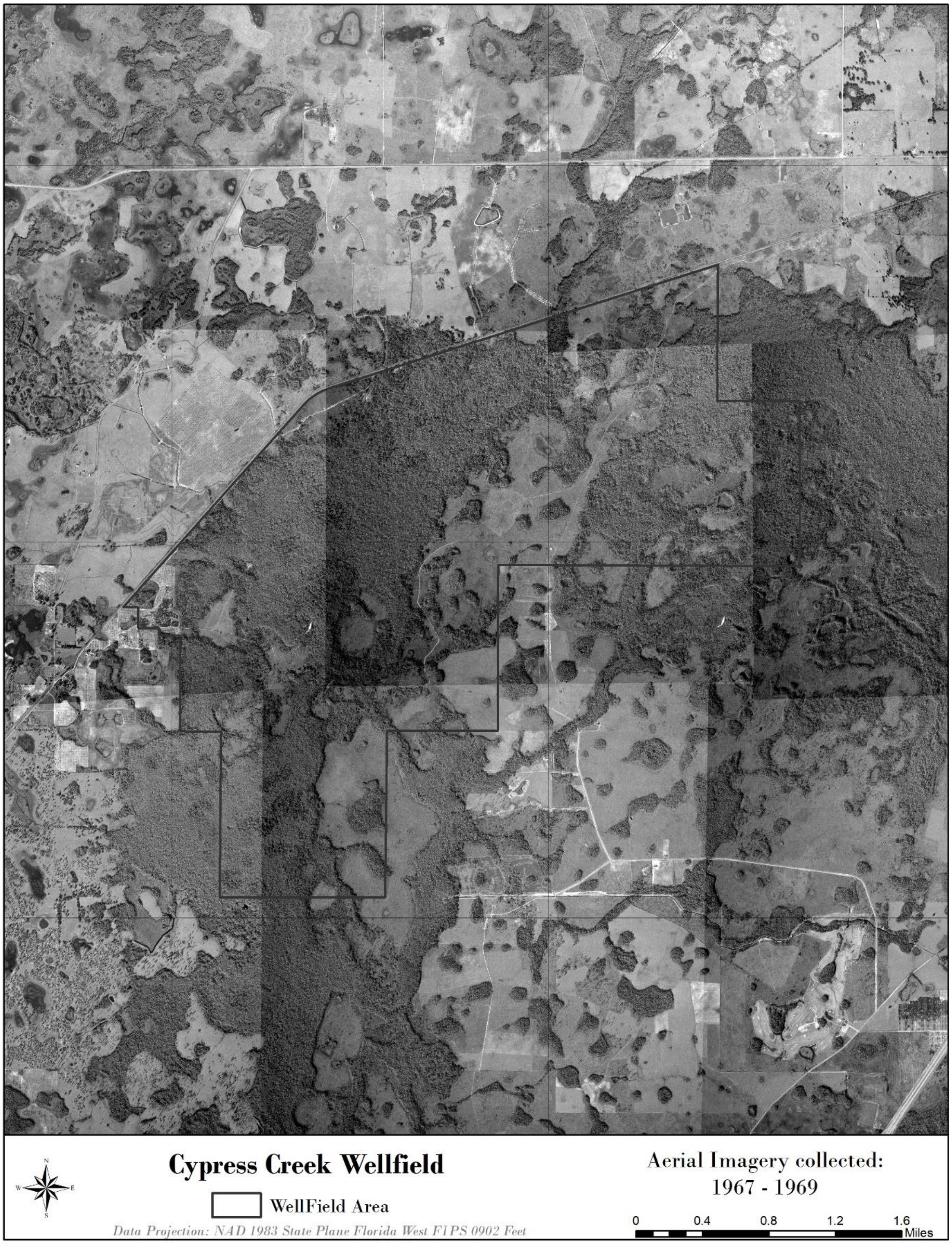

Figure 3.19: Aerial Photograph of the Cypress Creek Wellfield Area from 1967 – 1969

Prior to the formation of the Authority, the City of St. Petersburg, Pasco County and Pinellas County created the Cypress Creek Management Board in 1973. This Board was formed to guide the development of the proposed Cypress Creek Wellfield (Figure 3.2) which was to be the first regional water supply facility for the Tampa Bay area (Camp Dresser & McKee, 1982). The concept of developing a wellfield in this area was formally added to the District Four Rivers Basin project in November 1973 by agreement between the District, Pinellas County and the City of St. Petersburg (Southwest Florida Water Management District, 1975). This agreement outlined that land acquisition and the development and operation of the flood-control and water management functions of the project would be performed by the District while the Pinellas County, St. Petersburg, and Pasco County would develop the wellfield facilities.

The flood-control and surface water management portion of the project was conceived by the U.S. Army Corps of Engineers as a permanent impoundment-type reservoir facility with a conservation pool and an extensive levee system. The levee system would retain flood waters above a permanent conservation pool and these flood waters would be routed down Cypress Creek with a constructed seven-mile long flow-way connection to divert much of the flood flow to Trout Creek. The portion of the flows diverted to Trout Creek would be routed to the Lower Hillsborough Flood Detention Area. The original plan called for an approximate 12,000 acre impoundment area with eight miles of levees. The levees were to be at a low elevation and constructed along previously disturbed lands except in the areas in the Cypress Creek floodplain. The Cypress Creek impoundment area was to be separated into two basins with the first levee at the approximate location of the current Cypress Creek Wellfield access road; a structure within this levee would allow for discharge of water from this upper basin area south down the channel of Cypress Creek. The lower impoundment area would be located behind a second levee system located on the north side of State Road 54 with control structures to regulate the flow down Cypress Creek and to divert more significant flows down a constructed canal to Trout Creek. Maximum water depths within the upper and lower pools at flood stage would be 13 feet and 15 feet, respectively. The combined conservation pool for the upper and lower basins was sized to provide 34,000 acre-feet of permanent storage and an additional 63,000 acre-feet of flood storage. (Southwest Florida Water Management District, 1975).

Management of water in the upper and lower basins of the Cypress Creek Basin area was expected to provide water supply benefits in two ways. The regulation of flows in the Cypress Creek and Trout Creek system would provide sustained stream flow in these tributaries to the Hillsborough River which is the primary water supply for the City of Tampa. The second water supply benefit was the joint development of the impoundment reservoir and production wells located on the east side of the project boundary. The plan anticipated that the water stored in the impoundment area would recharge the aquifer and provide water to the wellfield production wells. The District evaluation report also stated that “the dewatering effects of the pumping will make available additional storage capacity in the upper sands”. The District suggested that this additional recharge could substantially increase the yield of the wellfield within allowable environmental constraints. The wellfield was to be developed in two phases: the first phase would be located to the east of the upper basin and the second phase would be developed along the lower basin at some future date.

The District’s assessment report also contained an extensive evaluation of the environment within the Cypress Creek Basin and the potential effects that could be observed following the development of the impoundment areas and wellfield. District staff expected some thinning and stress of the vegetation within the impoundment areas due to the increased water levels for sustained periods of time. The leakance rate of the water table to the Upper Floridan Aquifer was unknown at the time the project was developed so the rate of water table drawdown due to wellfield pumping was undetermined. The report also stated that the new housing developments to the south and east of the wellfield would benefit from a lower water table due to wellfield pumping. The benefits would be reduced flooding in the surrounding local wetlands and improved septic-tank operations. District staff predicted that any ecological impacts due to wellfield pumping would take years to occur, but these impacts were expected to be largely offset by the impoundment of water and the associated recharge of the water table.

The District assessment report for the Cypress Creek Basin project also cautioned that if the wellfield was constructed but the flood detention facilities were not developed, there would be a greater drawdown in the water table and Upper Floridan Aquifer with greater severity of impacts to the tree canopy and understory vegetation, enhanced desiccation of organic wetland soils leading to soil subsidence and tree fall, reduced wildlife due to habitat impact, and an increased risk of wildfire. The U.S. Army Corps of Engineers performed additional economic analyses and concluded in 1977 that the structures which had been planned in the Cypress Creek Basin were no longer justified under their evaluation criteria. The District completed additional studies to determine the feasibility of smaller control structures and develop an Operation and Management Plan for the wellfield and reduced flood detention area using these smaller structures (Seaburn and Robertson, Inc., 1980). The U.S. Army Corps of Engineers report states that "the Lower Hillsborough Flood Detention Area and the Tampa Bypass Canal were the first two and only components of the comprehensive system to be constructed within and upstream of the Hillsborough River Basin as part of the Four River Basins Project" (U.S. Army Corps of Engineers, 2013). The Cypress Creek Wellfield access road was elevated to form a low berm across the Cypress Creek Floodplain and the District constructed a water control structure where the creek intersected the berm. This is the only component of the original surface water impoundment project that was constructed. The District also developed a schedule to retain and manage the water behind the berm to maintain water levels for the floodplain system, manage the growth of nuisance vegetation species, and reduce fire risk. The water diversion stored behind the low berm would be used to offset stresses from wellfield pumping.

The wellfield was developed by the City of St. Petersburg with the initial ten production wells constructed between 1974 and 1977. An extended pumping test was conducted beginning in 1976 as ordered by the District so that the wellfield capacity and appropriate aquifer regulatory levels could be established (Leggette, Brashears & Graham, 1977a). The water produced for this long-term aquifer test was the first water pumped from the new wellfield. A regional pumping station was built by Pinellas County to treat the water from the wellfield and an 84-inch diameter transmission main was constructed from the wellfield to the county and city water treatment plants located further downstream. The City of St. Petersburg owned approximately 1,280 acres of the wellfield area with the remaining 3,700 acres owned by the District. Agreements were executed in 1976 for the Authority to assume management responsibility for the Cypress Creek Wellfield and pumping station on January 1, 1977 (Camp Dresser & McKee, 1982).

The District issued the first Consumptive Use Permit for the Cypress Creek Wellfield (CUP No. 27703650) in March 1978 by District Order 78-24. This permit authorized an average annual quantity of 30 mgd and was set to expire on Dec. 31, 1980. The permit required the Authority to conduct an aquifer stress test for the wellfield between April 18, 1978 and June 27, 1978 and determine if "significant anomalous events" or "unanticipated events" would occur as a result of wellfield pumping at 30 mgd. The aquifer stress test was continued until Dec. 31, 1978 to cover a longer time period and drier conditions; neither significant anomalous events nor unanticipated events occurred. (West Coast Regional Water Supply Authority, 1978). It was noted however, that several water table monitoring wells went dry during the period of the 30 mgd wellfield test. Wellfield pumping continued in 1979 under the initial permit which was the first year in which the average annual pumping rate reached or exceeded 30 mgd. The District renewed the Consumptive Use Permit in September 1979 at the existing rate of 30 mgd based on the monitoring data that had been obtained at the wellfield. The final three production wells and associated wellfield collection main were constructed in early 1980 on the east side of the wellfield extending to almost the eastern property boundary. The wellfield maintained an annual average quantity of 30 mgd and a peak month quantity of 40 mgd until the issuance of the Consolidated Permit in 1998.

The District began ecological monitoring at the Cypress Creek Wellfield in 1975 and the Authority assumed and expanded the monitoring program in 1978. As was noted during the initial wellfield testing in 1978, the water table in some areas of the wellfield was very low or dry for periods of time and some wetlands in these areas had low or no standing water for long periods. The Authority began a limited augmentation program in 1978 and 1979 for two marshes on the northern part of the wellfield that had been dry. Two isolated cypress wetlands on the east side of the wellfield were added to the augmentation program in 1980 by adding groundwater from nearby production wells (GPI Southeast, Inc., 2012). Other candidate mitigation sites with very low or absent water levels were identified in the District's comprehensive report for management of the wellfield. These additional sites were not augmented by the Authority; however, monitoring at these and other sites continued to better understand the relationship between pumping and ecological changes (Seaburn and Robertson, Inc., 1980). The historical environmental monitoring reports include descriptions of the environmental impacts that began to appear after several years of wellfield pumping at an average rate of 30 mgd and periodic dry conditions. These impacts included invasion of nuisance and exotic vegetation, transition of upland plants into wetland areas, soil subsidence and oxidation, and extensive tree fall in the floodplain areas of the wellfield. These conditions are discussed in more detail in Section 3.9.

Homes in the Quail Hollow subdivision were constructed after 1974 and continued through 1995, including some along Quail Run Drive, immediately south of the wellfield property boundary. These homes were constructed with septic tank systems which exist to the present time. This development is visible to the southeast of the wellfield property in the aerial photograph from 1988 – 1989 (Figure 3.20) along with low-density residential development to the west of the wellfield.

Figure 3.20: Aerial Photograph of the Cypress Creek Wellfield Area from 1988 – 1991

Development adjacent to the Cypress Creek Wellfield continued in the 1990’s with the construction of Saddlewood Estates, located on the east side of the wellfield property boundary. The Environmental Resource Permit (ERP No. 405686) for Phase I of this development was issued in 1989 with road construction beginning in 1990; home construction was generally complete by the late 1990’s. The ERP for Phase II of this development was issued in 1995 and home construction in Phase II began by 1998 with the final construction of homes by 2004.

The subdivisions of Saddlewood Estates and Quail Hollow are both located adjacent to the east and southeast property boundary of the Cypress Creek Wellfield and are visible in the 2018 – 2019 aerial photograph in Figure 3.21. These communities experienced extensive flooding in the summer of 2003 as the region received over 80 inches of rainfall, with extensive rainfall recorded in December 2002 and June/July 2003. Water Year 2003 was also the first year of reduced pumping from the Cypress Creek and other regional wellfields as described in Section 3.15 of this report. The flooding within these two communities led to the creation of a surface water management system on the eastern side of the wellfield to alleviate some of the flooding that is now experienced in these communities on a frequent basis and to restore impacted wetlands on the east and central part of the wellfield. This project is described in detail in Section 3.13.2.3.

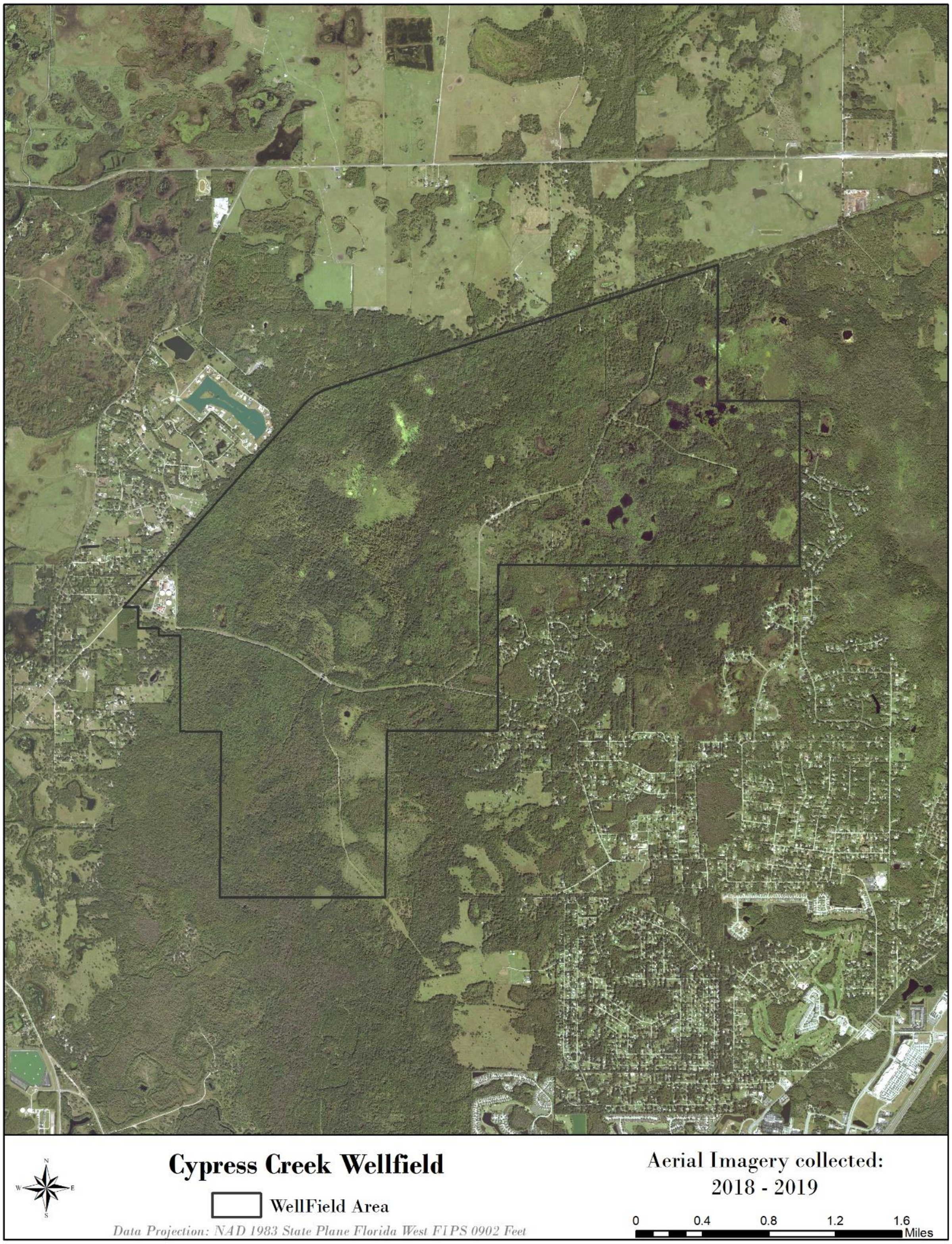

Figure 3.21: Aerial Photograph of the Cypress Creek Wellfield Area from 2018 – 2019

3.6.3 Northwest Hillsborough Regional Wellfield

The northwest Hillsborough County area was another focal point of growth and development in the years following World War II. In 1950, the total population of Hillsborough County was 249,894 people. Over the next two decades, the population doubled to 490,265 people in 1970 (Table 3.1). Growth continued with the county population doubling to nearly a million by 2000. Aerial photography from 1938 (Figure 3.22) through the early 1950's show that Hillsborough County to the northwest of the City of Tampa was used for agriculture purposes with multiple streams and associated floodplains extending to Tampa Bay.

Figure 3.22: Aerial Photograph of the Northwest Hillsborough Regional Wellfield Area from 1938

Flooding in the northwest Hillsborough County area became a major concern in the 1950's as this area began to transition from agriculture to residential/commercial land uses. To alleviate the flooding issues, the U.S. Soil Conservation Service constructed two channels, Channels A and G, in the Rocky Creek and Sweetwater Creek watersheds. The construction of Channel A is clearly visible in the lower left corner of the northwest Hillsborough County aerial photograph from 1967 – 1969 (Figure 3.23). Other minor channels were connected to these main channels and largely completed by 1972. These channels carried flood waters to Tampa Bay in the wet season and also lowered water levels in the surficial aquifer near the channels, making the land suitable for development. It has been estimated that the urbanization and the construction of interconnected surface water drainage systems in northwest Hillsborough County have lowered the water table in the area by as much as 5 feet as compared to the pre-development period (HSW Engineering, Inc., 2018b). A change in the surface water management gate operation in Channels A and G in 2014 resulted in decrease of surface water in the main channels of 2-3 feet which likely further lowered local water table elevations. The extensive urbanization of the area surrounding the Northwest Hillsborough Regional Wellfield is evident in the aerial photograph from 2018 – 2019 (Figure 3.24).

Figure 3.23: Aerial Photograph of the Northwest Hillsborough Regional Wellfield Area from 1967 – 1969

Figure 3.24: Aerial Photograph of the Northwest Hillsborough Regional Wellfield Area from 2018 – 2019

New subdivisions constructed in the northwest Hillsborough County area were served by community production wells and local water distribution systems installed by the developers. Hillsborough County began acquiring these community water systems in 1970 and operated 12 separate water systems by 1980. These dispersed water supply systems had deficiencies including no interconnections, varying water quality concerns, limited water treatment capabilities, lack of backup supply during power outages, and capacity limits in some of the individual water systems. A water supply plan was completed for this specific region in 1980 to estimate future demands and develop water supply alternatives for this growing area. The study recommended the construction of a County water treatment plant at the Section 21 Wellfield, purchasing water from the City of St. Petersburg and Authority and eventually phasing-out the original dispersed production wells (Ross Saarinen Bolton & Wilder, 1980).

Beginning in 1973, Hillsborough County considered the construction of a new wellfield to the west of Sheldon Road. Test wells were constructed in 1974-1975 but the specific capacity of the wells was relatively low. The County continued to assess this option through the late 1970's due to increasing water demand and deteriorating water quality (including high chloride concentrations) from the dispersed wells located south of Waters Avenue in northwest Hillsborough County (Hillsborough County, 1976). The cumulative supply capacity of the franchise wells acquired by the County was 7.6 mgd (University of South Florida Water Atlas) and in 1981, a Water Supply Contract was executed between the Authority and Hillsborough County for the development of water supply projects in the northwest and south-central service areas of the County. The Authority's 1982 Regional Water Supply Needs and Sources update report identified a new linear wellfield located south of the Section 21 Wellfield to meet the needs in northwest Hillsborough County (Camp, Dresser & McKee, 1982). The Authority began a testing program in early 1983 at the proposed Sheldon Road location by deepening the existing test production well; the specific capacity was improved but remained relatively low. The report recommended construction and testing of another test well site along Gunn Highway to provide additional data necessary to design a regional wellfield in that area (CH2M Hill, 1983b).

The Authority and Hillsborough County received a joint Water Use Permit in 1984 that consolidated 16 permits for the small individual franchise water systems in northwest Hillsborough County and included the seven new wells of the Northwest Hillsborough Regional Wellfield (Figure 3.2). This permit was issued for an average annual quantity of 8.8 mgd. This quantity remained the same until the issuance of the Consolidated Permit in 1998. The County gradually removed all of the small franchise production wells from service by the early 1990's following the construction of this regional wellfield. The Authority constructed six new production wells in the northwest between 1983 and 1985 and converted the existing test to a production well at the former Sheldon Road test site (CH2M Hill, 1986). Six of the production wells were constructed in the vicinity of Gunn Highway from Sheldon Road toward Dale Mabry Highway and one production well (NWH-7) was constructed on Van Dyke Road to the west of the Section 21 Wellfield. Production well NWH-7 was constructed along the Authority's regional pipeline to the Cosme Water Treatment Plant to provide additional supply to the City of St. Petersburg. This well was connected directly to the Lake Park Pumping Station in 2010 to serve the demands of the northwest Hillsborough County area.

3.6.4 Morris Bridge Wellfield

The City of Tampa and District began exploration for a wellfield location north of the Hillsborough River in 1969 to augment the City's water supply during high demand times and meet future water needs. The District executed an agreement with the City in 1970 giving them permission to conduct well drilling and aquifer testing activities within six sections of land located within the Lower Hillsborough River Flood Detention Area. This property and the surrounding area were essentially undeveloped as shown in aerial photography from 1967 – 1969 (Figure 3.25). The agreement gave the City the option to secure the right to develop and use this area if the aquifer testing proved favorable. Between 1970 and late 1973, several test wells and monitor wells were constructed and it was determined that this location would support a wellfield. Twenty production wells were constructed on this 3,800 acre parcel in 1976; the wells had 16-inch diameter casing to approximately 220 feet below land surface and total depths ranging from 542 to 682 feet below land surface. Much of this property was isolated wetland and stream systems and the contractor who constructed the wellfield built a loop access road through the property connecting to each of the production wells. The City first used the Morris Bridge Wellfield (Figure 3.2) in an emergency mode to augment the Hillsborough River Reservoir during in the month of May 1977 at a rate of up to 20 mgd (Tampa Water Department, 1979). This water was discharged into Trout Creek to raise the elevation of the City's reservoir during a drought.

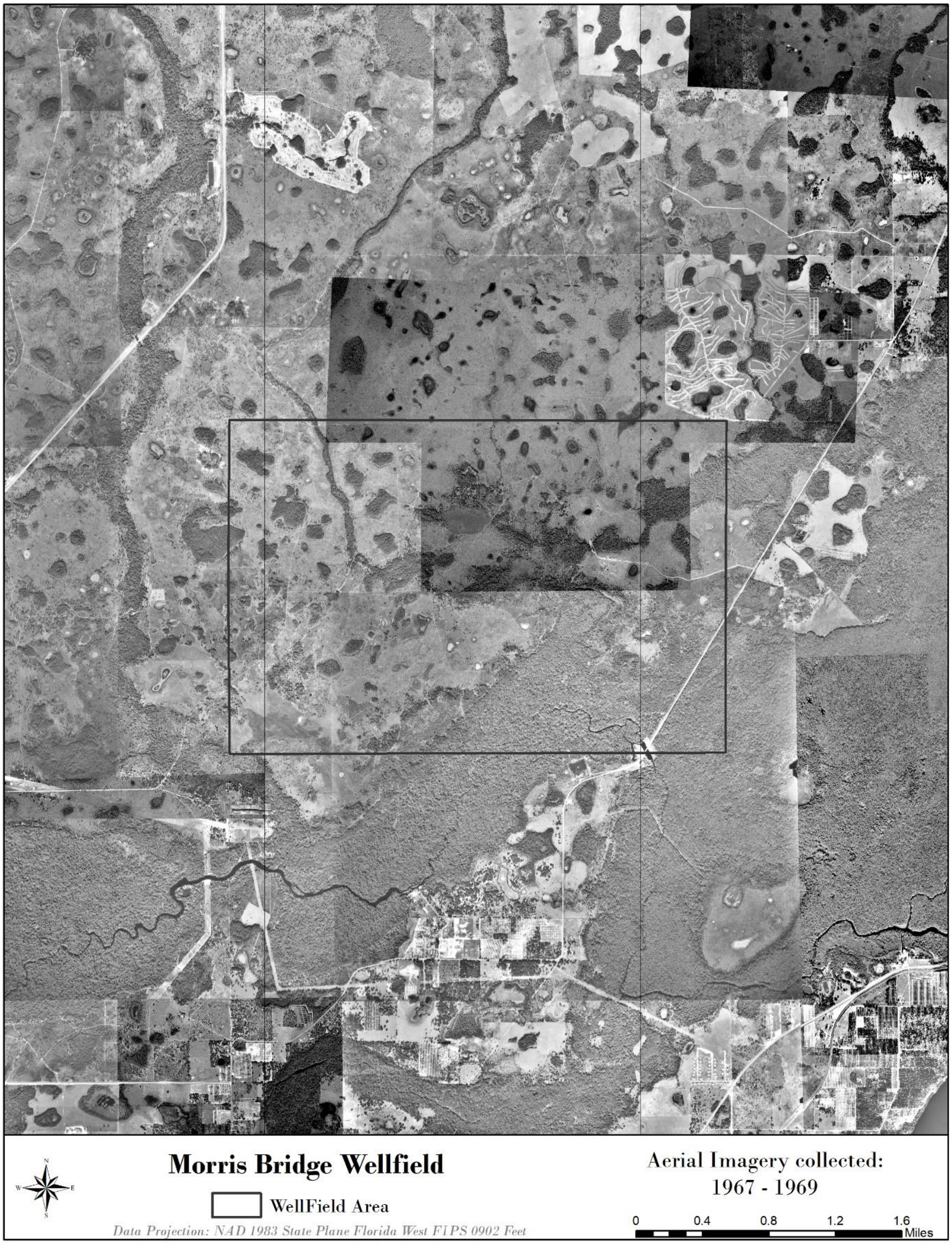

Figure 3.25: Aerial Photograph of the Morris Bridge Wellfield Area from 1967 – 1969

The City submitted a Consumptive Use Permit application in November 1977 and the District issued a series of Board Orders requiring additional well construction and testing to support the permit application. The water pumped during the wellfield testing was used within the City's water distribution system beginning in April 1978. The annual average pumping rate from the Morris Bridge Wellfield ranged from approximately 12.5 to almost 18 mgd during Water Years 1978 through 1982. The District approved Consumptive Use Permit No. 204180 in November 1983 allowing for an average annual rate of 15.5 mgd and a maximum daily rate of 30 mgd from the wellfield (Dyer, Riddle, Mills & Precourt, Inc., 1986). These permitted quantities remained until the issuance of the Consolidated Permit in 1998. The wellfield access road and production wells are visible in the aerial photograph from 1988 – 1989 (Figure 3.26). At the time of this photograph, residential development was occurring on the north and west borders of the wellfield.

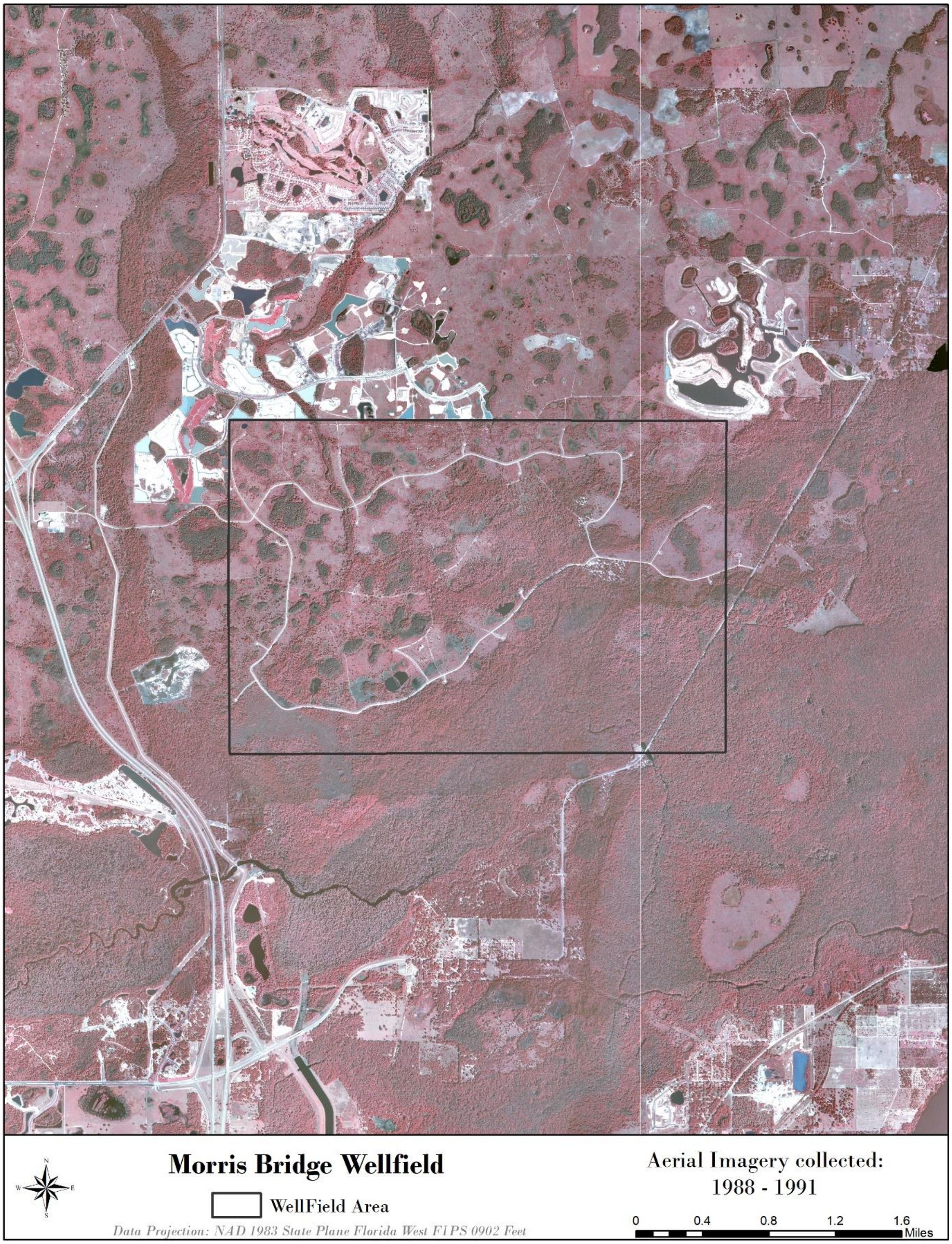

Figure 3.26: Aerial Photograph of the Morris Bridge Wellfield Area from 1988 – 1991

The Morris Bridge Wellfield Analysis conducted for the City in 1986 assessed the current ecological condition of the environment on the wellfield and discussed the predicted impacts of wellfield pumping. The analysis predicted the relative degree of impact to different wetland types with declines of the water table in 0.5-foot increments. Some moderate impacts were predicted for some wetland types with 1.0 foot of drawdown in the water table and more significant impacts were expected to marsh and isolated wetland communities with 1.5 to 2.0 feet of water table decline. The riverine systems flowing through the property would be relatively unaffected by pumping since the drainage basins feeding these riverine systems are located largely off the wellfield and pumping would not cause changes in these drainage basins. The ecological discussion of this report stated that some wetlands in the northern part of the wellfield had low water levels and may not be underlain by a clay confining layer making them more susceptible to the effects of pumping. It was also noted that the southern part of the loop access road was constructed above grade to retain water on-site for aquifer recharge. During the wet winter months of 1985, high water impoundment behind the wellfield road killed some vegetation in flatwoods habitat. The culverts under the loop road were insufficient to allow drainage of flood waters in time to prevent the vegetation mortality (Dyer, Riddle, Mills & Precourt, Inc., 1986).

The City of Tampa applied to renew and combine their Consumptive Use Permits for the Hillsborough River and Morris Bridge Wellfield in August 1989. This permit was issued in September 1989 and combined the supply sources together under the City's existing permit for the Hillsborough River (CUP No. 202062.02). The Morris Bridge Wellfield was authorized for an average annual quantity of 15.5 mgd with a peak month average of 27 mgd and a maximum day quantity of 30 mgd. The City continued to use the wellfield to meet peak demands, especially during the dry spring months and during drought conditions. Impacts to wetlands were discussed in the City responses to District Questions 26 – 28 from the permit application. The City consultant identified impacts to marsh wetlands throughout the wellfield in an analysis of 1988 data and aerial photographs. These were vegetative impacts largely focused in the central and northern parts of the wellfield. Field inspection of cypress systems showed vegetation and tree impacts including impacts due to insect and fire damage in the early 1980's. In response to District Question No. 37, the consultant identified a marsh between production wells MB-154 and MB-155 with depressions that were known to have occurred prior to 1989; this location corresponds to the currently-monitored wetland MBR-10 (Dyer, Riddle, Mills & Precourt, Inc., 1990).

The wellfield property has remained in the same physical condition as when first developed by the City of Tampa; it is now maintained by the District as a day-use facility known as the Flatwoods Wilderness Park. In the early 2000's, Tampa Bay Water modified three of the drainage structures under the south loop road in 2005 to alleviate some of the vegetation impacts noted by the District and City of Tampa on both the upstream and downstream sides of the structures (Reynolds, Smith & Hills, 2003). The structure modifications also eliminated scouring of sediments near the structures by reducing the flow velocity of these channelized systems. Tampa Bay Water also restored an access trail near monitored wetland MBR-30 in 2019 to provide access to the site and potentially improve the hydroperiod and high-water levels in this wetland. Other physical feature changes are associated with the significant development that has occurred on the immediate northern and western boundaries of the wellfield. The Hunter's Green, Arbor Greene, and Cory Lake Isles developments were constructed in the 1990's and 2000's, have permitted stormwater management systems and are located within the headwaters of the Clay Gully and Wild Hog Slough systems. The extensive urbanization to the north and west of the wellfield are clearly visible in the aerial photograph from 2018 – 2019 (Figure 3.27).

Figure 3.27: Aerial Photograph of the Morris Bridge Wellfield Area from 2018 – 2019

3.6.5 Cross Bar Ranch Wellfield

Population growth and an increasing demand for water in the 1970's led Pinellas County to purchase property in north-central Pasco County for a potential water supply wellfield. The county population had surpassed 500,000 people in 1970 and would reach 728,531 people by 1980 (Table 3.1). The annual average pumping rate from the Eldridge-Wilde Wellfield reached 30 mgd in Water Year 1971 and the County needed another water supply source. They acquired the Norris Cattle Tract in 1975 as their next water supply source and this property would become the Cross Bar Ranch Wellfield (Pinellas County Utilities, unknown). The property was approximately 8,000 acres and had been owned and used by the Norris Cattle Company for approximately 30 years (Leggette, Brashears & Graham, 1978). A review of historical aerial images of the property show extensive ditch systems already constructed or under construction by 1941 (Figure 3.28). These ditches connected to most of the wetland systems on the property in a south-to-north direction to a larger ditch (known as Jumping Gully) that flows off the property to the west, eventually to Crews Lake. The intent of this system is to move excess standing water off the property, making the property more suitable for cattle ranching. In the late 1950's and early 1960's, some citrus was grown on the central and southern portion of the property (see Figure 3.29) but was phased out by the mid 1980's (see Figure 3.30). Historic images show that there was very little development in this area through the 1960's.

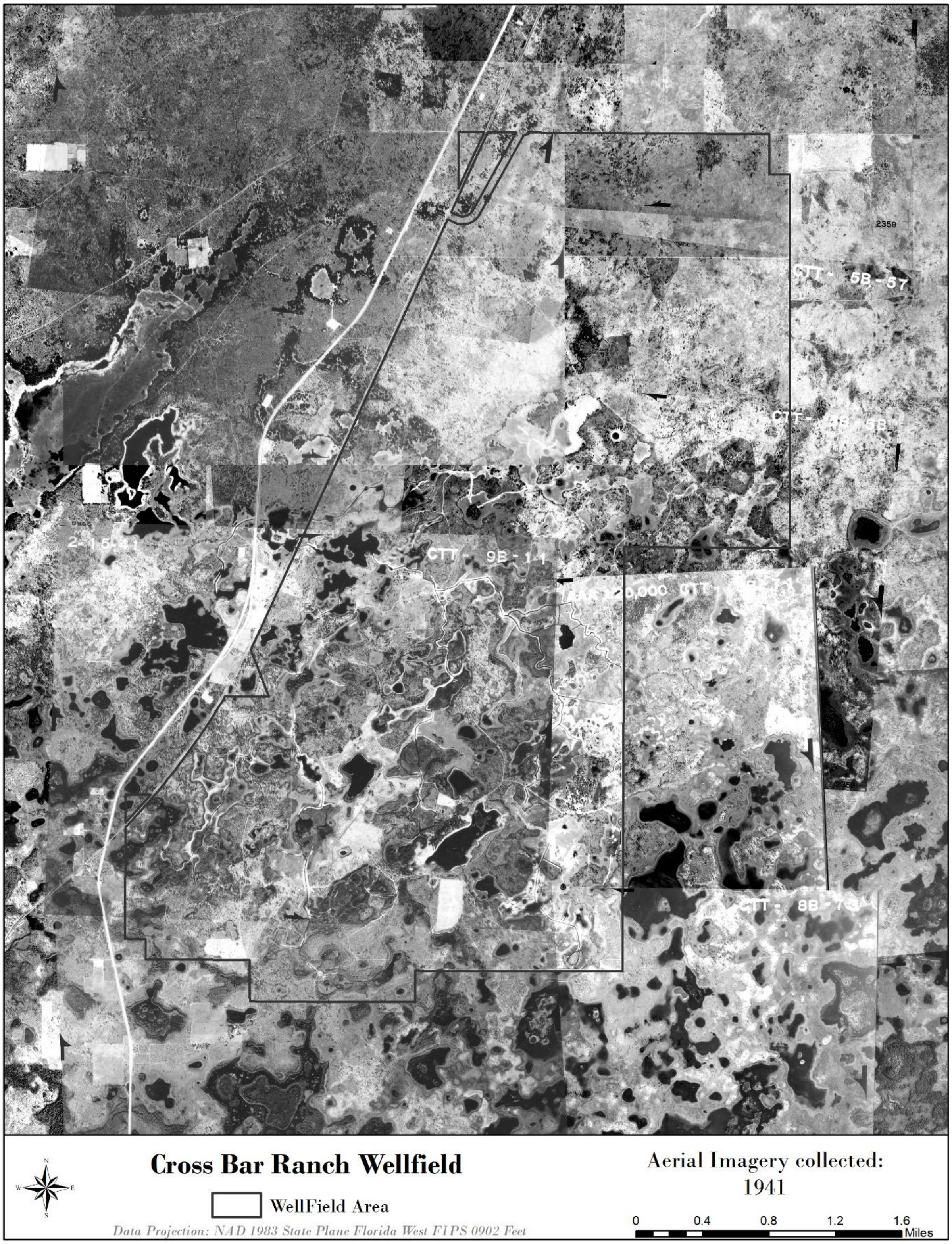

Figure 3.28: Aerial Photograph of the Cross Bar Ranch Wellfield Area from 1941

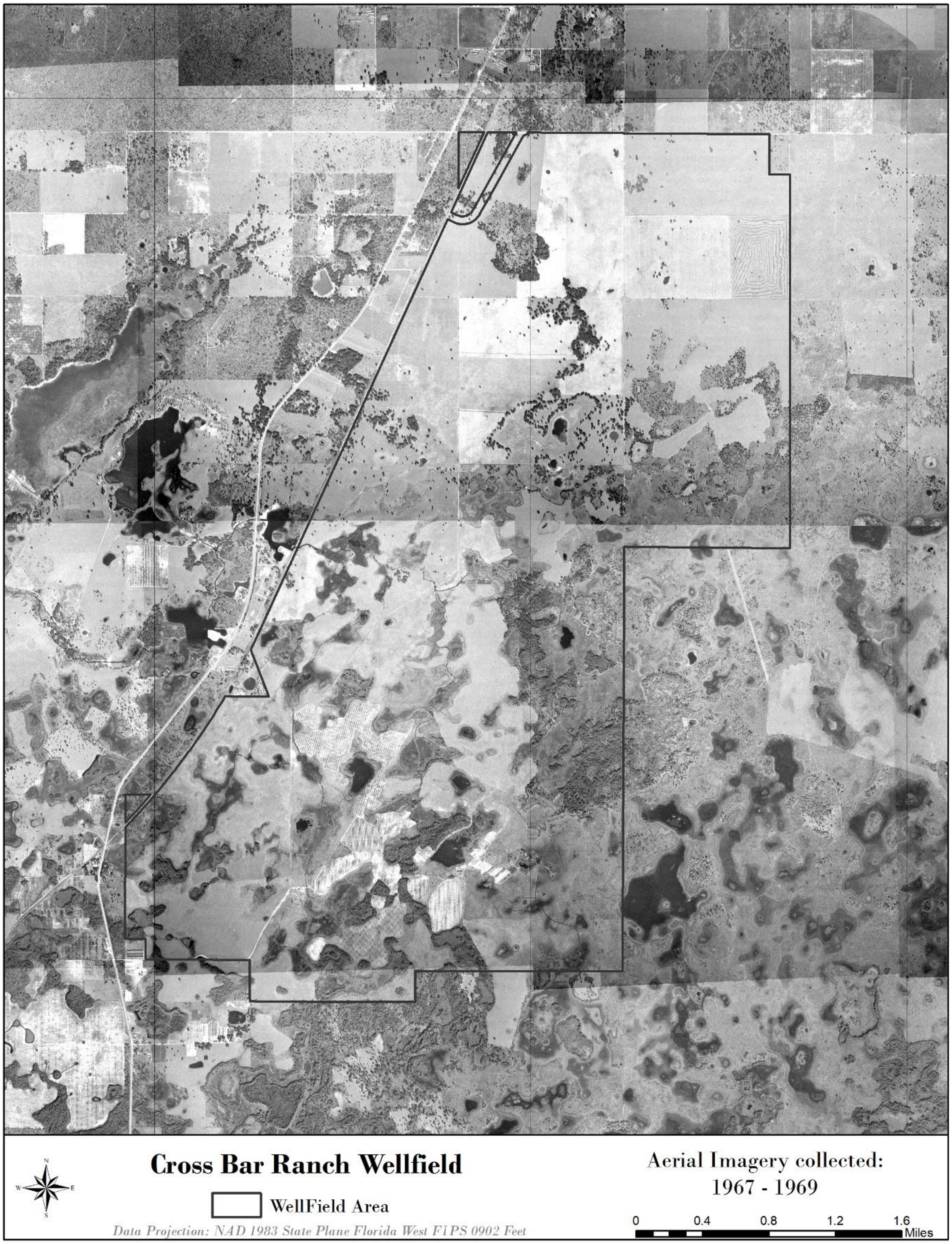

Figure 3.29: Aerial Photograph of the Cross Bar Ranch Wellfield Area from 1967 – 1969

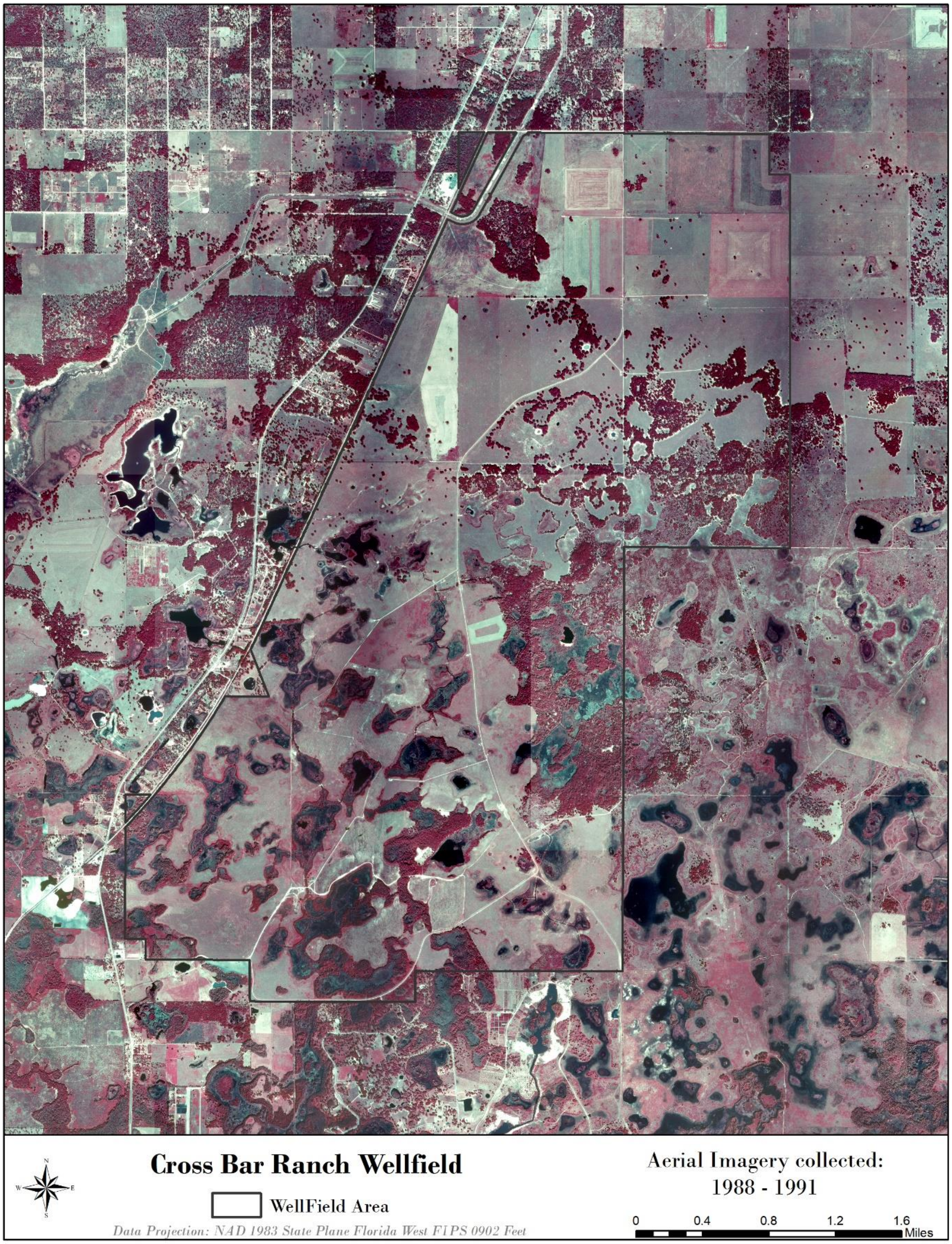

Figure 3.30: Aerial Photograph of the Cross Bar Ranch Wellfield Area from 1988 – 1991

In 1976, Pinellas County evaluated the water supply potential of this property and found that the land was favorable for the development of large quantities of potable water. An additional hydrogeological investigation performed in early 1977 provided the detail that would be needed to support a Consumptive Use Permit for the site. Included were alternative configurations of production wells that should minimize any pumping-related effects off of the property and conform to the Consumptive Use Permit evaluation criteria of the District at that time (Leggette, Brashears & Graham, 1977b). The Authority and Pinellas County executed the Cross Bar Water Development Agreement in November 1977 which granted the Authority the right to develop a wellfield on the Cross Bar Ranch property (Camp Dresser & McKee, 1982).

The Authority continued the hydrologic evaluation of the Cross Bar Ranch property including the installation of wells into the Upper Floridan Aquifer and surficial aquifer in order to complete three aquifer performance tests in the north, central, and southern portions of the property. The results of the pumping test program were used to develop a groundwater flow model and alternative production well alignments. The selected alignment of the production wells showed a predicted drawdown in the upper Floridan aquifer of approximately 5 feet at the property boundaries with 1 to 2 feet of drawdown predicted in the water table at the property boundaries (Leggette, Brashears & Graham, 1978). The well drilling and testing program data and groundwater modeling analysis were submitted to the District to support a Consumptive Use Permit application and the District issued a permit (CUP 27704290) in October 1978 for an average annual quantity of 15 mgd average and a maximum day quantity of 20 mgd. This allowed for the construction of the first phase of the wellfield to begin (Camp, Dresser & McKee, 1982).

The Authority submitted the well construction and testing information from the first phase of wellfield construction to the District and the Consumptive Use Permit was reissued in February 1980 for an annual average quantity of 30 mgd and a maximum day quantity of 45 mgd. This permitted quantity remained until the issuance of the Consolidated Permit in 1998. This second permit allowed the Authority to proceed with the second phase of wellfield construction (Camp, Dresser & McKee, 1982). A total of 17 production wells were installed between 1978 and 1980, in a general north to south alignment in the center of the Cross Bar Ranch property (Figure 3.2). The wellfield began pumping water for the region in April 1980 at an annual average quantity of approximately 4 mgd in Water Year 1980. Annual average pumping rates remained at or below 15 mgd until Water Year 1987 when the average annual pumping rate was increased to 22.8 mgd.

During the wellfield development, the Cross Bar Ranch continued to be operated as a cattle ranch under a lease from Pinellas County. In 1990, the County also purchased the 4,092-acre Al Bar Ranch, located on the eastern border of the Cross Bar Ranch, to provide a natural buffer and wellhead protection area for the wellfield (Pinellas County Utilities, 2009). The County has continued to manage the Cross Bar Ranch with cattle ranching operations on the north side of the property and began planting pine trees in the mid-1990's on the south and central portions of the property for pine needle and timber production. Several areas of the adjacent Al Bar Ranch have also been planted with pine trees and parts of the property have been enhanced for scrub jay habitat.

The Cross Bar Ranch Wellfield remains in a rural and agricultural setting; however, homes have been constructed adjacent to the wellfield on the south and west-central portions of the property. Pasco Lake is located just off the west property boundary where the drainage system known as Jumping Gully exits the property. A few homes appear in 1974 aerial photographs for this area but at that time, none were found on the west side of U.S. Highway 41. A few homes appear on or near Pasco Lake and the first houses located west of U.S. Highway 41 appear by 1985 (see Figure 3.30). More residential construction in the area between the wellfield and Crews Lake is evident by 1990 and 1995. The Pasco Trails Estates neighborhood is located immediately south of the wellfield and north of State Road 52 and appears in 1985 aerial photographs. Additional homes were constructed in the late 1980’s and early 1990’s. The current landscape around the wellfield can be seen in the 2018 – 2019 aerial photograph presented in Figure 3.31.

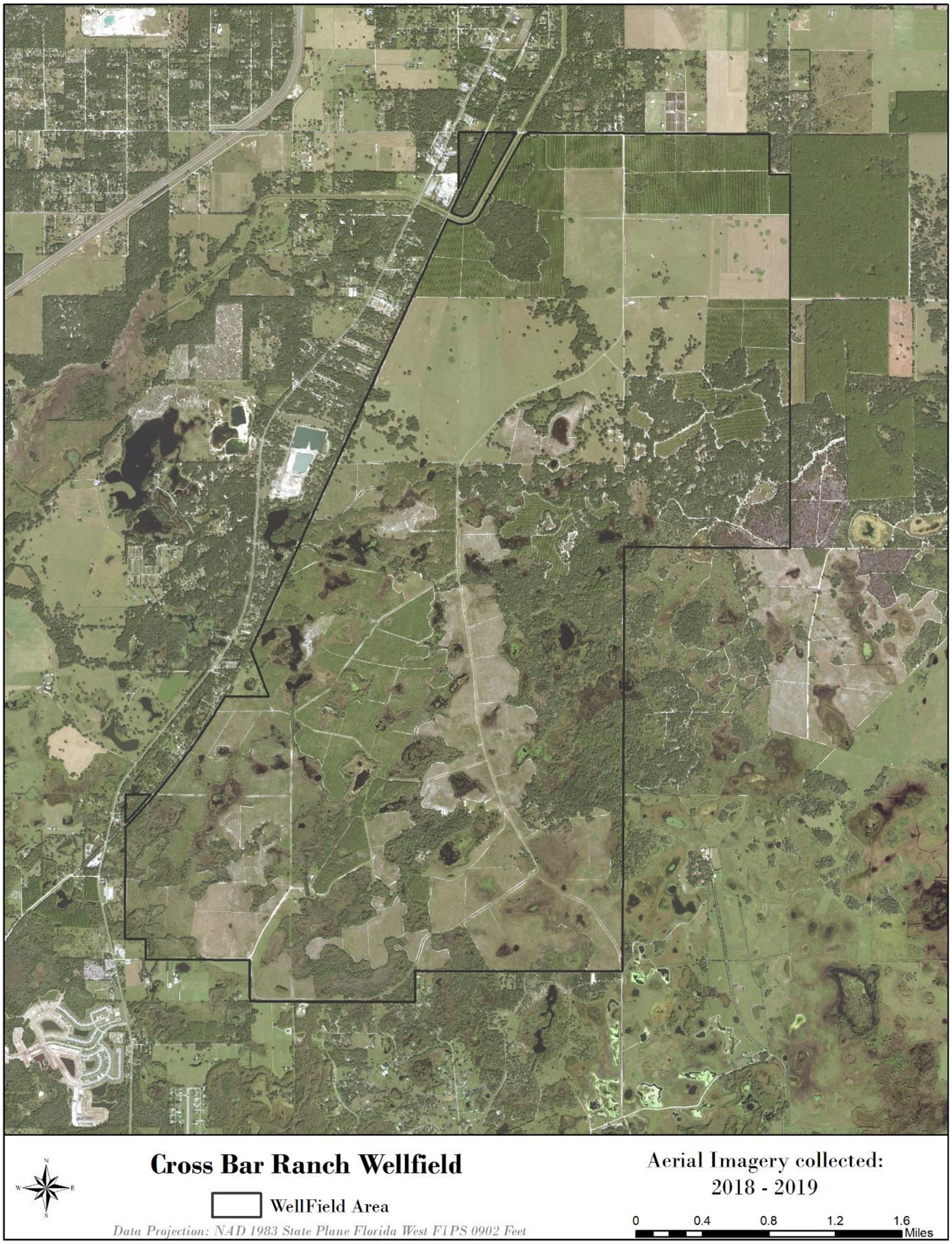

Figure 3.31: Aerial Photograph of the Cross Bar Ranch Wellfield Area from 2018 – 2019

3.7 Regulatory Changes (1989)

District staff were working on revisions to multiple permitting rules and procedures in early 1988 including new impact criteria that could be used in the issuance of Water Use Permits under District Rule 40D-2, Florida Administrative Code (F.A.C.). The Authority filed an administrative challenge in February 1988 to District Rule 40D-2.301 which contains the criteria for issuance of a Water Use Permit. This specific provision of the Rule 40D-2.301 was referred to as the “5-3-1 Rule” due to the presumption that these levels of pumping-related drawdown did not cause unacceptable adverse impacts (see Section 3.4). The Authority’s petition contained arguments against both the technical basis of this portion of Rule 40D-2.301, F.A.C. and past and future application of these considerations to existing Water Use Permits held by the Authority and member governments. This rule was ultimately invalidated, and the District continued work on revisions to their Water Use Permitting rules.

The District began public workshops in late 1988 to revise Water Use Permitting Rule 40D-2, F.A.C. due to limited water resources and continued population growth within the District. For the first time, the District developed a Basis of Review to provide detail and clarification on permitting rules. Design aids were written to provide applicants with guidance in the development of technical supporting materials that would be required to support permit applications. These new rules were adopted into Chapter 40D-2, F.A.C. in 1989 and included modifications of the conditions of issuance for a permit, including the complete Basis of Review for issuance of Water Use Permits. A new and significant change was that the rules governing adverse impacts to water resources now applied to wetlands, lakes and aquifers both on and off of the applicant’s property. The original Water Use Permitting rules did not prohibit adverse impacts due to pumping on the property owned or controlled by the permittee. In 1989 this changed; regulatory protection now applied to all water resources and environmental features within the District boundaries. When these new permitting rules were adopted, impacts that were once allowed under the former rules were now prohibited and there were no provisions in the rules to address this issue.

Later in 1989, the District identified the northern part of Tampa Bay as the Northern Tampa Bay Water Use Caution Area (NTB WUCA). This designation was made to address adverse impacts to water resources from groundwater withdrawals associated with rapid growth and development pressures in the region. The District implemented a strategy to limit further impacts within the area by reducing the per capita water consumption rate, implementing water conserving landscape ordinances, metering withdrawals from large permits, promoting public education on the importance of water conservation and encouraging the development of alternative water supply sources. Technical studies including the Water Resource Assessment Program were initiated by the District to provide the information needed to better understand the hydrologic system in the Tampa Bay area and determine the amount of water that could be withdrawn from the aquifer and surface water bodies without causing adverse environmental impacts (Southwest Florida Water Management District, 1996a).

3.8 Development of Additional Regional Wellfields

The population of the Tampa Bay area continued to increase to more than 1.9 million people by 1990. Before the close of the century, the regional population would increase to 2.27 million people (Table 3.1). All three Tampa Bay area counties grew during the 1990's but Hillsborough County showed the greatest gains followed by Pasco County. The population growth in Pasco County between 1990 and 2000 was greater as a percentage of their total population. The Authority needed additional water supplies to meet the demand that grew with the population and two additional regional wellfields were constructed north of Tampa Bay to meet this water demand.

3.8.1 North Pasco Wellfield

Much of the population growth in Pasco County by 1990 occurred near the coastline. The water demand for this area was predominantly met by Pasco County Utilities and the City of New Port Richey and came from the Starkey Wellfield, dispersed wells operated by the County, the City's production wells, and an interconnect with the Pinellas County Water System. The Authority needed additional water to meet the projected growth in the west Pasco area and two sources were identified in the 1986 Needs and Sources Update report; an expansion of the Starkey Wellfield (which was completed in 1989) and the development of a linear wellfield extending north from the Starkey Wellfield (Camp Dresser & McKee, Inc., 1986). This potential wellfield was named the North Pasco Wellfield and the 1986 report recommended development of this wellfield in the 1990 – 1995 timeframe.

The Authority completed a drilling and testing program for the proposed North Pasco Wellfield (Figure 3.2) in 1990 that included the construction of three test production wells located near the Florida Power Corporation transmission line easement between the Starkey Wellfield and State Road 52. This property was in the initial stages of development as a residential, commercial, and light industrial community known as the Serenova Development. The wellfield area is presented in an aerial photograph from 1988 – 1991 (Figure 3.32); residential areas existed only to the west of the wellfield at that time. An aquifer performance test was completed and the results indicated that the area was suitable for the development of a wellfield. Test production wells NP-2, NP-4 and NP-6 were constructed and tested as part of this exploration study in a linear alignment toward the Starkey Wellfield (Geraghty & Miller, Inc., 1990). The results of the drilling and testing program were used to support a Water Use Permit application for the North Pasco Wellfield which was issued by the District in December 1990. The permit (No. 2010051) authorized an annual average quantity of 8.52 mgd and a maximum daily rate of 16.1 mgd from six production wells, the three test production wells drilled in 1990 and three wells to be constructed later. This permitted quantity would remain in effect until the issuance of the Consolidated Permit in 1998.

Figure 3.32: Aerial Photograph of the North Pasco Wellfield Area from 1988 – 1991

The Authority designed the wellfield and collection main in phases. Phase I of the design included a collection main that extended from the Starkey Wellfield collection main to a location south of State Road 52. Production wells NP-4 and NP-6 would be equipped in Phase I to supply water to the West Pasco County and New Port Richey service areas through the connection to the Starkey Wellfield. Phase II of the project would include the addition of proposed production wells NP-3 and NP-5 and the final two production wells (the proposed NP-1 and the existing NP-2) would be added as Phase III of the wellfield development (Knepper & Willard, Inc. 1990). The North Pasco Wellfield began production in Water Year 1992 delivering water to the West Pasco County and New Port Richey service areas. The Authority began construction of the Phase II production wells in 1993. Production well NP-5 was completed but construction of well NP-3 was stopped due to sand infilling the open borehole (Atlanta Testing & Engineering, 1994). Well NP-3 was later plugged and abandoned due to the potential occurrence of a sinkhole developing around the well. The Phase III construction plans for this wellfield were never initiated.

The North Pasco Wellfield was operated as an extension of the Starkey Wellfield since both served the same member governments through a common pipeline. The annual average pumping rate from the North Pasco Wellfield ranged from 1.2 to 2.9 mgd and the combined annual average pumping rate from the two wellfields ranged from 12.7 to 15.0 mgd between 1992 and 2007. The water produced from the Starkey Wellfield and the two connected production wells of the North Pasco Wellfield were adequate to meet the demands of the West Pasco and New Port Richey service areas during this time period and production wells NP-2 and NP-5 were never equipped or connected to the wellfield collection main. Tampa Bay Water would later decide to reduce wellfield pumping for environmental reasons and meet the future demand in these service areas by constructing a pipeline to the Regional System as discussed later in this chapter. In Water Year 2017, the combined pumping rate from the Starkey and North Pasco Wellfields had been reduced to such a degree that maintaining production wells NP-4 and NP-6 was no longer cost-effective. The two wells were plugged and abandoned, and the North Pasco Wellfield was decommissioned in Water Year 2018.

The property known as the Serenova Tract was acquired by the Florida Department of Transportation and preserved in its natural state to mitigate for impacts resulting from the construction of the Suncoast Parkway located along the east side of the property (Figure 3.33). This property is approximately 6,500 acres in size and ownership and the overlying conservation easement was transferred to the District and is now included as part of the Starkey Wilderness Preserve (Southwest Florida Water Management District, 2005b). Some new residential development can be seen on the north side of the wellfield property near State Road 52 in the recent aerial photograph, but the majority of the area remains undeveloped at this time.

Figure 3.33: Aerial Photograph of the North Pasco Wellfield Area from 2018 – 2019.

3.8.2 Cypress Bridge Wellfield

Population growth in the central Pasco planning area was expected to consume the water supply quantity available for this region by the mid-1990's. The 1982 Needs and Sources Update report prepared for the Authority recommended that the Authority conduct tests and gather information to determine if a linear supply source could be developed between the Cypress Creek and Morris Bridge Wellfields (Camp Dresser & McKee, 1982). In the early-to-mid 1980's the only residential developments in this area were the Pebble Creek subdivision in northern Hillsborough County and the Williamsburg neighborhood in southern Pasco County, both located on the east side of County Road 581. These communities were served by their own permitted water supply wells. These neighborhoods are the only visible development in the 1988 – 1991 aerial photograph in Figure 3.34 along with the initial construction work for the Saddlewood Corporate Park located south of State Road 54 and west of Interstate I-75.

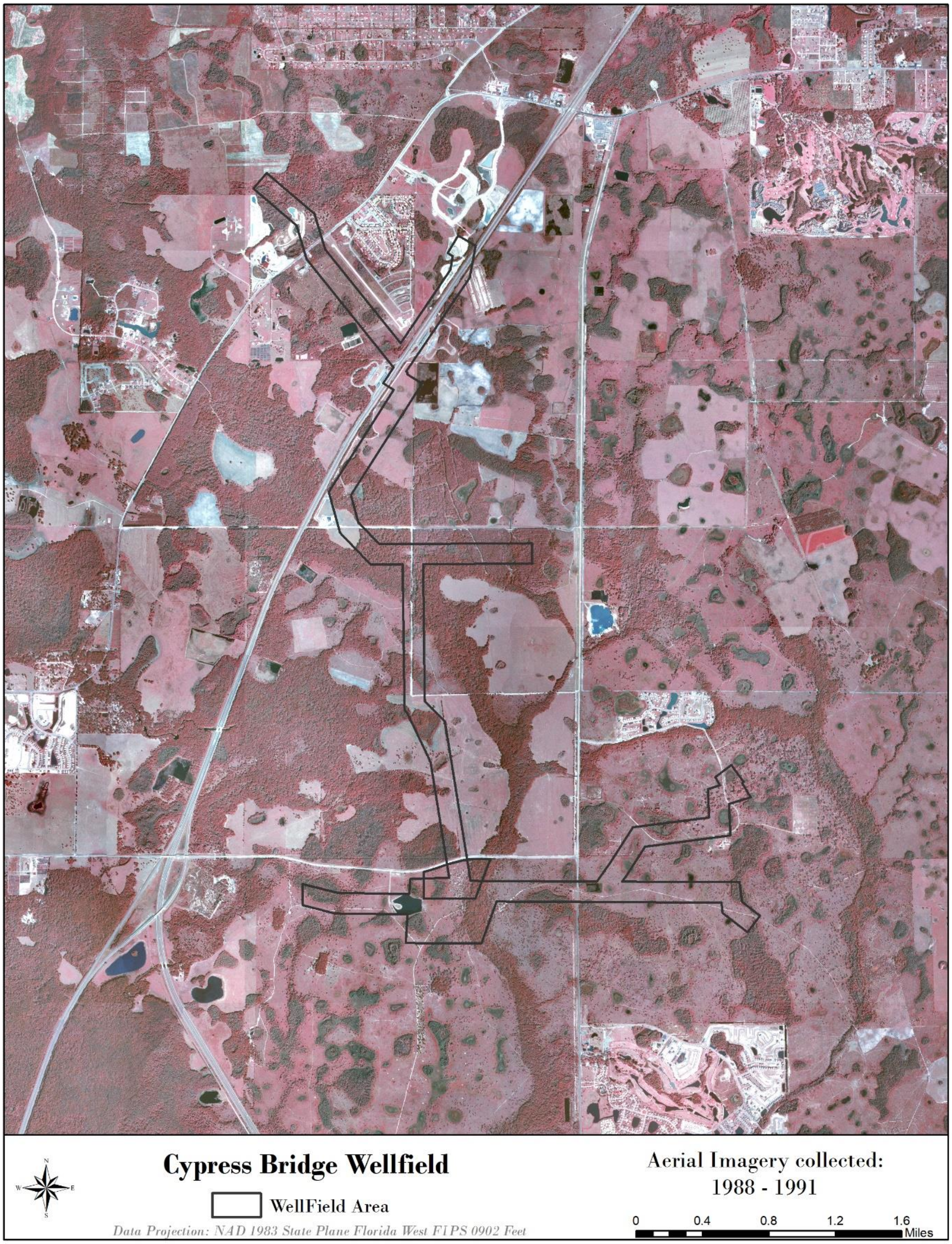

Figure 3.34: Aerial Photograph of the Cypress Bridge Wellfield Area from 1988 – 1991

The Authority began hydrogeologic testing in the area with the construction of monitor wells and a test well that would eventually become production well CYB-5. The aquifer testing at this location proved favorable for continued exploration of a potential wellfield in this area. The 1986 Needs and Sources Update report identified major new developments and increased demand coming to the central Pasco area in the next few years. The report recommended that the Authority complete testing and analysis to confirm that the area would support a wellfield and file a Consumptive Use Permit application for the wellfield (Camp Dresser & McKee, 1986). Two additional test production wells were installed and tested in 1988 at what would be become production wells CYB-2 and CYB-7. These two wells were constructed on a north-south line with the prior CYB-5 test well site in between them. The aquifer performance tests conducted at the two new sites confirmed that this was a suitable location for a new facility which would eventually be known as the Cypress Bridge Wellfield (CH2M Hill, Inc., 1988).

In early 1986, the Authority had submitted a request to the District for a temporary Consumptive Use Permit with limited wells and quantities from the Cypress Bridge Wellfield. A temporary permit was issued to the Authority with conditions requiring the collection and analysis of data. As the well construction and testing program continued, this data was submitted to the District. In late 1988, the Authority requested approval for the construction of 11 production wells with an average annual quantity of 8 mgd and a maximum daily quantity of 25 mgd from the Cypress Bridge Wellfield. The District issued Consumptive Use Permit No. 208426.00 for the 11 existing and proposed production wells at the requested quantities in June 1990. These permitted quantities remained in effect until the issuance of the Consolidated Permit in 1998.

A total of ten production wells were eventually constructed in northern Hillsborough County and south-central Pasco County along County Road 581 with the northern production wells located to the west of I-75 (Figure 3.2). Production well CYB-3 was never constructed but the other ten production wells could produce the permitted quantities. The final six production wells for the wellfield were constructed in 1992 (Schreuder & Davis, Inc., 1993). At that time, the wellfield area was largely in a rural setting with land in a natural state or cattle ranch operations. However, the area quickly changed to an urban setting with multiple planned communities with permitted stormwater management systems. At the time of this report, most of the formerly open land has been developed with the exception of some land in Pasco County to the east of County Road 581, between the County line and State Road 54. More developments have been permitted in this area and various phases are currently under construction (Figure 3.35).

Figure 3.35: Aerial Photograph of the Cypress Bridge Wellfield Area from 2018 – 2019

Production well CYB-6 is the well that originally served the Williamsburg subdivision since 1983. Groundwater pumping continued from this well to serve that community and pumping from the other initial wells was slowly added to serve the local demands. The cumulative pumping rate from the wellfields exceeded 1 mgd in Water Year 1992 but remained below 2 mgd through Water Year 1995. Once all ten production wells were drilled and equipped, the wellfield was used to meet both the growing local and regional water demands. The remainder of the production wells came online between January and July 1996.

Since the Cypress Bridge Wellfield is one of the newest wellfields, the Authority was able to implement an environmental monitoring program before the wellfield began production. The work to select and establish wetland monitoring sites at the wellfield began in late 1986 and data collection at individual wetlands began in January 1988. Several wetlands were selected for monitoring on the property formerly known as the Saddlebrook Corporate Park located west of I-75 and south of State Road 54 in the area where production well CYB-2 was installed. Monitoring sites 1, 2, 3, and 24 had sinkholes in or at the edge of the wetlands at the beginning of the monitoring program. These sinkholes were documented between 1988 and 1990, long before significant quantities of water were pumped from the Cypress Bridge Wellfield. These monitoring sites with historic sinkholes are located closest to production wells CYB-1 and CYB-2 which did not begin pumping until January 1996 (Dooris and Associates, 2012). The Authority collected environmental data at the wellfield monitoring sites for several years before wellfield pumping rates increased in 1996; however, the rapid urbanization in the area has made the assessment of environmental change and determination of impacts more difficult.

3.9 Environmental Impacts

The environmental impacts that were observed in and around the wetlands in northern Tampa Bay area wellfields are related to reduced water levels and shortened hydroperiods; these impacts would become the catalyst for regional litigation. Low or absent water levels are very noticeable in lakes because local residents observe them daily but changes to wetlands are not as readily observed and can be more subtle. Lake level decline generally does not cause severe and lasting impacts unless the lake dries completely, or lake bottom sediments are exposed for long periods of time. Water level impacts to wetlands are more ecologically severe due to the relatively shallow water depth of most wetlands systems. One to two feet of water level decline is noticeable in a lake but that same amount of decline may be enough to completely dry out a wetland. After prolonged periods of low or absent water levels, wetlands can experience soil loss, changes in wetland vegetation, treefall, loss of wetland-dependent wildlife, and damage from wildfires. Groundwater pumping at high quantities from the Upper Floridan Aquifer as well as periods of below-average rainfall can cause low wetland and lake water levels on a regional basis. The alteration of historic surface water flows can cause higher or lower water levels on a sub-regional basis or within individual systems.

One or more of these water level impact factors were present over time at all 11 northern Tampa Bay area wellfields. Groundwater pumping was present at all wellfields at varying levels; some wellfields had very low levels of pumping such as the North Pasco Wellfield while others experienced annual average pumping rates of 30 mgd or more for multiple years. The Tampa Bay area has also experienced cyclic drought events; these two regional factors were the primary causes of low lake and wetland water levels in the wellfield areas. Local drainage modifications played a role in low water levels at specific sites but this is not a controlling factor for regional water levels except for large, extensive canal systems such as those constructed in the Northwest Hillsborough area. The environmental impact associated with older wellfields may have peaked during the periods of high historical pumping but on a regional basis, impacts observed in lakes and wetlands peaked in the 1990's. That was

3.9.1 Historical Increase in Ground Water Pumping

The decade of the 1990's began with the Tampa Bay area population having surged to almost 2 million people and by the year 2000, regional population would increase to 2,265,211 persons (Table 3.1). Florida drinking water supplies are primarily from groundwater resources and until the introduction of the alternative water supplies in 2002, groundwater from area wellfields was the only regional water supply source that Tampa Bay Water had to meet the demands of the member governments. The City of Tampa uniquely relied on the Hillsborough River as their main water supply source and some member governments had small groundwater well systems located in areas remote from the regional wellfields. The wellfields withdraw water from the Upper Floridan Aquifer which causes a lowering of the potentiometric surface in that aquifer. The degree of drawdown is relative to the quantity of water withdrawn and the influence of wellfields can overlap if they are located close enough to each other. The location of the 11 wellfields and the increasing quantity of water withdrawn over time make wellfield pumping a regional driver for change in water levels. The lowering of the potentiometric surface of the Upper Floridan Aquifer can cause indirect impacts to overlying lakes and wetlands by inducing a higher rate of water leakage through the wetland sediments and surficial sands into the underlying limestone aquifer.

Figure 3.36 shows the progression of pumping from the 11 northern Tampa Bay wellfields since the Cosme-Odessa Wellfield began pumping in Water Year 1931. The graph shows how the wellfields were developed, generally one at a time, and the increase in the annual average pumping rate of the wellfields over time. The increase was gradual at first, corresponding to a relatively slow rate of regional growth. Comparing this cumulative pumping graph to the graph of population growth (Figure 3.1), it is easy to see the association between large increases in population and groundwater pumping. Between 1950 and 1960, the region's population doubled, and the regional population essentially doubled again between 1960 and 1980. During these two time periods (1950 – 1980), the cumulative pumping from the wellfields on-line shows an exponential growth curve. By the mid-1980's, the increasing rate of average annual wellfield pumping slowed but continued to gradually increase to 160 mgd by Water Year 2000.

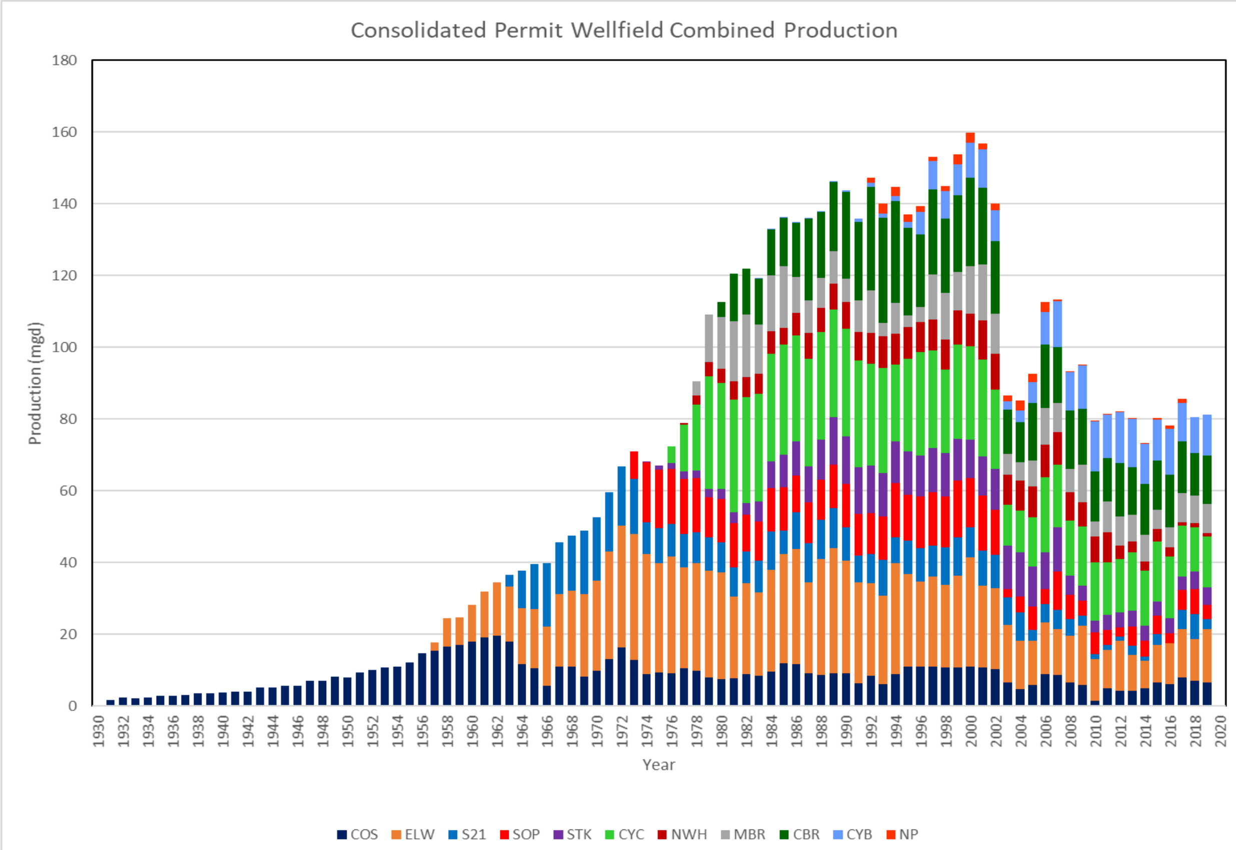

Figure 3.36: Consolidated Permit Wellfield Combined Production by Water Year

The highest annual average pumping rate for each wellfield occurred at different times in the past and this data is more clearly seen in pumping graphs from each of the 11 wellfields. The Cosme-Odessa Wellfield was the first to be constructed north of Tampa Bay and the annual average pumping rate steadily increased to almost 20 mgd by 1962 (Figure 3.37). As Pinellas County grew and phased out their water supply sources located along the beaches and central part of their county, the annual average pumping rate from the Eldridge-Wilde Wellfield increased to 35 mgd by 1973 (Figure 3.38). The Section 21 Wellfield was constructed by the City of St. Petersburg to meet their growing water demand and provide a reduction in pumping at the Cosme-Odessa Wellfield. The annual average pumping rate from the Section 21 Wellfield quickly increased to over 17 mgd in 1966, its fourth year of operation (Figure 3.39). Various environmental concerns were noted at these three wellfields during the times of high pumping periods as highlighted in Section 3.3; it is important to note that these wellfields were pumping at their highest average rates before the first water regulations were enacted in 1972 and before the first regulatory permits were issued. Even after the first permits were issued for these wellfields, impacts to lakes and wetlands on the wellfield properties were not prohibited. Nonetheless, new wellfields were in development to provide additional supplies and allow reductions from existing wellfields.

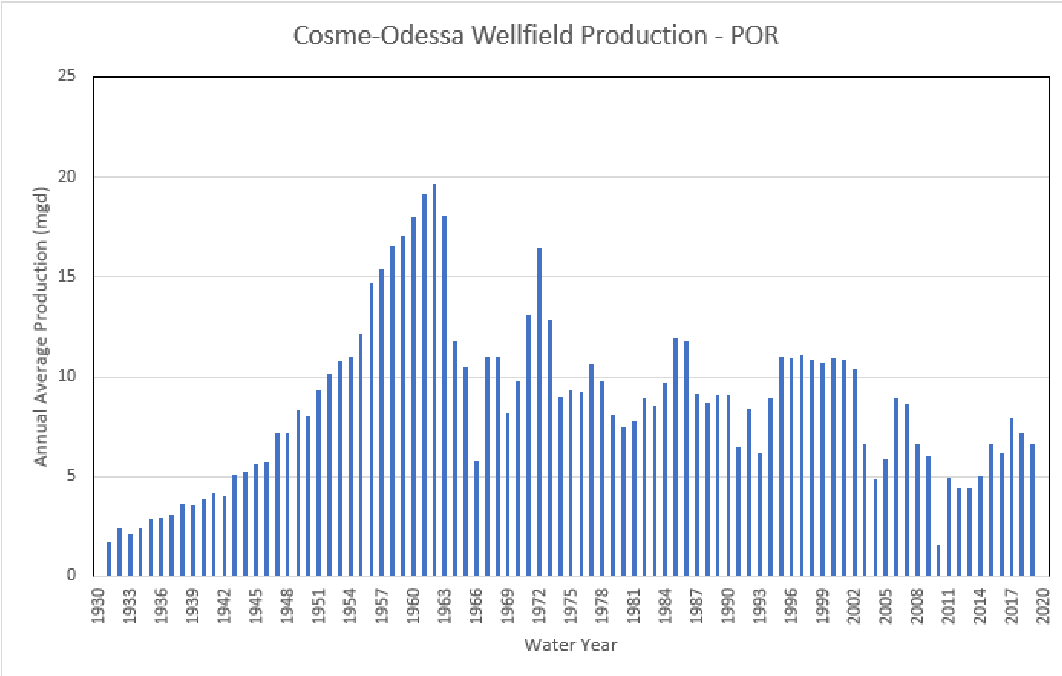

Figure 3.37: Annual Average Pumping – Cosme-Odessa Wellfield

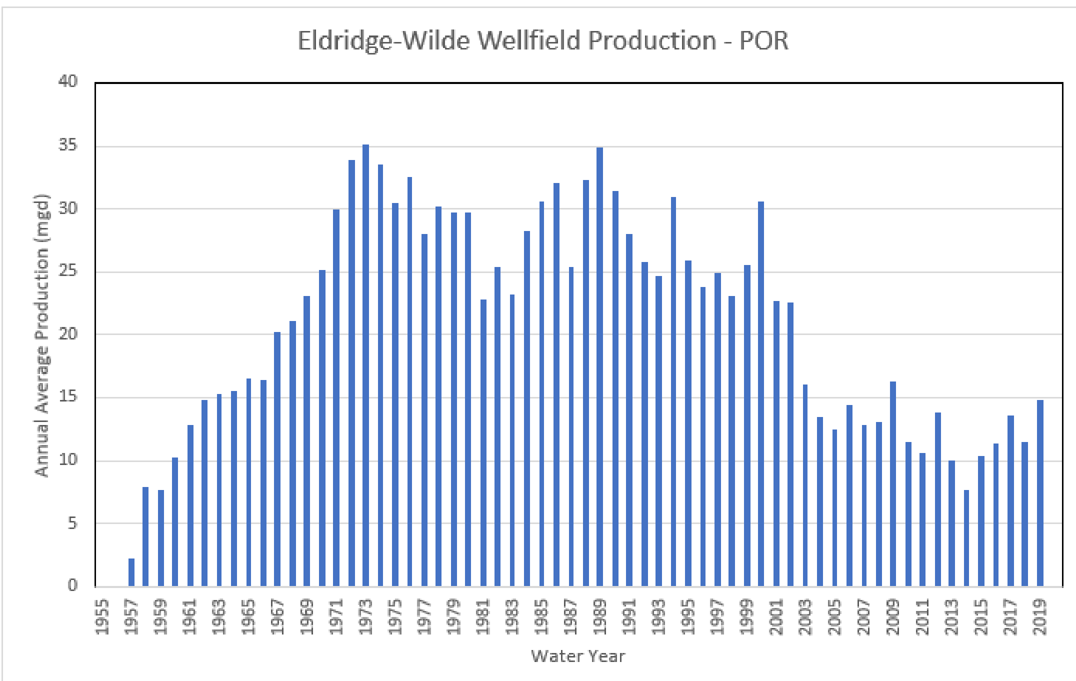

Figure 3.38: Annual Average Pumping – Eldridge-Wilde Wellfield

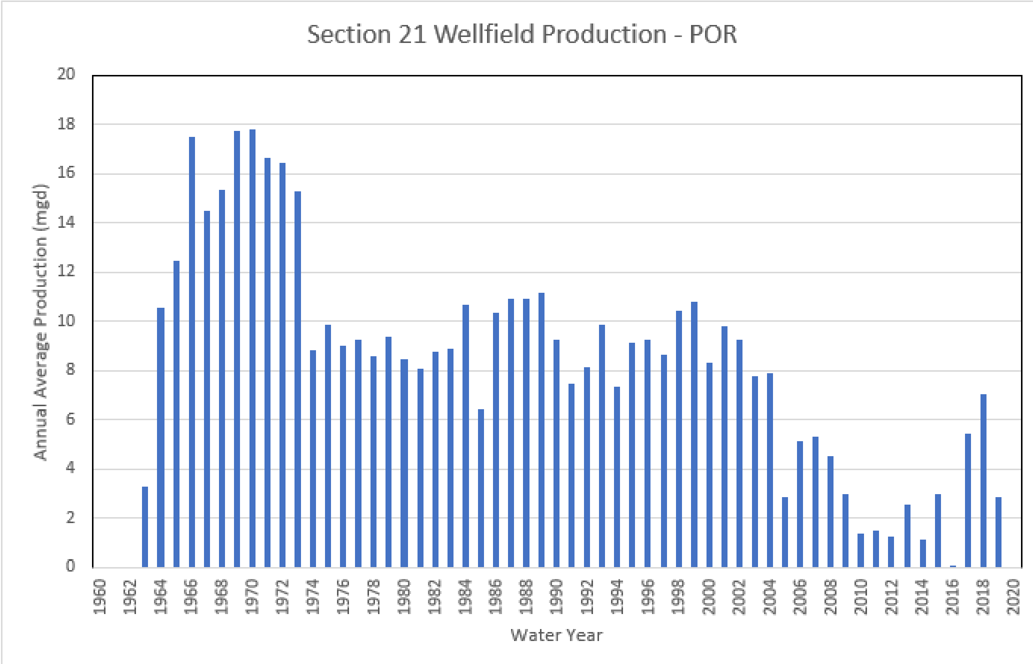

Figure 3.39: Annual Average Pumping – Section 21 Wellfield

The South Pasco Wellfield came online in mid-1973 and the average pumping rate in 1974 exceeded 16 mgd (Figure 3.40), allowing the pumping rate at the Section 21 Wellfield to be greatly reduced. The West Coast Regional Water Supply Authority began pumping from the Cypress Creek Wellfield in 1976 to meet regional demands and the average annual pumping rate from the wellfield rapidly increased to approximately 30 mgd in 1979 and remained at this level for many years (Figure 3.41). The second regional wellfield developed by the Authority was the Cross Bar Ranch Wellfield but the pumping rate from this wellfield remained stable at or below 15 mgd for the several years of operation. The annual average pumping rate at the Cross Bar Ranch Wellfield first exceeded 20 mgd in 1987 and ranged between 18 and 29 mgd for 16 years (Figure 3.42). The Morris Bridge Wellfield was constructed and operated by the City of Tampa to supplement their water supply from the Hillsborough River. Growing demand in their system created the need to pump the wellfield at an average annual quantity of 13 to 18 mgd between 1979 and 1985 (Figure 3.43).

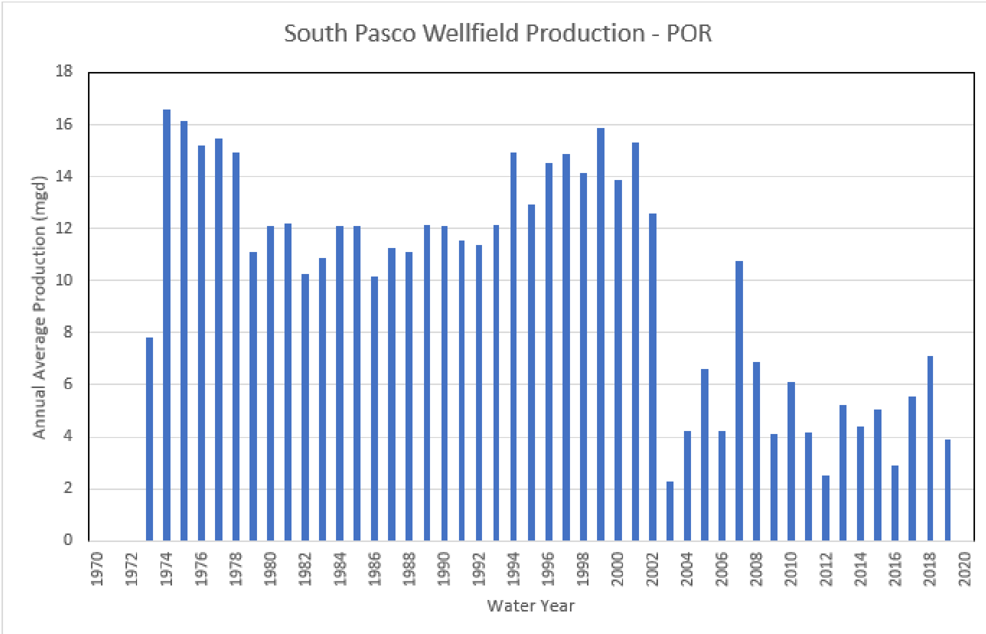

Figure 3.40: Annual Average Pumping – South Pasco Wellfield

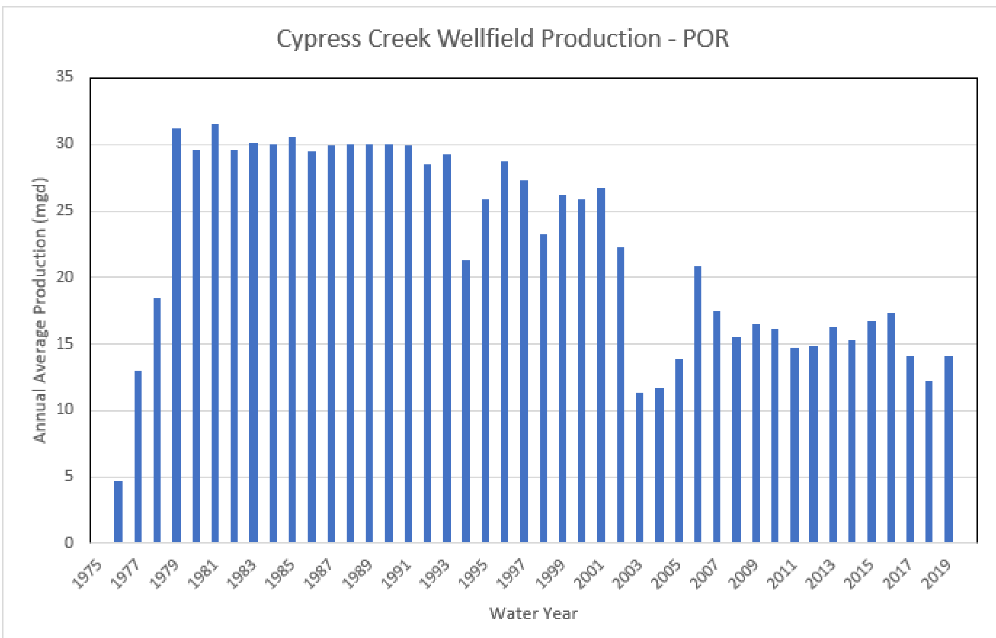

Figure 3.41: Annual Average Pumping – Cypress Creek Wellfield

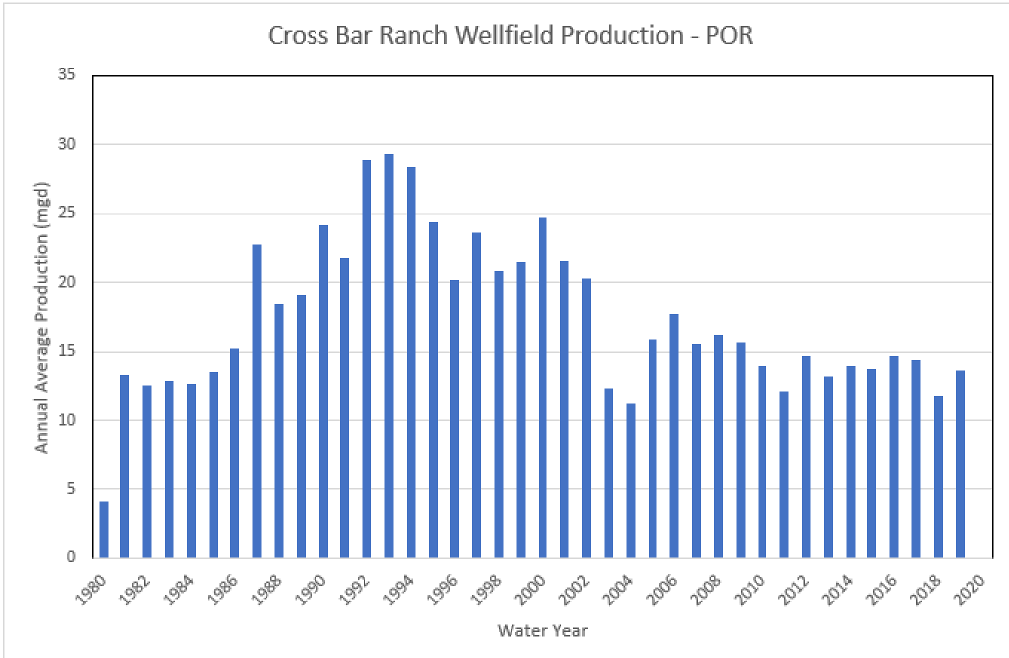

Figure 3.42: Annual Average Pumping – Cross Bar Ranch Wellfield

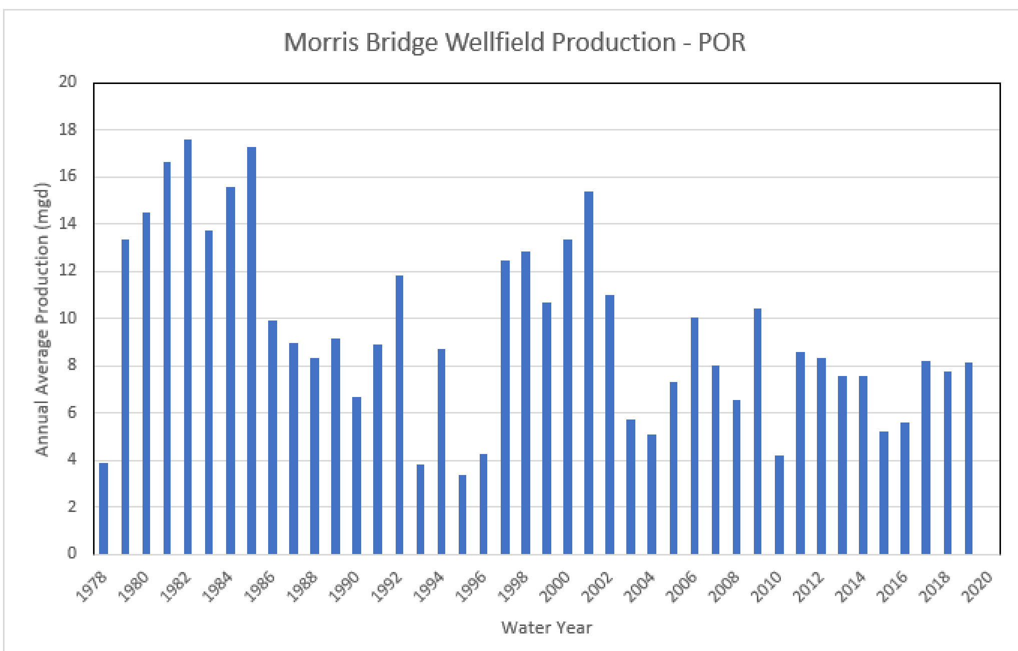

Figure 3.43: Annual Average Pumping – Morris Bridge Wellfield

The average production rate from the Northwest Hillsborough Regional Wellfield increased gradually as the dispersed neighborhood production wells were placed into service. The pumping record from these wells begins in mid-1977 but several of the dispersed wells were in existence before then; the data for those production wells prior to 1977 is unavailable. The annual pumping rate from the dispersed wells first exceeded 6 mgd in Water Year 1984 and the seven regional production wells began producing as they were developed with the first placed into service during Water Year 1985. The annual average pumping rate gradually increased from 6 mgd until 1992 when the annual average pumping rate from all active wells exceeded 8 mgd. The wellfield pumping would reach an average of approximately 11 mgd in 2001 (Figure 3.44).

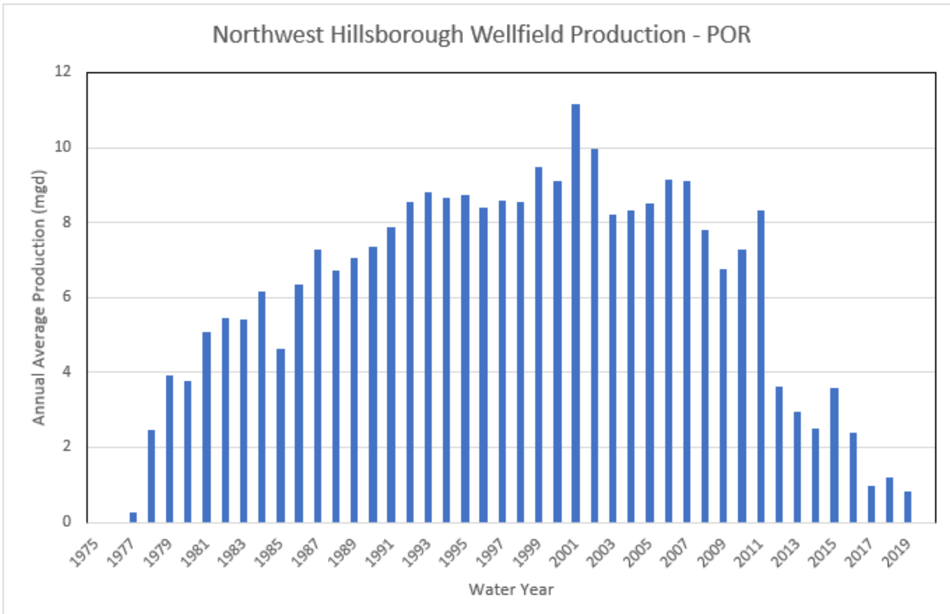

Figure 3.44: Annual Average Pumping – Northwest Hillsborough Regional Wellfield

The Starkey Wellfield was constructed to meet the demands of the New Port Richey and West Pasco Service areas. The average pumping rate gradually increased, remaining at or below 3 mgd through 1982. Between 1983 and 1989, the average pumping rate from the wellfield would increase rapidly to approximately 13 mgd. Completion of the North Pasco Wellfield in 1992 allowed the pumping at the Starkey Wellfield to be reduced but it remained between 10 and 12 mgd through 2007 (Figure 3.45). The two active production wells of the North Pasco Wellfield never exceeded an annual average quantity of 3 mgd (Figure 3.46) but the addition of this wellfield allowed the Agency to distribute pumping from the two wellfields over a larger area and not continue increasing the pumping rate at the Starkey Wellfield. The combined pumping from these two wellfields reached a maximum average of 15.02 mgd during Water Year 2004. The last of the 11 wellfields to become fully operational was the Cypress Bridge Wellfield. In 1996, the annual average pumping rate from the wellfield production wells increased to approximately 6 mgd and exceeded 10 mgd by 2001 (Figure 3.47). The average pumping rate from this wellfield has not decreased, with the exception of Water Years 2003 – 2005 when alternative water supplies were first introduced into the Regional System. The annual average pumping rate at this wellfield has since fluctuated between 9 and 14 mgd.

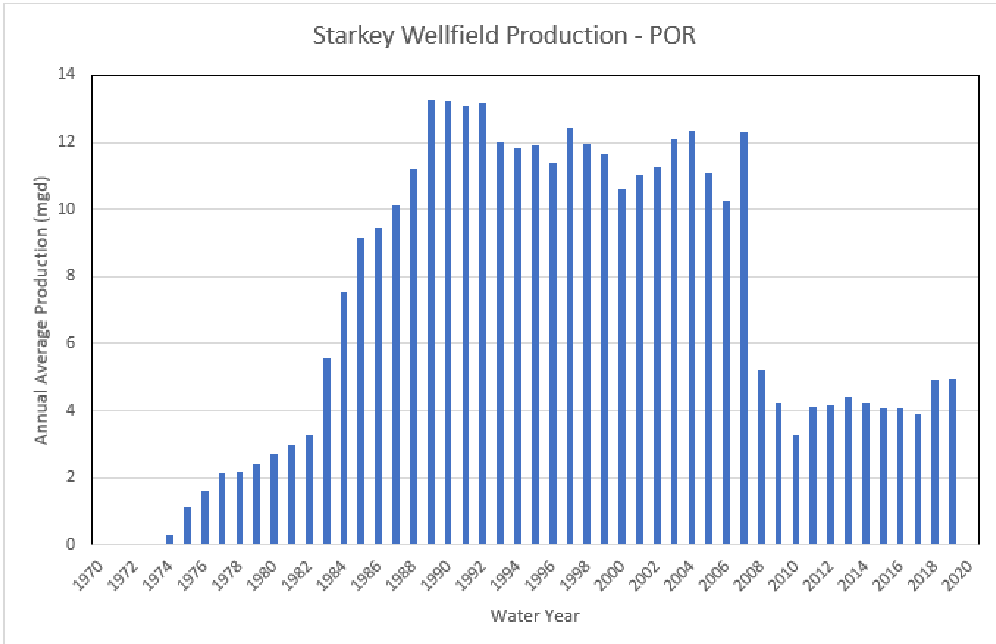

Figure 3.45: Annual Average Pumping – Starkey Wellfield

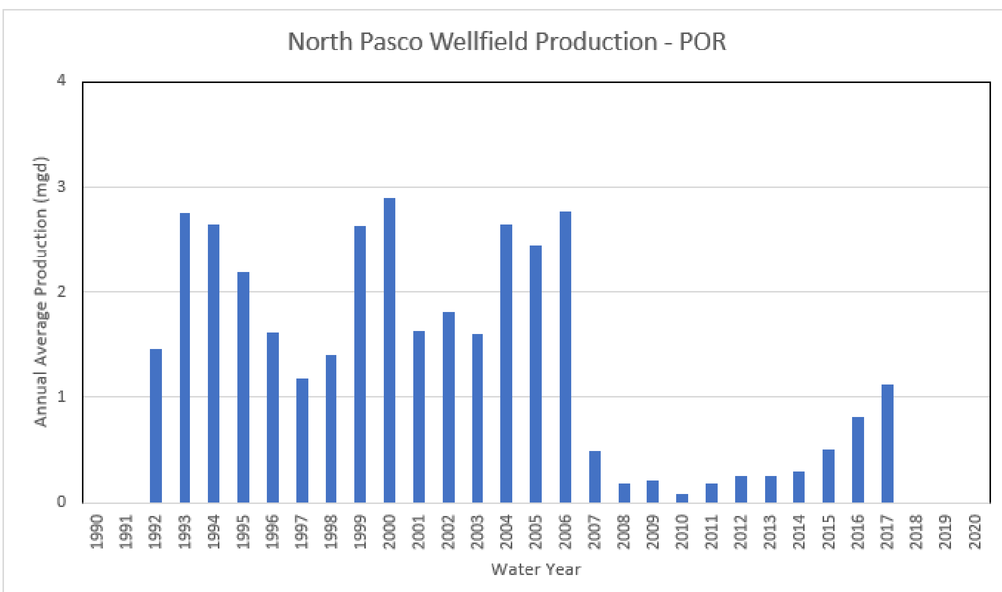

Figure 3.46: Annual Average Pumping – North Pasco Wellfield

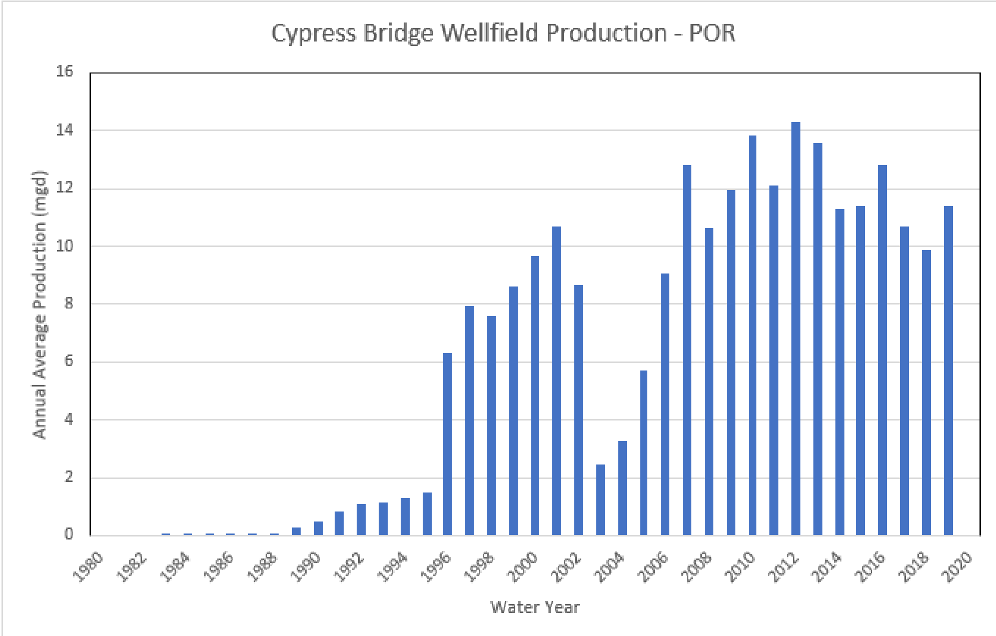

Figure 3.47: Annual Average Pumping – Cypress Bridge Wellfield

The chronology of wellfield development shows that nine of the 11 wellfields were pumping at high rates before the District's Water Use Permitting Rule changes of 1989 and all but the North Pasco and Cypress Bridge Wellfields reached their peak production periods before the date of this rule change. This is important because prior to 1989, adverse environmental impacts were not prohibited on property owned by a permittee. Understanding how and when historical wellfield pumping had impacted wetlands and lakes under different regulatory thresholds and rules is essential to fully and properly characterize the history of wellfield pumping and impacts and the recovery that has been achieved.

3.9.2 Rainfall Trends

The second driver of regional water level change is rainfall. Years with above-average rainfall will directly increase the water level in area lakes and wetlands and within the Upper Floridan Aquifer that is the underlying support for regional surface water features. A year with significantly below-average rainfall or sequential years of low rainfall will directly cause water levels in surface features to decline and also cause a lowering of the potentiometric surface of the Upper Floridan Aquifer. The flat topography in the Tampa area and the interconnected nature of lakes and wetlands in the area can enhance the effects of low rainfall if surface water flows are not well managed or regulated. Land surface changes caused by road construction and land development has physically interconnected lakes and wetlands and reduced the size of catchment basins surrounding some surface water features, exacerbating the effects of low rainfall periods.

The 1990's included several consecutive years of below-average rainfall in the Tampa Bay area. Between 1992 and 1997, most of the wellfield areas experienced rainfall deficits each year between two and 20 inches leading to a large cumulative deficit. Figure 3.48 presents total Water Year rainfall at seven of the Northern Tampa Bay wellfields and compares the rainfall totals to the long-term average rainfall total at the NOAA rainfall gage at St. Leo in eastern Pasco County. The data used to create this graph is from work performed by Dr. Brian Ormiston for the Recovery Assessment Plan (Ormiston, 2020). This report will be discussed in greater detail in Chapter 15. Each wellfield is represented as an individual bar for each year to show the variability between wellfield areas; however, the rainfall during this six-year period was low for all wellfields with few exceptions. Regionally, environmental impacts reached a peak during the mid-1990's given the low rainfall for six consecutive years and regional wellfield pumping that ranged from 137 to 153 mgd. It is possible that the lakes and wetlands around the wellfields could have withstood either this low rainfall period or the high pumping rate without adverse impacts but the influence of both these drivers caused lake and wetland water levels to drop. It is difficult to separate the effects of low rainfall and high groundwater pumping rates on lake and wetland water levels but the signs of environmental impact were widely observed during the 1990's and extended beyond the measurement of low water levels.

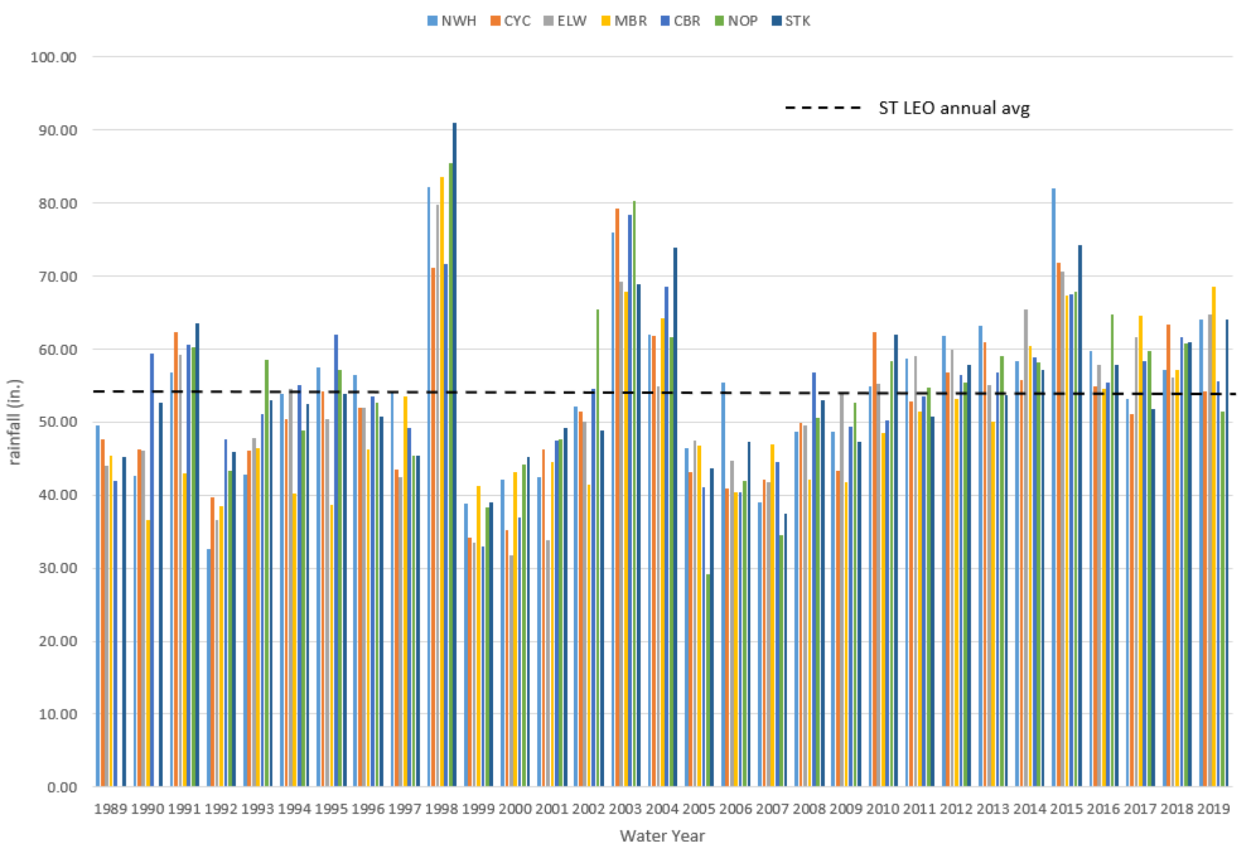

Figure 3.48: Annual Rainfall by Wellfield WY89-WY19

3.9.3 Observed Environmental Impacts

The environment in and around the wellfields has been studied through data collection and analysis since the U.S. Geological Survey began recording lake water levels at the Cosme-Odessa Wellfield in the 1930's. The District began monitoring the wellfields in the early 1970's and the Authority began monitoring the environment at the new regional wellfields in the late 1970's. Environmental impacts are sometimes immediate such as the sinkholes that formed on and near the Section 21 Wellfield when it first began pumping. Other impacts take time to develop like the increased intrusion of salt water into the aquifer in coastal areas in response to groundwater pumping and a lowering of the regional potentiometric surface head. Adverse impacts to lakes and wetlands also develop relatively slowly following sustained periods of time with low water levels and reduced hydroperiods. Over time, the District and Authority noted environmental impacts on the wellfields and these observations are documented in numerous reports produced by both agencies. The annual monitoring and assessment reports for each of the 11 wellfields contain descriptions of the sites monitored for each wellfield: a summary of impacts and site descriptions can be found in the most recent annual reports for the 11 wellfields (Tampa Bay Water, 2020 a-j). This Recovery Assessment Report is not a compendium of impacts observed at each wellfield over time but rather a regional discussion of the types of ecological impacts observed at the wellfields with some specific examples.

It is often difficult to determine the cause or causes of a specific impact. The impacts described in this section were documented on some or all the 11 northern wellfields and pumping from the wellfields at high annual rates for sustained periods was a cause of the impacts. In some cases, low levels of groundwater pumping can cause these types of impacts if a lake or wetland is very “leaky”. This general term is used when the standing water in a lake or wetland is not sustained by the underlying organic sediments following a decline in the potentiometric surface beneath them. Periods of low seasonal or annual rainfall is also a regional factor in these impacts and land surface and drainage alterations may play a role in specific instances.

3.9.3.1 Types of Documented Impacts

The following sections discuss specific types of historical environmental impacts that were documented on and near the 11 wellfields. The information presented in this section is not meant to apportion specific responsibility to any cause(s) but to present the environmental conditions on and near the wellfields that caused concern for the Authority, the District, the member governments, and the public.

3.9.3.1.1 Low or Absent Water Levels

Lake and wetland water levels in west-central Florida naturally fluctuate in an annual and seasonal rainfall pattern. Water levels increase to an annual or seasonal high at the end of the four-month summer rainy season and then gradually decline during the eight drier months of winter and spring. This is the natural fluctuation cycle that was present when the existing systems formed, and it is healthy for systems to experience periods of low water levels. Some types of wetlands need a period of time each year with no standing water so that organic soils can consolidate and seeds from wetlands plants and trees can germinate. The first visible sign of an ecological impact is a dramatic decrease in a lake or wetland water level or a more gradual lowering of the water level that persists for an extended period of time. A change in lake or wetland water level is observable over a relatively short period of time and can be tracked by recording the water level elevation against a known elevation reference. There is a time lag between water level change and subsequent ecological change. An extended period of time with low or absent water levels can lead to ecological changes that take time to develop and are only observed with regular monitoring over time.

The period-of-record hydrographs for two lakes and two wetlands are provided in Figure 3.49 as examples of the decrease in and recovery of water levels at the wellfields. Starvation Lake is located on the Section 21 Wellfield in northwest Hillsborough County. The water level in Starvation Lake decreased about 12 to 13 feet soon after the wellfield began pumping in 1963 and remained at a very low elevation until the mid-1970's. This lake was not completely dry when water levels were this low but did separate into two pools. The water level decrease in Horse Lake was more gradual and not as severe as in Starvation Lake. This lake is located at the Cosme-Odessa Wellfield in the area of the initial production wells that were drilled in the 1930's. Water levels in Horse Lake gradually decreased until the early 1970's and reached their period-of-record low elevation in 2002 at the end of a severe, multi-year drought. The green horizontal lines on the two lake hydrographs indicate the Minimum Level that would eventually be established for these two lakes by the District. The Minimum Level is a lake-specific reference elevation that should be achieved 50% of the time which would indicate that the lake is "healthy".

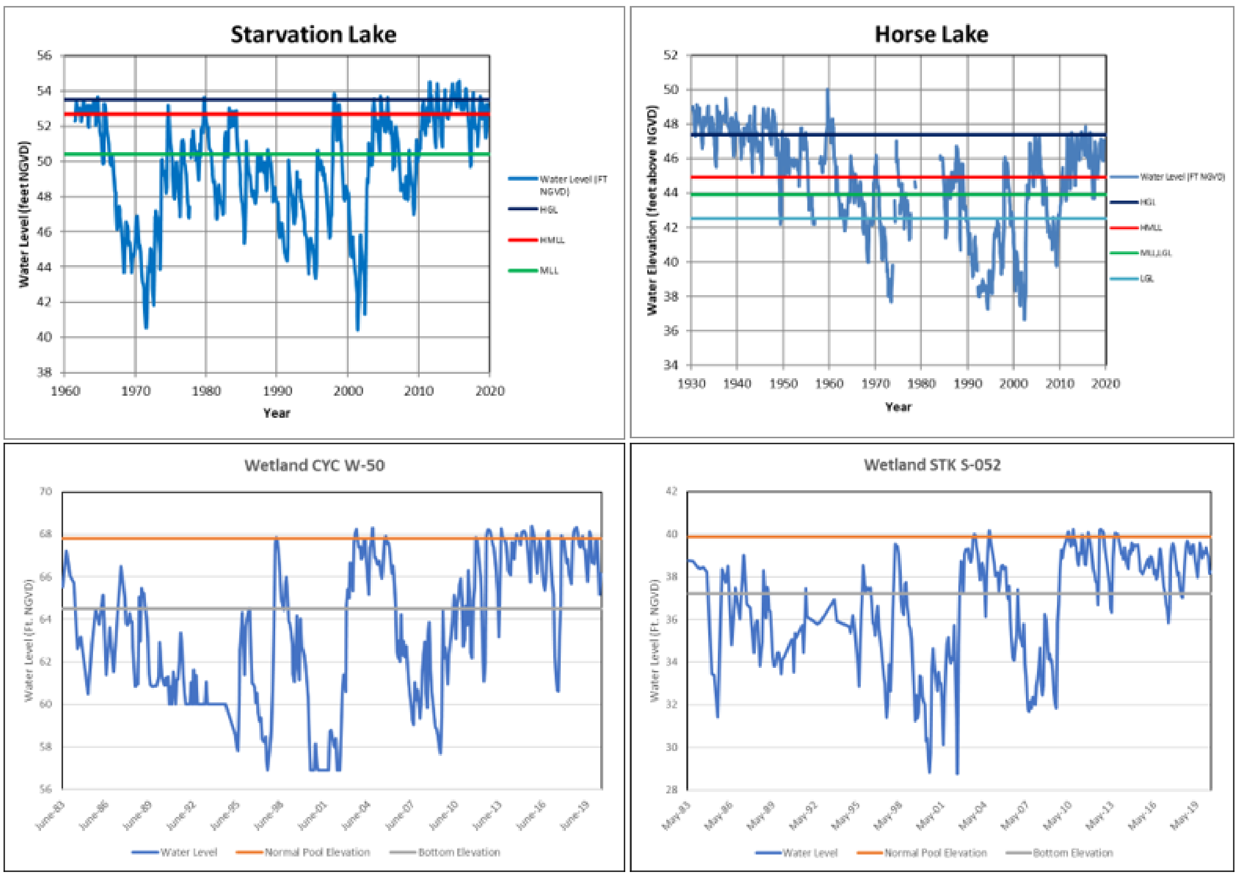

Figure 3.49: Period of Record Hydrographs of Starvation Lake, Horse Lake, Wetland CYC W-50, and Wetland STK S-052

The hydrographs for two wetlands show that their water level fluctuations also approached 11 feet in magnitude, but this also accounts for the periods of time when the wetland water levels dropped below the wetland bottom elevations. The gray line on both wetland hydrographs indicates their respective bottom elevations so that the full range of water level fluctuation can be observed and analyzed. An orange reference line is also included on these two graphs to show the expected seasonal high water level in the wetland based on ecological indicators. Pumping at the Cypress Creek Wellfield began in 1976 before the Authority started collecting water level data from wetland W-50. The first 15 years of data collection at this wetland showed that there was little standing water in the wetland and the water level often fell to 4 to 6 feet below the wetland bottom. The water level pattern in wetland S-052 at the Starkey Wellfield is very similar in that the wetland seldom experienced standing water and only for short periods of time. The annual pumping rate at the Starkey Wellfield began to increase in 1983, about the same time as water level data collection began in this wetland. These two wetlands provide a good example of the extended periods of time with low or absent water levels that can promote changes to the wetland ecology.

The hydrographs are effective at showing the water level data and the range of water level fluctuation at monitored sites; however, they cannot convey the environmental condition of these lakes and wetlands. Two photographs of Lake Rogers from 2002 are shown in Figure 3.50. The top photograph is an oblique aerial view of the lake showing that the water level in the lake had dropped to the point where much of the lake bottom sediments were exposed and the lake had separated into four pools. This lake is located in the original section of the Cosme-Odessa Wellfield and the region was at the end of an extreme drought when these photographs were taken. The bottom photograph is a ground-level view of Lake Rogers at the same general time and shows two of the five staff gages in the lake; the lake had receded to the fifth and deepest staff gage at the time of the photograph. Figure 3.51 shows a ground-level view of Starvation Lake in 2001 when the water level was as low as it was in the early 1970's (Figure 3.49). Stanford Lake is located just west of the Cypress Creek Wellfield and this lake was completely dry in May of 2002 before the severe regional drought finally ended (Figure 3.52). These photographs convey the visual impact of extremely low water levels in area lakes during a time when wellfield pumping was at its highest and rainfall was at its lowest. These water level conditions certainly occurred at some locations in the past; however, photographs from earlier years are generally unavailable or of poor quality. Nonetheless, the conditions shown in these recent lake photographs are what the water managers, government officials and the public were discussing in the 1990's.

Figure 3.50: Aerial View and Ground-level View of Lake Rogers in 2002 **(photos courtesy of District staff)**

Figure 3.51: Starvation Lake 2001

Figure 3.52: Stanford Lake (CYC C-03) – May 2002 (photo courtesy of RS&H staff)

Low water levels were not only observed in lakes. Figure 3.53 presents photographs of four wetlands with no standing water in the 2000 to 2001 timeframe. This was the period of the highest annual wellfield pumping rate and during an historic drought. Wetland S-018 is a marsh at the Starkey Wellfield that shows mud cracking in the bottom sediments of the wetland. Wetland W-21 at the Cypress Creek

Wellfield is a riverine wetland just south of where the channel of Cypress Creek passes under the wellfield access road. Two cypress wetlands are shown in the bottom two photos depicting the condition of wetlands NW-50 at the South Pasco Wellfield and Lake Dan Cypress at the Eldridge-Wilde Wellfield. The water level was below the bottom of all four wetlands at the time of the photographs and signs of ongoing ecological impact are evident including soil desiccation, treefall, and the invasion of upland vegetation into the formerly hydrated areas of the wetlands. These are some of the impacts that can occur with prolonged water deficit in wetlands.

Figure 3.53: Photographs of Dry Wetlands; a) Starkey Wetland S-018 (2000), b) Cypress Creek Wetland W-21 (2001), c) Eldridge-Wilde Wetland Lake Dan Cypress (2001), and d) South Pasco Wetland NW-50 (2001). (Photos c and d provided courtesy of District staff)

3.9.3.1.2 Vegetation Change

The plant species that are found in wetlands can change over time due to a sustained change in water levels and hydroperiod. Different plant species need different growing conditions; some only grow in moist soils or even in standing water while others cannot tolerate soils that are wet for long periods of time. If the soil hydration changes for a sustained period, those soils become suitable for different plant species. This is the basis of the wetland vegetation monitoring program that has been implemented by the District and Tampa Bay Water since 2005 called the Wetland Assessment Procedure (see Section 5.5.2.3). In this monitoring program, plants commonly found in west-central Florida have been classified by the wetland zone in which they are commonly associated. These zones are Deep and Outer Deep (located in the deeper parts of a wetland with typically inundated or wet soils), Upland (outside of the wetland edge with typically dry soils) and a Transition zone that lies between the Outer Deep and Upland zones. The monitoring procedure assesses what plants are found to be growing in each wetland zone and an impact is identified when indicator plants are found to be growing outside of their normal zone. Figure 3.54 illustrates the “migration” of upland or adaptive plants into deeper parts of a wetland that had contained moist or inundated soils. In the top panel of the figure, the plants are all located in their appropriate zones. In the middle and bottom panels, the water level has declined, and upland and transition zone plants have now moved into the deeper parts of the wetland where they had not previously grown. This would be the condition when a wetland has a long period of time (years) with little or no standing water. The plant species do not actually migrate or move but the soils with a reduced saturation level or hydroperiod have created a new area where these less water-tolerant plants can become established. This change in wetland vegetation is one of the long-term visible signs of an ecological impact.

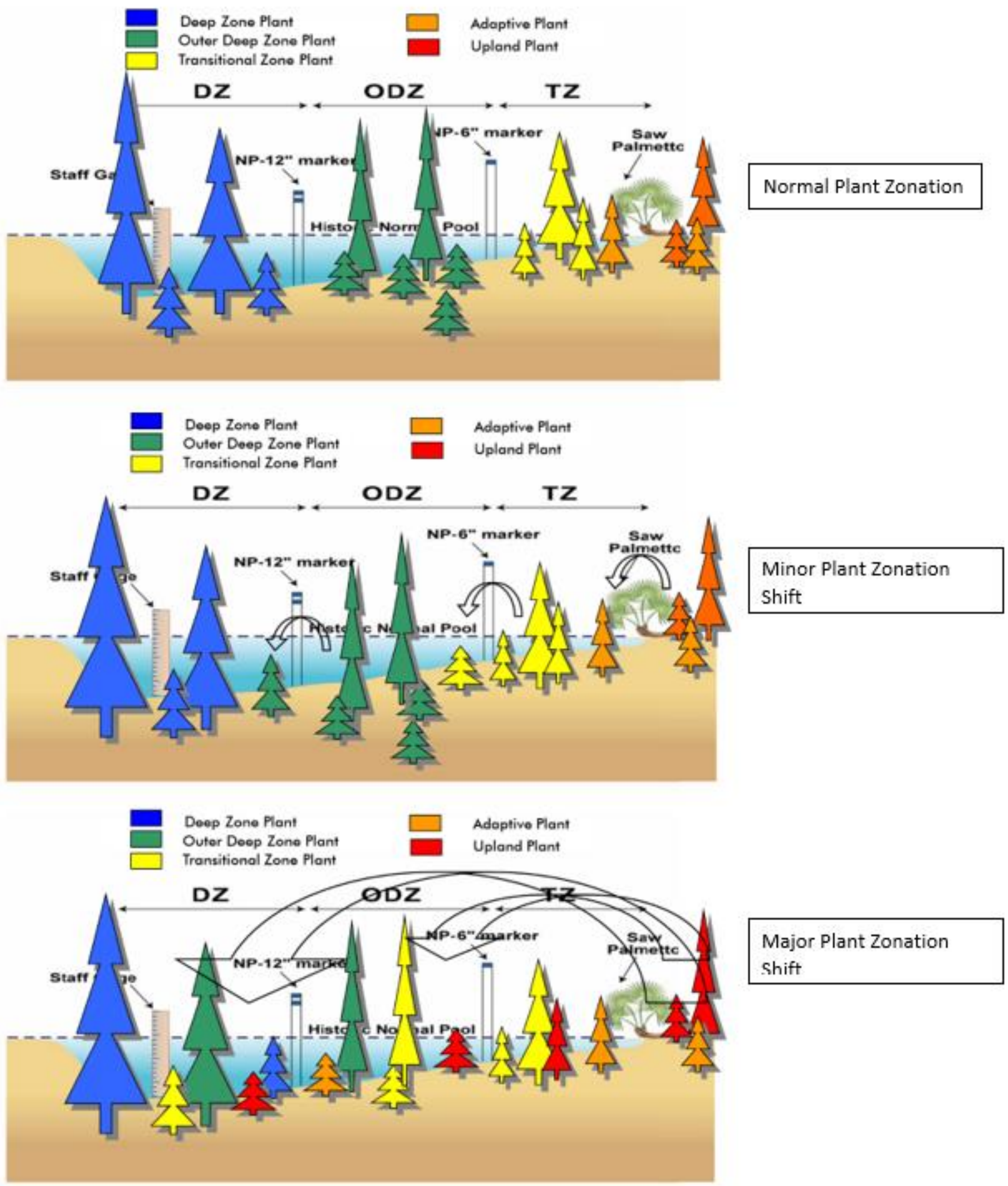

Figure 3.54: Illustration of the Progression of Upland Plant Migration into Wetlands

Adverse changes in wetland vegetation in four wetlands can been seen in the photographs presented in Figure 3.55. Wetland W-16 was one of the first wetlands to show significant water level change at the Cypress Creek Wellfield with no standing water for multiple years and the water table was often more than 10 feet below the bottom of the wetland. The soils of this marsh continued to support wetland vegetation; however, the presence of mature slash pine (*Pinus elliottii*) in the center of the wetland is a negative vegetation change. Slash pine is considered an adaptive species which will germinate in drier soils but can tolerate wetter soils once the trees mature. Dogfennel (*Eupatorium capillifolium*) is another adaptive plant and the presence of this species in the deepest part of Wetland S-005 at the Starkey Wellfield is another negative vegetation change. At the time of the photo, the Dogfennel was almost as tall as the staff gage indicating it had been there for some time. This species will die out relatively quickly if the wetland is again inundated for sustained periods of time. Wetland EWWF-3 at the Eldridge-Wilde Wellfield also had mature pines within the wetland along with other upland and transitional vegetation at the time of the 1989 photograph. The photo of Wetland C at the Cypress Creek Wellfield shows that nuisance or exotic species like Skunkvine (*Paederia foetida*), another adaptive species, can become established during periods of sustained low water levels

Figure 3.55: Photographs of Changes in Wetland Vegetation; a) Cypress Creek Wetland W-16 (2016), b) Starkey Wetland S-005 (2002), c) Eldridge-Wilde Wetland EWWF-3 (1989), and d) Cypress Creek Wetland C (1994). (Photo b provided courtesy of GPI, Inc. staff and photos c and d provided courtesy of District staff)

The negative vegetation changes that occur with sustained low or absent water levels are gradual and will appear over years depending on the plant species. The converse is also true; when sustained standing water returns to a wetland, it takes time for many of the less water-tolerant species to die back. This lag time between hydrologic change and vegetation change makes assessment of impacts and recovery challenging and requires regular monitoring of the same wetlands by wetland scientists over multiple years.

3.9.3.1.3 Reduction in Wildlife Habitat

The larger wellfield properties including the Starkey, Cypress Creek, Cross Bar Ranch, Eldridge-Wilde, and Morris Bridge Wellfields provide refuge and breeding habitat for wildlife. This is of particular importance in the Tampa Bay area as the region continues to change to a more urban landscape. Tampa Bay Water's environmental monitoring programs have always included wildlife observations, but it is difficult to draw informed conclusions about wildlife due to the multiple stresses that cause changes in wildlife populations. Wetlands at multiple wellfields have been documented as roosting and foraging habitat for wetland-dependent birds and several wetlands have been identified as long-term rookeries. Wellfield wetlands also provide a habitat for amphibians and the Environmental Monitoring Program (Section 5.5.2.2) contains monitoring guidance on the observation of frog species and their different breeding requirements. Some frog species such as the bull frog and pig frog require wetlands with a hydroperiod of at least 250 days for breeding. The reduction or loss of standing water in lakes and wetlands for sustained periods of time will change the amount of available habitat for these bird and amphibian species, as well as mammals that use wetlands as a water source during times of drought.

3.9.3.1.4 Soil Subsidence and Oxidation

Wetland soils can subside by compaction of unconsolidated organic soil material or the oxidation of organic sediments that were previously under anerobic conditions (inundated and not exposed to the air). These conditions can occur when a wetland is dry for long periods of time or the wetland soils are infrequently saturated. Soil elevation change is a very slow process on the order of years or decades and soil subsidence is already moderate to severe when it becomes easily visible. Wetland soils can also subside due to subsurface collapse features in the underlying limestone aquifer, but this is a more rapid condition and is not necessarily related to changes in water levels.

The Authority measured wetland soil elevation change at five of the northern Tampa Bay wellfields between 1986 and 1998 in a study of soil subsidence. Twenty-one wetlands at the Cross Bar Ranch, Cypress Creek, Cypress Bridge, North Pasco, and Northwest Hillsborough Regional Wellfields were monitored to record the change in soil elevation over sequential years. Each monitored wetland had multiple points where soil change was surveyed to provide a median elevation change for the entire wetland. Soil subsidence was greatest in the deepest parts of the monitored wetlands and soil subsidence of 0.01 to 0.87 foot was recorded at 16 of the 21 monitored wetlands during the study. Five of the monitored sites had slight soil accretion over the period of study with a maximum increase of 0.13 foot (Berryman & Henigar, Inc., 2000b). This study also found that the median hydroperiods of the studied wetlands were significantly correlated with the maximum rates of soil subsidence; wetlands with shorter hydroperiods had higher rates of soil subsidence.

Figure 3.56 contains photographs of soil subsidence in wetlands at four of the wellfields. Wetland MBR-10 at the Morris Bridge Wellfield contains numerous depressional features in the center of the marsh that were documented in the late 1980's. The depression in the top left photograph is 10 to 15 feet in diameter and approximately two feet deep. The soil slumping in wetland STK S-24 at the Starkey Wellfield is not as large or deep as the depressional feature at MBR-10 but there are numerous soil cracks extending away from the soil slump at STK S-24. Two examples of soil loss at the base of cypress trees are presented in the bottom two photographs for Section 21 Wellfield Wetland NW-53 and Starkey Wetland #3. These photographs show moderate to severe soil subsidence/oxidation with the wetland soils well below cypress roots that were once covered by wetland soils.

Figure 3.56: Photographs of Wetland Soil Subsidence; a) Morris Bridge Wetland MBR-10 (2017), b) Starkey Wetland S-24 (2007), c) Section 21 Wetland NW-53 (2007), and d) Starkey Wetland #3 (2007). (Photos b – d provided courtesy of District staff)

3.9.3.1.5 Treefall

Some of the environmental impacts discussed in this section are sequential. In cases where wetland soil subsidence/oxidation is moderate to severe and resulting in exposed tree roots, treefall can be a subsequent impact. Once the wetland soil subsides away from the base and roots of the trees, they have less stability and are prone to leaning or falling during high wind events or if the subsidence becomes too great, simply to support the tree. The soil subsidence study completed by Berryman & Henigar found that the monitored sites with the highest degree of soil subsidence also had multiple leaning and fallen trees. Many of the monitored wetlands in the wellfield monitoring programs have varying degrees of treefall (see photos b – d in Figure 3.53 for examples of treefall within isolated or connected wetlands). This environmental impact takes years to develop following long periods of little or no standing water in a wetland. Wetlands with treefall are not uncommon at the older wellfields that had high rates of sustained pumping in past decades and this impact can be severe in floodplain areas.

Treefall within the Cypress Creek and Dye's Crossing floodplains at the Cypress Creek Wellfield was first recorded in 1983 in the main floodplain of the creek in the center of the wellfield. An assessment of the extent of treefall in these two floodplains was completed in 2019 using aerial photography interpretation and field review. This analysis reported that treefall had been documented in the Dye's Crossing Floodplain on the eastern side of the wellfield for more than 20 years. The aerial photography indicated the presence of approximately 768 acres of moderate treefall (less than 50 percent of the tree canopy present) and 615 acres of severe treefall (less than 10 percent of the tree canopy remaining) in the Dye's Crossing Floodplain as of October 2018.

This assessment also reported that there were 474 acres of moderate treefall and 144 acres of severe treefall in the Cypress Creek Floodplain as of October 2018. This is the floodplain area of the wellfield upstream of the surface water control structure where Cypress Creek flows under the wellfield access road. Some of the treefall is the result of the death of tree species that became established in deep areas of the floodplain during extended periods of low inundation; these tree species died and fell when the normal periods of inundation returned following the reduction in pumping at the wellfield. Some of the treefall is attributed to the impoundment of water upstream of the water control structure at high levels for extended periods of time (2003 – 2004, 2012 – 2013 and 2017). The control structure and culverts under the wellfield road were closed during times of flooding and water flooded into the adjacent mesic forest areas for long periods of time, killing many of the trees adjacent to the floodplain. This area is slowly recovering as can be seen in the aerial photography interpretation section of the Water Year 2018 Annual Report for the Cypress Creek Wellfield (Tampa Bay Water, 2019c). The recent photography shows the recruitment of wetland trees within the areas of moderate and severe treefall in response to the return of normal inundation patterns.

Photographs a – c in Figure 3.57 show the treefall in the Cypress Creek Floodplain described above at three of the long-term monitoring stations within the floodplain (Wetlands W-21, W-44 and W-49). These photographs show the treefall in the floodplain at its greatest extent with most of the trees either standing dead or having already fallen. High rainfall during 2003 and 2004 brought high flows through the Cypress Creek Floodplain and it is likely that many trees in the floodplain fell during this high-flow period after having experienced soil subsidence in the prior years; the oxidized soils were not able to support the floodplain trees in the presence of high surface water flows. Some of the fallen or standing dead trees were also species that had become established in the floodplain during times of reduced inundation. The oblique aerial photograph of Wetland S-036A at the Starkey Wellfield from 2005 also shows severe treefall. This wetland in the center of the Starkey Wellfield had experienced soil subsidence for several years and it is thought that the treefall in this wetland happened during a high-wind event because most trees fell in one direction. If that was the case, the weakened soil structure under the trees was not enough to support the trees during the high wind event.

Figure 3.57: Photographs of Treefall; a) Cypress Creek Wetland W-49 (2005), b) Cypress Creek Wetland W-44 (2006), c) Cypress Creek Wetland W-21 (2006), and d) Starkey Wetland S-036A (2005). **(Photos a and c provided courtesy of C. Grizzle, photo b) provided courtesy of District staff, and photo d provided courtesy of GPI, Inc. staff)**

3.9.3.1.6 Wildfire

Fire is a natural occurrence and is a natural method of vegetation control and regeneration. Fire is not caused by low water levels, but the effects of a fire may be magnified in areas are dry for long periods of time. Wildfire and prescribed fire events for land management purposes can negatively affect wetlands if the fires are not controlled, burn at very high temperatures due to abundant dry vegetation (high fire fuel load) or occur during very dry periods of time. In these cases, the impact to wetlands can be catastrophic. The fire can burn all the groundcover and shrubs and damage or kill the wetland trees if the fire temperature is very high. If a wetland has an extensive peat layer in the underlying soils, a fire in that wetland can smolder for weeks, producing abundant smoke and burning off much of the organic soil. If fire damage to wetland soils or vegetation is extensive, it can take years or decades for the wetland to recover. The two photographs in Figure 3.58 show the effects of wildfire in two wetlands at the Starkey Wellfield during 2007 and 2017.

a)

b)

Figure 3.58: The Effects of Wildfire on Wetlands; a) Starkey Wetland S-005 (September 2007), and b) Starkey Wetland S-052 (June 2017). (Photos provided courtesy of GPI, Inc. staff)

3.9.3.2 Dry Wetland and Lake Complaints

Environmental impacts were observed by the public and complaints of dry wetlands and low lake water levels were sent to the Authority by individual citizens. The majority were filed in the early to mid-1990's during the time of low rainfall and high wellfield pumping. Figure 3.59 shows the location of 204 individual environmental complaints received by the Authority, and all but three of these complaints occurred prior to January 2003 (the reduction in wellfield pumping began in late 2002). There were clusters of complaints to the southeast of the Cypress Creek Wellfield from the Quail Hollow Estates and Saddlewood Estates communities, south of the Cross Bar Ranch Wellfield (Pasco Trails Estates), throughout the Cosme-Odessa Wellfield, and along the chain of lakes in the Lutz area. The Water Use Permits for each of the wellfields required an investigation and report of findings for all complaints. These reports are included in the files of Tampa Bay Water and the District and were used to assemble the data presented in this complaint location map.

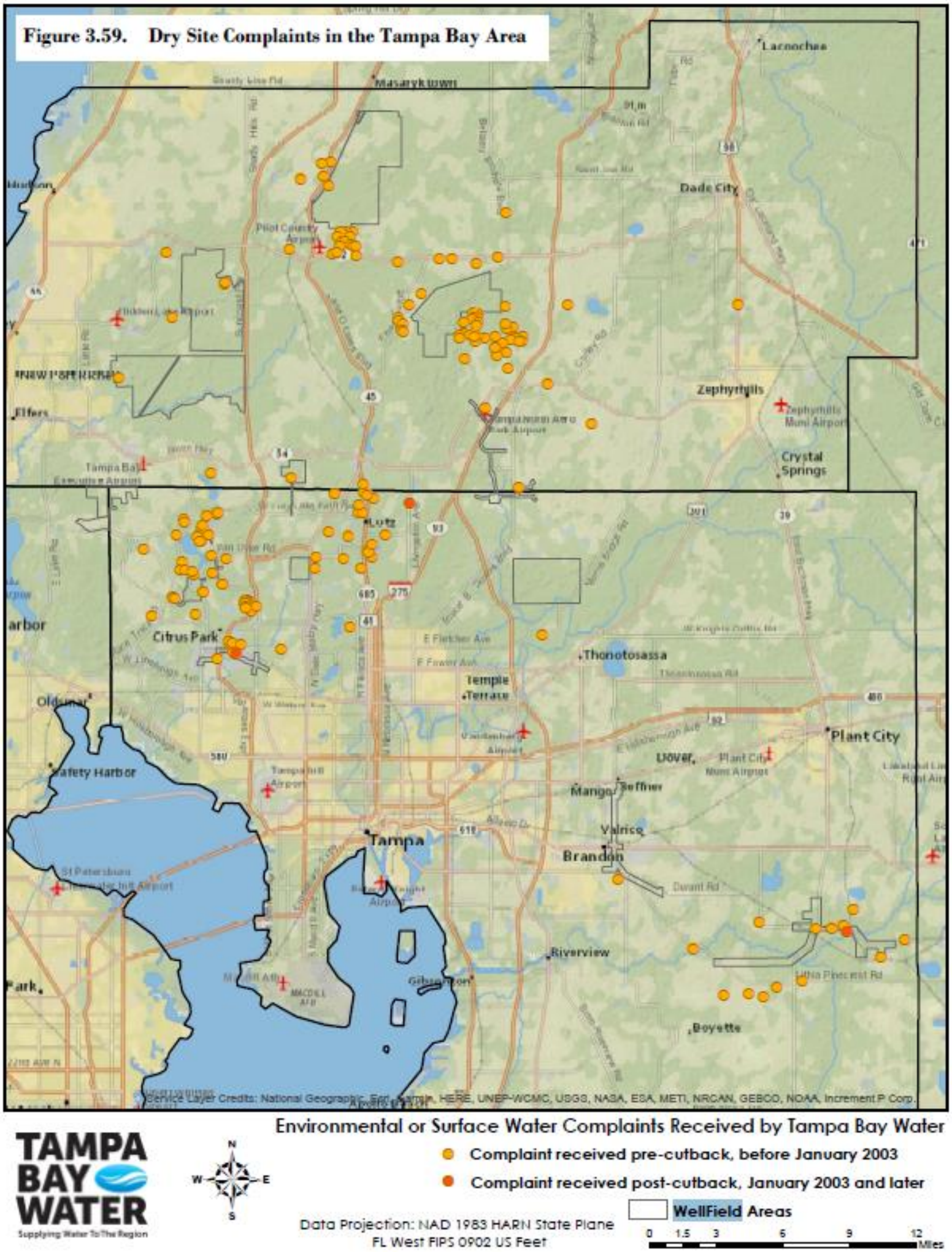

Figure 3.59: Dry Site Complaints in the Tampa Bay Area

3.9.4 Northern Tampa Bay Recovery Strategy (Phase 1) – Chapter 40D-80.073

Due to environmental stress to the water resources of the Northern Tampa Bay area, Section 373.042(4) Florida Statutes (F.S.), as amended by the Florida Legislature in 1996, directed the Southwest Florida Water Management District to establish minimum flows and levels for this region by October 1, 1997 (Southwest Florida Water Management District, 1999b). The District began the public process of developing minimum flows and levels for multiple water bodies as described in the Northern Tampa Bay Minimum Flows and Levels White Papers (Appendices 6.3 and 6.8) and Sections 6.3.2. and 6.4.2 of this report. The Florida Legislature added Section 373.042(1)(a), F.S. effective July 1, 1997 which directed the District to consider changes and structural alterations to watersheds, surface waters, and aquifers and the effects such changes and alterations have had, and the constraints such changes or alterations have placed, on the hydrology of an affected watershed, surface water, or aquifer when establishing minimum flows and levels. District staff continued the public process to finalize the minimum flows and levels for the initial set of waterbodies which were approved by the Governing Board in October 1998.

Chapter 373.0421(2), F.S. requires the adoption of a recovery or prevention strategy if, at the time a minimum flow or level is initially established or is revised, the existing flow or water level in the water body is below, or is projected to fall below the applicable minimum flow or level within 20 years. The Statute adds that the recovery or prevention strategy shall include the development of additional water supplies and other actions to achieve recovery to the established minimum flow or level as soon as practicable or prevent the existing flow or level from falling below the established minimum flow or level. The recovery or prevention strategy must include a phased-in approach or timetable which will allow for the provision of sufficient water supplies for all existing and projected reasonable-beneficial uses, including the development of additional water supplies to offset reductions in permitted withdrawals.

The District Governing Board approved the initiation of additional rulemaking in May 1997 to create the recovery and prevention strategy for minimum flows and levels that were in development at the same time. This new rule of the District (Rule 40D-80, F.A.C.) established the regulatory portion of the recovery or prevention strategy. The complete strategy was to be found within the District's Water Management Plan. The plan may include water resource supply and development projects and funding assistance, environmental restoration projects, conservation programs, and water shortage mitigation plans. The section of this rule that was developed to address recovery of natural systems for Pasco, Northern Hillsborough, and Pinellas Counties is found in Rule 40D-80.073, F.A.C. These rules were approved by the District Governing Board in September 1998 and were adopted on August 3, 2000.

This Recovery Strategy requirement applied to all water use permittees within the defined area with the primary focus of this initial Recovery Strategy the 11 groundwater wellfields located north of Tampa Bay. Water Level recovery to the anticipated minimum flows and levels for wetlands and lakes was the objective of this recovery strategy which was effective through December 31, 2010. Among other provisions, the Recovery Strategy required that groundwater withdrawals from Tampa Bay Water's 11 northern wellfields would be reduced to a 12-month running average of 90 mgd by 2008 to promote recovery in the area lakes and wetlands. To compensate for this reduction in groundwater withdrawals, the District committed through a separate agreement to assist in funding alternative public water supplies of at least 85 million gallons per day. This Recovery Strategy rule was a key component of the larger environmental recovery strategy in the Northern Tampa Bay area. This rule enabled the issuance of a consolidated permit for the 11 individually permitted wellfields, authorizing the phased reduction in pumping as the new alternative water supplies were developed. This rule worked in concert with the District's Water Use Permitting Rule 40D-2, F.A.C. to allow this unprecedented consolidation of groundwater resources followed by a significant reduction in groundwater pumping from historic levels.

3.9.5 Litigation Over Wellfield Permit Renewals

The Tampa Bay area had long struggled to find an acceptable balance between supplying water for the region, protecting the environment around the wellfields and achieving inter-governmental peace on water supply issues. Tension existed between the local governments because the coastal communities had purchased land in other counties to develop wellfields that would not be at risk for salt-water intrusion as had happened with the very early groundwater wells near the coastline. The inland counties where the wellfields were located accused the coastal communities of taking their water, the water that would be needed for their current and future citizens and the water that was needed to sustain the ecological communities near the wellfields. In the early to mid-1990's, the Authority and its member governments who owned and operated their own wellfields were working to understand the implications of the permitting rule changes of 1989 and how these changes would affect wellfield operations and yield. Environmental impacts had been documented at the existing wellfields north of Tampa Bay and the period of below-average rainfall in the early and mid-1990's brought wide-spread community attention to low water levels in area lakes and wetlands and impacts to wetland vegetation. The Tampa Bay area had been engaged in episodic "water wars" for the past few decades but in the mid-1990's, these water supply and environmental issues erupted into a massive legal and political fight. The renewal of the Water Use Permits for four wellfields in the northwest Hillsborough area was the trigger for this battle.

Much has been written about the Tampa Bay "water wars" and the animosity that they created within the region. The intent of the summary presented in this report is not to retell the story in detail but to briefly summarize the positions, parties, and discussions from an objective point of view. The administrative hearing on the four Water Use Permits is an important chapter in the water supply history of West-Central Florida and this summary is written to provide context for the subsequent regional water supply decisions and actions.

In 1992, the Authority and the City of St. Petersburg filed applications to renew the Water Use Permits for the Cosme-Odessa and Section 21 Wellfields as both entities were responsible for their operation. The City also filed an application to renew the Water Use Permit for the South Pasco Wellfield which the City alone operated. The Authority and City provided additional supporting information at the request of the District and these three permit applications were deemed complete in mid-1994. The Authority also filed an application to renew the Water Use Permit for the Northwest Hillsborough Regional Wellfield in 1994 making this the fourth wellfield permit under review by the District. The District issued proposed permits for the four wellfields in February 1995, but the duration of each proposed permit was only one year. The District stated in the proposed permits that the one-year permit duration was necessary to resolve differences over the appropriate quantities that should be assigned to each permit and to undertake a regional plan and revised permitting rules for the NTB WUCA to address environmental impacts associated with withdrawals authorized by Water Use Permits. Receiving permits with a duration of one year was unacceptable to the Authority and City due to the amount of time and money required to develop the permit applications and supporting documents and the lack of certainty it created for any future public water supplies.

The Authority and multiple member governments requested administrative hearings from the State of Florida to resolve the questions surrounding the proposed one-year permit terms and new permit conditions. Of the six member governments of the Authority, two joined the case in support of the Authority and two joined the case in support of the District. The cities of New Port Richey and Tampa did not join the legal proceedings as individual entities. These requests were consolidated into one administrative hearing which was scheduled for January 1996 but was delayed until July 1996. Between the time of the request for administrative hearing on the four permits and the final administrative hearings, the parties tried to negotiate the development of environmental performance standards and the use of a subject matter expert arbitration panel to resolve the differences in technical and legal opinions of the parties. Unfortunately, none of these attempts to reach consensus worked and the parties continued to move further apart in their deliberations.

The Authority wanted to develop strategies that would both apply to all water users in the region and preserve the Authority quantities. The District's position was that the environmental impacts on and near the wellfields were primarily due to historical and current pumping levels from the wellfields and the environmental remedies should be applied first to the wellfield permits (the largest user of groundwater in the Northern Tampa Bay Area). The District's position followed the 1989 revisions to Chapter 40D-2 that prohibited adverse environmental impacts, whether or not they occurred on property owned or controlled by a permittee. Prior to the administrative hearing, the District proposed new permits for the four wellfields that would result in reduced levels of groundwater pumping over the proposed 10-year term and mitigation of lakes and wetlands that were adversely impacted by wellfield pumping. This proposal was not accepted by the Authority since it would mean a reduction in water supply capacity and risk public health and safety due to lack of adequate water supplies.

The District revised their proposed agency action in the month prior to the beginning of the administrative hearing to a denial of all four Water Use Permits. The parties went into the administrative hearing with polar opposite positions; issue the permits for the existing quantities versus denial of the permits. The hearing lasted for six weeks and the Administrative Law Judge issued the recommended order in May of 1997 stating that the four permits should be issued for 10-year terms at the existing average annual quantities with continued environmental monitoring. He also found that adverse environmental impacts had occurred primarily because of pumping from the Cosme-Odessa, Section 21, and South Pasco Wellfields. He found that the wellfields had been operated in full compliance with the conditions of the past permits and that the permit applications at the requested annual average quantities met all permitting criteria for issuance; however, the issue of existing and historic environmental impacts was not resolved.

The estimated cost of litigating these four permit renewals likely exceeded $10 million including legal and expert witness fees, document research and reproduction, and the administrative cost of the hearing; however, for this expense of public funds, no new water supply was developed and no environmental systems were restored. Since the administrative hearing did not resolve the issue of existing and historic environmental impacts, the region still had to find a way to meet the growing demand for water and address the environmental impact due to groundwater use. The Water Use Permit for the Cross Bar Ranch was also being renewed during this time making it the fifth wellfield permit under consideration. The Tampa Bay region had grown weary of litigation over water supplies and began discussions of a regional solution to address both the environment and water supply. At the end of all the regional litigation, none of these five individual Water Use Permits were issued as all parties agreed to waive the time clock requirements for issuance of the five permits to discuss a regional solution. The resolution of these two critical issues would take significant regional conversation, cooperation, setting aside parochial perspectives, proactive legislation and, of course a great deal of money.

3.10 Formation of Tampa Bay Water

During the 1996 session, the Florida Legislature considered several pieces of legislation that would modify the structure of the Authority in a number of ways. The bill that passed the Legislature that year instead directed the Authority and its members to evaluate the Authority's structure and operations and submit a report to the Legislature by February 1, 1997 containing recommendations for improvements. The Authority retained KPMG Peat Marwick, LLP (KPMG) in June 1996 to conduct an independent analysis and present recommendations on improvements to the Authority and to work with the Authority staff, Board members, and member government staffs on these restructuring efforts. The KPMG study found that the existing method of contracting water entitlements had created a fragmented approach to water supply delivery that met the short-term need of each jurisdiction rather than the long-term need of the region. Each member government jurisdiction had different populations, future growth projections, water supplies, and water usage. The study found that the Authority's governance and financing structure exacerbated these divisions rather than overcoming them. During Fiscal Year 1995, the price that each member government paid for wholesale water from the Authority varied from $0.24/1,000 gallons (City of St. Petersburg) to $1.19/1,000 gallons (Hillsborough County). They described the Authority as a "collective, where each member can veto action by withholding its support, rather than a true partnership". KPMG stated that these differences prevented the Authority from moving forward in the development of new water supply sources (KPMG Peat Marwick, LLP, 1997).

The facilitated working group of the Board members, member government and Authority staff, with support from KPMG staff, reached consensus on the Authority's future in a series of workshops in October through December 1996. The working group had three vision statements:

- The Authority will be responsive and responsible by providing an adequate water supply to members without a negative impact on the environment,
- The Authority will operate as a regional system supplying water in an efficient manner at equitable prices, and
- The Authority will be a stable institution with a clear mission.

The working group further outlined fundamental changes needed to make the revised Authority a true partnership:

- There are no individual entitlements to water; each jurisdiction can use what it needs as long as overall capacity exists,
- All jurisdictions pay the same wholesale rate for water,

- The entire entity guarantees project financing, eliminating the threat of a single vote veto,
- A true majority vote authorizes the system to act,
- The Authority serves as the exclusive provider of wholesale water to the region, and
- Jurisdictions are fairly compensated for their existing facilities acquired by the Authority as part of the transition to a regional system.

The KPMG report was completed in January 1997 and submitted to the Florida Legislature ahead of the 1997 Legislative session. The KPMG report included numerous recommendations including expanding the Authority Board from five to nine members (all to be elected officials) with an equitable distribution of members across the three counties; the Authority will serve as the region's exclusive provider of wholesale water and acquire groundwater facilities from the members, giving all members uniform access to system-wide supply capacity; the Authority will focus on implementing the Master Water Plan projects to assure the development of diversified water supplies and the creation of an integrated system; and, that funding strategies should fairly compensate members for the past while moving to a uniform water rate for the future (KPMG Peat Marwick, LLP, 1997).

The Florida Legislature passed Chapter 97-160, Section 30, Laws of Florida as a result of the Governance Study completed by KPMG which encouraged and facilitated the implementation of the Governance Study recommendations. This legislation specifically directed that the restructured Authority would be the sole and exclusive provider of wholesale drinking water supplier to the member governments and that the Authority would have the absolute and unequivocal obligation to meet the wholesale drinking water needs of the member governments by charging a uniform rate for water supplied to the members. The legislation also directed the Authority and District to submit a plan or agreement for the joint development of alternative water supply sources and facilities with sufficient supply capacity to meet both the projected needs of the member governments for the next 20 years and the needs of local natural systems. During 1998, the Authority and the member government staffs, special counsel, and consultants worked to carry out the mandate of the 1997 Florida Legislature. The Board members, member government staff, and Authority staff continued to meet in regular workshops to develop the details of how the new Authority would operate including new governing documents. Three key agreements were drafted that would lead to the restructuring of the Authority; these agreements were the Amended and Restated Interlocal Agreement between the member governments, the Master Water Supply Contract between the Authority and the member governments, and the Property Transfer Agreements between the Authority and each member government (Nabors et. al., 1998).

These governance documents, along with new legislation requested to authorize or clarify the Authority's or member government's power to enter into certain provisions of the Amended and Restated Interlocal Agreement, would accomplish the restructuring of the Authority. Senator Jack Latvala sponsored and supported this legislation through approval during the 1998 Legislative Session. The three governance agreements were initially approved by the Authority Board of Directors in March 1998 and in April 1998, the Board approved the name "Tampa Bay Water" for the reorganized and restructured agency. The Board confirmed their approval of the governance agreements in May 1998 along with an historic agreement with the District that was also required by the 1997 legislation.

Key provisions of the Amended and Restated Interlocal Agreement are summarized above with respect to the structure and operations of the new agency, Tampa Bay Water. Other significant provisions include a quantification of the water supply source quantity that would be developed to replace some of the existing wellfield pumping quantity for the benefit of reducing environmental stress at the 11 northern wellfields. The agreement quantified a phased reduction in groundwater pumping down to a cumulative annual average quantity of 90 mgd by December 31, 2007 and provided guidance on how this replacement supply quantity would be allocated between the three counties. All parties agreed to use a defined arbitration process to resolve disputes on permitting issues rather than administrative hearings or litigation (Tampa Bay Water, 1998a).

3.10.1 Acquisition of Member Government Wellfields

The Amended and Restated Interlocal Agreement provided for the acquisition of water supply assets (wellfields and infrastructure) by Tampa Bay Water from the member governments with limited exceptions, which are delineated in Article V of the Agreement. Tampa Bay Water acquired the permitted production capacity from the members for the wellfields that the members owned and controlled as well as the wellhead sites, pumping appurtenances, and associated pipelines. The total cost of these acquisitions by Tampa Bay Water was $158.7 million. The following wellfields and production capacities were acquired from each of the member governments:

- City of St. Petersburg
  - South Pasco Wellfield – 16.9 mgd of production capacity
  - Section 21 Wellfield – 12.0 mgd of production capacity
  - Cosme-Odessa Wellfield – 12.0 mgd of production capacity
- Pinellas County
  - Eldridge-Wilde Wellfield – 35.24 mgd of production capacity
- City of Tampa
  - Morris Bridge Wellfield – 15.5 mgd of production capacity
- Pasco County
  - North Pasco Wellfield – 6.6 mgd of production capacity
- City of New Port Richey
  - North Pasco Wellfield – 1.4 mgd of production capacity
- Hillsborough County
  - Crippenwood and Manors of Crystal Lakes wells – approximately 0.6 mgd of production capacity

These six wellfields and dispersed production wells in northwest Hillsborough County were added to the wellfields owned and operated by Tampa Bay Water; Cypress Creek, Cross Bar Ranch, Starkey, Cypress Bridge, and Northwest Hillsborough Regional Wellfields. Through the execution of the Amended and Restated Interlocal Agreement and associated agreements, Tampa Bay Water was now responsible for the operation and maintenance of the 11 northern Tampa Bay area wellfields.

3.10.2 Partnership Agreement

The Authority, the member governments, and the District negotiated another historic agreement at the same time that the founding documents for Tampa Bay Water were underway. The negotiated agreement, informally known as the "Partnership Agreement" focused on the development of new, alternative water supplies (other than groundwater) and the reduction in pumping from the 11 northern wellfields. The Partnership Agreement satisfied the requirement of the 1997 State Legislation regarding the joint development of alternative water supply sources and facilities that would supply sufficient supply capacity to meet both the projected needs of the member governments for the next 20 years and the needs of local natural systems. This agreement was approved during a joint Board meeting between the Authority and District in April 1998 and was individually approved by the Authority and each member government board in May 1998 (Southwest Florida Water Management District, 1998a).

The Partnership Agreement required Tampa Bay Water to develop new alternative water supply projects that would provide an annual average quantity of at least 85 mgd to allow the reduction in the pumping rate from the 11 northern wellfields to an average annual quantity of 90 mgd by December 31, 2007. This quantity of new water supply was also projected to meet the new water supply needs of the member governments for the upcoming planning horizon. The Agreement contained a stated objective of ending the litigation and administrative hearings and avoiding future litigation and hearings between the parties on water supply issues. The Agreement also required Tampa Bay Water to develop and implement an Operations Plan to direct the operation of the regional system, including the 11 northern wellfields, to avoid or minimize environmental stress in the vicinity of these wellfields. In return, the District committed to provide $183 million to assist with the capital cost of developing and constructing the alternative water supplies necessary to achieve the historic reduction in wellfield pumping. The funding assistance for the construction of new water supplies was a crucial part of the restructuring of the Authority into Tampa Bay Water.

The Partnership Agreement was an historic achievement for another reason; it was the vehicle used to ultimately resolve the Consumptive Use Permit litigation for the four northwest Hillsborough-area wellfields and the pending permit renewal for the Cross Bar Ranch Wellfield. The District, Tampa Bay Water, and the member governments agreed to consolidate the 11 individual wellfield permits into one permit known as the Consolidated Permit. This permit would be issued to Tampa Bay Water who would own and operate all the wellfields acquired through the governance reformation. When all documents were executed, the operation of these wellfields would be the sole responsibility of Tampa Bay Water who would operate the individual wellfields as part of a regional system. Upon completion of the new regional water supplies and connecting infrastructure, the wellfield pumping rates would be greatly reduced and all wellfields would be operated as part of regional system, with the intent of avoiding or minimizing environmental stress in the vicinity of the wellfields. In addition, the cost of water to Tampa Bay Water's member governments would now be the same, regardless of the supply source. Removing cost from the discussion paved the way to regional operations for the benefit of both the citizens of the region and the environment.

3.10.3 Master Water Plan System Configuration I

The Authority had always planned for future water demands through studies of "needs and sources" dating back to the original plan in 1978 (Ross, Saarinen, Bolton & Wilder, 1978). Two updates to this initial study were completed by Camp Dresser and McKee in 1982 and 1986 and all of these planning documents reviewed the water supply needs of the member governments over a long-term planning horizon and discussed potential supply sources to meet those needs. The Authority staff initiated an update process in 1992 known as the Resource Development Plan to meet the growing demands of the member governments. Through this planning process, current supply sources were quantified, and future water demands were evaluated. Many water supply concepts and projects were considered during this vetting process and the Authority Board of Directors approved the first Master Water Plan in December 1995. This plan contained the necessary infrastructure and water supply projects to be developed in phases to meet the regional demand through the year 2005. The plan also contained developmental alternatives to be evaluated further to determine if they were viable supply projects, including brackish water desalination, seawater desalination, and a supply source based on high water flows in the Hillsborough River system (West Coast Regional Water Supply Authority, 1995).

The Authority actively pursued the feasibility studies, design, and permitting activities necessary to turn the water supply concepts in the 1995 Master Water Plan into water supply and infrastructure projects ready for Board evaluation and selection as the next supply and infrastructure projects. Following the reorganization into Tampa Bay Water and the execution of the Partnership Agreement with the District in mid-1998, the Tampa Bay Water Board approved a slate of projects called System Configuration I of the Master Water Plan in November 1998. The Partnership Agreement with the District called for the development of at least 85 mgd of alternative water supplies to allow the reduction in wellfield pumping and meet future demands. Tampa Bay Water still had to complete design and permitting work before it would be known which projects would ultimately be completed and the water supply yield from each source. The list of supply projects approved under System Configuration I in 1998 exceeded the 85 mgd requirement and included water supplies from the Alafia River, Tampa Bypass Canal (including the Hillsborough River during high flow periods), a regional reservoir, a seawater desalination facility, and groundwater sources including Cone Ranch and dispersed wells, the Brandon Urban Dispersed Wells and an expansion of the Cypress Bridge Wellfield. A surface water treatment plant and large-diameter transmission mains were also included in this slate of projects. This program would have a capital cost of $680 million which was greatly offset by $183 million in cooperative funding from the District (Tampa Bay Water, 2020k).

3.11 New Water Supply Development

A growing region must provide the water necessary for all uses; public supply, industry, agriculture, recreation, and the environment. It must create and sustain a safe, reliable, and affordable water supply. If water supplies are not available, are limited, or are significantly higher in cost than other metropolitan areas, future growth will be limited until these issues are resolved. Businesses will locate in other areas where the water supply and economic pressures are more favorable and growth in local population and housing will be limited. In extreme cases, the lack of water supplies or an exorbitant cost for water could cause a region to lose business and people. There are other significant factors that affect where businesses locate and where residential housing occurs, but an affordable and reliable water supply are key factors.

The Tampa Bay area acknowledged that sustainable and affordable water supplies were of vital importance to the region and it was time to move past the “water wars”. Through the reorganization of Tampa Bay Water and the completion of the Partnership Agreement with the District, the mission to diversify regional water supply sources was underway. These efforts would lead to the creation of an interconnected regional supply system that could expand to meet the expected growing water demand into the future. The capital cost of the water supplies and infrastructure necessary to create this interconnected regional supply system would total $1.68 billion (through the year 2019) including the acquisition cost of the member government wellfields. The development of alternative water supplies meant that Tampa Bay Water could meet the current water needs of the member governments at an affordable cost and also meet future water demands through the planning horizon. It also meant the region would lessen reliance on groundwater sources enabling the environment around the wellfields to recover as pumping rates were significantly reduced. Using a diverse set of water supplies to provide for the water needs of all users, including the environment would support this approach and its success. This would be an enormous step toward balancing the needs of the regional citizens and the environment.

3.11.1 Description of Sources

Tampa Bay Water was racing to develop new water supply projects under very tight timeframes as the population of the Tampa Bay area continued to grow. By the year 2020, the three-county population had reached 2,265,211 people, approximately 300,000 more than lived in Tampa Bay in 1990. The Partnership Agreement with the District required Tampa Bay Water to have one or more projects completed with an average annual capacity of at least 38 mgd by December 2002 and to have the remaining projects completed by December 2007 with an average annual quantity of at least 85 mgd (inclusive of the initial 38 mgd). Tampa Bay Water proceeded with the simultaneous development of multiple source projects and pipelines to ensure that these contractual requirements could be met. The initial ground-breaking for the construction of these future water supply projects occurred in September 2000. This section presents a brief summary of the development of the new water supplies; additional information on each supply source and system component can be found in Tampa Bay Water's records and historical reports. Additional information on the different supply sources and how they are operated can be found in Chapter 4 of this report.

The cornerstone of the regional alternative water supplies is the Enhanced Surface Water System and is made up of a Surface Water Treatment Plant, surface water intakes on the Tampa Bypass Canal and Alafia River, an off-stream reservoir, and miles of large-diameter pipelines and the booster stations needed to move vast quantities of water (Figure 3.60). The Surface Water Treatment Plant is in central Hillsborough County and is co-located with a High Service Pumping Station that allows the water from all of the alternative supply sources to be distributed throughout Tampa Bay Water's Regional System. The Surface Water Treatment Plant came online in August 2002 with a permitted capacity of 66 mgd of surface water. The treatment processes incorporated into this plant include pH adjustment, enhanced coagulation, flocculation and sedimentation, primary disinfection using ozone, biologically active filtration, secondary disinfection, and alkalinity adjustment. The Surface Water Treatment Plant would be expanded to an FDEP-rated capacity of 120 mgd in 2010.

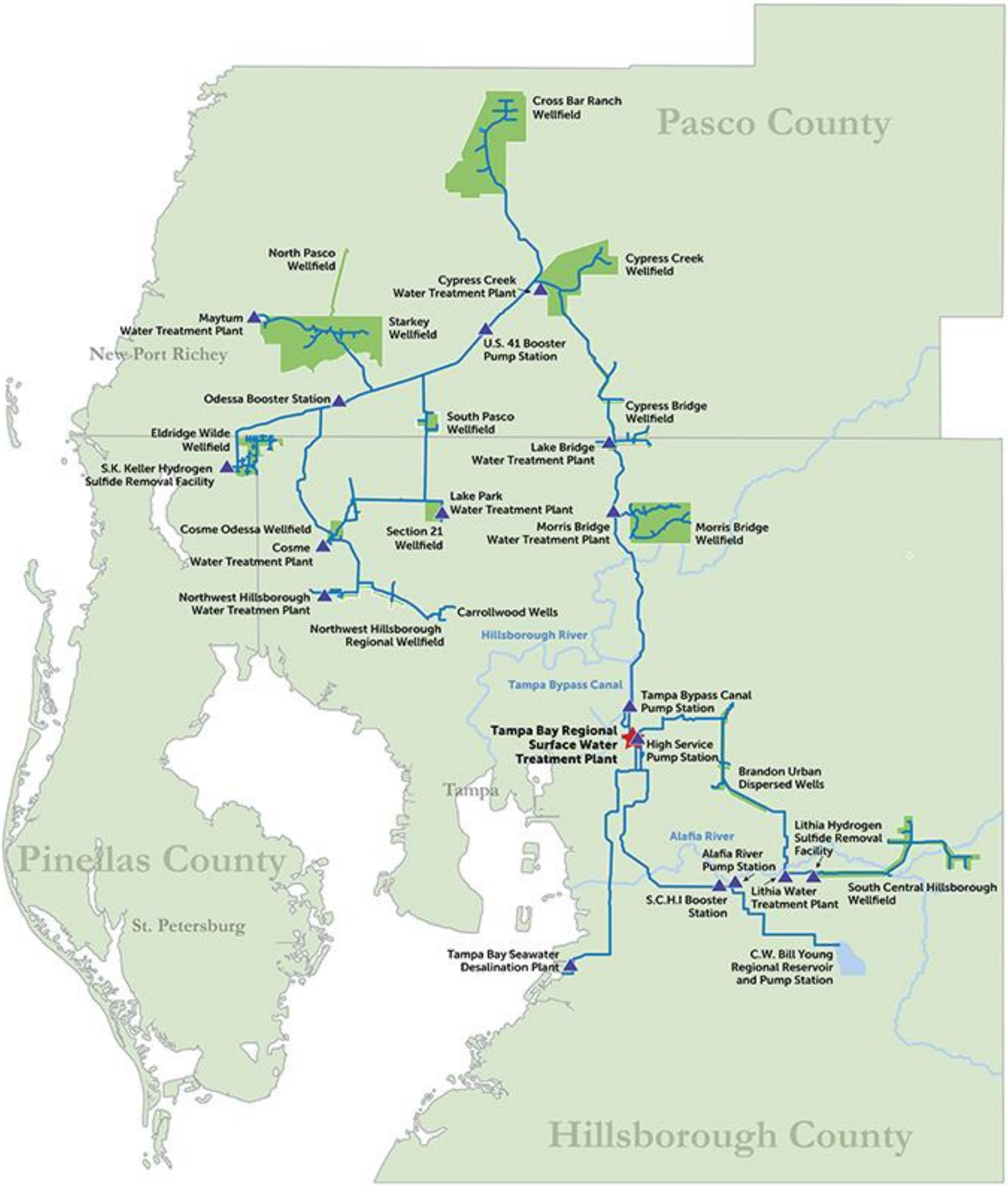

Figure 3.60: Tampa Bay Water Regional System

The Surface Water Treatment Plant is connected to two supply sources and an off-stream reservoir. The Tampa Bypass Canal Pumping Station is the primary surface water supply source and came online in September 2002 as the first alternative to groundwater supply in Tampa Bay Water's system. The supply is the middle and lower pools of the Tampa Bypass Canal, that was originally constructed in the 1960's and 1970's by the U.S. Army Corps of Engineers as a flood conveyance system to protect the City of Tampa and the City of Temple Terrace from flood events. The Canal is connected to the Hillsborough River by the Harney Canal allowing water to be diverted from the River to the Canal during times of high river flow and the Canal can supply water to the River during times of low river flow to augment the City of Tampa's primary water supply source. Tampa Bay Water is permitted to withdraw up to 258 mgd of water during certain high flow conditions from the Tampa Bypass Canal to supply the Surface Water Treatment Plant and for storage in the off-stream reservoir for future use.

The Alafia River Pumping Station supplies up to 60 mgd of permitted water from the Alafia River to either the Surface Water Treatment Plant or to the off-stream reservoir. This second alternative supply source and the second supply source for the Surface Water Treatment Plant came online in February 2003. The third supply and storage component of the Enhanced Surface Water System is the C.W. Bill Young Regional Reservoir, located in southeastern Hillsborough County. Tampa Bay Water broke ground on the construction of this facility in May 2002 and it was placed into service in 2005. The Regional Reservoir was designed and constructed to store up to 15 billion gallons. The Regional Reservoir underwent renovation which was completed in 2014 due to issues with the interior wave erosion soil cement layer. Following renovation, the storage capacity is now 15.5 billion gallons. Tampa Bay Water stores water from the Tampa Bypass Canal and Alafia Rivers in the Regional Reservoir during the summer months when plentiful surface water flows are available. During the typical eight-month dry season (October through May), water stored in the Regional Reservoir is available to meet production needs of the Surface Water Treatment Plant when river flows are insufficient, making this a robust alternative supply system.

The second alternative supply source type developed by Tampa Bay Water during this period was a Seawater Desalination Facility located adjacent to the Tampa Electric Company's Big Bend Power Station on Tampa Bay. This facility was developed for Tampa Bay Water by a private contractor and construction commenced in May 2001. The facility uses reverse osmosis technology to treat water from the power plant's cooling towers and discharges the brine concentrate back into the power station's cooling water discharge canal to minimize the effects of the brine concentration to the ecosystems in Tampa Bay. The sustainable supply capacity is currently in the 18-20 mgd range. The desalination facility first delivered water to the region in March 2003 but was soon taken off-line in 2005 for improvements necessary to improve reliability. The facility was returned to service in 2007 and has since delivered over 26 billion gallons of drinking water to the Tampa Bay region. Currently, the facility is operated seasonally to meet peak dry season water demands.

Tampa Bay Water completed one groundwater supply project under System Configuration I, the Brandon Urban Dispersed Wells. This was not a new supply source for the area but a rejuvenation of a past supply source. Similar to the development that occurred in Northwest Hillsborough County (see Section 3.6), each neighborhood in the Brandon area had been developed with a water supply system using one or more groundwater wells. As the Brandon area in southern Hillsborough County expanded, Hillsborough County Utilities began to interconnect and serve these neighborhoods with potable water and sewer services. Tampa Bay Water was able to use one of the existing supply wells and added four others to redevelop a wellfield capable of delivering an annual average of 6 mgd to the region. The Brandon Urban Dispersed Wells became operational in June 2002.

3.11.2 Interconnection with Existing System

System Configuration I of the Master Water Plan included pipelines and other infrastructure necessary to move the alternative water supplies from source to treatment and connection with Tampa Bay Water's Regional System. An 84-inch diameter pipeline approximately 2 miles long was constructed to move water from the Tampa Bypass Canal Pumping Station to the Surface Water Treatment Plant. The North-Central Hillsborough Intertie connects the Surface Water Treatment Plant to the Regional System, connecting to the Morris Bridge Transmission Main in northern Hillsborough County. This 84-inch diameter regional transmission main is 13 miles in length and was completed in May 2002. The South-Central Hillsborough Intertie is a 72-inch diameter pipeline that connects the Surface Water Treatment Plant to the Alafia River Pumping Station. This 13-mile long pipeline was placed into service in February 2003. An 84-inch diameter pipeline from the Regional Reservoir to the Alafia River Pumping Station and the South-Central Hillsborough Intertie completes the surface water system interconnections. These large-diameter pipelines make full use of the surface water supply sources and interconnect all the alternative supply sources with Tampa Bay Water's Regional System.

Other, smaller diameter pipelines were necessary to connect other supply sources developed during System Configuration I. A 14.5 mile pipeline was necessary to connect the Tampa Bay Desalination Facility to the Regional High Service Pumping Station. This 42-inch diameter pipeline was completed in 2003. A series of pipelines was also required to connect the new Brandon Urban Dispersed Wells to the Regional High Service Pumping Station and to the Lithia Water Treatment Plant in southern Hillsborough County.

Tampa Bay Water completed a tremendous amount of water supply construction in a relatively short period of time. All these supply and pipeline projects were large-scale, complex design and construction projects completed under tight time constraints. In total, the cost of the initial system configuration was approximately $680 million.

3.11.3 Infrastructure Improvements and Interconnections

Tampa Bay Water continued planning for the future as soon as the capital construction under the Master Water Plan System Configuration I was completed. The Board selected potential supply projects in December 2003 for consideration as future water supply projects to meet regional demands through the year 2020. Tampa Bay Water completed the construction of System Configuration II projects in 2011 and the ten new projects were all infrastructure projects designed to more fully use the alternative water supplies developed during System Configuration I. These projects included an expansion of the treatment and pumping capacity at the Regional Surface Water Treatment Plant as described above, expansion of the Tampa Bypass Canal Pumping Station, expansion of multiple pump and booster stations, and the construction of additional pipelines and booster stations. These capital projects also enhanced the reliability of Tampa Bay Water's Regional System. The capital cost of these ten projects was approximately $226 million with the District and State funding $122 million of the total cost (Tampa Bay Water, 2020k). In total, Tampa Bay Water spent more than $900 million in capital construction during

System Configurations I and II to ensure that the Tampa Bay area has adequate drinking water at an affordable rate. The water needs of the environment have been realized by cutting the groundwater pumping rate at the 11 northern wellfields and replacing that permitted capacity with alternative water supplies.

3.12 Original Consolidated Permit (1998 permit)

The Partnership Agreement between the West Coast Regional Water Supply Authority, the member governments, and the District contained a draft Consolidated Permit as Exhibit B. This permit consolidated 11 individual Water Use Permits held singly or jointly by the West Coast Regional Water Supply Authority and the individual member governments into a single Water Use Permit issued only to Tampa Bay Water. All parties to the Partnership Agreement negotiated the conditions of the permit which was to be issued even though an application was never filed to consolidate the 11 permits into one. During mid-to-late 1998, the pending administrative proceedings concerning four of the individual permits were resolved between all parties and the District modified certain rules to allow the issuance of the new permit. The final permit conditions were negotiated and the District issued the Consolidated Permit on December 15, 1998 and the permit became effective on January 1, 1999 (see Appendix 3.1).

The issuance of this permit allowed Tampa Bay Water to operate the wellfields as an interconnected system and moved the region away from preferentially operating wellfields to meet demands based, in part, on the different cost of water from each source. The permit required and allowed Tampa Bay Water to reduce the pumping levels at the wellfields once the new alternative water supply sources were developed and connected to the regional supply system. The expiration date for the permit was December 31, 2010 allowing the permit to remain in effect until after Tampa Bay Water developed alternative water supply sources and reduced the wellfield pumping to an average annual limit of 90 mgd. The original Consolidated Permit contained many special conditions requiring data collection, reporting, and completion of technical studies. Four requirements of the permit are of great importance to the current Recovery Assessment Plan. Those elements: a reduction in wellfield pumping, the development of an Operations Plan, the development of a Phase 1 Mitigation Plan, and a revision of the Environmental Management Plan are discussed in the following sections.

3.12.1 Reduction in Pumping

The most important aspect of the original Consolidated Permit was the reduction in pumping that would be achieved during the term of the permit. The reduction in groundwater pumping is one of the stated objectives of the Partnership Agreement and a key component of the Amended and Restated Interlocal Agreement (Tampa Bay Water, 1998a). Prior to the issuance of the Consolidated Permit, the 11 individual permits allowed a cumulative average annual quantity of 192 mgd to be pumped from the 11 wellfields. This pumping quantity was never reached; however, the highest 12 consecutive months of pumping from the 11 wellfields was an average of 167.2 mgd between March 2000 and February 2001. This rate of pumping occurred during an extreme drought and prior to the completion of the alternative water supplies.

The original permit contained a series of phased reductions in the average withdrawal from the 11 wellfields. From January 1, 1999 through December 31, 2002, withdrawals were limited to 158 mgd on a

36-month running average basis. From January 1, 2003 through December 31, 2007, withdrawals were limited to 121 mgd on a 12-month running average basis. Finally, from January 1, 2008 through the expiration of the permit, withdrawals were limited to no more than 90 mgd on a 12-month running average basis. In negotiating the initial withdrawal limit of 158 mgd, Tampa Bay Water and the member governments estimated that these annual quantities would provide sufficient water to meet the regional demand, based on long-term average conditions. A 36-month running average compliance period was granted in order to use a single numerical value for compliance through the end of 2002 that would accommodate normal seasonal variations in pumping as well as moderate growth in regional demand.

This initial period of the permit also required compliance with a facility quantity table included in both the permit and the Partnership Agreement, also with a 36-month running average basis. This table listed an individual quantity limit for each of the 11 wellfields. Table 2 of the original Consolidated Permit also identified the average annual and peak month pumping limitations for the production wells at each wellfield. These individual well quantities were based on the distribution of pumping prior to 1998 and were listed as reference values; however, Tampa Bay Water was not limited to these quantities as long as the wellfield limits, as modified and approved by the District, were met. Tampa Bay Water was to rotate pumping within and between the wellfields to meet demands and regulatory levels in the Upper Floridan Aquifer and to minimize wellfield impacts to the greatest degree possible.

The Partnership Agreement included requirements for allocating the reduction in wellfield pumping between the three counties as soon as the alternative water supplies were on-line. A minimum of 40% of the reduction was allocated to wellfields in Pasco County, a minimum of 20% at wellfields in Hillsborough County, a minimum of 10% at wellfields in Pinellas County, and the remaining 30% was to be applied by the Operations Plan based on environmental conditions. These requirements were included in the formulation of the Operations Plan and compliance with these reduction allocations were reported in the Annual Operations Plan reports.

When the Partnership Agreement was negotiated, Tampa Bay Water believed that at least one of the new alternative water supply sources would be on-line by December 2002, allowing pumping from the wellfields to be reduced by that date. The second phase of the permit was based on this assumption and represented an intermediate step in reducing the wellfield pumping limits. Tampa Bay Water further anticipated having all the new supply sources on-line by 2007 and the final reduction of pumping to an annual average limit of 90 mgd was to begin on January 1, 2008. The Consolidated Permit was a negotiated document and there was no single analysis performed by Tampa Bay Water or the District that concluded that 90 mgd was the appropriate long-term average pumping limit for these wellfields. Rather, it was the best estimate of the quantity needed to promote significant environmental recovery and provide a stable water supply quantity that Tampa Bay Water and the District could use for water supply planning purposes. Collectively, it was assumed that an annual average quantity of 90 mgd would be relatively close to the sustainable long-term average capacity of the wellfields but it was acknowledged that the actual quantity may, in reality, be higher or lower than 90 mgd.

The permit compliance period changed in January 2003 to a 12-month running average basis instead of the initial 36-month basis. This change made the Consolidated Permit consistent with the rules of the District and all other Water Use Permits. This 12-month running average pumping limit was in effect through the end of the permit in December 2010. Another significant change that occurred in January 2003 was that Tampa Bay Water's operation of the wellfields was no longer constrained by the limits in the facility quantity table. The Operations Plan was to govern the allocation of pumping between the wellfields beginning in January 2003 and apply the rotational flexibility to areas of greatest environmental need, to the maximum extent possible.

3.12.2 Operations Plan

The requirements for the development and implementation of an Operations Plan are included in Special Condition 4 of the original Consolidated Permit as well as in the Partnership Agreement and the Amended and Restated Interlocal Agreement. This plan was set in place to define and control how Tampa Bay Water would operate the 11 northern wellfields under the Consolidated Permit. In the early phase of the original Consolidated Permit before the alternative supply sources were available, it would rotate pumping to reduce environmental stress on the wellfields to the greatest extent possible. After the alternative supply sources were integrated into the regional supply system, the Operations Plan would be used to manage the reduction in groundwater pumping by county as previously described and manage the reduced pumping from the wellfields to promote environmental recovery by maximizing water table levels to the greatest extent possible.

The specific requirements for the Operations Plan, the history of its development, and several of the key components are discussed in Section 3.14 of this report. Section 3.14 of this report focuses on the aspects of the Operations Plan that are key to this Recovery Assessment Plan such as the control points and weighting system, the Unit Response Matrix, and the information exchange and response protocol that was implemented between the Operations Plan and the environmental monitoring program.

3.12.3 Phase 1 Mitigation

The reduction in pumping from the 11 wellfields was the most important aspect of the Consolidated Permit; the most anticipated result of the reduced pumping levels was recovery of lakes and wetlands on and near the wellfields. Low water levels in area wetlands and lakes, caused in part by the high pumping levels from the 11 northern wellfields, were the reason for the phased reduction in wellfield pumping to 90 mgd. The expectation was that substantially reduced pumping, managed by the Operations Plan, would result in environmental recovery; however, it was not known at that time how much recovery would be achieved at this lower annual average pumping level.

The initial Consolidated Permit required Tampa Bay Water to identify existing unacceptable adverse impacts to environmental features in the area of the wellfields, identify sites with a significant adverse impact, determine which sites should be mitigated, and complete acceptable mitigation for pumping impacts. The permit defined the specific area where Tampa Bay Water would evaluate lakes and wetlands (Figure 3.61). The Candidate Sites Evaluation Study created an inventory of candidate environmental mitigation sites where mitigation for pumping impacts would be focused. After completing the inventory of candidate mitigation sites, Tampa Bay Water was required to complete a Phase 1 Mitigation Plan to prioritize the wetlands for mitigation based on their ecological importance and the feasibility of mitigation. Finally, the Agency was required to begin implementation of wetland mitigation projects and annually report on progress. The development and implementation of the Candidate Sites Evaluation Study and the Phase 1 Mitigation Plan are summarized in more detail in Section 3.13 of this report.

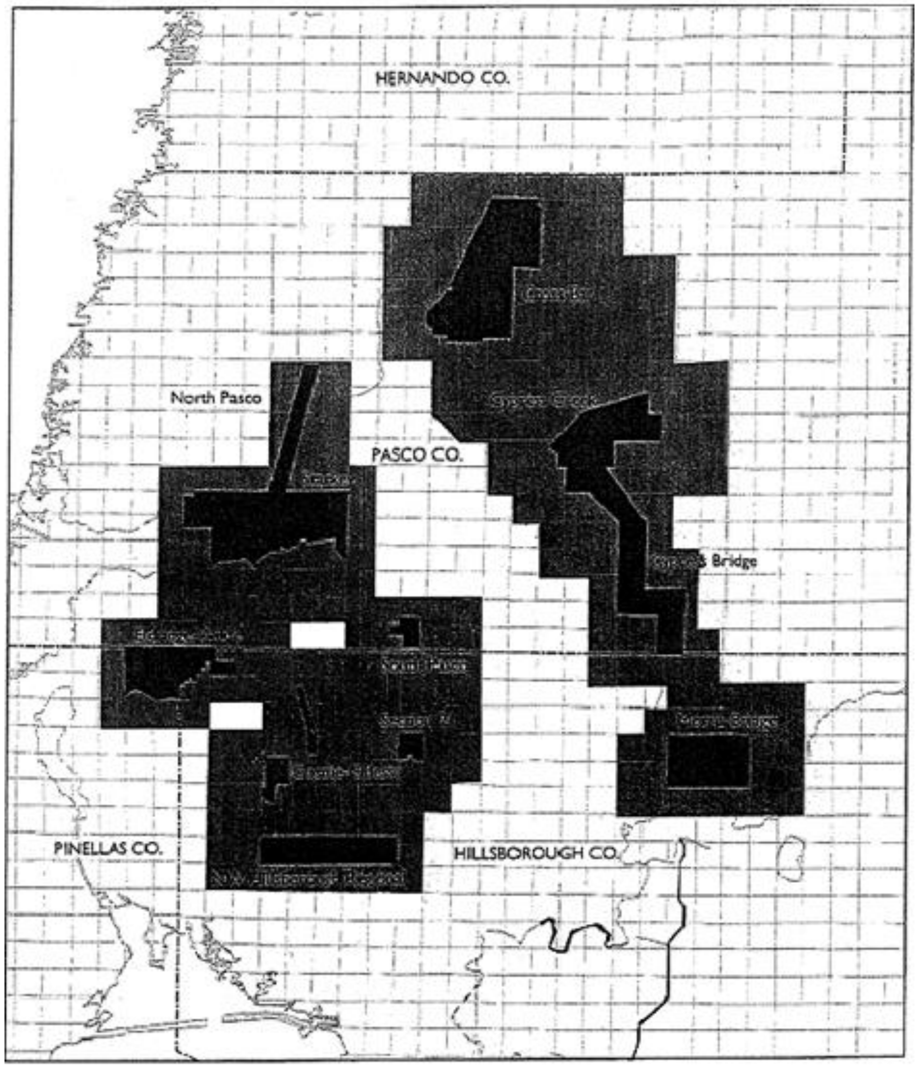

Figure 3.61: Phase 1 Environmental Mitigation Area – from the original Consolidated Permit

3.12.4 Revised Environmental Management Plant

Tampa Bay Water had been monitoring the environment around the 11 northern wellfields under an Environmental Management Plan (EMP) developed in February 1994. This EMP is contained in the initial Consolidated Permit as Exhibit B to the permit and was written based on the District 40D-2 permitting rules adopted in 1989. The changed permitting rules in 1989 required mitigation, to the satisfaction of the District, for any adverse impact to environmental features or off-site land uses that was caused by groundwater withdrawal. The 1994 EMP was created to outline how environmental features would be monitored, how the collected data would be analyzed to detect adverse impacts related to groundwater pumping and identify steps to address impacts when detected. The EMP outlined the criteria needed to identify how impacts to wetlands and lakes would be determined.

The initial Consolidated Permit required Tampa Bay Water to revise the monitoring components of the EMP and develop an updated EMP in collaboration with District technical staff. The updated EMP was to apply to all wetlands and lakes identified in the monitoring site tables of the new permit, require the collection of water levels twice monthly, standardize how water level data collection for wetlands would be made using staff gages for surface water and piezometers for below-ground water levels, and develop a scientific methodology for assessing unacceptable adverse impacts based on the standards contained in the District's permitting rules. Additional information about the data collection and assessment program (current EMP) for the Consolidated Permit wellfields is contained in Section 5.5.2 of this report.

3.13 Candidate Site Evaluation Study/Phase 1 Mitigation Plan

Condition 6.A. of the original Consolidated Permit directed Tampa Bay Water to perform a Candidate Site Evaluation Study (CSES). This evaluation required a determination of what lakes and wetlands located near the wellfields would not fully recover following the permit-specified reductions in wellfield pumping. As a final product of the CSES, the permit required a prioritized list of lakes and wetlands that were likely candidates for mitigation due to adverse impacts from continued pumping of the 11 wellfields at an annual average of 90 mgd. Following the completion of the CSES, Tampa Bay Water was required to develop and implement a Phase 1 Mitigation Plan to develop and implement mitigation projects for the priority lake and wetland candidate sites. Tampa Bay Water was also required to submit an annual report to the District on the progress of the implementation of the Phase 1 Mitigation Plan. The implementation of these studies and the mitigation projects evaluated and constructed are discussed in the sections that follow.

3.13.1 Candidate Sites Evaluation Study

The first step in developing the CSES was creating an inventory of candidate environmental sites within the study area defined in the original Consolidated Permit (Figure 3.61). Tampa Bay Water developed a database inventory of wetlands and lakes within the 362 square mile study area using a geographic information systems (GIS) approach. The consultant reviewed many Tampa Bay Water and District datasets and assessment reports to develop a rating of environmental stress for each of the wetlands within the study area. The relative scale of environmental stress applied to each wetland ranged from 1 to 3 with a 1 indicating the site was severely changed or stressed and a 3 assigned to sites not significantly changed and exhibiting low or no stress. The inventory also identified sites with obvious anthropogenic changes, such as ditching, and sites that were augmented with groundwater to maintain water levels and ecological health. Lakes and wetlands that received a 1 or 2 stress score indicating severe or significant change were classified as candidate sites. The stress classification from the monitored lakes and wetlands were used to infer and assign stress classifications for lakes and wetlands with no monitoring or assessment data. There were 11,501 wetlands and lakes identified in the study area and 3,408 sites (27,969 acres) were classified as candidates for further study (Figure 3.62). In this early phase of the study, the list of potential candidate sites was inclusive (conservative) since later phases of the study would identify the wetland features whose impacts can be primarily attributed to groundwater pumping. A full presentation of the methods used to develop the final maps and tables of candidate sites is presented in the Candidate Phase 1 Mitigation Sites GIS Inventory; Supplement to the Phase 1 Mitigation Plan – Candidate Sites Evaluation Study (Berryman & Henigar, 1999).

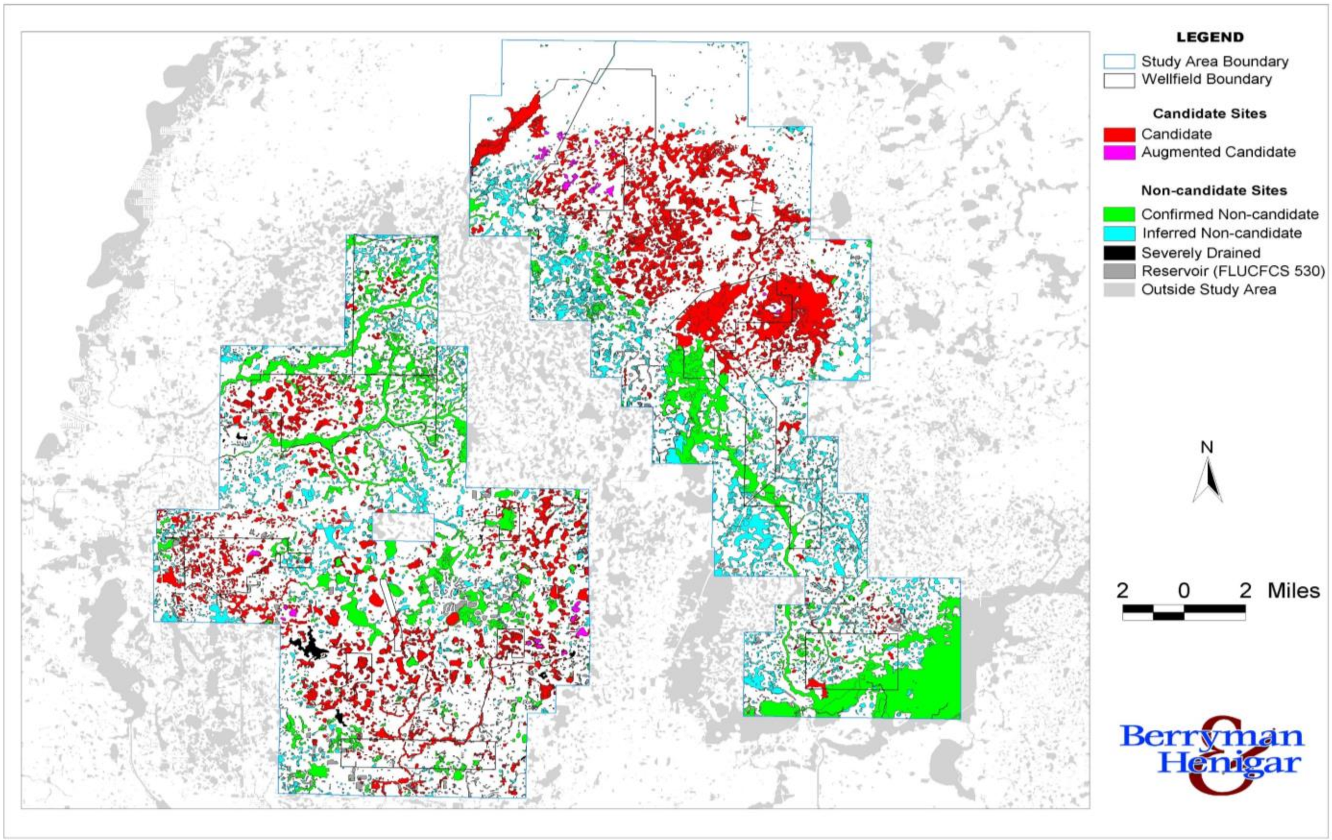

Figure 3.62: Map of Candidate Sites for Further Study in the Candidate Sites Evaluation Study

The second part of the CSES focused on developing a list of wetlands and lakes (potential mitigation sites) that were adversely impacted by wellfield pumping but were not expected to recover when the wellfield pumping was reduced to an average annual rate of 90 mgd. The list of candidate sites was assessed using aerial photointerpretation to exclude as mitigation candidates those sites whose stressed condition occurred prior to nearby wellfield pumping. The presence of other factors that may have caused deleterious changes in wetland ecological conditions, such as land-use or drainage alterations, were recorded for each site. Aerial photographs from the most recent date (just prior to the time of the analysis) and one historical date (pre-dating or soon after the onset of wellfield pumping) were analyzed to produce this site-specific data for later use in subsequent analyses.

Hydrologic modeling was used to predict which potential candidate sites were expected to undergo hydrologic recovery as wellfield pumping was reduced to an average annual quantity of 90 mgd. Hydrologic recovery was determined by simulating the predicted change in median long-term wetland water levels that would result from the cutbacks in groundwater pumping to 121 mgd in 2003 and to 90 mgd in 2008. Total production from the 11 wellfields was simulated using the Central Northern Tampa Bay (CNTB) integrated hydrologic model for the original permitted rate of 158 mgd and for the reduced rates of 121 and 90 mgd. Since the CNTB model did not explicitly represent individual wetlands and lakes, the predicted change (improvement) in water levels in these specific features could not be directly assessed. The predicted drawdown in the surficial aquifer was generated for these pumping scenarios and formed the basis of the wetland recovery analysis.

A recovery analysis method was developed, described as the "normal pool offset method", to correlate water levels in the surficial aquifer with water levels in wetlands. The water table/wetland water level relationship was based on long-term data collected from 177 monitored wetlands and long-term median surficial aquifer water levels from monitor wells in the northern Tampa Bay area. Two distinct wetland/surficial aquifer correlations were generated, one for wetlands in a mesic landscape and a different relationship for wetlands in a xeric landscape. The primary difference in these two types of isolated wetlands was the relationship between surficial aquifer and wetland water levels when water was present (above the bottom of the wetland). The soil types were identified from published soil survey maps that surrounded the wetlands of each type.

The normal pool offset method was applied on a landscape scale by predicting the water levels in wetlands based on the model-predicted surficial aquifer levels, the water level relationships between the surficial aquifer and wetlands based on surrounding upland soil type, and the average depth of wetlands based on surrounding soil type. These predicted wetland water levels were compared to the normal pool elevation for each wetland to determine if the result was within 1.8 feet below the wetland normal pool elevation, an estimation of health based on prior work by the District (Southwest Florida Water Management District, 1999b). Predicted wetland water levels were generated for the pre-pumping cutback period, pumping the 11 wellfields at an annual average of 121 mgd, and pumping the wellfields at an annual average of 90 mgd. If the calculated normal pool offset in a wetland was predicted to be less than 1.8 feet, the wetland was considered to be recovered based on that level of wellfield pumping.

Based on the combined results of the aerial photographic analysis and the hydrologic recovery analysis, 969 sites (16,770 acres) were excluded from consideration as candidates for mitigation by the CSES. Final candidate mitigation sites (662 sites, 12,233 acres) were ranked using prioritization criteria based on the requirements given in the original Consolidated Permit (Figure 3.63). These prioritization criteria were derived from aerial photographic analysis and GIS data that were expected to quantitatively assess the importance of natural wetland functions, significance in the landscape, and probability of further site condition degradation. For each of the five types of wetland classes evaluated (forested, floodplain forest, forested marsh, marsh, and lakes), the proposed candidate mitigation sites were ranked by quartile with the top 25% of sites in each class designated as "highest" priority and the lowest 25% of sites in each class designated as "lowest" priority. A full presentation of the data, assumptions, methodologies, and results of the CSES are presented in the report "Phase 1 Mitigation Plan – Candidate Sites Evaluation Study" (Berryman & Henigar, 2000).

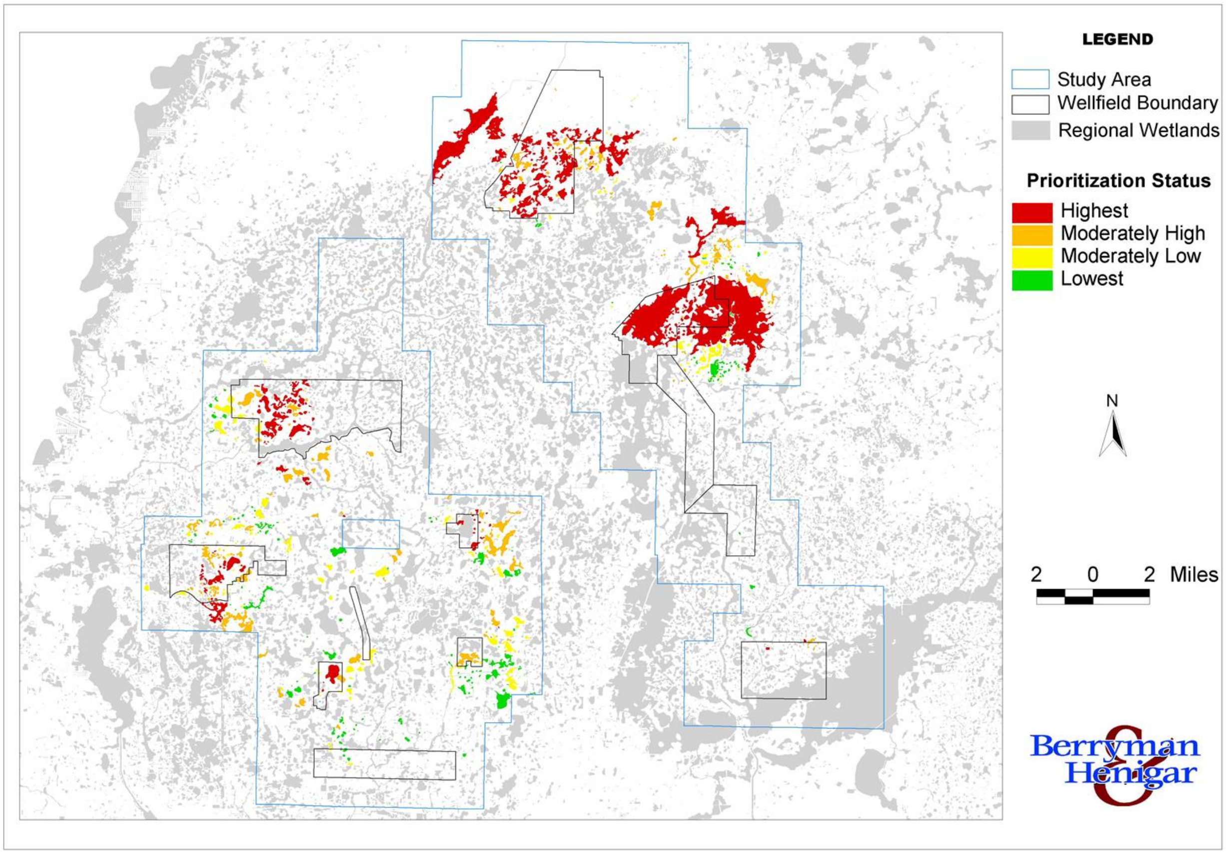

Figure 3.63: Map of Prioritized Mitigation Sites from the Phase 1 Mitigation Plan – Candidate Sites Evaluation Report

3.13.2 Phase 1 Mitigation Plan

The Phase 1 Mitigation Plan was developed between July 2000 and January 2001. To complete this extensive body of work within a seven-month timeframe, the work was subdivided into two geographic regions and completed by two teams of consultants under one project scope. The Eastern wellfield area included the Cypress Creek, Cypress Bridge, Cross Bar Ranch, and Morris Bridge Wellfield areas, and the Western wellfield area included the Section 21, Cosme-Odessa, South Pasco, Northwest Hillsborough Regional, Eldridge-Wilde, and Starkey/North Pasco Wellfield areas.

The scope of work for each area included: selecting target sites for mitigation; evaluating potential restoration water sources and estimating water needs for each target site; identifying feasibility issues and constraints; developing success criteria; and developing planning level project designs, cost estimates, and schedules for each target site. Mitigation options identified in the plan include drainage modifications, surface water diversions, and augmentation with reclaimed water, storm water and/or groundwater. During the development of the Phase 1 Mitigation Plan, Tampa Bay Water and the consultant teams held coordination meetings with the District and member government representatives to review interim work products.

Tampa Bay Water and the District acknowledged that due to the large number of candidate sites, mitigation plans should be developed for a subset of the top-ranked sites identified in the CSES report. The Phase 1 Mitigation Plan included 191 potential mitigation projects that address the 306 prioritized target mitigation sites. Planning level designs, cost estimates, and schedules for each of the 191 potential mitigation projects are included in the final Phase 1 Mitigation Plan (Berryman & Henigar Inc. and HDR Engineering, Inc., 2001). The implementation of the Phase 1 Mitigation Plan projects was expected to be a multi-year effort in accordance with the requirements of the original Consolidated Permit.

Tampa Bay Water and the District did not anticipate that all potential projects included in the Phase 1 Mitigation Plan would be implemented due to limited rehydration water sources, site-specific feasibility issues and constraints, the ability to obtain necessary permits, and landowner participation. Both agencies also anticipated that the Optimized Regional Operations Plan would optimize water level recovery associated with the scheduled pumping reductions. In other words, the level of recovery was anticipated to be greater than predicted in the CSES and would reduce the number of necessary environmental mitigation projects. The Phase 1 Mitigation Plan was submitted to the District on February 5, 2001 and approved by the District in September 2001.

Due to limitations in environmental data and the groundwater flow modeling tools available at the time that the CSES was prepared, Tampa Bay Water and the District staff recognized that quantifying the extent and degree of wellfield-related impacts to individual wetlands throughout the Phase 1 Mitigation Area were only approximations. Therefore, many conservative assumptions were used in the CSES and Phase 1 Mitigation Plan to avoid under-predicting the impacts to wetlands. Due to the multiple conservative assumptions, the number and acreage of wetlands predicted to not fully recover under pumping reductions to 90 mgd was likely greatly over-estimated. Observations of the recovery of regional wetlands since 2002 have shown this to be true. The return to normal to above-normal rainfall levels during this period and the reductions in wellfield pumping to 90 mgd or below have resulted in wetland recovery on a regional scale. Many wetlands not predicted to fully recover at a pumping level of 90 mgd have shown water levels indicative of either full recovery or recovery at higher levels than predicted as will be discussed through the remainder of this Recovery Assessment report.

3.13.2.1 2007 Plan Update

The District's approval of the Phase 1 Mitigation Plan report in 2001 required an update in 2005 using improved modeling tools and additional data. Tampa Bay Water and the District expected that the Integrated Northern Tampa Bay application of the new Integrated Hydrologic Model (see Section 3.14.3) would be available to provide improved predictions of groundwater recovery for the wellfield areas; however, the calibrated model was not complete at the time of the 2005 update. As a result, the update to the Phase 1 Mitigation Plan was delayed until 2007, allowing Tampa Bay Water staff to complete an extensive data quality control check of historical wetland water level data. The goal of the update was to use the updated data to assess the current condition of the monitored wetlands following the first phase of pumping reduction and focus on a short list of projects that could be implemented in the next five-year period.

The updated environmental data was used in the Phase 1 Mitigation Plan update to evaluate the condition of monitored wetlands that had been prioritized for mitigation in the original Phase 1 Mitigation Plan. Based on wetland water level data from Water Years 2001 – 2006 and ecological condition data collected by the Wetland Assessment Procedure (WAP) and Wetland Health Assessment (WHA), wetlands that met their criteria of health were removed from the list of candidate sites for mitigation projects. It is significant to note that the period of Water Years 2001 – 2006 included the initial Consolidated Permit pumping level of 158 mgd and the first stage of pumping reduction to 121 mgd; many of the monitored wetlands showed signs of recovery even before pumping was reduced to an annual average of 90 mgd. An additional 18 wetlands were removed from the candidate mitigation list due to physical changes that had either filled the wetlands or converted the wetlands to stormwater ponds.

The Phase 1 Mitigation Plan Update was completed in December 2007 (GPI Southeast, Inc., 2007). The predictive analyses of recovery at an average pumping rate of 90 mgd were not updated but the empirical data collected from monitored wetlands was used to update the status of those wetlands with respect to their health and need for potential mitigation. The update listed 21 projects that planned to mitigate approximately 750 acres of wetlands (Figure 3.64). These were projects that the consultant believed could be implemented within the next five years. A variety of project types were proposed including surface water diversion, sump pumps in adjacent stormwater ponds, drainage restoration, and in two projects, groundwater augmentation. Conceptual mitigation plans were developed or updated for these 21 projects and the planning level details for each project are presented in the report appendices.

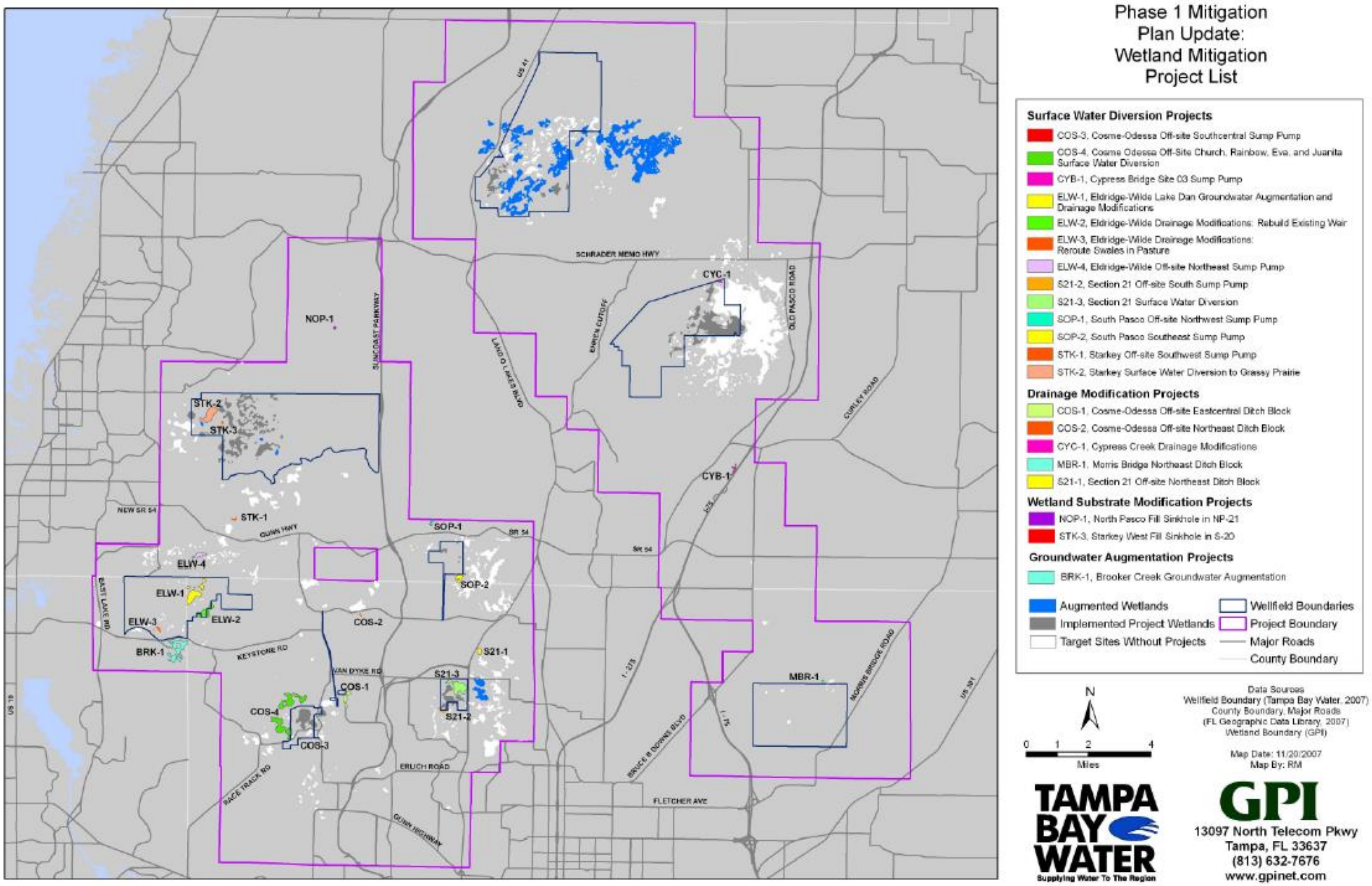

Figure 3.64: Map of Wetland Mitigation Sites from the Phase 1 Mitigation Plan Update

3.13.2.2 Plan Implementation

The original Consolidated Permit required Tampa Bay Water to "implement specific mitigation plans to address unacceptable adverse impacts to wetlands, lakes, and surface waters". Tampa Bay Water began implementing Phase 1 Mitigation Plan projects after the original report was approved by the District. The renewed Consolidated Permit was issued in January 2011 and required Tampa Bay Water to continue evaluating and implementing the conceptual mitigation projects during the term of the renewed permit (discussed in Section 3.17). Both the original and renewed Consolidated Permits require Tampa Bay Water to submit an annual report on the status of the Phase 1 Mitigation Plan; the most recent Phase 1 Mitigation Plan Annual Report (July 2019 – June 2020) is included as Appendix 3.2. This report provides a listing of all projects added to the Phase 1 Mitigation Plan over time and summaries of all projects that have been investigated and/or constructed.

Tampa Bay Water has worked through many constraints in the implementation of the Phase 1 Mitigation Plan such as the availability of rehydration water sources, landowner participation, potential impacts to offsite land owners, public opposition to specific projects, and availability of funds to implement projects that require considerable capital costs. Multiple conservative assumptions in the Phase 1 Mitigation Plan were incorporated into this work to avoid under-predicting the impacts or over-predicting the recovery to wetlands on and near the wellfields. Tampa Bay Water recognized that many of the wetlands would recover given the reduction in pumping even though the predictive analyses indicated they would not. The Agency chose to implement projects that were located on or close to the wellfields where feasibility studies indicated long-term benefits could be achieved. It was important to commit funds to implement projects that would provide significant benefit and where wetlands were less likely to fully recover when the average annual pumping was reduced to 90 mgd. In some cases, projects were designed and implemented that met multiple objectives as described in the following section.

Since the implementation of the Phase 1 Mitigation Plan in 2001, Tampa Bay Water has included funds in the annual budgets for feasibility studies and construction of projects that were deemed feasible and would provide a measurable environmental benefit. Funds that were not spent during a given year were placed into the Rate Stabilization Fund of the agency and earmarked for construction of wetland mitigation projects. This has helped fund the cost of large capital cost projects without over-burdening the budget during years with project construction. Tampa Bay Water has also received cooperative funding from the District for many of the feasibility studies and mitigation construction projects, as well as grant funds from the U.S. Environmental Protection Agency and the Florida Department of Environmental Protection for specific feasibility studies and project construction.

The District approved the initial Phase 1 Mitigation Plan in 2001 that included a list of seven environmental restoration projects. Since that time, four additional projects have been developed and added to the District-approved list of restoration projects. To date, five of the projects have been deemed feasible and the projects have been constructed. Feasibility studies have been completed for six of the projects but these have not been constructed for various reasons. The following sections give a very brief summary of each of the 11 projects and the current status. Please see the Phase 1 Mitigation Program Annual Report (July 2019 – June 2020) in Appendix 3.2 for additional information.

3.13.2.3 Projects Constructed

3.13.2.3.1 Cross Bar Ranch Wellfield Wetlands Restoration – Phase 2

Pinellas County owns and manages the Cross Bar Ranch and Tampa Bay Water owns the production well sites on this property and operates the wellfield as part of the regional supply system. A large and complex agricultural drainage system was created prior to 1938 by previous owners of the Cross Bar Ranch to enhance cattle grazing acreage (HDR Engineering Inc., 2004a). This ditch network connects wetlands on the property in a north-south direction, diverting water from wetlands into Jumping Gully where it flows off-site. The size of the ditches generally increases as they move water from south to north with an associated general lowering of the channel and culvert inverts. The impact of this ditch system was to reduce onsite storage and recharge and to lower the surface water elevations.

In 2001, Pinellas County installed four ditch blocks in the west-central portion of the ranch under Phase 1 of this project to begin restoring water levels in these artificially-connected wetlands. Tampa Bay Water subsequently completed a surface water modeling analysis to predict the hydrologic effects of ditch blocks at an additional 16 locations on the Cross Bar Ranch. Based on the results of the modeling, Tampa Bay Water permitted and constructed six additional operable ditch block structures in 2005 to retain water in on-site wetlands. The additional ten ditch block structures were not included in the project Environmental Resource Permit (ERP) application due to the concern of offsite flooding associated with retaining additional water on the Cross Bar Ranch. The ERP issued for the construction of the ditch blocks contains a detailed operation schedule for the addition of riser boards in the structures in a certain sequence to prevent offsite flooding and to ensure that flow off the property continues so that downstream lakes are not adversely affected.

Since the ditch blocks were constructed, significant flow above the controlling elevations in the permit that allow operation of the structures has occurred a few times between Water Years 2015 and 2019. Some of Tampa Bay Water's ditch block structures have been partially operated during three years within this period; however, conditions have not been present that would allow full operation of all structures. There may be a need to revisit the operational schedule and triggers for the Tampa Bay Water and Pinellas County ditch block structures.

3.13.2.3.2 Cypress Creek Surface Water Management Project

Tampa Bay Water owns approximately 1,250 acres of the Cypress Creek Wellfield and this property is located on the eastern side of the wellfield. The remainder of the wellfield property is owned by the District and Tampa Bay Water operates production wells located on both parts of the wellfield. Above-normal rainfall received in late 1997/early 1998 and during Water Year 2004 resulted in significant flooding in Saddlewood Estates and the Quail Hollow subdivision, located immediately east and southeast, respectively, from the wellfield. A series of public meetings were held in late 2003 and early 2004 with Tampa Bay Water, the District, Pasco County, and residents of these two neighborhoods. The meetings focused on the flooding issues and options to alleviate these concerns. Following the public meetings, the District prepared a preliminary feasibility study that evaluated potential short-term solutions to move water from the east side of the wellfield to the main floodplain in the center of the Cypress Creek Wellfield, intending to alleviate the flooding concerns of nearby residents. The results of the District's preliminary feasibility study are contained in the report "Interim Flood Mitigation Project for Dye's Crossing" (Storm Water Resources of Florida, 2004).

The recommended alternative from this preliminary feasibility study was the replacement of the Dye's Crossing structure, a berm on the south property line of the wellfield, and a series of ditches and ditch blocks to passively move water from the east side of the wellfield toward the main floodplain of Cypress Creek through wetlands that were on the prioritized list of candidate sites for mitigation. Tampa Bay Water initiated a feasibility study to expand on the evaluations in the District-sponsored report to see if conceptually the project would help to restore stressed wetlands on the wellfield, retain water on the wellfield for recharge, and alleviate some of the off-site flooding issues. Surface water flow modeling was performed to determine how much water could be routed through the potential surface water management features to optimize the amount of water that could be routed through the wellfield, temporarily stored, and diverted through stressed wetlands before flowing off-site through the main channel of Cypress Creek. The "Cypress Creek Wellfield Surface Water Management Project Feasibility Study and Basis of Design Report" (Reynolds Smith & Hills, Inc., 2007) contained multiple project alternatives that would work together to accomplish all stated objectives.

The surface water flow model was refined during the Environmental Resource Permitting process and used to complete the final project design. The structure under the Dye's Crossing Road in the eastern part of the wellfield was replaced with an updated, larger structure to reduce the peak stage upstream of the structure (Saddlewood Estates) to the greatest extent possible, allowing additional flow through the structure without causing downstream flooding concerns (Quail Hollow). A long berm was constructed along the southern property boundary to allow water to stage up and prevent this additional water from flowing through the wellfield and into the Quail Hollow subdivision. This berm is just under one mile in length and followed the natural contours of the landscape. This is primarily an earthen berm, except for one section made of concrete and containing a structure and weir to allow natural levels of flow to exit the wellfield property into wetlands and creek systems in Quail Hollow. Additional project components included ditches, swales, and ditch blocks to allow gravity to move the water stored behind the southern property berm through stressed wetlands, before flowing into the main channel of Cypress Creek in the center of the wellfield.

The project was constructed in 2007 to blend in with the natural environment and used construction alternatives to allow enhancement of natural surface water flow systems wherever possible. Following the construction of the project, the wellfield returned to a normal to above-normal rainfall condition beginning in Water Year 2010; this rainfall has generated sufficient surface water flows to demonstrate that the project components work as designed. Water level data in the recipient wetlands in Water Years 2012 and 2013 indicated that additional surface water was available during years with normal rainfall that could be diverted to the west toward target wetlands. Tampa Bay Water initiated a feasibility study in 2014 to identify additional improvements to the surface water management system to allow additional flow to wetlands west of Dye's Crossing during high water conditions. The recommended improvements are detailed in "Cypress Creek Wellfield Surface Water Management Project Modifications, Feasibility Study and Basis of Design Report" (RS&H, Inc., 2014b). Following permitting of these recommended changes, the additional surface water management system features were constructed in 2015. Since the initial project was constructed, Tampa Bay Water has monitored and assessed the health of the wetlands affected by this surface water management project. Annual monitoring and assessment reports have been submitted to the District and the U.S. Army Corps of Engineers; the most recent assessment report details the success of the project to-date (Pritchett Steinbeck Group, Inc., 2019).

The Cypress Creek Surface Water Management System as constructed and modified provides some relief of flooding concerns in Saddlewood Estates, located upstream of the Dye's Crossing structure. Tampa Bay Water entered into a settlement agreement in 2008 to resolve litigation filed by the Saddlewood Estates developer and Homeowners' Association. Under the terms of the agreement, Tampa Bay Water committed to design and install facilities to allow the installation and operation of two 11 cubic foot per second (cfs) pumps at Dye's Crossing to pump water over the structure during times when Saddlewood Estates experiences significant flooding. This emergency pumping would be in addition to the water already flowing through the Dye's Crossing structure at the time of flooding and this emergency transfer of water must be authorized by the District. Tampa Bay Water completed the technical assessments needed to permit these additional system components and the details of the investigation are contained in "Technical Memorandum: Design Feasibility of Additional Pumping Over Dye's Crossing Road" (Reynolds, Smith, & Hills, 2014a). The technical memorandum summarizes the additional surface water model analyses used to determine the amount of water that can be pumped over the Dye's Crossing Road during flood conditions without causing any additional flooding concerns in the downstream community (Quail Hollow). Tampa Bay Water constructed permanent placement areas for the two 11 cfs pumps and dedicated electrical connections for the pumps in Spring 2015.

The District issued an Emergency Field Authorization to Tampa Bay Water on August 24, 2015 requiring the installation of two 11 cfs pumps and initiation of emergency transfer of water over the Dye's Crossing Road to alleviate flooding in Saddlewood Estates. Between August 27 and September 11, 2015, Tampa Bay Water pumped approximately 188 million gallons of water over the Dye's Crossing Road, in addition to the water flowing through the Dye's Crossing structure. The District issued a second Emergency Field Authorization to Tampa Bay Water on September 15, 2017 requiring the emergency transfer of water over the Dye's Crossing Road to alleviate flooding in Saddlewood Estates. Between September 18 and 25, 2017, Tampa Bay Water pumped approximately 99 million gallons of water over the Dye's Crossing Road, in addition to the water flowing through the Dye's Crossing structure. The Saddlewood Estates Homeowners' Association requested that the District issue authorizations for emergency pumping in the summer of 2016 and 2018 but flooding conditions were not extensive enough for the District to issue the requested authorizations. While the additional water pumped over the Dye's Crossing Road provides a hydrologic benefit to the wetlands downstream of the pumps, the wetlands upstream of the pumps were lowered by a significant volume of water; water that would have helped maintain water levels in these upstream systems during the next dry season.

3.13.2.4 Big Fish Lake Groundwater Augmentation

Big Fish Lake is a shallow wet prairie/lake system located approximately 2.5 miles east of the Cross Bar Ranch Wellfield and north of the Cypress Creek Wellfield. The lake is located on property now owned and managed by the Dillard Cattle Company, LLC (formerly owned by the Barthle Brothers Ranch, LLC). In the past, Big Fish Lake has ranged in size from completely dry during severe drought periods to over 700 acres during very wet periods. The water level in the lake was often very low or dry during the drought and high-pumping period in the 1990's. Tampa Bay Water assessed the condition of the lake and determined that it would not fully recover when the average pumping level of the Consolidated Permit wellfields was reduced to 90 mgd.

The Barthle Brothers Ranch, LLC obtained a Water Use Permit from the District in 2000 to augment the lake due to chronic low lake levels; their permit also authorized water use for agricultural purposes on the ranch. Tampa Bay Water constructed an augmentation well for Big Fish Lake that was subsequently operated by the Barthle Brothers Ranch; the agency also assumed the ongoing operating cost of the augmentation well. The augmentation permit authorized an annual average limit of 310,000 gallons per day (gpd) and a peak month quantity of 540,000 gpd. These quantities were sufficient to maintain a hydrated pool near the augmentation well but the lake level did not rise above the established Minimum Level during any time except for 2004 which was a high rainfall period including four hurricanes and 2005.

Tampa Bay Water and the Barthle Brothers Ranch executed a new lake augmentation agreement in 2016. Under this new agreement, Tampa Bay Water installed and equipped a second, larger augmentation well that can discharge into two different areas of Big Fish Lake. The District issued a new Water Use Permit for lake augmentation to Tampa Bay Water and the Barthle Brothers Ranch authorizing an annual average quantity of 1,540,000 gpd and a peak month quantity of 2,540,000 gpd from the existing and new augmentation wells. The ranch operator continues to operate and maintain the augmentation well systems and the operational costs are directly paid by Tampa Bay Water. A combination of normal to above-normal rainfall, lower wellfield pumping levels, and augmentation have sustained water levels in Big Fish Lake at or above the established Minimum Level since mid-2014.

3.13.2.5 Brooker Creek Preserve Wetland Augmentation Project

The Pinellas County Department of Environmental Management began a wetland rehydration study in 1997 in the Brooker Creek Preserve located in northeastern Pinellas County. Three wetlands were augmented beginning in 2001 to study the effectiveness of augmentation for environmental restoration. Wildlife and plant ecological monitoring and assessments were conducted for several years by St. Leo University as part of this study. Tampa Bay Water became a co-permittee with Pinellas County on the augmentation Water Use Permit and has been responsible for the augmentation, monitoring, and reporting requirements since 2013. Tampa Bay Water established management levels for the three augmented wetlands and these metrics are included in the augmentation Water Use Permit. The permit allows for an annual augmentation quantity of 131,000 gpd and a peak month quantity of 199,000 gpd.

The Water Use Permit will expire in 2021, shortly after the Consolidated Permit expiration date. Augmentation quantities have been minimal in the past several years and Tampa Bay Water will assess the hydrologic recovery of these wetlands as part of this Recovery Assessment Plan. The hydrologic recovery at the three wetlands will be compared to the established management levels to determine if the sites have recovered and if future augmentation is necessary. The six-year running median water level for wetland sites 1 and 2 have exceeded their management levels for several years while the six-year running median water level for site 3 has increased to just below the established management level for the past two years. Additional information on the augmentation program is found in the most recent annual report for this project “Water Year 2019 Environmental Assessment Report for the Brooker Creek Preserve Wetland Augmentation Project” (Water & Air Research, Inc., 2020).

3.13.2.6 Bonnet Lake Restoration Project

Pasco County constructed a project in 2012 to augment Grass Prairie on the Starkey Wellfield with water from the Pithlachascotee River as part of a flood relief project in the Bear Creek basin. The Phase 1 Mitigation Plan Update evaluated this project, including the potential for routing some of the augmentation water delivered to Grass Prairie to nearby wetlands. Tampa Bay Water completed the "Starkey Surface Water Diversion to Grass Prairie Feasibility Study" (Greenman-Pedersen, Inc., 2014) which concluded that the augmentation of Grass Prairie had the potential to benefit nearby wetlands, particularly S-8 (aka Bonnet Lake). The report "Starkey Hydrologic Restoration Project, Starkey Bonnet Lake (S-8) and Wetlands S-23 Augmentation vis Grassy Prairie Feasibility Study and Basis of Design Report" (Water & Air Research, Inc., 2016) contained updated analyses and modeling necessary to support permitting for the construction of this mitigation project. The project construction was completed in 2019 and included a high-water connection between Grass Prairie and Bonnet Lake via a below-ground 12-inch diameter pipe. Water began to flow through this connect upon completion of construction.

3.13.3 Projects Not Implemented

3.13.3.1 South Pasco Wellfield Drainage Modifications

Tampa Bay Water performed a feasibility study to determine if drainage structures on the South Pasco Wellfield could be modified to retain additional surface water on the wellfield property to increase the water levels in target wetlands. The study specifically evaluated modifications to two features on the wellfield; an earthen berm on the western edge of the wellfield, constructed in the late 1970's/early 1980's by the City of St. Petersburg to alleviate downstream flooding, and the north-south wellfield maintenance road that is crossed by multiple culverts. The objective of the project was to raise water levels in the wellfield wetlands without enlarging the extent of the wetlands and potentially alleviate some of the downstream flooding problems by holding additional storm water on-site for longer periods of time.

A digital terrain model was constructed for the project area including the wellfield and an existing Stormwater Management Model (SWMM) was modified to evaluate the effects of potential drainage feature modifications. Multiple alternative drainage modification scenarios were developed and assessed using the updated surface water flow model. The feasibility study concluded that the effects of permittable drainage modifications (without causing additional off-site flooding) would be minor and suggested that wetlands might fully recover given the anticipated reduction in pumping from this and other regional wellfields (Berryman & Henigar, Inc., 2004). Tampa Bay Water chose not to pursue this project due to the minimal wetland benefit and to avoid the potential for additional off-site flooding in adjacent neighborhoods.

3.13.3.2 Rocky Creek Lake Enhancement Project

The Rocky Creek basin in Northwest Hillsborough County experienced significant flooding during the 1997/1998 El Nino rainfall event. Lake Pretty is located immediately east of the Cosme-Odessa Wellfield and is in the chain of lakes within the flow path of Rocky Creek. In early 1998, water levels in Lake Pretty exceeded minimum flood conditions, threatening the lowest elevation house on the lake and inundating the lowest access road around the lake. District staff installed temporary diesel pumps and pipes to move water from Lake Pretty into Lakes Horse and Raleigh. Tampa Bay Water and the City of St. Petersburg pumped water from Lake Raleigh into Lake Rogers, which had extensive storage capacity at the time. Over a 90-day period, over 200 million gallons of water were pumped from Lake Pretty, attenuating the flooding concerns on that lake. During the water transfer, water levels in Lakes Horse, Raleigh, and Rogers increased by 2, 5.5, and 7 feet, respectively and the higher water levels in the recipient lakes lasted for more than one year. This emergency water transfer project was considered a great success but generated some citizen complaints due to the noise of the diesel pumps (Southwest Florida Water Management District, Northwest Hillsborough Basin, 2004).

Tampa Bay Water initiated a feasibility study in 2001 to determine whether this emergency water transfer project could be implemented on a permanent basis to alleviate flooding on the Lake Pretty chain of lakes and restore water levels in Lakes Horse, Raleigh, and Rogers. The feasibility study included a water quality assessment of the donor and recipient lakes, surface water budget modeling for the lakes and preliminary design for the water transfer infrastructure. While the feasibility study was in process, flooding concerns in the summer of 2002 allowed the District and Tampa Bay Water to again implement the emergency water transfer from Lake Pretty to Lakes Horse, Raleigh, and Rogers. In addition to these three recipient lakes, water was also transferred from Lake Rogers to Lakes Juanita, Rainbow, Little Moon, Eva, and Church. Electrical power was installed to the water transfer pumps at Lakes Pretty and Raleigh to alleviate the noise complaints associated with the diesel pumps during the 1997/1998 emergency water transfer effort. The emergency water transfer during 2002/2003 lasted for almost eight months and moved 456 million gallons of water to the multiple target lakes.

The project feasibility study was completed in 2005 stating that the lake enhancement project was feasible and should be implemented (Berryman & Henigar, Inc., 2005). At this point, the District decided that they would be the lead for the design and construction of this water transfer project and began negotiating with property owners for the necessary easements and land for the pumps, pipelines, and discharge structures. The District made considerable progress toward acquiring the critical parcels for construction of this project during the 2006-2011 timeframe. During 2012 and 2013, growing local public opposition to the project caused the District to suspend the project and hold public meetings to explore alternatives to the stated project. Of the three alternatives discussed with the public, overwhelming support was given to not constructing this project but to set attainable Minimum Levels for Lakes Horse, Raleigh, and Rogers given the reduced level of pumping from the wellfield along with continued monitoring of lake and groundwater levels and management of local groundwater pumping levels. In June 2013, the District adopted Minimum Levels for Lakes Raleigh and Rogers (Minimum Levels for Lake Horse had already been established but were adjusted in 2016) that were based on the current physical characteristics of the lakes without attempting to restore the lakes to pre-development conditions. The information evaluated in establishing Minimum Levels are presented in separate reports for these two lakes (Southwest Florida Water Management District, 2013a and 2013b). After these Minimum Levels were established, Tampa Bay Water and the District agreed to terminate this restoration project due to the lack of need and citizen opposition.

3.13.3.3 Eldridge-Wilde Wellfield Area Drainage Modifications

This project was designed to evaluate the potential for drainage modifications on the Eldridge-Wilde Wellfield to improve water levels in wetlands on the wellfield. The feasibility study was designed to include an evaluation of the wetlands and drainage ditches near Lake Dan and the ditches that carry water into and out of this lake; three specific locations were identified in the Phase 1 Mitigation Plan (Berryman & Henigar Inc. and HDR Engineering, Inc., 2001). Before the feasibility study for this project began, the wellfield property was purchased by the Hillsborough County Environmental Lands Acquisition and Protection Program and Pinellas County in 2008, each acquiring the land within their respective county boundaries. Lake Dan and the wetlands and ditches that were to be evaluated in a feasibility study are located on the Hillsborough County portion of the wellfield property. Hillsborough County developed a land management plan focusing on the restoration of the property to a natural setting. The county informed Tampa Bay Water that they would take the lead on all environmental restoration activities on the property they acquired.

The feasibility study then focused only on the potential augmentation of Lake Dan. Tampa Bay Water historically had augmented Lake Dan on an as-needed basis with water from production well ELW-139. An augmentation test was performed between April and early June 2010 to collect hydrologic data and develop an analytical water balance model for the lake. The leakage rate from the lake into the underlying aquifers was estimated using this model and a future potential augmentation rate between 0.5 and 0.85 mgd was estimated, depending on the desired target elevation of the lake and rainfall conditions (HSW Engineering, Inc., 2012a). Since the augmentation test was completed in 2010, Tampa Bay Water has not augmented Lake Dan. The water levels have naturally fluctuated around the established Minimum Level for the lake since 2010, annually reaching the High Minimum Level and rarely falling below the Low Guidance Level.

3.13.3.4 Section 21 Wellfield Restoration

Tampa Bay Water began a study in 1995 to evaluate the potential to restore stressed wetlands and lakes on the wellfield property. The initial concept was to restore two small wetlands on the northwest corner of the wellfield using reclaimed water or stormwater from the Interceptor Canal. This canal was constructed in 1963 just south of the wellfield to convey stormwater runoff away from surrounding residential areas Brushy Creek and out into Tampa Bay. The proposed source of reclaimed water was Hillsborough County's Dale Mabry Advanced Wastewater Treatment Plant. Before a pilot project was implemented, Tampa Bay Water and the member governments determined that a public health risk assessment was needed to evaluate potential human health risks associated with using the proposed source waters for wetland restoration on a wellfield. A Risk Assessment Plan of Study (HDR Engineering, Inc., 1995) was developed in 1995 to guide this process.

The project scope expanded during the evaluation process to include additional stressed lakes and wetlands throughout the wellfield that were identified in the Phase 1 Mitigation Plan (Berryman & Henigar, Inc. and HDR Engineering, Inc., 2001). The initial studies to support the public health risk assessment included extensive site characterization including numerous soil borings, monitor well construction, testing of soil/aquifer properties, ground-penetrating radar surveys, aquifer tracer tests, and an aquifer performance test. A surface water flow model (AdICPR) was developed to simulate the application of source waters to wetlands located on the wellfield and the subsequent routing of the applied water through the interconnected wetland and lake systems. The site-specific data was used to develop a MODFLOW groundwater flow model to develop water level and flux data used in fate and transport models (MODPath and MT3D) developed for the project. These models estimated travel times of restoration water to production wells and the relative concentrations of restoration source waters in the water that would be pumped from production wells.

The ambient water quality in four lakes and six production wells on the wellfield was evaluated along with the potential source waters in the Interceptor Canal and the Hillsborough County Dale Mabry Advanced Wastewater Treatment Plant. Water quality parameters included constituents regulated by the State of Florida Primary and Secondary Drinking Water Standards, nutrients, pesticides, microbiological constituents and selected constituents of emerging concern. An interim report of the data collection, assessment and modeling evaluations was prepared in 2002 (HDR Engineering, Inc., 2002). Based on the results of this interim assessment report, Tampa Bay Water deepened the casings in the production wells on the wellfield to improve water quality in the wells and reduce the drawdown in the surficial aquifer to the greatest extent possible. The casings in three of the five active production wells were deepened from approximately 75 feet below land surface to approximately 200 feet below land surface. Physical issues with the other two active productions wells prevented the deepening of those well casings.

The report "Water Quality Evaluation Process for Wetland and Lake Restoration Projects" was developed in 2003 (HDR Engineering, Inc., 2003) as part of the ongoing study. This report provided a process to address water quality concerns associated with wetland or lake restoration projects on or near public supply wellfields. The process consists of developing a conceptual model of the subject site, followed by progressive levels of evaluation performed in a tiered fashion. These processes are based on the Environmental Protection Agency's (EPA) risk assessment guidance documents for human health and ecological risk assessment. This process was applied in the subsequent risk assessment evaluation for this proposed wetland restoration project.

The deepening of the production well casings at the Section 21 Wellfield moved the project into a second phase of study. The flow and transport models were revised to reflect the new well configurations and pumping data. The production wells, lakes, and potential source waters were sampled monthly for one year to update the water quality characterizations completed in the initial phase of the project. The risk assessment portion of the study was completed following the additional water quality sampling and analysis. The assessment quantified potential exposure risks for chemical and microbial constituents for both workers at the wellfield and for the general public, as the Section 21 Wellfield serves as a public recreation park for local citizens. The public health risk assessment report documents all of the work performed (HDR Engineering, Inc., 2007) and stated that "the Section 21 Wellfield Restoration project, if implemented, would not pose any significant risks with respect to chemical constituents, and would not significantly increase the background risk with respect to microbiological constituents". The study also concluded that "the ecological screening indicates that for the parameters evaluated, these screening results suggest little potential for adverse ecological effects" and suggested that additional evaluation and testing of the reclaimed water source be conducted.

Tampa Bay Water has not elected to proceed with this project at this time, considering the sustained water level increases recorded due to the production well modifications and pumping reduction from the Section 21 Wellfield.

3.13.3.5 Starkey Wellfield Reclaimed Water Pilot Project

A feasibility study was initiated in 1997 to evaluate the use of reclaimed water sprayfields in upland areas of the Starkey Wellfield to increase water levels in the surficial aquifer and rehydrate stressed wetlands adjacent to the sprayfields. Pasco County received a General Permit for Addition of a Major User of Reclaimed Water from the Florida Department of Environmental Protection (FDEP) in 1998 to allow the land application of reclaimed water on the Starkey Wellfield (Law Engineering and Environmental Services, Inc., 2001). The first and second sprayfield zones covered approximately 27 acres and were constructed in 1999; testing of the system was performed using water from the Starkey Wellfield. Tampa Bay Water constructed and monitored wetland transects and monitor wells and collected water quality samples to identify baseline conditions. A third sprayfield was designed but not constructed; a draft operating plan for the entire system was developed in February 2002.

The application of reclaimed water was deferred pending the results of the public health risk assessment for the Section 21 Wellfield Restoration Project. By the time that the framework and process for performing a public health risk assessment were completed in 2003, Tampa Bay Water was connecting the West Pasco Service Area to the regional supply system through construction of the West Pasco Transmission Main. It was anticipated that the delivery of regional water through this new pipeline would significantly reduce the pumping level at the Starkey and North Pasco Wellfields. Regional water delivery to the West Pasco Service area began in December 2007 and since that time, the combined average annual pumping rate from these two wellfields has been approximately 5 mgd. Given the recovery documented on the Starkey Wellfield since December 2007, Tampa Bay Water deferred any further action on the Starkey Wellfield Reclaimed Water Pilot Project.

3.13.3.6 Starkey Ecosystem Enhancement Project

The objective of the Starkey Ecosystem Enhancement Project was to divert a percentage of the wet weather flows from the Anclote and Pithlachascotee Rivers into wetlands on the wellfield to enhance the wetland water levels and ecological function. A second goal of the project was to determine if the successful implementation of the wetland restoration would create additional water supply capacity from the Starkey Wellfield, an “enhanced yield”, given the recharge of the wetlands and aquifer at the wellfield. The project feasibility study was initiated in 2002 and completed in February 2004 (HDR Engineering, Inc., 2004b).

The feasibility study analyzed the available surface water yields and potential withdrawal schedules for the Anclote and Pithlachascotee Rivers at locations adjacent to the Starkey Wellfield. The potential effects of surface water diversions on river stages, floodplain wetlands, and downstream salinity regimes were evaluated. Samples of the two rivers were collected to confirm that water quality met the primary drinking water standards and that river water can be safely applied to wetlands on the Starkey Wellfield. A short-term wetland augmentation test program was implemented to estimate wetland water requirements. The results of the augmentation test program were used to develop water budgets for individual target wetland sites. Based on the water budget results and the availability of surface water, it was estimated that up to 450 acres of wetlands could be enhanced by the surface water diversions. A proposed conceptual engineering design included locations and sizes of surface water intakes, pump stations, pipelines, meters, and discharge structures.

The feasibility study concluded that approximately 2 to 8 mgd of "enhanced yield" could be developed at the Starkey Wellfield if diversions from both rivers were successfully implemented. Further evaluations of the models and methods used to generate this estimate were recommended. As with the Starkey Wellfield Reclaimed Water Pilot Project, Tampa Bay Water has deferred any further evaluation of the Starkey Ecosystem Enhancement Project given the recovery documented on the Starkey Wellfield since December 2007 when the West Pasco Transmission Main was completed and placed into operation.

3.14 Tampa Bay Water Operations Plan

The West Coast Regional Water Supply Authority was a groundwater-only utility that relied on wellfields to meet the water supply needs of the Member Governments. The reorganization into Tampa Bay Water and the expectation of new alternative water supplies presented both a significant opportunity and challenge. The new water supplies would provide for significant reductions in pumping at the 11 northern wellfields and allow environmental recovery on and near those wellfields. In order to meet this opportunity, a rigorous and systematic process using multiple data sets, model forecasts, and myriad constraints was needed for a water supply system that would rapidly expand. A robust tool was required that would be able to incorporate new information as the water supply system evolved. This tool would guide supply management decisions for three very different water supply sources, ensure that water demands for the region were met at each Member Point of Connection, and manage the wellfield pumping to promote environmental recovery.

3.14.1 History and Requirements

Tampa Bay Water was required to develop and implement an Operations Plan by the Amended and Restated Interlocal Agreement (Tampa Bay Water 1998a); the Partnership Agreement between Tampa Bay Water (Southwest Florida Water Management District 1998a), the Member Governments and the District; and, the Consolidated Permit for the 11 wellfields covered under this permit (Southwest Florida Water Management District, 1998b). The Amended and Restated Interlocal Agreement requires the Operations Plan to be based on scientific methodology, evaluating the relative level of environmental stress at each of the wellfields and operating in a manner that reduces wellfield pumping in areas with the highest levels of environmental stress. The Amended and Restated Interlocal Agreement provided guidance on how the reduction in groundwater pumping from the 11 wellfields would be applied once new water supply sources were developed.

The Partnership Agreement provided further guidance by requiring that the Operations Plan govern how Tampa Bay Water will manage and operate the water supply system, including the 11 wellfields, to avoid, if possible, or minimize environmental stresses in the vicinity of the 11 northern wellfields. The Tampa Bay Water and District technical staffs defined the elements that would be incorporated into the Operations Plan and these requirements were included in the Partnership Agreement that was fully executed in June 1998 and in the draft Consolidated Permit that was attached as Exhibit B to the Agreement. As required by the Consolidated Permit (summarized), the Operations Plan shall:

1. Define and control how Tampa Bay Water will operate the 11 wellfields,
2. Provide the protocol used to select among available supply sources to meet demand and avoid or minimize environmental stresses,

3. Rely on ground water elevations at specified monitoring wells as a surrogate for wetland water levels and lakes to gauge environmental stresses (increased groundwater levels will indicate less environmental stress),

4. Use available models to analyze the relationships between groundwater pumping and water levels in the aquifers,

5. Include procedures to use mathematically-based optimization software to select the optimal scenarios of the distribution and rate of groundwater pumping from the wellfields to maximize groundwater levels in the surficial aquifer,

6. Maximize the surficial aquifer levels at the specified monitoring wells according to a specified weighting/ranking system, using the surficial aquifer levels as a surrogate for water levels in lakes and wetlands, and

7. Include data and software for hydraulic modeling and optimization modeling of alternative wellfield operational scenarios.

The Partnership Agreement required Tampa Bay Water to develop the Operations Plan and submit the Plan to the District by July 1, 1998. The Agreement outlined the process for District review, approval, and subsequent implementation of the Operations Plan by Tampa Bay Water. Both the Partnership Agreement and the Consolidated Permit require the approval by the District of any material changes to the Operations Plan and the submittal of annual implementation reports. Modification of the Operations Plan is also required any time that Tampa Bay Water adds new supply capacity to the regional system or makes a material change to the model or optimization method.

A draft Optimized Regional Operations Plan was submitted to the District on June 30, 1998 and was modified on October 30, 1998 to incorporate changes based on comments received from District staff. The revised plan (Tampa Bay Water, 1998b) was approved by the District on November 20, 1998 and went into effect on January 1, 1999.

3.14.2 The Operations Plan and the Optimized Regional Operations Plan (OROP)

The terms Operations Plan and Optimized Regional Operations Plan were initially synonymous and the initial plan governed the pumping distribution from the 11 northern wellfields, the only regional supply sources. As the new alternative sources of water were developed, they were incorporated into the Operations Plan and new protocols were needed to guide the selection between the multiple source water facilities to meet regional demands. Water from the Surface Water Treatment Plant was first introduced into the regional supply system in September 2002, allowing Tampa Bay Water to begin reducing the pumping levels from the 11 northern wellfields. Starting with the Optimized Regional Operations Plan Annual Report for Water Year 2005 (Tampa Bay Water, 2006), Tampa Bay Water introduced an Operating Protocol into the process. The Operating Protocol guides the selection of water sources to meet the member governments water demands while minimizing environmental stresses and ensuring reliability of the regional water supplies. The protocol includes general guidance on the use of all regional supply sources and describes the annual, monthly, and weekly planning process for meeting the demands at each Point of Connection.

Beginning with the Optimized Regional Operations Plan Annual Report for Water Year 2009 (Tampa Bay Water, 2010), Tampa Bay Water began distinguishing between the Operations Plan and the Optimized Regional Operations Plan as two distinct elements used to govern the operation of the regional system. The Operations Plan is the comprehensive process that is comprised of the operating protocol, the Optimized Regional Operations Plan, and supporting models and data used in the development of a weekly well rotation schedule for the Consolidated Permit wellfields. The objectives of the Operations Plan are to improve Tampa Bay Water's ability to understand the water-level effects of water supply operations that affect environmental conditions, enhance water supply management programs to benefit the surrounding environment, and increase water levels in areas of interest while meeting member government water demands. To summarize, the Operations Plan is the entire set of data, model predictions, demand forecasts, and system constraints that are used to make water supply source decisions to meet the water demands of the Member Governments. The Operations Plan provides guidance for the use of all water supply sources (ground water, surface water, desalinated seawater, and the off-stream reservoir), not just pumping levels for the wellfields.

The Operations Plan was updated in January 2010 and included in the application to renew the Consolidated Permit in 2010. The renewed Consolidated Permit required the Operations Plan to be updated again to be consistent with changes to the relationship between the Optimized Regional Operations Plan and the Environmental Management Plan which is described in Section 3.17.3. The Operations Plan was revised accordingly in April 2011 (Tampa Bay Water, 2011) and this revision currently governs system operations. The Updated Operations Plan can be found in Appendix 3.3 of this report. The General Operations Protocol that the Agency uses is included in the April 2011 Operations Plan Update report as Table 1 of that report.

The Optimized Regional Operations Plan (OROP) is a key component of the Operations Plan. The OROP is an optimization program developed by Tampa Bay Water staff that uses output from several models, current hydrologic and pumping data, and a set of operating constraints. The OROP program manages the pumping from the Consolidated Permit wellfields, the Brandon Urban Dispersed Wells, and the Carrollwood Wells by developing weekly production schedules. These weekly production schedules reflect all system constraints, meet the forecast water demand for the coming week at each point of connection, and optimally distributes the pumping to the production wells in each of these wells to minimize drawdown based on current water level conditions at each wellfield.

The OROP is the program that Tampa Bay Water uses to optimize pumping rates from the individual production wells to minimize drawdown in the aquifer and enable the recovery of environmental conditions as measured by lake and wetland water levels. Based on the forecast demand for the coming week, the known constraints within the system, and the seasonal source allocation schedule for the Surface Water Treatment Plant and Desalination Facility, the regional system demand to be met by the groundwater sources is determined; the OROP then identifies the optimal distribution of groundwater pumping to meet surficial aquifer water level targets. The following sections of this report summarize the inputs and constraints used by the OROP and some of the components of the program that are critical to the Recovery Assessment Plan. For additional information on the original formulation of and changes to the Operations Plan and the OROP, please refer to the reports that detail the mechanics of the models, present the changes made over time, and report its implementation and effectiveness (Tampa Bay Water 1998b, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009b, 2010, 2011, 2012, 2014, 2016a, 2018a, and 2020l).

3.14.3 Models, Data, and Constraints

Multiple models provide input to the optimization model including the Integrated Northern Tampa Bay (INTB) Model through the development of a Unit Response Matrix (URM), a group of artificial neural network models, surface water forecasting tools, and short-term demand forecasting models. The INTB Model is a calibrated ground and surface water flow model application using the Integrated Hydrologic Model (IHM) and supporting data for Tampa Bay region. The Operations Plan Update (Tampa Bay Water, 2011) contains a summary description of the models that provide input to the OROP. Input to the optimization model includes forecasted water demands at each point of connection to the member governments, surface water availability and Tampa Bay Water's scheduled withdrawals from the Hillsborough River/Tampa Bypass Canal system, Alafia River and the Regional Reservoir, and scheduled production from the seawater desalination facility. The optimization model schedules production from the wellfields to meet forecasted member government water demands based on current hydrologic conditions, operational constraints, permit limits, forecasted treated surface water reliably available from the regional Surface Water Treatment Plant, and reliably available desalinated seawater. The model also seeks to optimize groundwater levels based on target elevations at a selected set of surficial aquifer and Upper Floridan Aquifer monitoring wells called control points which are further discussed in Section 3.14.4. The optimization model adheres to operating policies and physical limits of the regional system infrastructure as well as the conditions of the Consolidated Permit and other water use permits. Policy issues are addressed by using weights to assign preferences to maximize groundwater levels at the control point locations. The output of the optimization routine is a weekly schedule prioritizing pumping from all active production wells of the Consolidated Permit.

The optimization model has an objective function that seeks to maximize aquifer water levels based on a system of constraints and the relationships between the decision variables. The constraints that govern the optimization model generally fall into one of four categories: physical constraints (e.g., pump capacities, high and low limits for numerous conveyance facilities), regulatory constraints (e.g., wellfield pumping limits, specified water levels), operational constraints (e.g., water quality, minimum production limits, hydraulic limitations), and demand constraints. An additional set of constraints that represent the integrated surface/groundwater hydrologic system (via the Unit Response Matrix approach) is required to complete the optimization formulation.

The hydrologic model, which is based on the physical characteristics of the surface and groundwater systems, simulates changes in water levels due to changes in pumping and rainfall. The pumping/water level relationships are based on the INTB Model application providing a unit response for each production/monitor well combination which relates pumping changes to water level changes.

Water quality constraints are also present within the optimization model as first presented in the OROP Annual Report for Water Year 2005 (Tampa Bay Water, 2006). The operations staff of Tampa Bay Water identified raw water quality concerns associated with iron concentrations at the Cross Bar Ranch and Morris Bridge Wellfields and sulfide concentrations for the Morris Bridge, Starkey, and South Pasco Wellfields. Blending groundwater with elevated levels of these constituents with treated surface water caused water quality problems for the member governments. The best way to avoid these problems is to manage the combination of wells that are used at each wellfield to meet the needed production rate from the wellfield and maintain target concentrations for these parameters. The constraint limits the iron and sulfide concentrations in water produced from the associated wellfield. These constraints were added to the optimization formula and the model seeks to meet these additional constraints in conjunction with maximizing the water levels at the control point wells.

3.14.4 Control Points and Target levels/Weights

The OROP was designed to maximize water levels in the surficial aquifer by optimizing pumping rates from the Consolidated Permit wellfields to meet regional water needs on a weekly basis. In order to maximize water levels, Tampa Bay Water had to select specific points to analyze and develop a mechanism for relating the influence of pumping to changes in water levels. The founding principles for the development of the Optimization Plan focused on key lakes and wetlands as the primary environmental features of concern. Wetlands and lakes are more sensitive to water level change than the underlying aquifers and are the features that are directly observable.

All Tampa Bay Water production wells are drilled into the Upper Floridan Aquifer and the effects of wellfield pumping can be most easily detected in this aquifer. Drawdown in the Upper Floridan Aquifer occurs on a short time scale but takes a number of weeks or a few months to “stabilize” given the local hydrologic properties of the aquifer and a constant pumping rate. The drawdown from wellfield pumping extends upward through the confining unit (where present) at the top of the Upper Floridan Aquifer into the surficial aquifer but the magnitude of drawdown in the surficial aquifer is usually less than observed in the underlying limestone aquifer. There is also a delayed response to pumping-related drawdown in the water table of the surficial aquifer of approximately 18 months depending on the aquifer properties and the groundwater pumping rate.

The drawdown in the surficial aquifer can also cause water level change in wetlands and lakes that occur within the surficial aquifer. These drawdown effects are again diminished since most wetlands and lakes have a layer of organic material or clay underneath them that tends to slow the leakage of water through these bottom sediments. Tampa Bay Water chose to use ground water levels at surficial aquifer monitoring wells as surrogates for wetland and lake water levels since water levels in the surficial aquifer can be correlated to wetland and lake water levels. Water level changes in the surficial aquifer due to wellfield pumping can be derived through calibrated groundwater models; therefore, the surficial aquifer was chosen as the target for maximizing water levels. The implication is that increased water levels in the surficial aquifer will result in less environmental stress (improved conditions) in the wetlands and lakes contained in the surficial aquifer.

Tampa Bay Water selected 31 surficial aquifer monitor wells as control points for the initial optimization model as described in Appendix C of the Revised Optimized Regional Operations Plan (Tampa Bay Water, 1998b). These monitor wells were chosen based on location within or near the 11 northern wellfields, provided representative spatial coverage for each wellfield, and each monitor well was located near wetlands or lakes of concern. Additional selection criteria included: locating the wells in areas with representative leakance properties between the surficial and Upper Floridan Aquifers, choosing wells that have water levels which show a strong statistical relationship with nearby wetland or lake water levels, and wells having water levels that displayed a strong match to predicted water levels as simulated by the integrated hydrologic model available at that time. These additional selection criteria were necessary to find wells that were representative of broad areas of each wellfield and whose water levels effectively correlate with water level data in nearby wetlands and lakes and with the regional hydrologic model. The selection of the initial 31 surficial aquifer monitor wells was a collaborative effort between Tampa Bay Water staff and consultants and the District technical staff.

Historical water level data were then used to perform statistical correlation analyses for each of the selected control points and a nearby wetland or lake of concern. Regression relationships were developed for each control point and wetland pair and these relationships formed the basis for a target water level at each control point and the weighting function for each site. The correlation analysis used was a linear regression of the control point water level data to the wetland or lake water level data. This analysis mathematically represents the relationship as a "best-fit" line between two variables (i.e., two water level data points from the same date).

Figure 3.65 (from Tampa Bay Water, 2011) illustrates this concept and its application at a control point from the Starkey Wellfield. In this example, the water level data from control point STK-20s is graphed against the water level data from nearby wetland STK-S-90 using date-matched data for the period of record. The mathematical relationship between the water level in the control point well and the wetland is defined by linear regression and is shown on the left graph. Based on this relationship, any water level in the wetland can be associated with a correlating water level in the control point well. A water level of 31.17 feet NGVD in wetland STK-S-90 has been designated as the surrogate minimum level for this wetland (this concept is described in Section 6.3.2). This level, serving as a target water level elevation to be maintained on a regular basis, should be sufficient to preserve the ecological health of this wetland. Based on the linear regression relationship, when the water level in wetland STK-S-90 is at this elevation, the corresponding water level in control point well STK-20s is 28.97 feet NGVD. This is defined as the target elevation for this control point well.

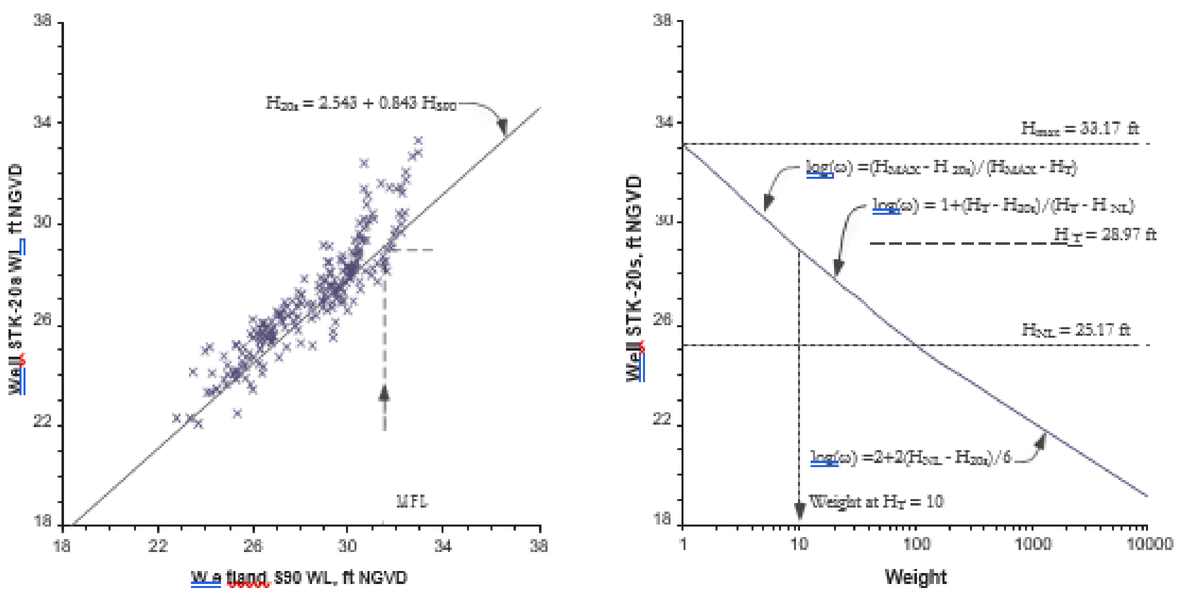

Figure 3.65: The Piecewise Linear Weighting Function on Semi-Logarithmic Scale

As the water level in this control point well falls below this target elevation, the weighting factor in the optimization program increase as shown on the x-axis of the right graph in Figure 3.65. The increased weighting factor signals a preference to increase water levels at this site and causes the optimization program to reduce pumping in nearby production wells, allowing water level recovery in the surficial aquifer, wetlands and lakes in the vicinity. In the optimization program, a weight of 10 means that the water level in a control point well is at the target elevation. As water levels fall below this target level, the weight increases on a logarithmic scale (the x-axis on the right graph in Figure 3.13-1 is a logarithmic scale). When water levels continue to decline below the target level in a control point well, the weights increase logarithmically and the signals to reduce pumping at the nearby production wells becomes stronger in the optimization program.

Target levels were established in this manner for the initial control point wells. A target level for three control point wells (SERW-s at the Cross Bar Ranch and WT-5-500 and WT-9-500 at the Cypress Bridge Wellfield) were set using a different method. A wetland meeting the screening criteria could not be identified near SERW-s so the average water level in the well from the base line period of 1980 – 1987 was chosen as the target level. There was insufficient correlation with nearby wetlands for two of the three Cypress Bridge Wellfield control points so the target levels for these two wells were based on the average water level from the baseline period prior January 1, 1996.

Since the implementation of the OROP in January 1999, changes have been made to the original set of 31 control points. Some of the new control points were added as new groundwater facilities (e. g., Brandon Urban Dispersed Wells and Carrollwood Wells) were added to Tampa Bay Water's regional system. Other control points have been added or changed to provide additional spatial coverage for the 11 northern wellfields in response to observed wetland or lake stress consistent with the OROP and EMP Interaction Protocol (see Section 3.14.7). The changes to the list of control point wells are documented in previous OROP annual reports referenced in Section 3.14.2 of this report. Currently, there are 40 surficial aquifer control points and two Upper Floridan Aquifer monitor wells which are used as control points in the optimization routine for the Brandon Urban Dispersed Wells. The locations of these 42 control point wells are shown in Figure 3.66.

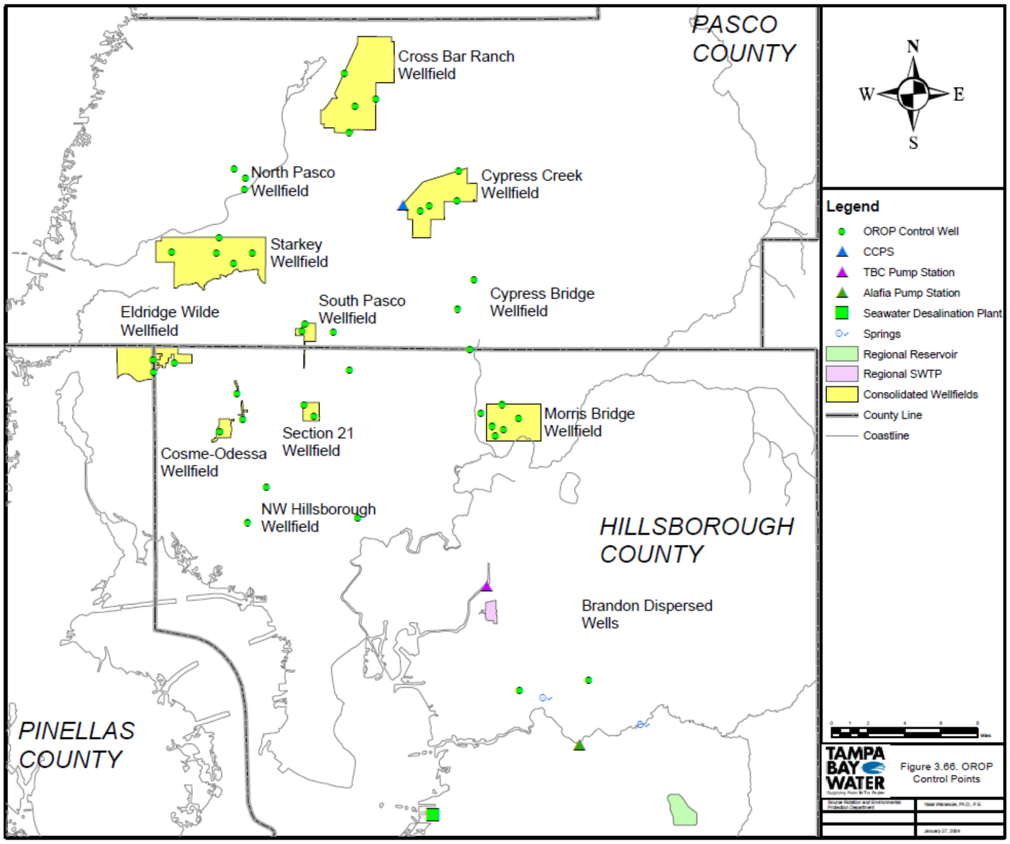

Figure 3.66: OROP Control Points

The original annual OROP update reports contained a reevaluation of the correlation and regression equation analyses that were performed for the original control point wells. The updated analyses were performed with the most current water level data at the control point wells and associated wetlands and lakes to continually improve the water level relationships. As appropriate and based on the updated analyses, the target elevations for the control point wells were updated and approved for use by the District. For the 2004 OROP annual report (Tampa Bay Water, 2005), an evaluation was conducted to determine if the wetland/control point regression analyses needed to be updated annually. The results indicated that conducting regression updates every other year is sufficient for control points that have been active for several years. The results of the bi-annual update to the control point target levels has been included in the biennial Operations Plan reports.

The current set of control point target levels was updated in the 2020 Operations Plan Biennial Report (Tampa Bay Water, 2020l) and is shown in Table 3.2. Of the 42 current control points, 37 are correlated to a specific wetland, lake, or spring flow in the case of the two Upper Floridan Aquifer wells for the Brandon Urban Dispersed Wellfield. Target levels for five of the control point wells (wells CB-A1S, SERW-s, and WRW-s at the Cross Bar Ranch Wellfield and WT-5-500 and WT-9-500 at the Cypress Bridge Wellfield) were initially set using a median water level from the control point well during a baseline period. The control point well in the middle of the Cypress Bridge Wellfield changed with the submittal of the 2020 Operations Plan Biennial Report. The new control point well is CYB-WT-5-1950 and the water level in the well is correlated with nearby wetland CYB-15.

Table 3.2: Updated Regression Results and 2019 Target Levels at OROP Control Points.

SeqNo	WELLFIELD	WELL	WETLAND	Is wetland xeric-associated?	Valid N	Corr. Coeff. Spearman's R	P value	KT slope (m)	constant (b)	NP or PE03	Min Level	Target Level 2019	Target Level 2017	Diff 2019-2017 TL	Start POR Date	End POR Date
1	BUDWF	BUD-14FL	Lithia Springs (Major)	NA	737	0.88	0.00	4.96	-35.19		27.83	12.70	13.29	-0.59	07/22/2000	09/26/2019
2	BUDWF	BUD-21FL	Buckhorn Springs	NA	656	0.60	0.00	0.50	4.44		12.64	16.49	15.33	1.16	09/16/2000	09/26/2019
3	CBR	CB_A1S	NA	NA	NA	NA	NA	NA	NA		67.89	68.02	68.02	0.00	01/07/1979	09/30/2019
4	CBR	SERW-s	NA	NA	NA	NA	NA	NA	NA			67.85	67.85	0.00	01/01/1979	09/30/2019
5	CBR	CB_SRWS	CB_Q01	no	510	0.95	0.00	0.81	13.89	74.3	72.50	72.30	72.49	-0.19	10/20/1990	09/17/2019
6	CBR	WRW-s	NA	NA	NA	NA	NA	NA	NA			56.80	56.80	0.00	03/19/2006	09/30/2019
7	COS	COS20S	L Rogers	no	1903	0.89	0.00	0.81	7.85		35.60	36.56	36.67	-0.11	08/15/1994	09/16/2019
8	COS	JAMES10S	NC262717	YES	640	0.94	0.00	1.17	-8.16	47.7	43.98	43.49	45.50	-2.01	11/16/1983	09/17/2019
9	COS	KEYSTN36	C142717	YES	560	0.96	0.00	0.90	5.29	59.8	56.13	55.80	57.39	-1.59	03/01/1989	09/17/2019
10	CYB	WT-5-200	NA	NA	NA	NA	NA	NA	NA			52.29	52.29	0.00	09/21/1993	09/30/2019
11	CYB	WT-2-500	CYB_W4	no	527	0.78	0.00	1.46	-36.38	71.0	69.20	64.63	64.52	0.10	10/07/1993	09/24/2019
12	CYB	WT-9-500	NA	NA	NA	NA	NA	NA	NA			47.56	47.56	0.00	7/1/1993	09/30/2019
13	CCWF	TB-22S	W12A	no	524	0.89	0.00	1.38	-27.27	63.8	62.00	58.14	58.54	-0.40	06/14/1984	09/16/2019
14	CCWF	TMR-1S	W45A	no	539	0.83	0.00	2.09	-81.90	71.5	69.70	64.03	63.53	0.50	12/04/1985	09/16/2019
15	CCWF	CYC 821SAR/CYC 821d	W41	no	547	0.92	0.00	1.40	-30.01	74.9	73.10	72.54	72.36	0.18	09/01/1981	09/17/2019
16	CCWF	W56B(UPLAND)	W23A	no	306	0.83	0.00	0.82	14.11	60.4	58.60	61.88	62.05	-0.18	05/28/2003	09/24/2019
17	ELW	ELW11S	EC112716	no	445	0.76	0.00	2.04	-23.72	24.0	22.20	21.52	21.55	-0.03	11/22/1998	09/25/2019
18	ELW	EW-SM15	PMD5 (NNW121716)	no	508	0.80	0.00	1.26	-6.05	28.9	27.10	28.09	27.68	0.41	11/29/1995	09/25/2019
19	ELW	EW-SM28	PMD11 (NW052717)	no	549	0.84	0.00	1.03	-1.93	38.2	36.40	35.61	35.91	-0.30	11/1/1991	09/23/2019
20	MBR	MB-23s	MB91	no	629	0.92	0.00	0.89	3.96	35.2	33.40	33.54	32.95	0.59	3/22/1991	09/25/2019
21	MBR	MB-24sh	MB30	no	589	0.84	0.00	0.75	5.27	34.4	31.71	28.92	28.94	-0.03	03/22/1991	09/26/2019
22	MBR	MB-25S	MB30	no	571	0.91	0.00	0.95	-0.13	34.4	32.60	30.78	30.86	-0.08	08/25/1989	09/26/2019
23	MBR	MB-4S	MB14	no	474	0.88	0.00	0.89	-0.59	35.1	33.30	28.89	29.03	-0.14	09/08/1989	05/15/2019
24	MBR	MB537S	MB88 (Clay Gully Cypress)	no	671	0.88	0.00	0.87	6.90	41.4	39.60	41.53	41.55	-0.02	10/01/1998	09/18/2019
25	MBR	SGW-1	MB91	no	460	0.90	0.00	0.72	12.43	35.2	33.40	36.56	36.15	0.41	03/04/1996	09/25/2019
26	NWH	RMP8_S	EC072818	YES	681	0.79	0.00	0.44	18.00	40.5	36.77	34.05	35.06	-1.00	06/01/1987	09/23/2019
27	NWH	RMP-13S	EC232817	no	634	0.89	0.00	0.53	8.32	22.5	20.70	19.35	19.28	0.06	06/01/1991	09/18/2019
28	S21	HILLS13S	WC212718	no	620	0.94	0.00	1.63	-33.69	54.4	52.60	51.84	51.12	0.72	02/01/1985	09/23/2019
29	S21	J26As-R	DOSSON	no	527	0.71	0.00	1.03	-0.23		52.40	53.71	53.53	0.18	11/1/1990	09/23/2019
30	S21	LUTZPK-40S	NW112718	no	200	0.94	0.00	1.15	-5.84	64.0	62.20	65.93	65.44	0.49	02/07/1995	09/30/2010
31	SOP	MATTS	CAMP	no	299	0.96	0.00	0.99	1.25		62.00	62.41	62.41	0.01	10/15/1983	09/23/2019
32	SOP	NORTH-S	PSE282618	no	546	0.87	0.00	0.79	12.19	59.2	57.40	57.49	57.49	0.00	08/01/1991	09/23/2019
33	SOP	SP47S	PTE332618	no	554	0.95	0.00	1.29	-17.31	59.0	57.20	56.34	56.57	-0.23	08/01/1991	09/23/2019
34	STK	EMW-16s	STKS62	YES	638	0.92	0.00	1.02	-1.18	44.2	40.49	39.92	40.97	-1.05	06/21/1984	09/16/2019
35	STK	EMW-8s	STKS113	no	423	0.93	0.00	1.24	-5.24	39.4	37.60	41.34	41.28	0.06	10/11/2001	09/16/2019
36	STK	STK-20S	STKS05	YES	403	0.96	0.00	0.90	7.49	27.9	24.23	29.30	30.09	-0.80	04/25/2002	09/17/2019
37	STK	STK-SM2S	STKS53	no	670	0.84	0.00	0.54	25.09	41.0	39.20	46.20	46.07	0.13	03/19/1983	09/16/2019
38	STK	STK-2A East	STKS73	no	881	0.88	0.00	1.10	-4.82	46.4	44.60	44.36	43.53	0.83	07/31/1995	09/30/2019
39	Carrollwood	CWD-Elem-SAS	Carroll	no	1715	0.85	0.00	2.11	-35.65		35.40	39.07	39.25	-0.18	08/15/2010	09/30/2019
40	CYB	CYB-WT-5-1950	CYB 15	no	551	0.91	0.00	0.74	15.74	57.8	56.00	57.26	NA	NA	07/29/1994	09/25/2019

Notes:

1) A median level from a baseline period was used to calculate the target level for SERW-s, A-1s, WRW-s, WT-05-200 and WT-09-500. Target levels (HT) in the BUDW wells is based on median flow (cfs) in the associated spring.

2) Wellfield abbreviations used: BUDWF = Brandon Urban Dispersed Wellfield; CBR = Cross Bar Ranch Wellfield; CCWF = Cypress Creek Wellfield; COS = Cosme Odessa Wellfield; ELW = Eldridge-Wilde Wellfield; NWH = Northwest Hillsborough Regional Wellfield; S21 = Section 21 Wellfield; SOP =South Pasco Wellfield; CYB = Cypress Bridge Wellfield; MBR = Morris Bridge Wellfield; STK = Starkey Wellfield

3) Xeric-associated wetlands, and associated PE03 values, are in brown type.

3.14.5 Unit Response Matrix (URM)

The development and application of unit response principles concerning the response of ground water levels to increments of pumping change is central to the development of the OROP. This concept forms the basis for the optimization algorithms to seek pumping schedules involving incremental changes in pumping from a base scenario. The optimization procedure employed in the development of the regional wellfield operations plan requires a matrix of influence coefficients called the Unit Response Matrix (URM). This matrix is embedded into the constraints of the optimization software. In simple terms, URM elements describe the rate of change of aquifer drawdown due to a unit increase in aquifer stress (pumping) at multiple locations referred to as control points.

The development of the original URM is described in the Revised Optimized Regional Operations Plan (Tampa Bay Water, 1998b). Tampa Bay Water was using the Integrated Surface/Ground Water (ISGW) model (SDI Environmental Services, 1997) at the time to simulate water level changes due to wellfield pumping and this model was used in the development of the original URM. The process of generating the URM involves developing a base model run for a given period. Then, multiple model runs are generated for the same period by pulsing a single production well (increasing the rate of pumping) by a unit increment for a specified stress period (i.e., 1 week) while keeping the pumping rate from all other wells unchanged. This pulsing procedure is repeated for all production wells that will be evaluated in the optimization model. The response at the control points due to the imposed additional pumping stress are the coefficients that are calculated by subtracting the water levels of the pulsed run from the base run. Once calculations are done for every point, the results are placed into the matrix of coefficients called the URM.

A base run was performed using the ISGW model with no pumping from any of the production wells in the 11 northern wellfields. The model was then run, one production well at a time, at a rate of 7 mgd for one week to simulate the drawdown from each production well on each control point monitor well. There were 172 active production wells when the URM was first generated so 172 additional model output files were created, one for each production well. To calculate the URM coefficients due to the one-week pumping stress, the water levels at the 31 control point wells from the pulsed runs were individually subtracted from the water levels at the control points in the no pumping base run scenario. The values of drawdown at the control point wells were added to the matrix from every run. The resulting matrix of water level differences as drawdown in feet at the control point wells contains the URM coefficients that are used in the optimization model. The matrix in reality is a vector of drawdowns at every control point due to the pulsing of individual pumping wells. Before using the matrix in the optimization run, the values within the matrix were normalized by dividing by 7 to produce the drawdown at each control point due to the pumping of each production well at a unit rate (1 mgd).

The optimization model assumes that the principle of superposition is applicable to the aquifer system response due to the imposed pumping stress. That is, the aquifer response in time and space due to the imposed pumping stress is linear and additive (i.e., it is scientifically valid to add the drawdown from each well together to find out the total drawdown from all production wells). This assumption was verified using the ISGW model and three aspects of linearity were demonstrated. The first aspect is that the water level response to pumping is a linear function of pumping and pumping changes. It was verified that the drawdown in control point wells due to pumping a well at 7 mgd was twice as much as pumping that well at 3.5 mgd. The second aspect tested is that the principle of superposition is spatially valid. It was verified that there is good agreement between the drawdown at control points when multiple production wells were pulsed at the same time versus pulsed individually and the resulting drawdown summed. The third aspect tested is that the principle of superposition of the drawdown over time is valid. It was verified that there is good agreement between the drawdown at control points when a well is pulsed for three consecutive weeks in a single model run versus pulsing that well for three consecutive weeks in three individual runs and summing the drawdown.

The validation of the principle of superposition with respect to drawdown stress at the control point wells due to production well pumping demonstrated that the URM was a valid approach for use in the OROP. The optimization model uses the matrices of Unit Response coefficients associated with each of the pumping wells along with constraints of permit conditions, to search for a formal mathematical solution that maximizes ground water levels while meeting the demand schedules for each delivery point. The mathematical solution provides the optimal distribution and schedule of pumping that meets demand and system constraints while maximizing water levels.

Over time, new control points were added to the original list of 31 wells or existing control points were modified. When this occurred, new coefficients were developed for each new control point using the ISGW model. Tampa Bay Water and the District developed a new calibrated Integrated Hydrologic Model (IHM) and a specific application for the Northern Tampa Bay area. This new model application is called the Integrated Northern Tampa Bay (INTB) model and the development of this model is described in (Geruink and Basso, 2013). A new URM was developed and validated in 2009 using the INTB model to take advantage of the most up-to-date simulation of the physical hydrologic system for the region. The new URM is described in the August 2009 report "Development and Validation of the New Unit Response Matrix for the Optimized Regional Operations Plan (OROP) Model" (Tampa Bay Water, 2009a). The new URM was included in the April 2011 Operations Plan Update (Tampa Bay Water, 2011) and continues to be used within the OROP.

Theoretically, the INTB model application of the IHM could be embedded as a constraint function within the optimization routine. Due to the long run times of the IHM, this is not practical since each optimization iteration would require multiple evaluations (model runs). The drawdown coefficients in the URM were generated from the calibrated INTB model and it has been demonstrated that using the URM to represent the physical pumping/drawdown relationship in the aquifer system is a valid approach The URM is also computationally efficient within the OROP allowing for weekly implementation of the model.

3.14.6 Implementation

Tampa Bay Water staff run the OROP model each week to produce a production schedule for the coming four weeks, with each schedule week beginning on Saturday. Figure 3.67 shows a diagram of the implementation process with the multiple types of input data required to accomplish this weekly wellfield pumping forecast. The process begins on Thursday with a discussion between the Water Production and Source Rotation Departments about production options for the upcoming week at the Surface Water Treatment Plant and to decide on the appropriate production quantity and use of the Regional Reservoir (withdrawal or storage quantity). Factors considered in determining these quantities include annual budget and current (year to date) production, near term (next week) and next month surface water availability, reservoir level, season, total system demand, and infrastructure constraints (e.g., scheduled maintenance, source water quality, chemical deliveries, production wells out of service). The Surface Water Treatment Plant quantities and reservoir use quantities are added to the OROP database for use in the weekly model run.

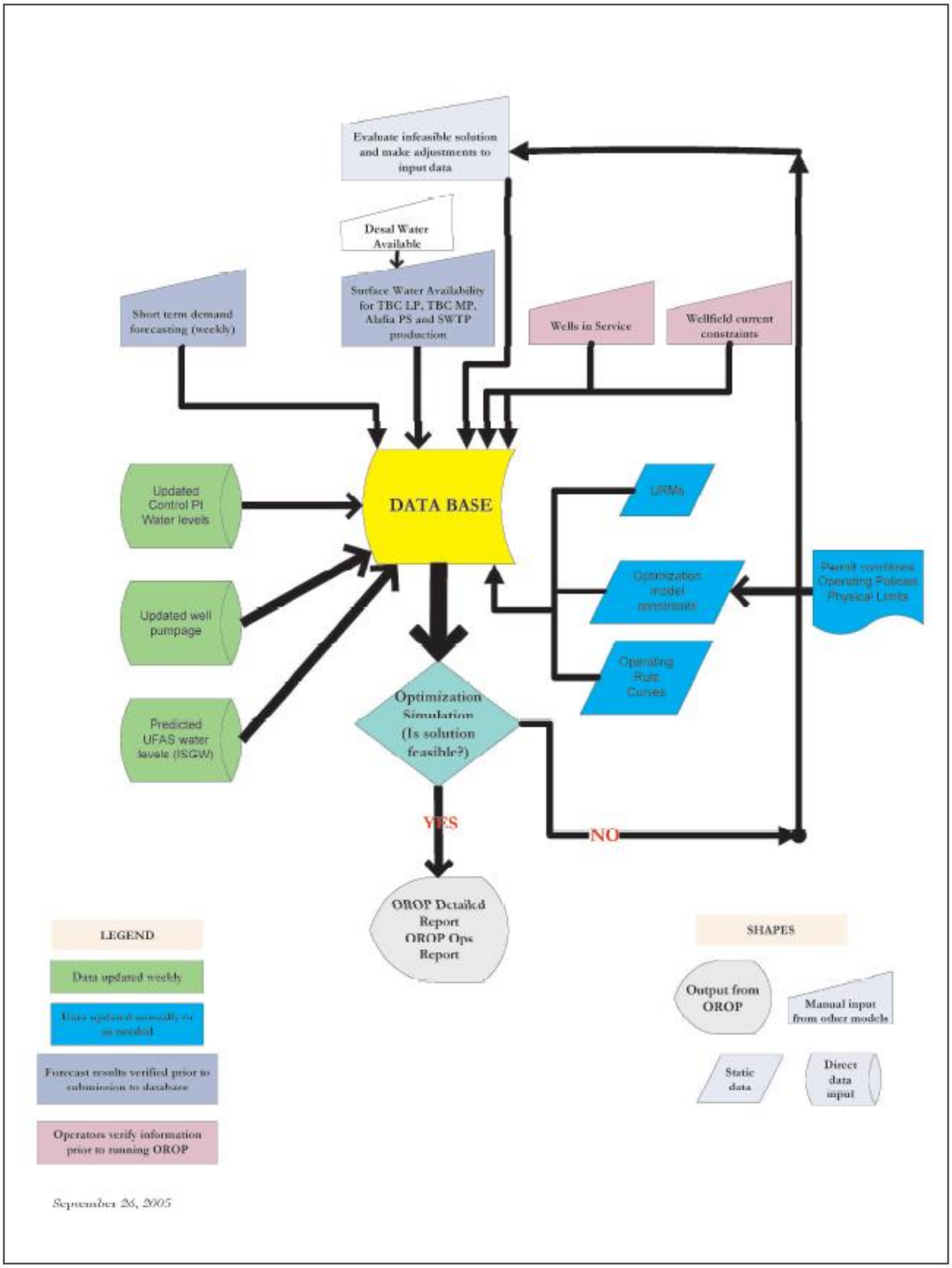

Figure 3.67: OROP Implementation Process

Additional alternative supply source information is generated on Friday of each week and entered into the OROP database. The weekly rates of surface water availability from the Alafia River, Tampa Bypass Canal Lower Pool, and Tampa Bypass Canal Middle Pool are developed using forecast models for the next four weeks. Weekly rates for the desalination facility are determined considering water quality, intake water temperature, blending ratios with treated surface water, seasonal demands, scheduled maintenance, and TECO activities that affect operation of the desalination facility.

On Friday, staff forecast the weekly demands at each of the OROP delivery points to the member governments. The results of the demand forecast are reviewed and either accepted or changed. The demand projections may be changed based on recent weather trends or an infrastructure change at a Point of Connection that has not yet been captured by the model. The list of production wells that are active and available for production is generated from data tables maintained by the Water Production staff. At this point in the process, the Water Production staff may also offer additional constraints at the wellfield level (turning off a wellfield, setting a production minimum or maximum limit, or accommodating the treatment and distribution system maintenance activities of the Member Governments if needed. These are not permanent constraints but available to handle short-term operational issues.

The most current water level data for the control point monitor wells and 18 Upper Floridan Aquifer monitor wells are retrieved from the agency's Enterprise database and added to the OROP model data sets. Predictive water levels for the same set of monitor wells are generated from artificial neural network models for use in the weekly OROP model run. Daily production from all active wells is acquired from the Agency Enterprise database to determine production well peak month quantities and the 12-month running average quantities to compare against program constraints. A schematic diagram of the OROP infrastructure is presented in Figure 3.68 and includes all water supply source inputs, pipe flows, and delivery points to the member governments.

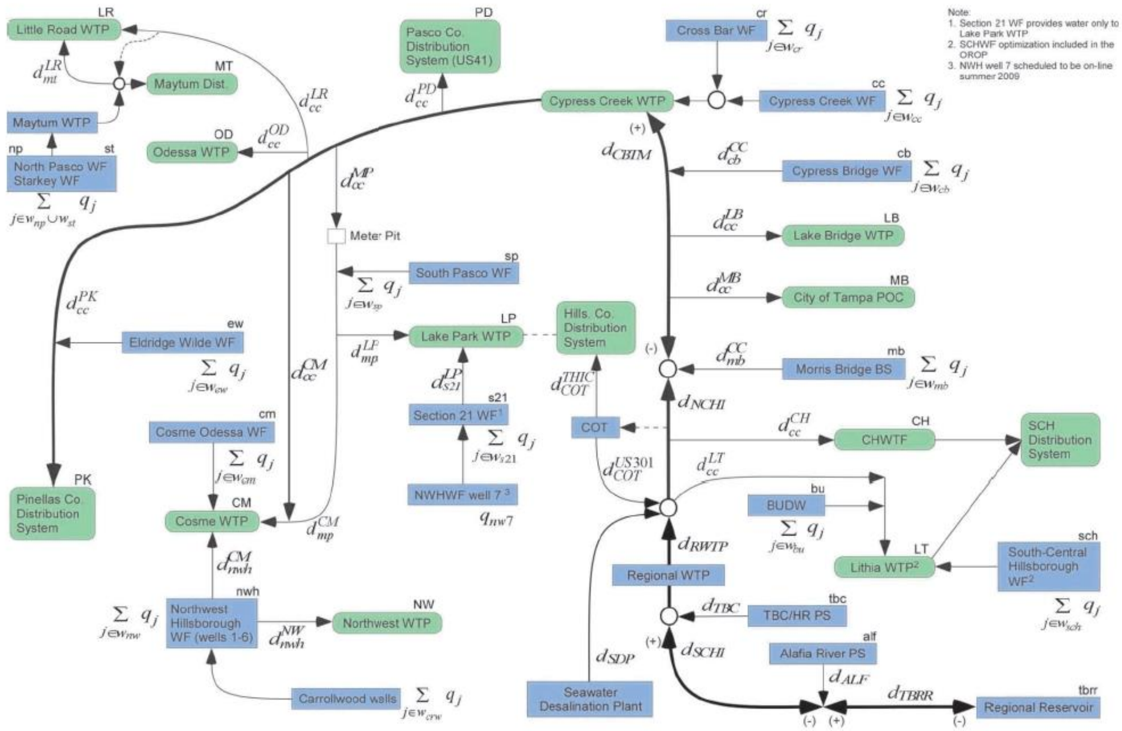

Figure 3.68: Schematic Diagram of OROP Infrastructure

The OROP model is run using all of the assembled data sets and incorporating all constraints. The program checks to see if all necessary data is present, calculates the weights for the control point wells based on the current water level data, and seeks an optimized, feasible solution. If the model determines that a solution is infeasible, the model identifies the problems and the manager makes adjustments in demand or supply options so that a feasible solution can be generated. When the model returns a feasible solution, the results are published and distributed internally for review. Reviewer comments are addressed as appropriate and the final results are published and distributed. The published schedule includes a summary of demands, surface water availability, wellfield pumping rates, well priorities, and control point weights. This schedule is used by the Water Production staff during the following week beginning on Saturday.

Once the weekly operational outlook is published and implemented, an electronic report is automatically generated and distributed detailing the weekly demand and supply forecast versus observations (usually within a week or two after the forecast). This report provides a snapshot of the OROP model performance. It includes a comparison of the forecast and actual values for (1) each demand delivery point – that is, what OROP expected a member government to ask for versus what they actually asked for; (2) forecast versus actual supply availability; (3) scheduled versus actual groundwater production by wellfield; (4) scheduled versus actual surface-water production; and (5) scheduled versus actual surface water source allocation. Mismatches between forecast and observed data are used to assess such factors as operational constraints not yet captured in the model and/or model performance. Short-term demand and supply forecasts are highly dependent on near-term weather conditions, and the agency is continually improving its models using operationally-available forecast products such as the Climate Prediction Center's seven-day quantitative precipitation forecast (QPF).

The primary purpose of the optimization model is to seek a pumping scenario that minimizes water level drawdown at the designated control points given the water demands, operational and system constraints, and availability of alternative water supplies. The weekly application of this model fulfills a fundamental requirement of the OROP to maximize the surficial aquifer levels at the specified monitoring wells according to a specified weighting/ranking system, using the surficial aquifer levels as a surrogate for water levels in lakes and wetlands.

3.14.7 OROP and EMP Referral Protocol

Tampa Bay Water implements an Environmental Management Plan (EMP) as required by the Consolidated Permit for the 11 regional wellfields. The EMP requires monitoring of wetland hydrology and ecology with a periodic review of environmental conditions at wetlands that could potentially be affected by water production. The EMP is described in greater detail in Section 5.5.2 of this report. Hydrologic parameters at monitored wetlands are statistically compared to reference and control sites semi-annually at the end of both the spring (dry) and fall (wet) seasons. Sites that fail this statistical test are called "outliers" and are tabulated and tracked during future semi-annual tests.

The District approved an OROP/EMP implementation protocol in June 2000 and this assessment and referral program began in Water Year 2001. In compliance with Special Condition 3 of the 2011 Consolidated Permit, Tampa Bay Water modified this protocol describing the interaction between the EMP and the OROP. This revised protocol is included as Appendix E in the Operations Plan Update (Tampa Bay Water, 2011). Under the updated protocol, no action is required for the first two consecutive times a wetland fails to pass the outlier test. If a wetland fails a third consecutive seasonal outlier test, a site-specific analysis is performed to determine if there is an adverse environmental impact at this wetland and if it is attributable to wellfield pumping. If adverse impacts due to wellfield pumping are confirmed, then the wetland site is referred to the OROP to attempt to relieve the impact. Actions undertaken within the OROP could include the adjustment of an OROP control point target level or the addition of a new control point.

The results of the semi-annual outlier tests and any site-specific wellfield impact analyses for wetlands referred to the OROP are reported in the annual reports for the 11 regional wellfields. These results are also reported in the biennial Operations Plan reports. Any recommended changes to the OROP control points or target elevations require approval by Tampa Bay Water's Board of Directors and the District prior to implementation. This wetland referral process between the EMP and OROP has resulted in the addition and modification of control point wells and their target elevations since the protocol was first implemented. These changes have been documented in the Operations Plan annual or biennial reports referenced in Section 3.14.2 of this report.

In April 2016, Tampa Bay Water requested that the District waive the requirement for site-specific wellfield influence tests through December 2018 since all wetlands monitored under the EMP were already being assessed to determine wellfield influence. The District approved the waiver for these specific assessments to avoid duplication of technical studies. Tampa Bay Water continued to perform the semi-annual outlier tests and have reported the results and tracked the wetland outlier status in the wellfield annual reports and the biennial Operations Plan reports. In May 2019, the District again waived the requirement for site-specific wellfield influence test reports until December 2020, when the Consolidated Permit will be under review by the District for renewal. The site-specific site analyses included in this final Recovery Assessment Plan report will be applied to any sites with three or more consecutive referrals at the time of the permit renewal.

The OROP continues to be an effective tool for minimizing pumping-related wetland impacts. By rotating pumping between production wells within and between the 11 Consolidated Permit wellfields, water levels are maximized given the current status of the key lakes and wetlands, the weekly member government water demands, the availability of surface water and desalinated seawater, and various system constraints. The flexibility within the Consolidated Permit wellfields allows Tampa Bay Water to rotate pumping away from areas of low water levels in the water table to the greatest extent possible and accommodate temporal rainfall patterns where some of the wellfields receive more rainfall than others. Operating the 11 wellfields as one large extended system has allowed Tampa Bay Water to meet the permit-required reduction in pumping to an average annual of 90 mgd and promote environmental recovery on and near the wellfields. This adaptive management system has allowed Tampa Bay Water to maintain a permitted annual average capacity that would likely not be achieved if the wellfields were operated individually. Given the current regulations governing groundwater withdrawals and the wetland metrics of recovery established for monitored systems, the ability to rest wellfields or shift pumping from a wellfield with low water table levels to a wellfield with higher water table levels is critically important.

The OROP will continue to schedule wellfield pumping during the term of the next Consolidated Permit. The EMP/OROP protocol will help Tampa Bay Water detect changes in wetland water levels that may be due to changes in wellfield pumping rotation, thereby preserving the environmental recovery already achieved. If wetlands do not continue to meet their metric of recovery or if the observed improvements in water levels do not continue, Tampa Bay Water will determine if this is due to the influence of wellfield pumping. If this does occur in the future, Tampa Bay Water will continue to reevaluate control point target levels, propose new control points, or modify current control points to attempt to alleviate the pumping impact.

3.15 Reduction in Ground Water Pumping

Tampa Bay Water introduced the first alternative water supply into the Regional System in September 2002 when the Regional Surface Water Treatment Plant came online. With the addition of this new supply source, pumping from the Consolidated Permit wellfields was reduced for the first time. This was an historic milestone for the Tampa Bay region as it marked the beginning of environmental recovery around these 11 wellfields. The reduction in pumping was sudden, dramatic, and it arrived at a critical moment in time. The Tampa Bay region had suffered through an historic drought from late 1999 through Spring 2002 and environmental impacts were obvious and wide-spread. Years of high levels of groundwater pumping, drought conditions, and human-imposed changes to the landscape resulted in many environmental systems that were significantly stressed.

The reduction in groundwater pumping can be easily identified in Figure 3.36. This graph shows the period-of-record annual average pumping from the 11 Consolidated Permit wellfields and the relative contribution of each wellfield to the total system pumping quantity. During the severe drought years of Water Years 2000 and 2001, the average annual pumping level from the 11 wellfields reached 159.9 and

156.9 mgd, respectively. In Water Year 2003, the first full year with a reduction in groundwater pumping, the 11 wellfields produced an annual average quantity of only 86.6 mgd, a cumulative pumping level not experienced at these wellfields since 1977. To put this average pumping quantity into perspective, only six of the 11 wellfields existed in 1977; the five remaining wellfields were either in development or had yet to be considered.

The original Consolidated Permit contained phased reductions in pumping from the wellfields to give Tampa Bay Water time to complete the new alternative water supply sources. Figure 3.69 displays the monthly average pumping quantity from the 11 wellfields beginning in January 1999, when the original Consolidated Permit became effective. This figure also shows the running average pumping quantity from the wellfields and the permit compliance limit for the different time periods. The initial phase of the permit allowed a wellfield pumping rate of 158 mgd based on a 36-month running average as described in Section 3.12.1. Tampa Bay Water exceeded the 158 mgd limit during March, April, and May 2001 by a slight amount as can be seen on Figure 3.69. The highest 36-month running average pumping rate was 158.91 mgd in March 2001 and was the result of extremely hot, dry conditions and the resulting high demand for water. During this time period, the highest monthly pumping rate from the wellfields was 210.56 mgd in May 2000 and the 12 month period with the highest average pumping rate was March 2000 to February 2001 (averaged 167.2 mgd).

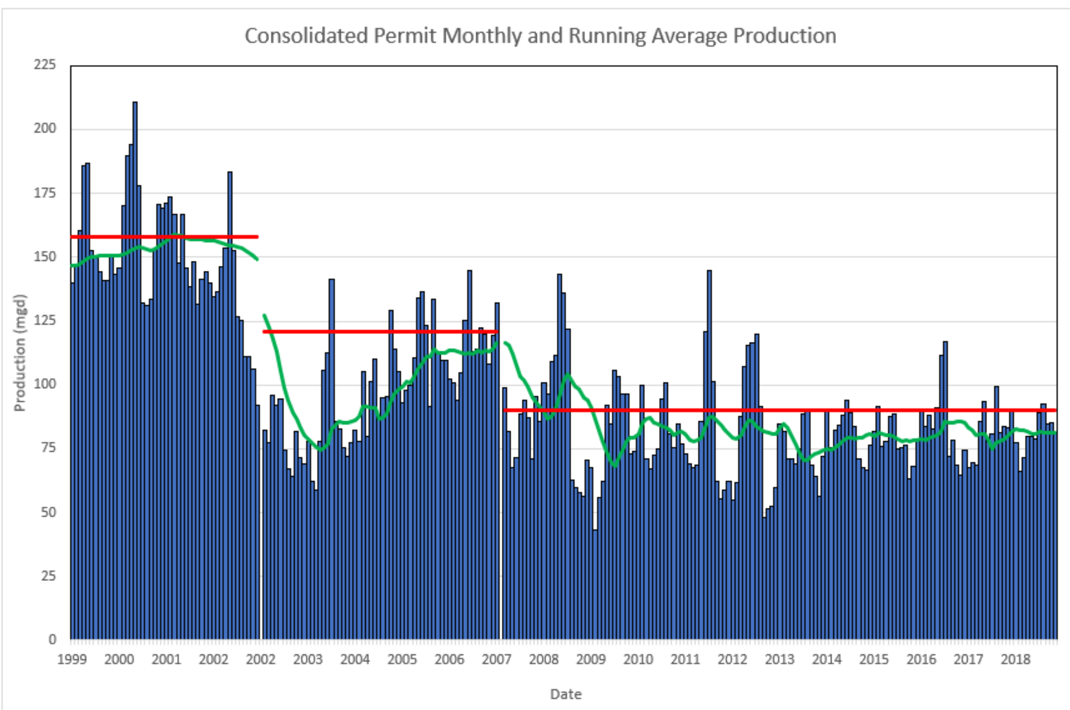

Figure 3.69: Consolidated Permit Wellfields Monthly and Running Average Production

Between January 2003 and December 2007, pumping from these wellfields was limited to 121 mgd on a 12-month running average basis. Compliance with this new limit was first measured at the end of December 2003 to give Tampa Bay Water a full 12-month period to adjust pumping rates down to the new limit of 121 mgd. Another drought hit the Tampa Bay area beginning in 2005 and while it was not as severe as the prior drought, it persisted for a longer period of time (through 2009). During this period, Tampa Bay Water managed the new alternative supplies and while the 12-month running average pumping rate from the wellfields increased, the 121 mgd permit limit was not exceeded.

The final phase of the original Consolidated Permit began in January 2008 and limited the wellfield pumping to 90 mgd on a 12-month running average basis. This permit limit and 12-month running average basis have also been in place through the duration of the renewed Consolidated Permit. By December 2008, the wellfield pumping was below this compliance limit (86.6 mgd); however, due to the continuing dry conditions in the spring of 2009 and the limited availability of stored water in the Regional Reservoir, the 12-month running average from the wellfield exceeded the 90 mgd limit from March through November of 2009. The maximum 12-month running average pumping rate during this exceedance period was 104.4 mgd in May 2009. The running average pumping level from the wellfields fell below the 90 mgd limit in December 2009 and has not since exceeded this threshold. Figure 3.69 shows that the 12-month running average pumping rate since January 2010 has fluctuated on an annual basis but has generally been between 75 and 85 mgd. On an annual basis, the average pumping rate between Water Year 2010 and 2019 was 80.3 mgd (Figure 3.36).

The lower pumping rates from the 11 wellfields reflect a significant reduction in groundwater pumping. Since 2010, the wellfield pumping has been cut in half as compared to conditions prior to the introduction of alternative supply sources (2000 through 2002). The wellfield groundwater pumping rate in the northern Tampa Bay area is comparable to 1977 levels and the improvement in area lakes and wetlands is remarkable.

3.15.1 Historical Pumping at Individual Wellfields

Tampa Bay Water reduced the pumping level from the Consolidated Permit wellfields beginning in September 2002; however, infrastructure constraints did not allow for pumping reductions at all 11 wellfields at that time. Seven wellfields were fully interconnected to the regional supply system in September 2002; the Cosme-Odessa, Eldridge-Wilde, South Pasco, Cypress Creek, Cross Bar Ranch, Cypress Bridge, and Morris Bridge Wellfields. Using these seven wellfields, Tampa Bay Water was able to meet the pumping reduction by county as specified in the original Consolidated Permit, the Amended and Restated Interlocal Agreement, and the Partnership Agreement with the District. The historical pumping data trends from each wellfield are discussed in Section 3.9.1 and this section focuses only on the reduction in groundwater pumping at each wellfield after 2002.

Tampa Bay Water and the City of St. Petersburg pumped the Cosme-Odessa Wellfield at a relatively constant rate of approximately 11 mgd from Water Years 1995 through 2002 (Figure 3.37). Since Water Year 2003, the annual average pumping from the wellfield has averaged approximately 6 mgd but has varied from year to year between 1.6 and 8.9 mgd. The pumping rate at the Eldridge-Wilde Wellfield also decreased significantly beginning in Water Year 2003 (Figure 3.38). This wellfield was pumped at an average rate of 25.5 mgd for the ten prior years but pumping has averaged only 12.6 mgd since Water Year 2003, a 50% reduction. The reduction in pumping at the South Pasco Wellfield was even more dramatic (Figure 3.40). Pumping at this wellfield ranged between 10 and 16 mgd since it was fully placed into service in 1974 with an average pumping rate of 14.1 mgd during Water Years 1993 through 2002. The annual average pumping rate at this wellfield was only 2.3 mgd during Water Year 2003 and has averaged 5.1 mgd since the initiation of pumping reductions. This represents a 64% reduction in the pumping rate at the South Pasco Wellfield.

The Cypress Creek Wellfield has been a cornerstone of the regional groundwater supply portfolio due to its location at the center of the water supply transmission system. Pumping at this wellfield increased to just over 31 mgd in Water Year 1979 and remained constant at approximately 30 mgd through 1993 (Figure 3.41). The average pumping rate between Water Years 1993 and 2002 was 25.7 mgd, only slightly lower than the constant 30 mgd pumping rate from previous years. Since the reduction in pumping that began in Water Year 2003, there has been only one year when Tampa Bay Water pumped the Cypress Creek Wellfield at greater than 20 mgd (Water Year 2006 average pumping rate was 20.8 mgd). Since Water Year 2003, the average pumping rate from the Cypress Creek Wellfield has averaged 15.2 mgd. The Cross Bar Ranch is another key part of the groundwater system due to its location and direct connection to the Cypress Creek Pumping Station. During the ten years before the reduction in groundwater pumping, the wellfield averaged 23.5 mgd (Figure 3.42). Since Water Year 2003, the annual average pumping rate has ranged from 11.3 to 17.7 mgd and the average pumping rate from Water Year 2003 through 2019 was 14.2 mgd.

The Cypress Bridge Wellfield was the last of the 11 wellfields to be developed and was fully interconnected to the regional system in late 2002 due to its location along the North-Central Hillsborough Transmission Main. This pipeline was constructed along with the alternative water sources to deliver the new water supplies to the Cypress Creek Pumping Station for distribution to multiple member governments. The average pumping rate from the Cypress Bridge Wellfield ranged from 6.3 to 10.7 mgd between Water Years 1996 and 2002 (Figure 3.47). Although the average pumping rate at the Cypress Bridge Wellfield was reduced during Water Years 2003 through 2005, the wellfield pumping rate has averaged 11.9 mgd since Water Year 2006, making this this the only regional wellfield that has not experienced a pumping reduction. The Morris Bridge Wellfield average pumping rate has varied over time; it was operated by the City of Tampa between 1978 and 1998 in conjunction with their withdrawal of water from the Hillsborough River. Since Water Year 1999, this wellfield has been operated by Tampa Bay Water as part of the regional groundwater system. The annual average pumping graph (Figure 3.43) shows a reduction in pumping rate starting in 1986 with a period of higher pumping between Water Years 1997and 2002 (average pumping rate of 12.6 mgd). Since the reduction in pumping in Water Year 2003, the wellfield has been pumped at an average of 7.3 mgd with a high of 10.4 mgd and a low of 4.2 mgd.

The Section 21 Wellfield became fully connected to the regional system in Water Year 2005 following the refurbishment of the wellfield production wells and improvements at Hillsborough County's Lake Park Pumping Station. The pumping rate from this wellfield had been relatively constant between Water Years 1974 and 2004 at approximately 9.1 mgd (Figure 3.39). Since Water Year 2005, this wellfield pumping rate has averaged 3.1 mgd. The annual average pumping rate has widely varied, from a high of 7 mgd to a low of 0 mgd during Water Year 2016. The wellfield was off from August 2015 through mid-October 2016 due to the discovery of a large sink feature on the southern part of the wellfield. Tampa Bay Water did not operate the wellfield during this time period to avoid interfering with Hillsborough

County's investigation of the sink feature and exploration of remediation measures. Tampa Bay Water returned the wellfield to service in Water Year 2017 following the conclusion of these subsurface investigations.

Perhaps the most dramatic reduction in pumping at any wellfield occurred at the Starkey Wellfield (Figure 3.45). Tampa Bay Water completed the West Pasco Transmission Main in December 2007 allowing the delivery of regional water to the West Pasco and New Port Richey Service Areas. The Starkey Wellfield produced an average of 11.5 mgd for the ten years prior to this date (Water Years 1998 through 2007). In subsequent years, the Starkey Wellfield has been pumped at a relatively constant rate of 4.3 mgd, a significant reduction. The North Pasco Wellfield delivered water to the same two service areas and this wellfield also had a notable reduction in pumping rate (Figure 3.46). Only two of the originally permitted six production wells at the North Pasco Wellfield were ever developed and the average pumping rate between Water Years 1992 and 2007 was only 2 mgd. Following the interconnection of the West Pasco Service area to Tampa Bay Water's regional water system, the average pumping rate at the North Pasco Wellfield declined to an average of 0.4 mgd between Water Years 2008 and 2016. Tampa Bay Water permanently retired the two North Pasco Wellfield production wells at the end of Water Year 2016 making the reduction in pumping complete. Prior to the groundwater pumping reduction in December 2007, the two wellfields pumped an average of 13.7 mgd between Water Years 1992 and 2007. From Water Year 2008 through 2019, the combined pumping rate averaged only 4.6 mgd, a combined reduction of 66%.

The Northwest Hillsborough Wellfield was the final Consolidated Permit wellfield to experience a reduction in pumping. The Northwest Hillsborough Transmission Main was completed in late 2011 bringing regional water supplies to Hillsborough County's Northwest Hillsborough Water Treatment Plant and allowing the Northwest Hillsborough Wellfield pumping to be reduced. For the ten-year period prior to the pumping reduction (Water Years 2002 through 2011), the wellfield pumping rate averaged 8.3 mgd. Since Water Year 2012, Tampa Bay Water has used the wellfield at an average quantity of 2.25 mgd (Figure 3.44).

3.15.2 Implications for Recovery and Analyses

The Starkey Wellfield became the focus for Tampa Bay Water to explore methods and procedures to assess wetland and lake recovery due to the reduction in groundwater pumping from the Consolidated Permit wellfields. Exploratory analyses of the monitoring data from this wellfield were performed since an immediate and significant reduction in pumping at this wellfield and it was probable that the monitoring data from this wellfield would provide insight into how to approach these analyses. When the West Pasco Transmission Main was complete and placed in service, the pumping rate at the Starkey Wellfield dropped during a single day. The connection was brought online on December 11, 2007; the Starkey Wellfield pumping rate on December 10 was 12.8 mgd and the pumping rate on December 12 was 2.6 mgd. The wellfield pumping rate remained low after this date and Tampa Bay Water and the District have collected a wealth of environmental data over the years at area wetlands. This presented a great opportunity to develop the recovery assessment methods in a test case mode. It was expected that the recovery signature would be most obvious at this wellfield given the change in pumping conditions. This exploratory assessment process and the development of the Recovery Assessment approach is discussed in Section 9.1 of this report.

Since the pumping from each wellfield was reduced at different time periods, Tampa Bay Water wanted a consistent approach in assessment methods and time period. Recovery assessment at the Starkey Wellfield began in 2008 and this time period was adopted for the remainder of the wellfields as detailed in Chapter 9. The Area of Investigation initially was developed using actual pumping data from calendar years 2008 through 2012 scaled up to 90 mgd (Section 5.3) and the spatial data sets developed to evaluate the unmonitored wetlands and lakes (Section 6.5) also began in 2008. The only wellfield that did not fit this time period was the Northwest Hillsborough Wellfield which did not experience a reduction in pumping until late 2011. However, for consistency, the same time period was used for the Northwest Hillsborough Wellfield (2008 – 2019), even though the first four years of this evaluation period were at a higher pumping rate. Differences in the evaluation of recovery at the Northwest Hillsborough Wellfield are discussed in Sections 9.2.11 and 12.11. The time period of 2008 through 2019 provided a balance of a significant period of time, relatively stable annual wellfield pumping rates, and varying rainfall conditions upon which to base the assessment of environmental recovery.

3.16 Observation of Environmental Recovery

Following the reduction in groundwater pumping and a return to more normal rainfall conditions, water levels began rebounding in lakes and wetlands that were previously dry or had very low water levels. Once system interconnections were completed and pumping was reduced at the wellfields, environmental improvement throughout the northern Tampa Bay area became readily apparent to environmental scientists and the public. Water levels in lakes and wetlands became a common site throughout the area and roadside ditches and swales retained water for long periods of time following rainfall events. Tampa Bay Water and District staffs began to examine recovery as opposed to adverse environmental impacts.

3.16.1 Observation and Reporting of Higher Water Levels and Recovery

The Tampa Bay region has achieved tangible environmental improvement by reducing wellfield pumping rates and allowing lakes and wetlands to recover. Tampa Bay Water and the District continued to record water level and ecological data from hundreds of lakes and wetlands on and around the wellfields following the reduction in groundwater pumping. Tampa Bay Water assembles this data into annual reports for each wellfield as required by the Consolidated Permit. These reports chronicle the success achieved for each monitored lake and wetland and the most recent reports for Water Year 2019 contain period of record hydrographs and ecological data for these monitored systems (Tampa Bay Water, 2020 a through j). These annual wellfield monitoring reports also include descriptions of each monitored site and document the changes observed during the history of monitoring.

Examples of water level improvement in the northern Tampa Bay area can be seen in the hydrographs presented in Figures 3.70 and 3.71. The period of record water level change in four lakes is shown in the first figure and the water level for each lake can be seen in relation to the site-specific lake management levels established by the District. Period of record hydrographs for Starvation Lake and Horse Lake can also be found in Figure 3.49. After the wellfield pumping reduction that began in late 2002 at most of the wellfields, lake water levels increased according to rainfall conditions and have remained at high levels since 2010. The second figure presents period of record hydrographs for four wetlands at the Cross Bar Ranch, Cypress Creek, South Pasco, and Starkey Wellfields. The hydrographs for wetlands CYC W-50 and STK S-052 can also be seen in Figure 3.49. These hydrographs show the wetland water level with respect to the bottom elevation and the normal pool elevation of each wetland. Following the reduction in wellfield pumping, the water levels seldom fall below the bottom of the wetlands and generally only during dry periods. The wetland water levels in these wetlands also reach the normal pool elevation each year which is a strong indication that water levels are fluctuating in a normal range and the wetlands should be in a recovering or healthy state.

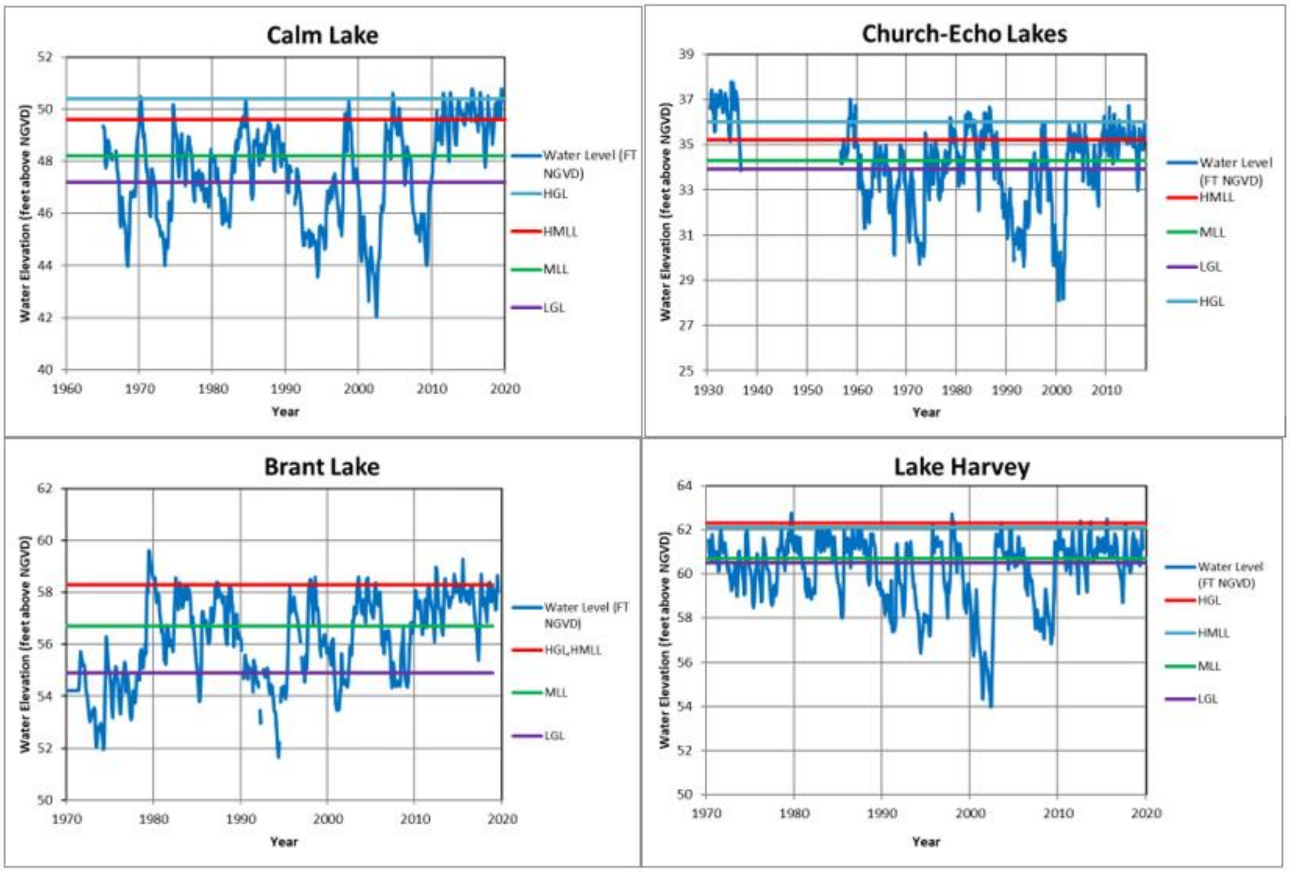

Figure 3.70: Period of Record Hydrographs of Calm Lake, Church and Echo Lakes, Brant Lake and Lake Harvey

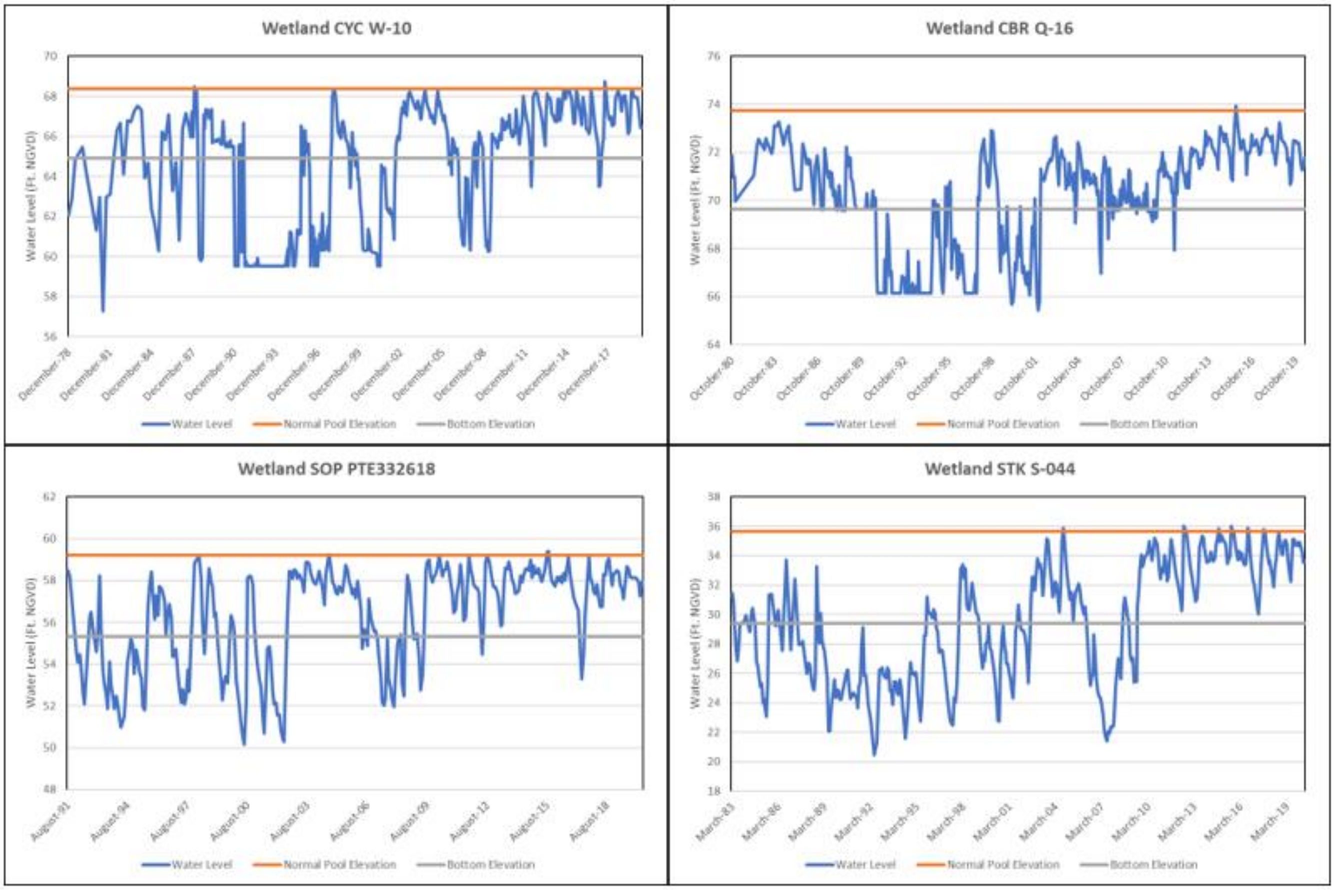

Figure 3.71: Period of Record Hydrographs of Wetlands CYC W-10, CBR Q-16, SOP PTE332618, and STK S-044

The observed improvements were not limited to higher water levels. In the years following higher water levels, many of the upland plants that had become established in the deeper zones of the monitored wetlands and lakes began to die out and wetland plants recolonized the soils in their place. Observations of wetland-dependent birds and amphibians increased in the wellfield areas, another significant sign of improved conditions and recovery.

The hydrographs presented in this section and the data in the annual wellfield monitoring reports document the environmental improvement seen on and near the northern wellfields; however, it takes photographs to clearly illustrate how significantly conditions have improved. Photographs from seven lakes and wetlands are presented with one photograph for each site before the reduction in wellfield pumping and one taken a few years after the pumping reduction at that wellfield. The improvement in water level in Starvation Lake at the Section 21 Wellfield is shown in Figure 3.72. The two photographs were taken in 2001 and 2015 and the lake water level increased approximately 14 vertical feet between the two photos. The 2001 photograph was taken during a time of extreme regional drought with a relatively high wellfield rate of groundwater pumping. The standing water conditions shown in the 2015 photograph are typical for most years following the reduction in pumping at this wellfield in 2004. Figure 3.73 shows photographs from 2002 and 2011 at Stanford Lake located just west of the Cypress Creek Wellfield. This is a shallow lake that is typically eight feet deep following the summer rains but the lake has reached depths of approximately 11 to 12 feet following the pumping reduction at this wellfield. At these very high water levels, the lake overflows into adjacent low-lying pasture areas surrounding the lake.

Figure 3.72: Starvation Lake at the Section 21 Wellfield, Water Level Improvement; photos from 2001 and 2015

Figure 3.73: Cypress Creek Wellfield Monitoring Site C-03 (Stanford Lake), Water Level Improvement; photos from May 2002 and February 2011 (Photos provided courtesy of C. Grizzle)

The return of water levels and vegetation can be seen in the before-and-after photographs for wellfield wetlands. Figure 3.74 shows the improvement of wetland C-25 located between the Cross Bar Ranch and Cypress Creek Wellfields between 2001 and 2016. The improvement in wetland vegetation is apparent in the two photographs presented in Figure 3.75 for wetland W-39 at the Cypress Creek Wellfield. The early photograph was taken in 2009 after the reduction in wellfield pumping but at the end of a multi-year drought event and the visible groundcover is either dead wetland species or upland plants. By 2016, more typical water levels had returned to this wetland allowing wetland vegetation to replace the upland vegetation that had grown in the deeper wetland zones. Improvements to water levels and wetland vegetation can also be seen in the two photographs of wetland W-46 at the Cypress Creek Wellfield between 1999 and 2010 (Figure 3.76). Wetland S-024 at the Starkey Wellfield is a wet prairie system that was dry and filled with upland vegetation in 2000 but sustained water levels and wetland vegetation returned to the site following the pumping reduction at this wellfield in December 2007 (Figure 3.77).

Figure 3.74: Cross Bar Ranch Wetland C-25; photos from March 2001 and 2016, Water Level and Vegetation Improvement (Photos provided courtesy of C. Grizzle)

Figure 3.75: Cypress Creek Wellfield Wetland W-39, Vegetation Improvement; photos from 2009 and 2016 (Photos provided courtesy of C. Grizzle)

Figure 3.76: Cypress Creek Wellfield Wetland W-46, Water Level and Vegetation Improvement; photos from September 1999 and September 2010 (Photos courtesy of RS&H, Inc. staff)

Figure 3.77: Starkey Wellfield Wetland S-024, Water Level and Vegetation Improvement; photos from 2000 and 2013 (Photos courtesy of GPI, Inc. staff)

There is no better example of environmental improvement or recovery than what has occurred at wetland S-044 in the center of the Starkey Wellfield. This wetland was given the name “Widowmaker” due to the significant number of wetland trees that fell following extensive subsidence of the wetland bottom in the late 1980’s. The wetland trees began to lean and fall immediately after the subsidence occurred and the tree canopy was almost completely gone by 1994; this was a dangerous site for ecological monitoring during that time period. A series of fires in the wetland further reduced the number of wetland trees. This wetland is now approximately seven feet deep following the collapse of the bottom sediments, an atypical depth for an isolated cypress wetland. Figure 3.78 contains two photographs of this wetland taken in May 2006 and May 2016, both at the end of the eight-month dry season. The photograph from 2006 shows the wetland in its typical dry condition before the dramatic reduction in pumping at the Starkey Wellfield in December 2007. Before this time, the wetland seldom had standing water but following the pumping reduction and a return to more normal rainfall conditions, the wetland now has standing water throughout the year. Since 2010, this wetland has not dried out and the water level reaches the normal pool elevation during most summer rainy seasons and is a dramatic example of environmental recovery.

Figure 3.78: Starkey Wellfield Wetland S-044; photos from May 2006 and May 2016, Water Level Improvement. Early (Photo provided courtesy of GPI, Inc. staff)

3.16.2 Regional Rainfall

The improvement in lake and wetland water levels is attributed to the reduction in pumping from the wellfields and a return to more typical rainfall conditions. The original Consolidated Permit was issued in 1998 which was a very wet year (Figure 3.48). Water Years 1989 through 2002 were very dry throughout the northern Tampa Bay region with annual rainfall deficits of 15 to 20 inches for some wellfield gages. The annual average pumping rate at the majority of the 11 wellfields was first reduced when the first alternative water supply sources were connected to Tampa Bay Water's Regional System in late 2002. Water Year 2003 was the first year with reduced pumping rates from the wellfields and Water Years 2003 and 2004 were both years with well above-normal rainfall. These two years of high rainfall and reduced wellfield pumping gave area lakes and wetlands a great start toward recovery; however, the region immediately entered another drought. Water Years 2005 through 2009 were consecutive years of below-average rainfall with annual deficits of 10 to 15 inches at multiple wellfield gages. This was a setback for environmental recovery but it would restart when normal rainfall conditions returned.

Normal rainfall conditions returned in Water Year 2010 and each year through at least Water Year 2019 has received average rainfall or higher. Figure 3.48 shows that some years like Water Years 2014 and 2018 were slightly above average across the wellfields but only Water Year 2015 was a very wet year with a rainfall surplus of at least 10 inches at each wellfield gage shown. What is unusual for this ten-year period is that none of the years have had below-average rainfall; it has been average to slightly above-average each year except for Water Year 2015. People throughout the Tampa Bay area often remark that the past several years have been very wet but the rainfall data at the wellfields does not support that observation. Perhaps generally normal to slightly above-normal rainfall combined with observations of widespread environmental improvement and significant standing water has led to the perception that the recent period has been very wet.

3.16.3 Flooding Issues and Complaints

The public has observed the improvement of water levels in the northern Tampa Bay area in recent years and they have filed numerous property flooding complaints with the District and local governments. Figure 3.79 shows the location of flooding complaints filed with just the District since January 2003. The figure shows flooding complaints across the three-county Tampa Bay area and separates complaints into two time periods, 2003 through 2009 and 2010 to January 2019. This latter period is the time when the annual average pumping level from the Consolidated Permit wellfields has remained below the 90 mgd permit limit. Complaints of flooding have been widespread but the location of many of the clusters of dry lake and wetland complaints adjacent to the wellfields (Figure 3.59) match the location of flooding complaints in the 2010 to 2019 period. Notable areas of flooding complaints are the Quail Hollow and Saddlewood Estates neighborhoods southeast of the Cypress Creek Wellfield, Pasco Trails Estates and Shady Hills neighborhoods to the south and west of the Cross Bar Ranch Wellfield, the Trinity area adjacent to the north border of the Eldridge-Wilde Wellfield, the Sierra Pines neighborhood located west of the South Pasco Wellfield, and the Section 21 Wellfield property which is annually flooded to the point where the public-access park is often closed. Citizens in many of these locations file flooding complaints each summer even though the recent ten-year period has been characterized by generally normal to above-normal rainfall with only one very wet year (Figure 3.48).

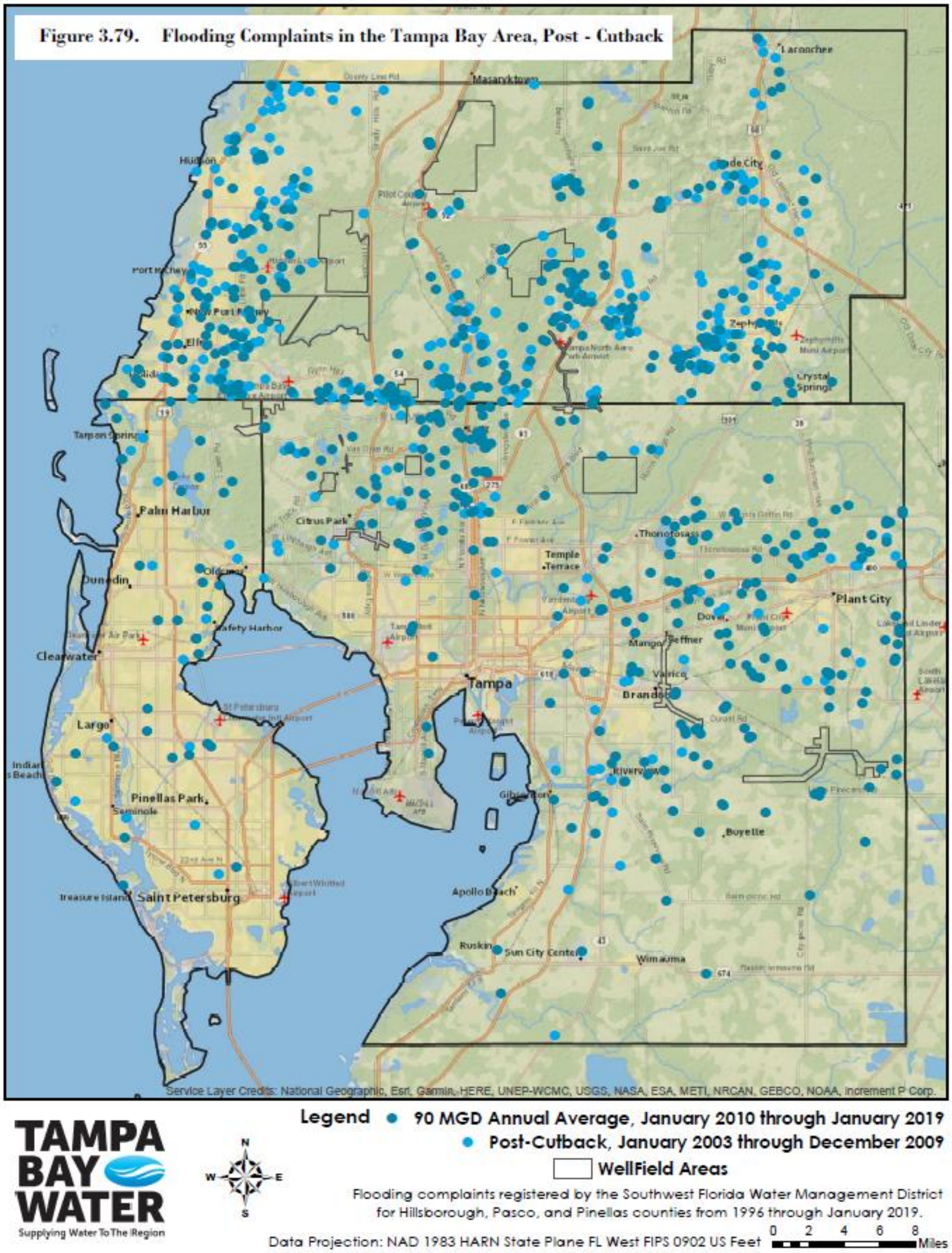

Figure 3.79: Flooding Complaints in the Tampa Bay Area, Post - Cutback

3.17 Consolidated Permit Renewal (2011 permit)

The original Consolidated Permit was scheduled to expire on December 31, 2010. Tampa Bay Water began a series of pre-application meetings with the District and the member governments on April 9, 2008 to discuss the form and content of the renewal application for the Consolidated Permit. Between April 2008 and December 2009, a total of 28 pre-application meetings were held between these parties and all aspects of the permit renewal were thoroughly explored. The District staff asserted at the initial pre-application meetings that while water level improvements had been documented in lakes, wetlands, and the aquifer in the Northern Tampa Bay area, full recovery had not yet been realized. District staff also stated their belief that recovery would not be fully achieved by the permit expiration date of December 31, 2010. This point was not disputed since the last phase of wellfield pumping reduction to an annual average limit of 90 mgd had not begun until January 2008 with compliance first assessed following December 2008. The 12-month running average pumping from the 11 wellfields dropped below 90 mgd in December 2009 and has remained below this limit since that time.

3.17.1 Northern Tampa Bay Recovery Strategy (Phase 2) – Chapter 40D-80.073

Environmental improvement on and near the Consolidated Permit wellfields had been observed and documented but by early 2009, the reduction in wellfield pumping below the 90 mgd annual average limit had only recently been accomplished. There was insufficient data at that time to make a determination concerning the final degree of recovery around the wellfields. The District determined that continuation of the Recovery Strategy Rule was necessary to allow further analysis of the amount of recovery that would be achieved by the stated reduction in wellfield pumping. The District Governing Board approved the initiation of rulemaking in April 2009 to amend the Comprehensive Environmental Resources Recovery Plan for the Northern Tampa Bay Water Use Caution Area (Chapter 40D-80.073, F.A.C.) to authorize a second phase of the Northern Tampa Bay Recovery Strategy through December 2020. This rulemaking initiative continued through 2009 with input from Tampa Bay Water, the member governments and the public.

The Governing Board approved the changes to the Northern Tampa Bay Recovery Strategy Rule (Chapter 40D-80.073, F.A.C.) in December 2009 and the rule became effective in May 2010. Changes to Chapter 40D-2, F.A.C. and the Water Use Permit Information Manual were also approved at the same time to be consistent with the changes made to Chapter 40D-80.073, F.A.C. The significant provisions of these rule amendments allowed the District to issue the renewed Consolidated Permit at the existing 90 mgd annual average quantity for another 10-year term and required Tampa Bay Water to continue managing wellfield pumping through the Operations Plan, continue environmental data collection, evaluate environmental recovery, and implement environmental mitigation as appropriate.

3.17.2 Permit Renewal and Continued Authorization of 90 mgd

Tampa Bay Water staff completed the Water Use Permit application package and supporting documents necessary to renew this permit in December 2009 and the Tampa Bay Water Board approved the filing of the permit renewal application on February 15, 2010. After the permit application was deemed complete on July 15, 2010, Tampa Bay Water and the District held 14 meetings to negotiate the specific conditions of the renewed permit. The District issued the renewed Consolidated Permit (No. 20011771.001) with an effective date of January 25, 2011 and an expiration date of January 25, 2021 (see Appendix 3.4).

The renewed Consolidated Permit was issued with an annual average pumping limit of 90 mgd from the 11 wellfields. There were clear signs of environmental recovery around the wellfields and the data collected under the original Consolidated Permit verified these improvements. Tampa Bay Water and the District agreed through this permit renewal that additional time was needed to assess the recovery of environmental systems in the Northern Tampa Bay area. It was important to assess environmental recovery during a period of relatively stable pumping from the 11 wellfields at a 12-month running average at or below 90 mgd and the new 10-year permit term at the existing quantity provided that opportunity. The renewal of the permit at an annual average limit of 90 mgd also gave Tampa Bay Water and the member governments assurance that the goals of the Agency reformation and the Partnership Agreement were being met – to provide for a stable, long-term water supply that promoted the recovery of environmental systems that had been stressed, in part, due to the earlier levels of groundwater pumping.

3.17.3 New Permit Condition requirements

The renewed Consolidated Permit contains several special conditions; only the conditions that pertain to the assessment of environmental recovery are summarized in this section. Please refer to the full text of the permit (Appendix 3.4) for additional information.

3.17.3.1 Operations Plan

Tampa Bay Water is authorized to continue managing groundwater withdrawals from the Consolidated Permit wellfields using the Operations Plan. An update to the Operations Plan was required within 180 days of permit issuance, including incorporation of changes to the relationship between the OROP and the EMP. This updated plan was submitted timely to the District (Tampa Bay Water, 2011) and is discussed in further detail in Sections 3.14.2 and 3.14.7 of this report. Special conditions of the renewed permit require Tampa Bay Water to submit a biennial report for the Operations Plan that highlights operational issues and performance for the two prior years and includes any changes proposed to the Operations Plan for the coming biennial reporting period. In addition, two weekly reports are submitted to the District as they are published; the proposed production schedule for the coming week for all active production sources and the weekly report of Operations Plan scheduled versus actual pumping average quantities.

3.17.3.2 Environmental Management Plan

As part of the renewed Consolidated Permit, Tampa Bay Water continues to collect data through an extensive hydrological and ecological environmental monitoring program. The permit contains an Environmental Management Plan (EMP) that guides the collection and analysis of environmental data from the wellfield monitoring programs to identify environmental impacts. The EMP contains procedures for directing new or recurring impacts to the OROP to see if adjustments to the distribution of wellfield pumping can resolve the impact. The EMP attached to the permit contains the Wetland Assessment Procedure (WAP) updated in 2005 by the District and Tampa Bay Water (see Appendix 3.4). The WAP provides details about the collection of ecological data and is described in additional detail in Section 5.5.2.3 of this report.

Special Condition 8 of the renewed Consolidated Permit required Tampa Bay Water to develop a process to be included in the EMP that would identify and assess impacts to streams and flow-through wetlands. A plan to develop this process was submitted to the District and a method of assessing impacts to streams or flow-through wetlands was submitted to the District (Ormiston, et al, 2014). This methodology has been implemented since that time and will be incorporated into the revised EMP in the 2021 renewal of the Consolidated Permit.

3.17.4 Phase 1 Mitigation Plan

The renewed permit requires Tampa Bay Water to continue to implement the Phase 1 Mitigation Plan to enhance the environmental recovery in and around the wellfields. The specific condition requires further evaluation and implementation of mitigation projects listed in Exhibit D.1. of the permit, where feasible. Tampa Bay Water has proposed new projects and terminated existing conceptual projects based on specific assessments and the continuing assessment of environmental recovery at 90 mgd. As described in Section 3.13 of this report, Tampa Bay Water has continued implementing projects on wellfields to mitigate for past impacts and to enhance the environmental systems on the wellfields to increase recovery. Mitigation work has primarily focused on wellfield properties where the initial feasibility studies indicated that long-term benefits would be achieved by construction of these projects.

3.17.5 Environmental Augmentation

Tampa Bay Water has augmented a small number of wetlands and lakes on some wellfield properties for ecological purposes. During drought periods, these augmented sites have been the only source of water for local wildlife and continuation of limited augmentation with groundwater has contributed to improved water levels at these lakes and wetlands. The renewed permit authorizes the augmentation of eight sites on the Cross Bar Ranch Wellfield, five wetlands on the Cypress Creek Wellfield, and Lake Dan on the Eldridge-Wilde Wellfield (Exhibit D.2 of the renewed Consolidated Permit). The water used to augment these sites comes from the local wellfield and is included in the wellfield pumping totals and compliance with the 90 mgd annual average permitted quantity. As required by Special Condition 10 of the renewed permit, Tampa Bay Water revised the augmentation schedules for these sites to better mimic seasonal water fluctuations and promote recovery (GPI Southeast, Inc., 2012). Given the sustained reduction in wellfield pumping and a return to normal to above-normal rainfall, the quantity of augmentation at these sites has greatly diminished in the past several years. Specific assessment of environmental recovery at these lakes and wetlands will be presented in Chapters 8, 9, and 12 of this report.

3.17.6 Annual Reports

The renewed Consolidated Permit requires Tampa Bay Water to submit an annual report for each of the 11 wellfields; this is the continuation of a permit condition from the original permit and is similar to requirements in all Agency Water Use Permits. These reports graphically present the data collected for each wellfield monitoring program for the prior Water Year as previously submitted to the District on a monthly basis. This data includes wellfield pumping and augmentation quantities, rainfall, water quality data, water levels in the surficial and Upper Floridan aquifers, water levels at lakes and wetlands, wetland vegetation data, wetland hydroperiods, wildlife usage, location and nature of environmental and well complaints, ecological monitoring site descriptions, and aerial photography.

The permit renewal application documents submitted for the Consolidated Permit in 2010 contained the latest annual report from each wellfield including all of the data types referenced above. These were interpretive reports that expanded on the normal content and focused on the recovery of the environment that had been documented as of Water Year 2009 (the date of the reports). Copies of the Water Year 2019 annual reports for these 11 wellfields are included with the current permit renewal application to document environmental recovery and to avoid duplication of work; period of record graphs of wetland water levels, vegetation, pumping, rainfall, and aquifer water levels are contained in these reports and will be referenced in future sections of this final Recovery Assessment Plan report as necessary (Tampa Bay Water 2020a, 2020b, 2020c, 2020d, 2020e, 2020f, 2020g, 2020h, 2020i, 2020j). Interpretive annual reports were not prepared for Water Year 2019 as this final Recovery Assessment Plan report provides the interpretation of the data through the assessment of environmental recovery at the 11 wellfields covered by this permit.

3.17.7 Permit Recovery Assessment Plan

Special Condition No. 11 of the renewed Consolidated Permit requires Tampa Bay Water to complete a Permit Recovery Assessment Plan that "includes an evaluation of the recovery of water resource and environmental systems attributable to reduction of the groundwater withdrawals from the Central System to a long-term average of 90 mgd, identify any remaining unacceptable adverse impacts caused by the Central System's withdrawals at a long-term average rate of 90 mgd, and identify and evaluate potential options to address any remaining unacceptable adverse impacts at the time of the Consolidated Permit renewal in 2020." The permit also requires Tampa Bay Water to develop a work plan and schedule for the development of the Recovery Assessment Plan and include a discussion of the issues and analytical techniques that will be used to complete the assessment. Annual status reports are required to be submitted to the District that demonstrate continued implementation progress. Tampa Bay Water was required to submit preliminary results to the District by December 31, 2018 and final results of the Recovery Assessment Plan are to be submitted with the renewal application for the Consolidated Permit in 2020.

This Recovery Assessment report is the fulfillment of this special condition of the renewed Consolidated Permit. The report also serves as documentation of the successful recovery of the local environment following the regional decision in 1998 to significantly reduce permitted groundwater pumping quantities from the 11 wellfields by almost 50%. A presentation of the methodical and rigorous process that Tampa Bay Water and the District followed to assess environmental recovery in the Northern Tampa Bay area begins in Chapter 5 of this report. All of the completed work that provides input and analyses into the final assessment of recovery is included in this report as appendices or references. The final results of the individual lake and wetlands assessments are presented on a wellfield-scale in Chapter 12, with a regional discussion of environmental recovery presented in Chapter 13. The final chapters of this report discuss the Recovery Assessment results in the context of the renewal of the Consolidated Permit and thoughts on the next term of the Consolidated Permit.

4: Regional System Operation and Planning

4. Regional System Operation and Planning

Tampa Bay Water owns and operates a diverse water supply system with three different water supply sources; ground water from 13 wellfields, surface water from two river systems, and a seawater desalination facility located on Tampa Bay (Figure 4.1). A 15.5-billion gallon off-stream reservoir stores surface water for use during the annual dry season and more than 270 miles of transmission mains carry the water from the sources to our treatment plants and the points of connection for delivery to the member governments. This is an extremely large and complex water supply system that is not described in full detail in this report; a thorough description is contained in Hazen and Sawyer, 2018. The information presented in this chapter focuses only on the water supply components of the regional system and discusses some of the operational constraints and the decisions that are made each day. This chapter discusses how the sources are interconnected and used as a single system to meet demand, how regional water demands are predicted and how water sources are allocated to meet those demands. Achieving a continuous balance between supply and demand is challenging for any regional water distribution system, and more so because Tampa Bay Water factors water quality, costs, and environmental health into short and long-term decision-making processes.

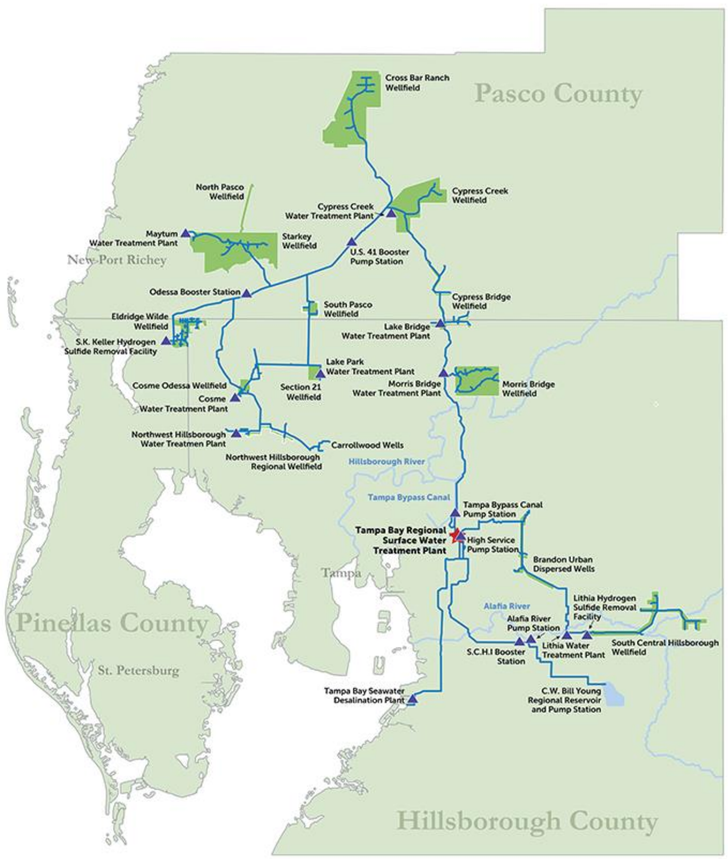

Figure 4.1: Tampa Bay Water Regional System

Tampa Bay Water delivers water to the member governments at 20 existing points of connection (Figure 4.2). A Point of Connection (POC) is a contractual term defined in Tampa Bay Water's governance documents that is basically where the Tampa Bay Water transmission system ends and a member government distribution system begins. Two types of water are provided to the members: treated regional system water and raw ground water. At some locations shown on Figure 4.2, there are multiple POCs where regional system water and ground water are delivered to the same water treatment plant. Raw ground water is water from production wells within a wellfield that is delivered to a single location and further treated to State and Federal Drinking Water Standards by the member government. Untreated or raw ground water is never introduced into a potable treatment main. Regional system water is a time and location-varying blend of treated ground water, treated surface water, and desalinated seawater that has been treated to State and Federal Drinking Water Standards. As treated water is introduced into the transmission network, the relative blend of water in the pipe downstream of that entry point changes with the addition of the new treated water. The water blend also varies seasonally since some sources are operated seasonally and the ratio of groundwater and surface water sources changes to meet current demand.

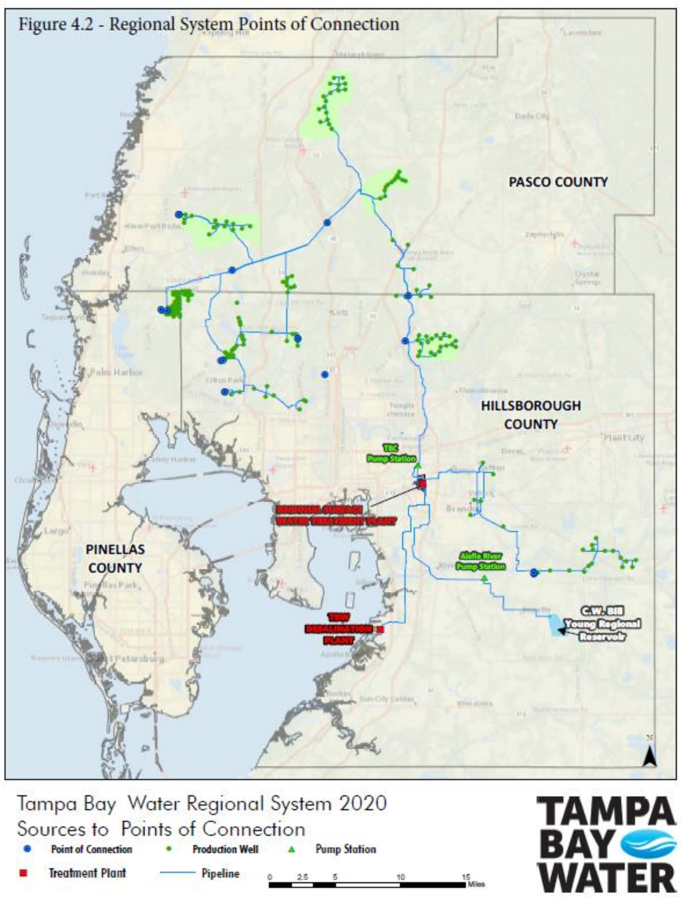

Figure 4.2 - Regional System Points of Connection

Figure 4.2: Regional System Points of Connection

In general, water from the Consolidated Permit wellfields is delivered to the northern POCs (north of the Tampa Bay Regional Facilities Site), which make up most of the connections with the member governments. Surface water and desalinated seawater are delivered to all POCs throughout the system, making up the difference between water demand and the available and scheduled supply from the multiple groundwater sources in the system. The North-Central Hillsborough Interconnect pipeline, which carries water north from the Regional Surface Water Treatment Plant to the northern POCs, was designed to flow in reverse mode only if needed for emergency purposes: this option has only been exercised for relatively brief periods of time since the transmission main was placed into service. This reverse flow through the transmission main occurred when the Regional Surface Water Treatment Plant was out of service.

The following sections describe the ground water sources of the regional system. The surface water and desalinated seawater sources will be described in Section 4.2 of this report.

4.1 Ground Water Sources

The ground water wellfields are the oldest and largest supply component of Tampa Bay Water's regional system. The Cosme-Odessa Wellfield was developed by the City of St. Petersburg and placed into service in 1931 and is the oldest wellfield in the regional system. The regionally significant wellfields (over 1 mgd) formerly owned by the member governments were acquired by Tampa Bay Water in 1998 as part of the water supply authority's governance restructuring and are now operated as part of the regional wholesale supply system. The regional system contains ground water wellfields authorized under the Consolidated Permit and additional wellfields that were separately permitted. Prior to 1998, 100% of the water that the West Coast Regional Water Supply Authority delivered to the member governments (164.4 mgd) was from ground water wellfields. In Water Year 2019, Tampa Bay Water pumped an annual average of 109.8 mgd from the wellfields, representing approximately 63% of the water delivered by Tampa Bay Water to the member governments. The remaining 37% of the water delivered by Tampa Bay Water during Water Year 2019 (annual average of 65.4 mgd) was from regional surface water and desalinated seawater supply sources. The reduction in ground water pumping rate is remarkable considering the continued population growth the Tampa Bay area has experienced over the recent decades. The following sections describe the different wellfields and how they fit into the operation of Tampa Bay Water's regional system.

4.1.1 Consolidated Permit Wellfields

Beginning in the 1930s through the 1990's, Tampa Bay Water's predecessor or the member governments developed the eleven wellfields located in the northern part of the Tampa Bay, known today as the Consolidated Wellfields. The development of these facilities is described in detail in Chapter 3. These eleven facilities are the Cross Bar Ranch, Cypress Creek, Cypress Bridge, Morris Bridge, Starkey, North Pasco, Eldridge-Wilde, South Pasco, Section 21, Cosme-Odessa, and Northwest Hillsborough wellfields and their locations are shown on Figure 4.1. These wellfields were governed by separate Water Use Permits that in total authorized an annual average pumping rate of 192 mgd prior to the issuance of the original Consolidated Permit in 1998. Six of these wellfields were owned and managed by the Authority. Through the governance reorganization into Tampa Bay Water and the Partnership Agreement with the Southwest Florida Water Management District (District), the Agency acquired the five remaining regionally significant wellfields from the member governments. This allowed for the issuance of the single Water Use Permit known as the Consolidated Permit. The phased reduction in pumping from these 11 wellfields is discussed in Section 3.12.1 of this report; the final phase of reduction required an annual average quantity of 90 mgd, the permitted pumping rate that is still in effect today under the renewed Consolidated Permit (2011).

4.1.1.1 Existing Wellfields and Changes Since 2011

Section 3.15 of this report discusses the period of record pumping data from each of the 11 Consolidated Permit wellfields and when each wellfield was interconnected to the regional system. Seven of the 11 wellfields were fully interconnected to the regional system when alternative water supplies began to come on-line in late 2002; however, Tampa Bay Water had to complete multiple infrastructure projects in order to fully interconnect the remaining four wellfields, which provided necessary operational flexibility. For example, the West Pasco Interconnect, a new regional system pipeline placed in service in December 2007, enabled Tampa Bay Water to reduce the combined pumping rate from the Starkey and North Pasco wellfields from a long-term average of 13.7 mgd to approximately 5 mgd. Tampa Bay Water plans to continue supplying the West Pasco County and New Port Richey service areas with regional system water and approximately 5 mgd of ground water from the Starkey Wellfield.

Because the Consolidated Permit wellfields were originally constructed for higher permitted production rates, the facilities' combined mechanical pumping and hydraulic capacities exceed the current permitted quantities. To improve efficiencies, Tampa Bay Water continues to evaluate facilities and infrastructure to identify the most judicious use of the available resources and capital while protecting the environment. In 1998, there were 181 production wells authorized in the original Consolidated Permit for the 11 wellfields. Over the past 20 years, Tampa Bay Water has evaluated production wells at the 11 wellfields to identify water quality issues, poor production or maintenance issues. These investigations have decreased the number of production wells in service over time. Today there are 135 production wells in service at the 10 remaining wellfields authorized under the Consolidated Permit.

Beginning in 2000, Tampa Bay Water began analysis of water quality concerns with production wells located at the Eldridge-Wilde Wellfield. During Water Year 2002, Tampa Bay Water removed 22 production wells from service primarily due to water quality concerns (Tampa Bay Water, 2004). Since 2002, two additional wells at the Eldridge-Wilde Wellfield have been removed from production (Tampa Bay Water, 2009b).

Tampa Bay Water completed an analysis in 2016 that evaluated the production wells at the Eldridge-Wilde, Morris Bridge, Starkey and North Pasco wellfields to determine if efficiency could be improved by reducing the number of wells and still meet the expected emergency demands at the POCs served by these wellfields. Multiple criteria were used in this assessment including actual and forecasted flow rates, water quality, maintenance cost/issues, and proximity to off-site domestic wells that may be eligible for mitigation under the Domestic Well Mitigation Program. The study recommended removing 10 wells from service at the Eldridge-Wilde Wellfield, five wells at the Morris Bridge Wellfield, and eight wells at the Starkey (five wells were already off-line) and North Pasco wellfields. These wells can be permanently removed from service without adversely impacting the ability of Tampa Bay Water to meet forecasted annual or peak day flows at any location. This allows Tampa Bay Water to satisfy the obligation to meet demand while reducing operating and maintenance costs for redundant infrastructure. The disposition of the identified Starkey, Eldridge-Wilde and Morris Bridge Wellfield production wells will be included in future renovation projects at these two wellfields.

In 2017, Tampa Bay Water abandoned the two production wells at the North Pasco Wellfield. These two wells were plugged and abandoned in late 2017 and this wellfield no longer exists. Since the two North Pasco Wellfield production wells are still on the Consolidated Permit and the monitored wetlands at the wellfield are included in this Recovery Assessment analysis, discussion of the facility is included in this report and is, for the purposes of this report, referred to as one of the 11 Consolidated Permit wellfields. With the renewal of the Consolidated Permit in 2021, the number of wellfields covered under the permit will be reduced to ten.

Production wells have been removed from service and properly plugged and abandoned during the current term of the Consolidated Permit. In 2015, Hillsborough County extended their water service lines north and began to deliver water to the Manors of Crystal Lakes subdivision. Production wells Crystal Lakes 1 and 2 were dedicated to serving this small community and were no longer needed. Tampa Bay Water abandoned production well Crystal Lakes 1 in 2015 and deeded well Crystal Lakes 2 to the District for monitoring purposes. As mentioned above, additional production wells at the Starkey, Morris Bridge, and possibly the Eldridge-Wilde wellfields will be abandoned as wellfield renovation projects are completed. These additional production wells will be removed from service during the next Consolidated Permit term.

4.1.1.2 Wellfield Constraints and Operations Considerations

Tampa Bay Water has invested significant time and financial capital into improving the reliability and flexibility of the regional water supply system by identifying and removing operating constraints. This is a continual process that will ensure that regional water demands are always met and achieve the maximum flexibility to rotate among supply sources, including the Consolidated Permit wellfields. Achieving maximum flexibility allows Tampa Bay Water to meet its obligation of environmental sustainability by rotating pumping between wellfields and supply sources to minimize the effects of groundwater pumping on the environment. As part of the Agency’s system reliability analysis, a compilation of system constraints and operating considerations have been developed and documented in several reports including the Agency’s 2018 Long-term Master Water Plan Update, Appendix 8A (Hazen and Sawyer, 2018). These constraints must be taken in their entirety for Tampa Bay Water to continue operating the regional system to meet demands reliably, maintain environmental stewardship, and manage costs. A few of the generalized constraints are:

- Operating all production wells on a regular frequency to control bacterial contamination in the wells,
- Maintaining minimum pipe flows in finished water transmission mains to sustain disinfection residual and avoid water quality degradation due to age,
- Meeting minimum treatment plant flow requirements which are based on engineering constraints,

- Maintaining minimum flows from individual wellfields to meet downstream treatment requirements,
- Maximum flows from wellfields (peak day available flow), and
- Hydraulic constraints of the system's transmission mains (minimum and maximum limits) as water moves through the regional system.

4.1.2 Other Groundwater Wellfields

4.1.2.1 Carrollwood Wells

Tampa Bay Water acquired the three production wells serving the Carrollwood community in 2003 from the Florida Governmental Utility Authority (FGUA). These wells were the sole source of water for this community located to the east of Dale Mabry Highway and north of Busch Boulevard (see Figure 4.1). At the time of the transaction with the FGUA, Hillsborough County acquired the right to connect the community to the County potable water distribution system and Tampa Bay Water acquired the Water Use Permit and water supply infrastructure. The permit was issued in June 2003 for annual average and peak month quantities of 0.82 mgd each.

These wells have been part of the Tampa Bay Water regional system since early 2008, when Tampa Bay Water completed infrastructure improvements and installed a pipeline to convey the water from the three wells to the raw water collection main for the Northwest Hillsborough Wellfield. The water from both the Carrollwood Wells and the Northwest Hillsborough Wellfield are delivered to Hillsborough County's Northwest Hillsborough Water Treatment Plant for delivery to customers of Hillsborough County's potable water distribution system. Tampa Bay Water renewed the Water Use Permit for this wellfield for the same quantities in October 2010 for a 20-year term. An important operational constraint of the Carrollwood Wells is that if the Northwest Hillsborough Wellfield production wells are not in operation, the Carrollwood Wells must also be offline. These three wells are located at the end of the pipeline and produce insufficient quantities by themselves to maintain bacterial clearance and water quality requirements in the larger portion of the Northwest Hillsborough Wellfield collector main.

4.1.2.2 South-Central Hillsborough Wellfield

The South Central Hillsborough Wellfield is located in south-eastern Hillsborough County near the intersection of Lithia-Pinecrest Road and Highway 39 (see Figure 4.1). The wellfield was first permitted (WUP No. 20004352) to the West Coast Regional Water Supply Authority and Hillsborough County in September 1986 for an annual average quantity of 24.1 mgd and a maximum day withdrawal of 44.6 mgd. This initial permit included 17 new wellfield production wells and 58 existing production wells located between Brandon and Sun City. Most of these existing production wells were installed before 1975 by individual developers to serve single communities or neighborhoods. Hillsborough County acquired these wells and were operating them as part of their South County potable water system. Tampa Bay Water constructed the South-Central Hillsborough Wellfield to replace these dispersed production wells, and over time, Hillsborough County and Tampa Bay Water abandoned the older production wells, converted them to monitor wells, or retained them for water supply capacity in the Brandon area.

Production well SC-1 is located at Hillsborough County's Lithia Water Treatment Plant and was in operation before the issuance of the initial permit for the wellfield. The other 16 production wells were constructed and placed into operation in 1988 and the water from all the wellfield production wells is delivered to the Lithia Water Treatment Plant. The initial plan was to phase in the wellfield production wells as the dispersed wells were taken out of service. When the wellfield wells became operational, the County's distribution system pressure exceeded the ability of the smaller individual wells to push water into the distribution system. As a result, the wellfield production wells quickly became the sole source of water supply for South Hillsborough County potable water system. The Water Use Permit for this wellfield has been modified and renewed multiple times at the permitted quantities as in the original permit. All water from the wellfield continues to be delivered to the Lithia Water Treatment Plant where it is combined with water from other regional sources to meet the continuing growing water demand in South Hillsborough County.

4.1.2.3 Brandon Urban Dispersed Wells

In the late 1980s, the West Coast Regional Water Supply Authority worked to redevelop a water supply in the Brandon area of Hillsborough County. Many of the dispersed production wells that were authorized under the initial South Central Hillsborough Wellfield Water Use Permit were located in the Brandon area and these individual wells produced an annual average quantity of 8.5 to 8.8 mgd in 1986 and 1987 (Southwest Florida Water Management District, 1991). The Northeast Brandon Wellfield was designed to serve the water demand of the South Hillsborough County service area along with the South Central Hillsborough Wellfield. The District drafted a Water Use Permit for the Northeast Brandon Wellfield permit in March 1991 for nine production wells at an average annual quantity of 8.2 mgd and a peak month quantity of 12.35 mgd. The wellfield included seven proposed production wells and two existing production wells that were formerly listed on the South Central Hillsborough Wellfield permit.

The Florida Strawberry Growers Association and Mr. Walter Harkala requested an administrative hearing on the proposed Water Use Permit on the basis that wellfield pumping would adversely affect agricultural permittees near the proposed wellfield. The parties to the hearing (West Coast Regional Water Supply Authority and the Florida Strawberry Growers Association) negotiated a settlement agreement prior to the hearing that limited the pumping from the wellfield to an annual average quantity of 1.0 mgd, a peak month quantity of 2.0 mgd, and a maximum daily rate of 4.1 mgd from five of the existing dispersed wells in the Brandon area. The water supply authority also agreed not to apply to permit any new production wells within a defined area during the six-year duration of the permit and to either abandon the five dispersed wells or convert them to monitor wells at the end of the permit term. The District issued Water Use Permit 2009870.00 for the limited Northeast Brandon Wellfield in accordance with the terms of the settlement agreement. Water from these five wells was locally used in Hillsborough County's distribution system to maintain system pressure and provide limited additional water supply.

The District issued Water Use Permit 2011732.00 to Tampa Bay Water and Hillsborough County in January 1998 authorizing the continued use of three of the five wells included in the Northeast Brandon Wellfield permit. The average annual quantity was limited to 50,000 gpd with a peak month of 75,000 gpd to boost local Hillsborough County distribution system pressures. This permit was modified in December 2010 (Water Use Permit 2011732.01) to authorize an annual average of 6.0 mgd and a peak month quantity of 9.24 mgd from five production wells, four new wells and one of the original dispersed wells located in southeast Brandon. This expanded wellfield, the Brandon Urban Dispersed Wells (Figure 4.1), became part of Tampa Bay Water's regional system and is situated along the Brandon Transmission Main and Brandon-South Central Connection Main that links the Regional Surface Treatment Facility and the Lithia Water Treatment Plant. As these are finished water lines (treated water), the water from the Brandon Wells is treated to drinking water standards and is delivered to the Lithia Water Treatment Plant for use in the South Hillsborough County potable water system. The water demand in southern Hillsborough County has increased over the past 5 years requiring all production from the South Central Hillsborough Wellfield, the Brandon Urban Dispersed Wells, as well as additional regional water to meet service area demands. Since regional water is delivered to the Lithia Water Treatment Plant via the Brandon-South Central Hillsborough Connection Main, all of the wellfield water must also flow toward the Lithia water treatment facility.

4.2 Alternative Supply Sources

Tampa Bay Water's supply portfolio includes surface water and desalinated seawater sources. These facilities were constructed following the 1998 reorganization with financial assistance from the Southwest Florida Water Management District as described in Sections 3.10 and 3.11 of this report. In Water Year 2019 (October 2018 through September 2019), these alternative supplies made up approximately 37% of the water that Tampa Bay Water delivered to the member governments. The information that follows briefly summarizes the operation of these water supply and storage facilities with respect to Tampa Bay Water's regional system. This report does not present a full description of the facilities or the complex operational decisions and constraints associated with them; it is simply a description of how they fit into the regional system along with the groundwater sources. A thorough description of the alternative water supply sources and associated infrastructure is contained in Hazen and Sawyer, 2018.

4.2.1 Surface Water Supply System

Tampa Bay Water's surface water facilities are known as the Enhanced Surface Water System. These facilities are made up of withdrawal structures on the Tampa Bypass Canal and the Alafia River, the Regional Surface Water Treatment Plant, the C.W. Bill Young Regional Reservoir and the pipelines and booster stations necessary to move these large quantities of water. Surface water was the first alternative water supply added to the regional system and began in late 2002.

Tampa Bay Water is authorized to withdraw water from the middle and lower pools of the Tampa Bypass Canal (see Figure 4.1) under Water Use Permit 20011796.002. This permit allows the withdrawal of up to 258 mgd from the Tampa Bypass Canal under certain elevation conditions in the canal and flow conditions over the City of Tampa's dam on the Hillsborough River. The limiting stage and flow conditions were set based on water level elevations established by the Army Corps of Engineers at water control structures along the Canal and Minimum Flow assessments performed by the Southwest Florida Water Management District for the Hillsborough River and Tampa Bypass Canal. The Tampa Bypass Canal Pump Station sends this surface water to the Regional Surface Water Treatment Plant or the Regional Reservoir for storage and use at a later time.

Water Use Permit No. 20011974.002 authorizes Tampa Bay Water to withdraw up to 60 mgd from the **Alafia River** at a pumping station near Bell Shoals Road southeast of Brandon (see Figure 4.1). The permit prescribes a withdrawal schedule based on the daily flow rate in the Alafia River and a sliding withdrawal scale when flow exceeds the established Minimum Flow threshold in the river. No water is withdrawn from the river when flow drops below this minimum threshold. The water harvested from the Alafia River is delivered to the Regional Surface Water Treatment Plant through the South-Central Hillsborough Intertie pipeline or to the Regional Reservoir. Since this is a single pipeline connecting the surface water plant and reservoir, if water is flowing from the surface water plant to the Regional Reservoir, any water pumped from the Alafia River must also flow along the same pipeline to the reservoir. Conversely, if water is flowing from the Regional Reservoir to the Regional Surface Water Treatment Plan, any water pumped from the Alafia River must also flow to the surface water plant. Flow from the Alafia River Pump Station can be delivered to both the Regional Reservoir for storage and the Surface Water Treatment Plant at times when all the withdrawal from the Tampa Bypass Canal is also feeding the plant. This is the typical operational mode in late summer or at the beginning of the dry season as Tampa Bay Water maximizes surface water resources and the Reservoir is nearly full but Tampa Bypass Canal withdrawals alone are not enough for to sustain the Surface Water allocation needed to meet demand.

Tampa Bay Water’s Regional Surface Water Treatment Plant is located at the Regional Facilities Site on the east side of the City of Tampa (see Figure 4.1). This plant treats surface water from the Tampa Bypass Canal, Hillsborough River, Alafia River, and C.W. Bill Young Regional Reservoir using a combination of coagulation, flocculation, high-rate sedimentation, ozone and biologically-active filtration processes. The treated water is pumped to ground storage tanks for blending with desalinated seawater before being pumped into the regional transmission main. From the regional transmission main, water flows to some member governments points of connection and north toward the Cypress Creek Pumping Station. Tampa Bay Water completed an expansion of the surface water plant in 2011 which increased the Florida Department of Environmental Protection (FDEP)-rated capacity to 120 mgd, which when raw surface water supplies are available, equates to a sustainable annual capacity of 90 mgd.

The C.W. Bill Young Regional Reservoir is located in southeastern Hillsborough County (see Figure 4.1) and was placed into service in 2005. This facility provides a drought resistance storage opportunity for the surface water system: Tampa Bay Water stores surface water from the Tampa Bypass Canal, Hillsborough River, and Alafia River during high flow times for use in times when flow in these rivers is insufficient to supply the Regional Surface Water Treatment Plant. The Regional Reservoir was taken off-line in 2012 for renovation and was returned to service in August 2014. The storage capacity of the Regional Reservoir is 15.5 billion gallons and the depth varies from 40 to 80 feet. The Regional Reservoir is connected to the Regional Surface Water Treatment Plant through the Reservoir Transmission Main and the South-Central Hillsborough Intertie pipeline. Originally, water was delivered from the reservoir to the surface water plant by gravity; however, Tampa Bay Water constructed a pump station in 2011 to allow increased drawdown capacity from the reservoir to the Surface Water Treatment Plant which in effect, increased its daily production capabilities. Operationally, the Regional Reservoir is intended to provide raw surface water to the Surface Water Treatment Plant during the typical eight-month dry season, when surface water flows can drop below regulatory or operational minimums. During the typical four-month summer raining season, the reservoir is refilled to capacity.

4.2.2 Seawater Desalination Plant

The Tampa Bay Seawater Desalination Plant is located in southern Hillsborough County (see Figure 4.1) adjacent to the Tampa Electric Company Big Bend Power Station on Tampa Bay. Tampa Bay Water co-located the plant with the power station to take advantage of the seawater used for the station's cooling towers. To remove salt from the seawater, the facility uses coagulation, flocculation, filtration and reverse osmosis. The concentrate from the reverse osmosis process is discharged into the power station cooling water stream (generally 1 billion gallons or more daily) and so ameliorates concerns associated with brine management. The desalination plant uses high-pressure reverse osmosis membranes to separate fresh water from the seawater and the finished water is piped north to the Regional Facilities Site for blending with water from the Regional Surface Water Treatment Plant. The rated capacity of the plant is 28.75 mgd; however, the sustainable supply capacity from the plant is 18 to 20 mgd, depending on the temperature and salinity of the influent water. The desalination plant has been in service since 2007 and has supplied more than 26 billion gallons of fresh water to the region since that time. Currently the plant is operated seasonally during the dry season to help meet demands and offset groundwater pumping. The water produced at this plant is the most expensive of the three supply source types due to the power consumption of the desalination process; however, this facility is a vital component of the regional system and is a drought-proof supply source.

4.3 Source Management

Tampa Bay Water's diverse regional system allows the region to meet the water demands of the member governments during the annual dry season and manage supplies during drought events. Each source water type has its own constraints including minimum flow thresholds and source water quality for the riverine systems, source water temperature and availability for the seawater desalination facility, operational levels and water quality for the water stored in the Regional Reservoir, and minimization of water level drawdown at the wellfields to reduce impacts to area lakes and wetlands. In addition to source constraints, physical system constraints such as minimum pipe flows, water treatment plant capacities, water quality delivered to the member governments, daily fluctuation in water consumption, and a steady increase in demands must be factored into operational decisions. In order for Tampa Bay Water to continue to reliably meet the growing water needs of the region, it must develop plans and programs to regularly assess system capacity, forecast future demand, and timely add new supply sources to the regional system.

4.3.1 System Capacity

Tampa Bay Water assesses the capacity of the water supply system in three ways, each for a specific purpose. The first is the aggregate capacity of all water supply sources and is discussed in Section 3.03 of the Amended and Restated Interlocal Agreement (Tampa Bay Water, 1998a). New water supply development actions are triggered when the actual delivery of water to the member governments exceeds 75% and 85% of this quantity. The aggregate rated capacity of all supply sources is 269.9 mgd. This quantity includes the running average annual capacity permitted for the groundwater wellfields by the District, the FDEP-rated capacity of the Regional Surface Water Treatment Plant, and the FDEP-rated capacity of the Tampa Bay Seawater Desalination Plant.

The surface water supply sources rely on seasonal and annual rainfall to provide sufficient flow to sustain the riverine and estuarine environments and to create flow above the low-flow thresholds allowing Tampa Bay Water to harvest a portion of the higher flows. Rainfall in west-central Florida displays a high seasonal fluctuation and can vary greatly from year to year. The combination of uncertainty in rainfall and river flows, permitting requirements, and operational constraints within the supply and treatment system results in the sustainable water supply capacity. This supply capacity combines the average annual permitted capacity of the groundwater wellfields (121.1 mgd), the projected sustainable supply capacity of the Regional Surface Water Treatment Plant (87 mgd) and the long-term sustainable capacity of the Tampa Bay Seawater Desalination Plant (16 mgd) (estimates are based on reliability assessment modeling performed by Tampa Bay Water staff for the Master Water Plan and Alafia River Water Use Permit). Based on these projections, Tampa Bay Water has determined that the sustainable water supply capacity of the regional system is 224.1 mgd.

Since Tampa Bay Water has the unequivocal obligation to meet the water demand of the member governments at all times and under all hydrologic conditions, the Agency must also acknowledge that there is a hydrologic dry condition supply capacity for the regional system. The Enhanced Surface Water System is most affected by a drought since river flow is dependent on rainfall and reservoir storage is dependent on sufficiently high river flows during the summer months to allow Tampa Bay Water to store additional surface water for dry periods. The dry condition supply capacity combines the average annual permitted capacity of each of the groundwater wellfields (121.1 mgd), the projected dry/drought supply capacity of the Regional Surface Water Treatment Plant (63 mgd) and a slightly increased average quantity from the Tampa Bay Seawater Desalination Plant (17 mgd). The regional dry supply capacity has been estimated at 201.1 mgd for the first year of a drought that corresponds to at least a 1-in-15 year drought condition. This definition of this dry supply capacity brings up a significant question; what happens when a drought extends into multiple years? The region's coordinated response to drought events and the Water Shortage Mitigation Plan is discussed in Section 4.6 of this report.

4.3.2 Annual Demand Projections

Tampa Bay Water has annually developed a long-term demand forecast for the six member governments since 2009 to document and track changes in water demand and to forecast future demands so that the Agency can timely meet the growing water needs of the region. Since 2017, a new Long-Term Demand Forecast System (LTDFS) model has been in use. In 2018, Tampa Bay Water updated its models using additional member government billing data and updated data sources. The updated LTDFS model is used for annual budgeting and source allocation processes (near-term forecasts up to five years into the future) and for long-range water supply planning in its probabilistic demand projection form (see discussion below). Water demand forecasts are made at least 20 years into the future.

The retail demand (water supplied from the members to their customers) is modeled for single family, multi-family, and non-residential sectors using separate models within the LTDFS model. Each of these models generates demand forecasts based on specific weather and socioeconomic projections for each water demand planning area. These models incorporate multiple factors that influence the use of water such as rainfall, temperature, price of water, median household income, housing units and density, persons per household, growth in housing, and non-residential square footage for multiple subsectors. Tampa Bay Water obtains the most recent available socioeconomic data from multiple sources for use in the annual demand forecasts, including the U.S. Census American Community Survey, the University of Florida Bureau of Economic and Business Research (BEBR), and Moody's Analytics.

Annually the demand forecast using the LFTDS model is compared with the most recent year of actual retail billing data per account for each member government in order to verify the predictive capability of the model and understand the uncertainty related to the socioeconomic data projections. The most recent available forecast used July 2017 through June 2018 as the base year for all water demand planning areas except for the City of Tampa, where the period of October 2016 through September 2017 was used (the latest period of billing data provided for assessment). The forecast versus actual demand for the base year was evaluated for each of the three sectors (single family, multi-family, and non-residential) and the model forecast as a whole. The comparison showed that overall, the model performed well with an error rate of 0.27% in the assessment of the base year condition.

The base year model was then used to forecast the long-term demand for the six member governments through the year 2045. The forecast models were run for the three sectors in each water demand planning area using the most current socioeconomic forecast data available. The model results show the long-term demand forecasts for the water demand planning areas which are used individually and as a whole in the budget, source allocation, and water supply planning activities. Tampa Bay Water subtracts the self-supply from certain member governments to arrive at the forecasted demand that will need to be met from the regional system. The information summarized in this section is presented in greater detail in the report "Demand Forecast Annual Evaluation and Update, November 2018" (Tampa Bay Water, 2019). Tampa Bay Water will continue to prepare annual updates to the long-term demand forecast in order to stay in front of changes in water use patterns and continually assess the need for new water supplies.

Tampa Bay Water has also developed a probabilistic version of the demand forecasting model to assess reliability of the regional system and determine when the region may need additional water supply. Water demand in the region is closely linked to the economic outlook of the region depending on whether the macro economy is in expansion or contraction. Key uncertainties captured in this model are those related to population projections, income, price of water, and weather. The probabilistic demand forecast provides a framework to include these uncertainties. The framework also provides the opportunity to understand how climate variability and resulting hydrologic changes may be investigated in tandem with the impact of the weather on water demand, allowing the agency to understand key uncertainties that drive the need for new water and develop strategies to address multiple future outcomes.

4.3.3 Master Water Plan

The water supply capacity of the regional system and the probabilistic demand projections are brought together in Tampa Bay Water's Master Water Plan, the Agency blueprint for meeting the members' future water needs. Section 2.09 of the Amended and Restated Interlocal Agreement (Tampa Bay Water, 1998a) requires Tampa Bay Water to update the Master Water Plan at least every five years. This plan is to include an updated list of water supply projects that could meet the forecast water needs of the member governments over a 20-year planning horizon. The Master Water Plan process ensures that new water supplies are timely developed to meet these future water demands. The original Master Water Plan was approved by the Tampa Bay Water Board in 1995 and was updated in February 1998 when the Board approved System Configuration I of the Master Water Plan (see Section 3.10). The Master Water Plan has been updated every five years since 1998 with the most recent update completed in December 2018 (Hazen and Sawyer, 2018).

The 2018 Long-Term Master Water Plan included all of the components required by the Amended and Restated Interlocal Agreement such as an assessment of existing supply facilities and capacity, the most recent long-term demand forecast, and identification of potential water supply options to meet future demands. This plan update was more comprehensive than prior updates and included additional components such as specific water demand planning area needs and options (Southern Hillsborough County), a system-wide reliability assessment, an assessment of climate variability, and an enhanced demand management plan. The plan included significant public outreach to gauge public opinions on potential new source options. The plan concluded that approximately 20 mgd of new regional water supply capacity is needed during the 20-year planning horizon and 10 mgd of this quantity needs to be on-line by the year 2028 (Figure 4.3). Three projects were recommended for further evaluation at the conclusion of the 2018 plan update: expansion of the Regional Surface Water Treatment Plant with existing source waters, expansion of the Tampa Bay Desalination Facility with existing source water, and development of new groundwater capacity through a net benefit associated with the South Hillsborough Aquifer Recharge Project.

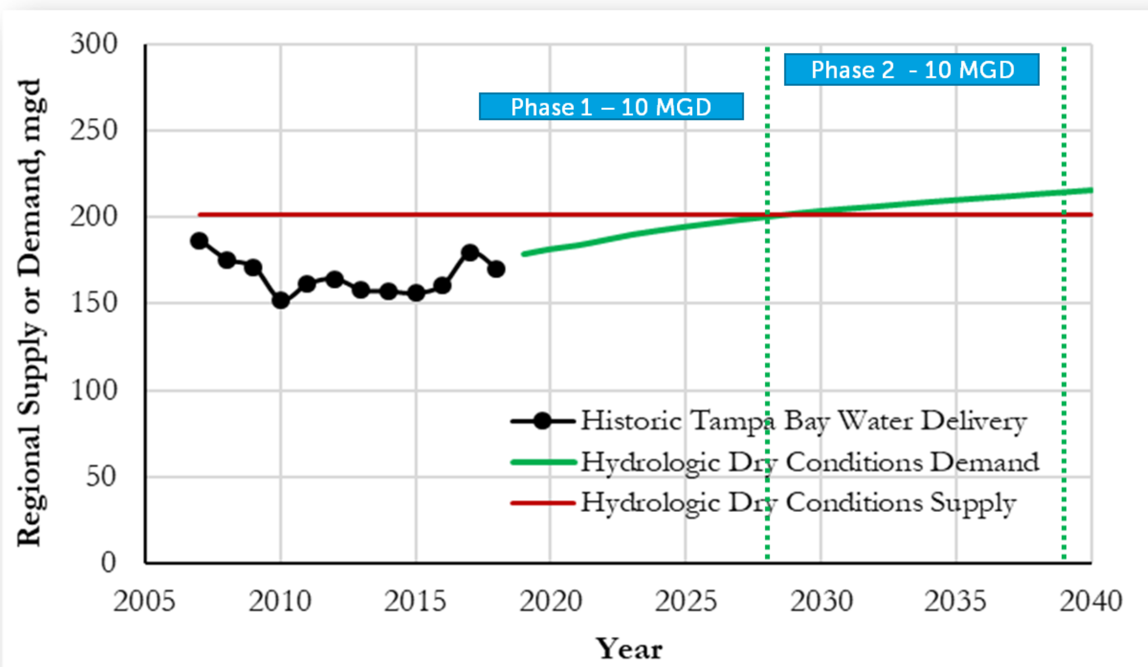

Figure 4.3: Tampa Bay Water System Capacity and Demand Projection

The Tampa Bay Water Board approved the 2018 Long-Term Master Water Plan in December 2018 and authorized staff to proceed with the evaluation of the three identified potential water supply options. These feasibility studies will be completed by 2021 and given the current demand forecast, it is anticipated that a recommendation on the preferred water supply option will be provided to the Board by the end of 2022 so that the new supply capacity can be on-line in 2028. The Board also approved the enhanced regional demand management plan which has the potential to reduce future demand by saving up to 11 mgd by the year 2030, potentially deferring construction of the next water supply source. Through annual long-term demand forecast updates, Tampa Bay Water will continue to track actual and forecast water demand to properly time the construction of the next water supply capacity for the regional system. Planning for the next five-year update to the Long-Term Master Water Plan has begun and will be completed by the end of 2023. This planning cycle is repeated every five years so that the Agency meets the unequivocal obligation to meet the water supply needs of the member governments.

4.4 Annual Production Forecast/Source Allocation

Tampa Bay Water completes its annual update to the Long-Term Demand Forecast Model (Section 4.3.2) before the end of each calendar year and the results are typically reported to the Board of Directors in December. Near-term demand projections are used to develop the upcoming annual budget (starting each October) at the beginning of each calendar year. As a not-for-profit wholesale water supply agency with a uniform water rate, the amount of water expected to be delivered to the member governments plays a role in the uniform water rate for the coming year. Higher water delivery means some additional operation and maintenance costs but can mean a lower unit cost for water delivered since the uniform rate is based on covering the actual expense of water supply development, delivery and maintenance plus maintaining appropriate balances in the contract required reserve funds.

Each annual demand forecast includes the projected demand for all six member governments with disaggregated forecasts for Hillsborough County's Northwest and South-Central Service Areas for the next six years. The amount of water self-supplied by member governments (City of Tampa, Pasco County, and the City of New Port Richey) is deducted from the regional demand forecast, given normal hydrologic conditions. Tampa Bay Water allocates an annual planned delivery of 6 mgd to the City of Tampa to account for uncertainty in Hillsborough River flow, which is the primary source of water for the City. This quantity reflects the average amount of water purchased by the City of Tampa during years in which it has purchased water from Tampa Bay Water.

Once the demand to be met in each water demand planning area is determined for the coming budget year, staff evaluate the available long-range climate and hydrologic forecasts for the same period of time. An allocation of ground water, surface water, and desalinated seawater from supply sources is identified and developed that will meet the forecasted demand, remain within all permit limits, and operate in an environmentally sustainable manner. Since the cost of treating the three types of supplies is different, the balance of these three water source types affects the uniform water rate for the coming year. Operating protocols call for maximizing the use of available surface water and managing groundwater resources to achieve environmental recovery and meeting all permit requirements. The seawater desalination facility has been operating at a steadily-increasing quantity to meet water demands and assist in environmental recovery around the northern wellfields. The annual budget is approved by the Board of Directors in June of each year for the coming Fiscal Year (Water Year) which begins in October.

At the close of each fiscal year, Tampa Bay Water staff reassesses the water supply allocation for the coming year in light of the latest climate and hydrologic forecasts. During September of each year, staff prepares a water source allocation plan that schedules monthly anticipated production for each supply facility using the monthly projected water delivery needed to meet the expected monthly member demand. This monthly allocation schedule is prepared just before the new fiscal year begins with knowledge of the current hydrologic conditions in the area and with a higher degree of confidence in the hydrologic forecasts for the coming year. The monthly allocations maintain the source allocation ratio that was used in the adopted budget for the coming year so that operating costs remain within the annual budget.

4.5 Within-Year/In-Season Source Allocation

Once the new Water Year begins each October, staff update the budgeted source allocation schedule at the beginning of each month throughout the year to reflect any month-to-month and seasonal adjustments necessary due to changes in climate/hydrologic conditions, member government demand, and/or facility constraints and outages. The key driver of seasonal allocation changes is the El Niño/Southern Oscillation conditions that tend to either bring a warm/dry or wet/cold winter that has significant impact on both near term demand and supply-side activities. The objectives of within-year seasonal source allocation are maximizing surface water availability, especially at the beginning of the Water Year, staying within permit limits, staying within the Agency's approved budget, and meeting member government demands in a fiscally and environmentally responsible manner. The monthly resource allocation is then used to guide week-to-week operations through Tampa Bay Water's Optimized Regional Operations Plan (OROP) (Section 3.14).

Given the seasonal source allocation, OROP's objective is to distribute groundwater production among wellfields and the active production wells within wellfields based on recent hydrologic conditions. The model provides production schedules by maximizing surficial aquifer water levels at key locations through weights tied to a given locality's wetland recovery target. If, for example, there has been higher rainfall and more favorable conditions in one part of the system than in others, OROP shifts wellfield production accordingly. Not only does this require a well-connected system that can satisfy the demand at a location (POC) in more than one way; the acquisition and use of recent hydrologic data is also critical to successful water resource management. The agency maintains a network of monitoring locations that are available in near real time. Environmental conditions are continuously monitored and assessed to determine the impacts of groundwater pumping. If there is a new environmental stress detected in an area, there are protocols in place for a detailed site assessment which could recommend the modification of an OROP control point or addition of another control point to attempt to alleviate the new environmental stress.

Once OROP's weekly operational outlook is published and implemented, an electronic report is automatically generated detailing the weekly demand and supply forecast versus actual pumping and delivery observations (usually within a week or two after the forecast). This report provides a snapshot of model performance. It includes a comparison of forecast and actual values for (1) each demand delivery point - that is, what the decision support tool expected a member government to ask for versus what it actually asked for; (2) forecast versus actual supply available; (3) scheduled versus actual wellfield production; (4) scheduled versus actual surface-water production; and (5) scheduled versus actual surface-water source allocation. Mismatches between forecast and observed data are used to assess such factors as operational constraints not yet captured and/or sub-model performance. Short-term demand and supply forecasts are highly dependent on near-term weather conditions, and the agency is continually improving its sub-models using state-of-the-practice operationally available forecast products such as the Climate

Prediction Center's seven-day quantitative precipitation forecast (QPF) and the global ensemble forecast system (GEFS). Both OROP schedules and the real time performance report of the various component models are shared with the members and the District.

4.6 Drought and the Water Shortage Mitigation Plan

The ability to meet water demands and remain in compliance with the groundwater supply limits is greatly enhanced by the availability of alternative water supplies. To demonstrate this system resiliency, examination of the three drought events experienced in the Tampa Bay area in the past 20 years is informative. The drought of 1998-2002 occurred before Tampa Bay Water's new alternative supply sources were developed, so the region relied on groundwater sources to weather this drought. The U.S. Geological Survey reported that the drought of 1998-2002 was one of the worst on record in west-central Florida based on precipitation and streamflow records dating back to the early 1900's (USGS, 2006). The effects on the region's groundwater supply sources are discussed in Section 3.15 when Tampa Bay Water exceeded the 36-month permitted capacity of 158 mgd from the 11 northern wellfields during the months of March through May 2001 (Figure 3.15.1). There were no other water supply options available and the region suffered through severe water restrictions for much of this drought period.

The next drought event in the Tampa Bay area began in 2005 and lasted through 2009. Based on an analysis of 3-year and 5-year moving average rainfall (Ormiston, 2020; Appendix 15.2), the severity (rainfall deficit) of this drought matched or exceeded the drought of 1998-2002 at the northern wellfields. The end of this drought event was so severe that the City of Tampa issued a ban on all outdoor irrigation until the summer 2009 rainfall began and the flow in the Hillsborough River increased. Tampa Bay Water's alternative water supplies were operational during this drought event; however, the duration and severity of this drought strained all regional supply sources. Tampa Bay Water actively managed the water stored in the C.W. Bill Young Regional Reservoir during this drought but tapped all of the stored water in the spring dry season of 2009 in order to keep the Regional Surface Water Treatment Plant in operation. The Seawater Desalination Facility delivered as much as 25 mgd of water supply in some months during the end of this drought period, but Tampa Bay Water still exceeded the 12-month average permitted limit of 90 mgd from the 11 northern wellfields from March through November of 2009 (Figure 3.15.1). The maximum 12-month running average pumping level from these wellfields was 104.4 mgd during May 2009 before the drought abated and wellfield pumping was under the annual permitted level in December 2009.

The third drought event of the past 20 years was short in duration but was notable for the lack of precipitation. The dry season of Water Year 2017 (October 2016 through May 2017) was widely reported as the driest dry season on record in the Tampa Bay area. Total rainfall recorded at the National Weather Service gage at the Tampa International Airport during this period was only 8 inches as compared to the expected total rainfall of 18.5 inches during this eight-month dry season. Tampa Bay Water managed water supply sources during this short-term event without depleting the reservoir storage or approaching any Water Use Permit limits. During this short-term event, flow in the Hillsborough River sharply declined and Tampa Bay Water supplied a significant quantity of water to the City of Tampa from late March through early June 2017. This is a periodic water delivery but is anticipated by Tampa Bay Water within the normal water source allocation and annual budgeting process. The implications of this type of high-capacity, short-duration supply event on the Consolidated Permit wellfields is discussed in Section

4.7 below. Tampa Bay Water was able to manage supplies through this short and intense drought such that the public barely noticed that the region was in a very dry condition. This is due to the regional commitment to build a diverse, resilient system over the past 20 years. This solution to past water supply problems was hailed as an example of regional cooperation by the Tampa Bay Times Editorial Board in April 24, 2017.

History has demonstrated that droughts will periodically occur even though when they will begin or how long they will last cannot be accurately predicted far in advance. Tampa Bay Water's surface water component is dependent on season-to-season and year-to-year fluctuations in rainfall. The new surface water sources have allowed Tampa Bay Water to greatly reduce reliance on groundwater sources by capturing excess summer streamflow during the summer rainy season; however, a management tool is needed to help operate the regional supply sources in an environmentally sustainable manner during extended drought periods while continuing to meet regional water needs. Following the significant 1999-2001 drought, Tampa Bay Water developed a three-phase Water Shortage Mitigation Plan in 2001. This plan was updated in 2009 in accordance with the District's Water Shortage Rule (Chapter 40D-21, F.A.C.) which allows public supply permittees to develop water shortage mitigation plans based on localized hydrologic conditions. These initial plans were implemented during water shortage periods between 2006 through 2009 and provided the agency with a strategy for identifying and responding to droughts and the resulting water supply shortages.

The 2009 Water Shortage Mitigation Plan relied on current and historic rainfall and river flow conditions and current Regional Reservoir levels to provide leading indicators of the likelihood of a water supply shortage. This Plan consisted of hydrologic-based triggers to initiate demand management and supply augmentation activities. Tampa Bay Water updated the Water Shortage Mitigation Plan again in 2017 (Tampa Bay Water, 2017) by modifying the triggers used to define water shortage stages. In addition to looking at past and current hydrological conditions, the updated Plan employs forecasted Regional Reservoir levels at the end of a three-month period using predicted streamflow as one indicator. This leading indicator of predicted hydrologic conditions allows Tampa Bay Water to incorporate uncertainty into supply and demand-side models, use enhanced weather/climate modeling and statistical methods, and implement proactive mitigation actions.

The four water shortage stages increase in severity both in terms of the conditions requiring implementation of each progressive stage and the demand management and supply actions to be implemented at each stage. Table 4.1 lists the hydrologic and water supply triggers for entering and exiting each of the four water shortage stages. Table 4.2 lists the demand management actions to be implemented by the District and the member governments as well as the supply actions to be implemented by Tampa Bay Water at each water shortage stage. Successful implementation of this Plan will allow Tampa Bay Water to meet demands during infrequent drought events and avoid the investment in additional water supply infrastructure that would seldom be used. As a result, the Long Term Master Water Plan can focus on and identify the long-term water supply capacity needed to meet regional water demands and develop the next supply sources when they will be consistently used to meet a regular demand, not just the higher demand observed during drought events.

Table 4.1: 2017 Water Shortage Mitigation Plan Hydrologic and Water Supply Triggers

Water Shortage Stages	HYDROLOGIC and WATER SUPPLY TRIGGERS	
	ENTERING	EXITING
I. Drought Alert (Moderate)	**RCD Rainfall: deficit ≥ 5" OR RMD Flow: deficit ≥ 10 mgd**	RCD-rainfall: deficit eliminated and surplus created **AND** RMD-flow: deficit relieved to less than 5 mgd
II. Drought Warning (Severe)	**RCD Rainfall: deficit ≥ 5" AND RMD Flow: deficit ≥ 10 mgd**	RCD-rainfall: deficit eliminated and surplus created **OR** RMD-flow: deficit relieved to less than 5 mgd
III. Regional Supply Shortage (Extreme)	**RMD Flow: deficit ≥ 10 mgd AND Reservoir forecasts less than reservoir elevation defined by supply shortage curve**	RMD Flow; deficit ≤ 5 mgd **OR** Both current **AND** forecasted reservoir levels above Stage III exit levels
IV. Water Supply Crisis (Critical)	**RMD Flow: deficit ≥ 10 mgd AND Reservoir forecasts less than reservoir elevation defined by water supply crisis curve**	RMD Flow; deficit ≤ mgd **OR** Both current **AND** forecasted reservoir levels above Stage IV exit levels

Table 4.2: 2017 Water Shortage Mitigation Plan Demand Management Actions and Supply Actions

Water Shortage Stages	Demand Management Actions	Supply Actions
I. Drought Alert (Moderate)	Members Implement District watering restrictions	Initiate public noticing
II. Drought Warning (Severe)	Members Implement District watering restrictions	1. Max surface water and desal 2. Request increase for Alafia River 3. Request lowering TBC middle pool
III. Regional Supply Shortage (Extreme)	Members Implement District watering restrictions	1. Activate Alafia River increase 2. Request lowering TBC lower pool
IV. Water Supply Crisis (Critical)	Members Implement District watering restrictions	1. Activate lowering pool stage 2. Request authorization to continue groundwater pumping

Tampa Bay Water and the member governments currently rely on the District to issue Water Shortage Orders during drought events. These Orders assist the member governments in implementing increasing water conservation measures, delivering a consistent public message during a drought event, and authorize additional surface water and groundwater withdrawals in accordance with Tampa Bay Water's Plan that are needed to meet critical water supply needs.

4.7 Consolidated Permit Wellfields - Considerations

Tampa Bay Water has an unequivocal obligation to meet the water demands of the members at all times and this is not a simple feat. The facilities used to meet this demand have been briefly discussed in this chapter and in Chapter 3 along with some of the many constraints within the regional system. The challenge faced each day is blending three different source water types throughout three counties from numerous facilities, each with different water quality characteristics and treatment processes, while meeting all drinking water quality standards to deliver water to the members at 20 unique locations at the required minimum pressures. This is accomplished each day while remaining in compliance with the specific requirements of the Water Use Permits for the supply sources as well as the FDEP requirements for the operation of water treatment plants and pipelines. Performing this work on a continuous basis while focusing on the future ensures that the current day water demands are met as well as those for each day in the future. Insight into the technical assessment and planning work that is used to ensure future demands are met have been briefly summarized in this chapter. As this chapter ends, there are implications related to the Consolidated Permit wellfields that must be acknowledged to best understand how the regional system can be operated to meet both water demands and achieve the recovery of wetland and lakes near the wellfields that were under stress.

Tampa Bay Water has two primary reservoirs; a groundwater reservoir and a surface water reservoir. These two systems must be operated together to maintain the reliable water supply system Tampa Bay Water has developed to meet the members demand both now and into the future. Hydrology in west central Florida is seasonal, and this requires seasonal operation of the two systems. The fully integrated regional system provides the opportunity to use each source water to its greatest advantage on a seasonal cycle to facilitate environmental recovery. The Desalination Plant is currently used during the dry season when water demands are high, surface water flow is low, and operating constraints for this facility are favorable. When surface water is plentiful in the summer and water demands decrease, it is currently possible to stop production from the Desalination Plant for the summer season; however, this condition is expected to change as regional demands increase. Surface water skimmed from the Tampa Bypass Canal and Alafia Rivers during the summer months fully supplies the Surface Water Treatment Plant and fills the Regional Reservoir for those times when river flows diminish. This optimal use of surface water flows allows for the reduction in groundwater pumping from the wellfields during the summer months and rainfall quickly refills the wetlands, lakes and aquifer. Wetlands and lakes reach their expected seasonal high levels much earlier now than when groundwater was Tampa Bay Water's only supply source. Wetlands and lakes end the summer rainy season in a healthy state and water levels gradually decline during the eight-month dry season, as they naturally would. The ability to reduce wellfield pumping rates during the summer months has contributed to the recovery of lakes and wetlands in the wellfield areas and will be a key factor in sustaining the environmental recovery achieved.

The Consolidated Permit wellfields make up the majority of the ground water supplies in the regional system and Tampa Bay Water maintains the pumping rate at or below the permitted 12-month running annual average quantity of 90 mgd. The average pumping limit at the end of the original Consolidated Permit was 90 mgd and it has remained the same during the term of the renewed permit. This quantity is also the premise behind this Recovery Assessment Plan – to evaluate the recovery of water resources and environmental systems attributable to the reduction in pumping from the Consolidated Permit wellfields to a long-term average of 90 mgd. To ensure that production does not exceed this 12-month running average limit from the Consolidated Permit wellfields, operationally the Agency plans to pump the wellfields at an annual average rate of less than 90 mgd because of the seasonal nature of hydrology and demands. The operational goal is to keep the 12-month running average pumping quantity from these wellfields below 85 mgd. This operational goal was set to allow production from the wellfields at a higher monthly rate when needed to account for seasonal dry periods, emergency conditions within the system or manage drought conditions without exceeding the permit limit. This operating strategy promotes environmental recovery and maintains a flexibility within the system to handle short-term events.

Tampa Bay Water essentially reserves for later use a portion of the authorized Consolidated Permit quantity to avoid violating the 90 mgd annual average permit limit. The value of this operational practice was demonstrated during the spring of 2017 when the area experienced an 8-month dry season with very little rainfall (Section 4.6). During this short-term drought event, flow in the Hillsborough River declined sharply and Tampa Bay Water supplied a significant quantity of water to the City of Tampa during the spring of 2017. The City of Tampa typically self-supplies through the Hillsborough River and Tampa Bay Water has only delivered water to the City when their demand exceeds what the Hillsborough River can deliver. Tampa Bay Water provided water to the City during March through early June of 2017 to help meet its demands with average monthly quantities of 27.1 mgd and 40.9 mgd in April and May, respectively. As all surface water flows were low, Tampa Bay Water increased the pumping rate of the Consolidated Permit wellfields to meet the City's demand. Since delivery of water to the City had been 0 mgd during the prior 12 months, the additional wellfield pumping during April and May caused a sharp increase in the 12-month running average pumping rate from the Consolidated Permit wellfields. Between March and May of 2017, the 12-month running average pumping rate from these wellfields increased from 80 to 85.5 mgd. If Tampa Bay Water had been pumping these wellfields at a 12-month running average closer to the 90 mgd permit limit, exceeding the permit limit may have occurred. This is a periodic occurrence which Tampa Bay Water has to include each year in its water supply allocation during the source allocation and budgeting processes.

As shown in the example above, the 90 mgd running annual average permit does not equate to 90 mgd of supply on a regular basis. The use of surface water supply sources is prioritized when they are available which has resulted in the Consolidated Permit wellfield monthly pumping quantities being relatively stable. Figure 3.15.1 shows a seasonal fluctuation in the pumping quantity from these wellfields. In general, the fluctuation in monthly pumping rate since 2012 has been relatively steady. During these past several years, the 12-month running average pumping from these wellfields has fluctuated between 75 and 85 mgd. This has been a benefit to the Recovery Assessment Plan analyses since a stable pumping rate during the recent time period on which to assess recovery of area lakes and wetlands solidifies confidence in the report results. Since the long-term average pumping rate from these wellfields is less than the 90 mgd permit limit, techniques were developed to assess the recovery of lakes and wetlands at an average pumping rate of 90 mgd. More detail is provided in Section 5.3 for the Area of Investigation and Chapter 6 for the various recovery metrics and assessment techniques.

Tampa Bay Water has scheduled the weekly pumping rates from the Consolidated Permit wellfields through the Optimized Regional Operations Plan (OROP) since 1999 under the original and renewed permits (Section 3.14). This tool allows for the rotation of pumping based on current hydrologic conditions (rainfall and surficial aquifer water levels) to distribute wellfield pumping and minimize drawdown. This process has achieved much greater recovery than was predicted by previous modeling analyses such as the Candidate Sites Evaluation Study and Phase 1 Mitigation Plan (Section 3.13). Tampa Bay Water plans to continue scheduling wellfield pumping in this manner during the next term of the Consolidated Permit to maintain the environmental recovery achieved and further improve water levels at wetlands that have improved but not quite reached their metric of recovery. The Agency will continue to explore modifications to the OROP to improve performance and will discuss any changes with the District as they are developed.

The Tampa Bay area has experienced an extended period of normal to above-normal rainfall in the past several years; however, drought will eventually return to this area. Continued use of the OROP to schedule wellfield pumping, especially during a drought, will help Tampa Bay Water manage the groundwater resources to minimize the effects of pumping. The Agency uses the triggers in its current Water Shortage Mitigation Plan (Section 4.6) to gage potential water supply shortages and to manage all supply sources to meet the demands of the member governments and avoid an exceedance of any permit limit. If a drought event becomes severe and lasts for an extended period of time, these operational management tools will help minimize the extent and duration of exceeding any permit limits if that condition becomes unavoidable.

Tampa Bay Water has successfully combined its diverse water supply system with management tools such as the Long-Term Demand Forecasting Model, Operation Plan and OROP, Master Water Plan, and Water Shortage Mitigation Plan to provide the region with a reliable water supply today and for the future. This combination of supplies and management tools gives the Agency the ability to promote environmental recovery, meet the growing water demand of the member governments, and operate the system in an environmentally sustainable manner under all forecasted hydrologic circumstances. The resilient nature of the regional integrated supply system has been demonstrated during the last two drought events experienced in the Tampa Bay area. These robust water management tools have proven to be a strong economic and environmental asset for the Tampa Bay community.

5: Recovery Assessment Plan

5. Recovery Assessment Plan

This chapter describes the formulation of the initial work plan, schedule, and the decisions that Tampa Bay Water and the District staff made to define the general issues to be addressed in the Recovery Assessment Plan. As discussions with the District progressed, the general area and specific features at which recovery would be assessed were identified and the multiple types of data that would be used in the analyses were defined. The initial work plan provided the framework for subsequent analyses and the volumes of historical data collected by Tampa Bay Water and the District provided the information essential for analyzing environmental recovery. The latter sections of this chapter describe the data used in these analyses and the sources of that data.

5.1 Permit Requirement for Recovery Assessment Plan

Special Condition No. 11 of the renewed Consolidated Permit requires Tampa Bay Water to complete a Recovery Assessment Plan that "includes an evaluation of the recovery of water resource and environmental systems attributable to reduction of the groundwater withdrawals from the Central System to a long-term average of 90 mgd, identify any remaining unacceptable adverse impacts caused by the Central System's withdrawals at a long-term average rate of 90 mgd, and identify and evaluate potential options to address any remaining unacceptable adverse impacts at the time of the Consolidated Permit renewal in 2020." At the time the renewed permit was issued in 2011, the scope and extent of the Recovery Assessment Plan and the analyses that would be required to complete the assessment were unknown. The permit requirements for the Recovery Assessment Plan were general in nature but the goals were clear: assess the degree of recovery to the water resources that is due to the reduction in wellfield pumping and mitigate any remaining adverse environmental impacts attributable to the groundwater withdrawals.

Following the significant reduction in wellfield pumping (described in Chapter 3) and a return to more normal rainfall conditions, water levels in lakes, wetlands, and aquifers across the Northern Tampa Bay area began to steadily increase. Documentation of environmental recovery was recorded in the abundance of empirical water level data that Tampa Bay Water and the District have collected at hundreds of monitoring locations across the region, many of which have data records exceeding 25 years. What remained was to determine what part of this recovery is due to the reduction in pumping from the wellfields and if any remaining impacts are considered adverse according to District permitting criteria. Tampa Bay Water developed this Recovery Assessment Plan to ensure that the requirements of Special Condition No. 11 were met at the time of the next permit renewal in late 2020.

5.2 Development and Formulation of Issues

Tampa Bay Water completed an assessment of predicted environmental recovery through the Candidate Sites Evaluation Study and Phase 1 Mitigation Plan under the original Consolidated Permit (Section 3.13). Due to limitations in the data and groundwater flow modeling tools available at the time those studies were completed, Tampa Bay Water and the District acknowledged that quantifying the extent and degree of predicted recovery through those analyses would be approximate. The original Phase 1 Mitigation Plan was prepared in 2001, before pumping from the wellfields had been reduced; the Phase 1

Mitigation Plan Update was completed in 2007 before the final pumping reduction to 90 mgd was in effect. The analyses completed in these prior assessments were predictive in nature. The Recovery Assessment Plan was prepared knowing that a significant period of time with wellfield pumping below 90 mgd would be available as part of the assessment. Thus, the opportunity to analyze actual water level data from monitored sites during two distinctly different pumping regimes, before and after the significant reduction in wellfield pumping, would be available. This opportunity was not available when the Phase 1 Mitigation Plan was developed and allowed the use of many additional analytical tools in the Recovery Assessment Plan evaluation.

Tampa Bay Water and the District staff acknowledged that Tampa Bay Water would not likely need to implement the list of potential wetland mitigation projects originally identified in the Phase 1 Mitigation Plan. It was expected that the predicted impacts at 90 mgd in the Phase 1 study were over-estimated due to the many conservative assumptions built into that assessment and that scheduling wellfield pumping through the Optimized Regional Operations Plan (OROP) would optimize water level recovery. The Recovery Assessment Plan analyses focus on the use of actual data since the extensive monitoring programs have generated sufficient data before and after the reduction in pumping to evaluate the effects of reduced pumping on the recovery of wetland and lake water levels. Modeling analyses have been used to supplement the recovery assessment analyses where appropriate.

The water level recovery in lakes and wetlands following the reduction in wellfield pumping has confirmed expectations that all of the potential mitigation projects were not needed. Many of the sites that were not predicted to fully recover have had high water levels for multiple years after the pumping reduction and some of the wetlands have been the subject of annual flooding concerns. The data and analyses that document these conditions are discussed on a wellfield-scale in Chapter 12 of this report.

5.2.1 Initial Work Plan and Schedule

Tampa Bay Water staff began the development of the work plan and schedule for the Recovery Assessment Plan in 2011 as required by Special Condition 11.A of the renewed Consolidated Permit. The permit condition specifically requires that:

> *"The Permittee shall submit to the District within 365 days of permit issuance, a work plan and schedule for the development of the Consolidated Permit Recovery Assessment Plan. This work plan shall include a detailed discussion of any proposed analytical techniques that will be used and timelines. Any changes to the analysis or implementation schedules in the work plan shall be submitted to the District."*

In early discussions with the District, staffs identified an objective of renewing the Consolidated Permit through the Water Use Permitting Rules of the District (Chapter 40D-2, F.A.C.) without having to rely on the implementation of a third phase of the Comprehensive Environmental Resources Recovery Plan for the Northern Tampa Bay Water Use Caution Area (Chapter 40D-80.073, F.A.C.). Tampa Bay Water and the District understood that this would require the successful completion of the Recovery Assessment Plan and these analyses would be the essential element needed for the renewal of the Consolidated Permit in 2020. In order to meet this objective, the Recovery Assessment Plan would have to be a rigorous and comprehensive study of environmental health and recovery, on both a regional and a site-specific basis.

The permit condition that specifies the requirements for the Recovery Assessment Plan requires that Tampa Bay Water evaluate the recovery of water resources and environmental systems that is attributed to the reduction in pumping from the 11 wellfields to no more than an annual average of 90 mgd. It also requires Tampa Bay Water to identify any remaining unacceptable adverse impacts caused by the pumping of these wellfields at a long-term average rate of 90 mgd. The third overall requirement of this condition is the development of potential options to address any remaining unacceptable adverse impacts at the time of permit renewal in 2020. This Recovery Assessment Plan was formulated to address these three requirements. The combination of these three requirements created the assumption that the Consolidated Permit can be renewed at 90 mgd in 2020 unless the results of the Recovery Assessment Plan demonstrate that there are widespread unacceptable adverse impacts to the environment that persist at an annual average pumping rate of no more than 90 mgd from the 11 wellfields.

Tampa Bay Water staff identified numerous issues that must be resolved within the Recovery Assessment Plan during a series of internal meetings in 2011. At the beginning of a technical study as complex and comprehensive as the Recovery Assessment Plan, it is not possible to know every issue that will need to be addressed or technical analysis that will need to be performed. As the Recovery Assessment Work Plan and Schedule were developed, the known issues were placed into two categories, regulatory and technical, and presented in a narrative form with a statement of the issue and an approach on how to resolve each issue. The statements of the issues and recommended approaches were written in a way that broadly conveyed the necessary intent but were not so narrowly focused that they would constrain discussions with the District staff or the way each technical study was proposed.

Tampa Bay Water and District staff met in January 2012 to discuss the proposed Work Plan and Schedule and the document was submitted to the District on January 24, 2012 in accordance with the permit requirement (see Appendix 5.1). The following section discusses the key regulatory and technical issues identified in the Work Plan and Schedule.

5.2.2 Key Issues

Tampa Bay Water staff committed to fully examine these Work Plan issues with the District before initiating any technical assessments. Staff of both agencies agreed that it was critical to reach consensus on each of the specific technical approaches before initiation of associated technical analyses since there were many sequential analyses to be performed and Tampa Bay Water had only a 10-year window of time to complete the assessments. The process established was to work through the identified regulatory issues at the same time and reach consensus on these topics since the regulatory guidance was critical to the technical analyses. Key regulatory and technical issues for the Recovery Assessment Plan are summarized below.

- **Regulatory issue: A temporal baseline for wetland impacts is necessary.** The 11 wellfields covered by the Consolidated Permit and subject to the Recovery Assessment Plan were developed over several decades and some were subject to high rates of historic pumping in the past. In some cases, historic impacts on and near the wellfields included structural and habitat/vegetation changes in lakes and wetlands. Significant soil subsidence was documented in some wetlands and sinkholes formed within other sites as the most extreme form of structural impacts. Some of the monitored wetlands are now a different type of wetland system than existed in the past. For example, wetland S-044 in the Starkey Wellfield was once an isolated cypress dome but is now a deep-water marsh with very few remaining cypress trees due to sinkholes and soil subsidence that occurred in the past. Tampa Bay Water's approach is to assess wetlands on the basis of the existing plant community and wetland structure, not on the wetland type that existed in the past.

- **Regulatory issue: Quantitative measures and standards for recovery, defined as the absence of an unacceptable adverse impact are necessary.** The District has established methods of setting Minimum Levels for isolated cypress wetlands and lakes in Chapter 40D-8, F.A.C. and the District has adopted Minimum Levels for a number of lakes and wetlands within this rule. The methodology for setting a minimum level for lakes and isolated cypress wetlands relies on both water level data and ecological data from the surface water features. However, the actual metric of health is the long-term water level, rather than an assessment of the ecological data. Tampa Bay Water's proposal is that recovery should be assessed on the basis of hydrology (water levels) while considering the available ecological data in the development of these scientifically-defensible metrics or standards of recovery. The direct use of ecological assessments was not proposed as a recovery metric or means of assessing recovery given the multiple influences on wetland ecology and the historical change that has occurred in and around wellfield areas. Field reviews were included at the conclusion of the Recovery Assessment Plan to evaluate wetlands for signs of adverse impact to assess the validity of these recovery analyses. This regulatory issue is similar to a technical issue (below) stating the need for quantitative hydrologic criteria or metrics for wetland types other than isolated cypress systems.

- **Regulatory issue: The geographic area or set of environmental features to be assessed must be identified.** Tampa Bay Water and the District monitor hundreds of wetlands and lakes in the Northern Tampa Bay area but in order to begin assessing the recovery of environmental features, the area of study needed to be specified and the specific features and sites identified for evaluation. Further, Chapter 40D-2.301, F.A.C. outlines the Criteria for Issuance of a Water Use Permit and requires that an applicant demonstrate that their withdrawals do not cause harm to the water resources of the area including wetlands and other surface waters. During early discussions with District staff, it was agreed that only assessing the recovery of wetlands and lakes with water level monitoring data would not completely meet the rule requirement. Tampa Bay Water and District staff agreed to identify the wetlands and lakes within a defined geographic area(s) of potential impact around the wellfields and attempt to assess the health/recovery of those sites. These geographic areas and a list of the unmonitored sites needed to be developed. The proposal did not include initiating monitoring of any additional wetlands or lakes but rather the development of different approaches to assessing the health or recovery of monitored and unmonitored sites.

- **Regulatory issue: A method of accounting for unacceptable adverse wetland impacts related to continued wellfield pumping at 90 mgd and determining the need for compensatory mitigation are required.** Tampa Bay Water proposed to develop a wetland mitigation assessment methodology to be used specifically for the Recovery Assessment Plan and renewal of the Consolidated Permit. The potential adverse impacts related to continued wellfield pumping at 90 mgd were expected to consist of alteration of wetland function as opposed to the loss of wetland acreage as typically addressed in Environmental Resource

Permits. This will require an assessment tool that differs from the Uniform Mitigation Assessment Method used state-wide to provide an accounting method of assessing wetland impacts and compensatory mitigation credits. This new method of assessing mitigation requirements is necessary to meet the permit condition requiring Tampa Bay Water to evaluate potential options to address any remaining unacceptable adverse impacts at the time of the Consolidated Permit renewal in 2020. An additional issue related to wetland mitigation is the need to establish a baseline condition on which to make this assessment of wetland function change; that is, in order to assess change, the assessment starting point (historic time period) must be identified for comparison to the current condition. This concept is discussed in detail in Section 6.9 of this report.

- **Technical issue: Quantitative criteria and assessment methods are necessary for different types of wetland systems.** This technical issue is related to the preceding regulatory issue as both identify the need for quantitative criteria of recovery. The technical approach to this issue includes the identification of the different wetland types included in the Recovery Assessment Plan. The District has developed methods for establishing minimum levels only for isolated cypress wetlands and lakes. The Water Use Permit Applicants Handbook – Part B (Section 3.3.1.1.4. Performance Standards) contains narrative performance standards but as discussed above, numeric standards of wetland health or recovery were needed. Tampa Bay Water proposed to work with the District staff to define the different wetland types to be assessed and develop quantitative metrics of health or recovery for each wetland type. The technical studies would also include an investigation of isolated wetlands in xeric versus mesic landscape settings, and if they are found to be hydrologically different, a separate recovery metric would be developed for isolated wetlands within a xeric landscape. The third element of this technical issue is the development of consistent evaluation methods that account for climate/rainfall variability.

- **Technical issue: A method of assessing the health or recovery of wetlands where no water level data exists is beneficial.** This issue is linked with the regulatory issue described above that states the reasons and need to identify unmonitored wetlands near the Consolidated Permit wellfields and include them in the Recovery Assessment Plan. The approach to this technical issue involves the use of a regional groundwater/surface-water flow model to investigate and define the areas where pumping from the 11 wellfields at the lower annual average limit of 90 mgd has the potential to affect wetland health. Once that area(s) is defined and the specific wetlands and lakes within that area have been identified, Tampa Bay Water staff would develop a method to predict the health/recovery for all identified wetlands and lakes that do not have water level data. This method includes an empirical approach with hydrological data and model-predicted information based on monitoring data.

- **Technical issue: A correlation between ecological condition and water level data in wetlands should be explored to give support to the primary assessment of recovery based on hydrologic (water level) data.** The long-term water level within a wetland is one of the primary influences on wetland health and change. When long-term water levels are too high or too low, the vegetation in that wetland is affected; some plant species will die out and others will become established within the wetland. Tampa Bay Water and the District have collected specific vegetation data at numerous wetlands for many years, first through quantitative transects and quadrats and more recently through the Wetland Assessment Procedure (WAP) and Wetland Health Assessments (WHA). The technical approach included using this available ecological data in the development of hydrologic metrics for different wetland types. It was also proposed to study the relationship between wetland hydrology and the available vegetation data to establish an understanding of whether, and how, wetland condition data can be used in the assessment of recovery.

- **Technical issue: The effects of land use and drainage changes associated with development must be evaluated to fully understand the hydrologic effects of these changes on wetland impact and recovery**. The goal of the technical approach is to determine any correlations between the effects of development and drainage alterations and wetland hydrology in urbanized areas and for wellfields with adjacent development. Any influence on wetland water levels from drainage alterations must be understood so that these effects in developed and developing areas can be separated from the effects of rainfall and reduced pumping. Only then can recovery be assessed and a determination of individual wetland recovery be completed. The final assessments of recovery for individual wetlands and lakes and for larger areas of wetlands (such as on a wellfield) will include an assessment of the effects of development and associated drainage changes. Any limitations to the amount of recovery that can be achieved will be included in the recovery assessment studies.

- **Technical issue: Climate and rainfall variability are significant factors in wetland health; recovery assessment methods are needed that account for spatial and temporal rainfall variability.** Recovery of environmental systems needs to be assessed without regard to the amount of rainfall received during the years preceding the Consolidated Permit renewal in 2020. If those years are dry, the results may be skewed to show an apparent lack of recovery, and if those years are wet, the results may over-predict the amount of recovery that is due to reductions in wellfield pumping. Tampa Bay Water proposed to develop assessment methods that account for temporal rainfall patterns and can discern the degree of recovery that can be attributed to the reduction in pumping from the 11 wellfields.

- **Technical issue: The identification of the data to be used and a quality control review of those data and MFL elevations are necessary.** Water level and wetland vegetation data have been collected for many years by Tampa Bay Water and the District. The data collection methods and practices have changed over the years and are now more robust than in the past. Tampa Bay Water and District staff agreed to define the data to be used, where the data are stored, and agreed to openly share the data that both agencies have collected. A mutual goal is to use a common set of high-quality water level and environmental data for all Recovery Assessment Plan analyses so there will not be any discussions over the validity or source of data at the conclusion of this process. Part of the work plan includes the continuation of rigorous quality control of all data collected and stored in the agency database and the collection of updated survey information where needed during the course of the analyses.

5.2.3 Defining Environmental Features to be Evaluated

The renewed Consolidated Permit requires Tampa Bay Water to complete a Recovery Assessment Plan that "…includes an evaluation of the recovery of water resource and environmental systems attributable to the reduction in groundwater withdrawals from the Central System to a long-term average of 90 mgd…". The specific environmental systems or features to be assessed are not identified in the permit condition language. Tampa Bay Water stated the need to identify the types of water resource features to be assessed as one of the regulatory issues in the Work Plan and Schedule. The water resource features in the Tampa Bay area can be separated into two groups: surface systems (lakes, wetlands, and rivers) and subsurface systems (Upper Floridan Aquifer and surficial aquifer). Discussions with District staff began in late 2012 to develop a list of specific systems and sites to include in the Recovery Assessment Plan and focused on these two broad types of features.

Tampa Bay Water and the District staff agreed that lakes, wetlands, and streams were important features to include in the Recovery Assessment Plan. Between the two agencies, there are long-term monitoring data for hundreds of lakes and wetlands on and near the Consolidated Permit wellfields. The District has adopted Minimum Levels for many lakes and some wetlands in the northern Tampa Bay area, which provide long-term monitoring data to assess as well as methods of establishing levels that were designed to prevent environmental harm to lakes and isolated cypress wetlands. The District has either established Minimum Flows or has scheduled the development of Minimum Flows into Chapter 40D-8, F.A.C. for the major rivers in the northern Tampa Bay area. Tampa Bay Water and District staff agreed that rivers would be assessed by the District using the MFL criteria and that key stream systems would be evaluated by other assessment tools to determine if they exhibited signs of adverse environmental impact.

The other water resource features of potential concern in the northern Tampa Bay area are the Upper Floridan and surficial aquifers. The surficial aquifer is important since surface water features are located at the top of this system and are associated with the water table in this aquifer. However, since agency staff agreed that lakes and wetlands would be assessed in the Recovery Assessment Plan, it was determined that a separate assessment of the surficial aquifer was unnecessary. Tampa Bay Water and District staff also determined that an evaluation of recovery in the Upper Floridan Aquifer would not be the focus of the Recovery Assessment Plan but water level data from the Upper Floridan and surficial aquifers would be very beneficial in these assessments. However, two issues of potential concern related to the water resources of the Upper Floridan Aquifer were discussed; the potential for saltwater intrusion into the aquifer and the potential impact of groundwater pumping on legal existing users.

The potential for saltwater intrusion into the coastal portion of the Upper Floridan Aquifer is not a regional concern but is considered a local or sub-regional concern in some areas (Southwest Florida Water Management District, 1996b). The District established Saltwater Intrusion Minimum Aquifer Levels in Chapter 40D-8.626, F.A.C. for seven monitor wells between the coastline and the wellfields nearest the coast (Eldridge-Wilde, Cosme-Odessa, and Northwest Hillsborough). These levels were calculated as the long-term average water levels through 1997 (Southwest Florida Water Management District, 1999a). The presumption behind this decision was that as long as the drawdown in the Upper Floridan Aquifer did not increase beyond the levels experienced prior to 1997, significant advance of regional saltwater intrusion would not be expected. Tampa Bay Water and the District agreed to address compliance with the Salt-Water Intrusion Minimum Aquifer Levels and the potential for salt-water intrusion as part of the Consolidated Permit renewal application documents, and not the Recovery Assessment Plan given the reduction in groundwater pumping since 1997.

The second potential water resource concern related to the Upper Floridan Aquifer is the possible impact to legal existing users from pumping of the Consolidated Permit wellfields. This concern has been successfully addressed through Tampa Bay Water's domestic well mitigation program. The potential for impact to other legal existing users has also decreased with the significant reduction in pumping from the Consolidated Permit wellfields. Agency staff agreed with the District that this issue would be addressed during the renewal of the Consolidated Permit and not as part of the Recovery Assessment Plan.

These discussions between Tampa Bay Water and District staffs defined what is meant by "water resource and environmental systems" as related to the Recovery Assessment Plan. The District confirmed in letters dated May 22, 2014 and June 19, 2015 (discussed further in the sections below), that the Recovery Assessment Plan will analyze the recovery of lakes and wetlands and that the evaluation of potential salt water intrusion and compliance with the Upper Floridan Aquifer minimum levels would be assessed during permit renewal. The sections that follow outline how the specific lakes and wetlands to be assessed in the Recovery Assessment Plan were identified.

5.2.4 Work Schedule and Process

The Work Plan and Schedule submitted on January 24, 2012, contained a general timeline to resolve the identified regulatory issues with the District and perform the technical analyses needed to complete the Recovery Assessment Plan. The initial schedule estimated that between 2012 and 2014, Tampa Bay Water would work through the regulatory issues with the District and perform the technical studies that would provide the foundation for assessing environmental recovery. The plan was to develop one or more scopes of work and retain consultants to complete the necessary studies and site-specific assessments between 2015 and 2018. The two Recovery Assessment Plan reports specified in the Consolidated Permit are the preliminary report of findings due by December 31, 2018, and the final study report which will be submitted with the Consolidated Permit renewal application package in late 2020.

Tampa Bay Water and District staff began meeting in late 2012 to work through the identified regulatory and technical issues. The working group included Tampa Bay Water staff and District staff from the Regulatory and Resource Management divisions. The fundamental issues that were identified in the Work Plan proved to be very complex and required many discussions, additional steps, and technical studies to address the issues. Tampa Bay Water staff developed a growing and evolving list of issues requiring discussion and additional technical work needed to move forward. Tampa Bay Water and District staff began to meet at least monthly in early 2014 and each meeting included a review of the work plan outline and schedule for resolving issues and completing studies. The tracking and scheduling documents evolved over time to better suit the needs of the working group and all updates were shared with District staff at meetings and through e-mail. Annual summaries of the Recovery Assessment work have also been included in each of the Annual Compliance Reports for the Consolidated Permit. These updates to the Work Plan and Schedule and summary reports were performed to satisfy the requirements of Special Condition 11 A and B of the 2011 Consolidated Permit All of the regulatory and technical documents submitted to date that inform or support the final results of the Recovery Assessment Plan are included as appendices in this report.

During the earliest coordination meetings, Tampa Bay Water and the District recognized that the work required to complete this assessment would necessarily be sequential with each analysis or discussion dependent on the decisions and conclusions reached in the previous step. Agency staff agreed that at each step of the process, Tampa Bay Water would develop a written document to summarize the regulatory issue and proposed resolution or the work performed to resolve respective technical issues. Tampa Bay Water submitted each of these written documents to the District for consideration and written concurrence. The District staff have reviewed each submittal and provided written concurrence or a list of questions/issues to be resolved. Tampa Bay Water addressed District questions on each issue before moving to the next step in the process. Tampa Bay Water has addressed all written questions and comments posed by the District staff in this report and its supporting studies. This iterative development of technical documents and District consideration and concurrence was necessary for two reasons. First, as the resolution of the issues build on each other, it was essential that the District staff be fully informed and in agreement with each piece of the Recovery Assessment Plan work as staff moved forward. Otherwise, if there was a fundamental disagreement on one or more of the considerations that formed the basis of the Recovery Assessment Plan, the resolution of those issues could require years of discussion much additional technical work. The second reason for this collaborative approach is the sheer volume of technical work that has been developed to support the conclusions of environmental recovery; review of the technical studies as they were developed will facilitate District review of the Consolidated Permit renewal application within the limited time frame for Water Use Permit review.

The complex nature of the Recovery Assessment Plan work has required many meetings and wetland field investigations with District staff over the past several years. A list of the 132 field investigations, technical meetings, and the topics discussed at each meeting is presented in Appendix 5.2. The process followed has allowed Tampa Bay Water to fully address all of the technical and regulatory issues associated with the Recovery Assessment Plan.

5.3 Definition of the Area of Investigation

The Recovery Assessment Work Plan and Schedule identified the need to establish a geographic area of investigation within which to focus the assessments of environmental recovery. Special Condition 11 of the renewed Consolidated Permit presents the requirements for the Recovery Assessment Plan and includes a map of the generalized area of surficial aquifer impacts as of 1998 (included as Figure 5.1). This is a general figure developed by the District (as included in the 2011 renewal of the Consolidated Permit) and was based on predictive modeling and field observations. Since this map was based on the higher levels of pumping from the 11 wellfields before the reduction in pumping began in late 2002, it represented a starting point for Tampa Bay Water's investigation of recovery. Based on observations of recovery discussed in Section 3.16, the area of impact in 1998 has substantially reduced in size a new Area of Investigation needed to be defined.

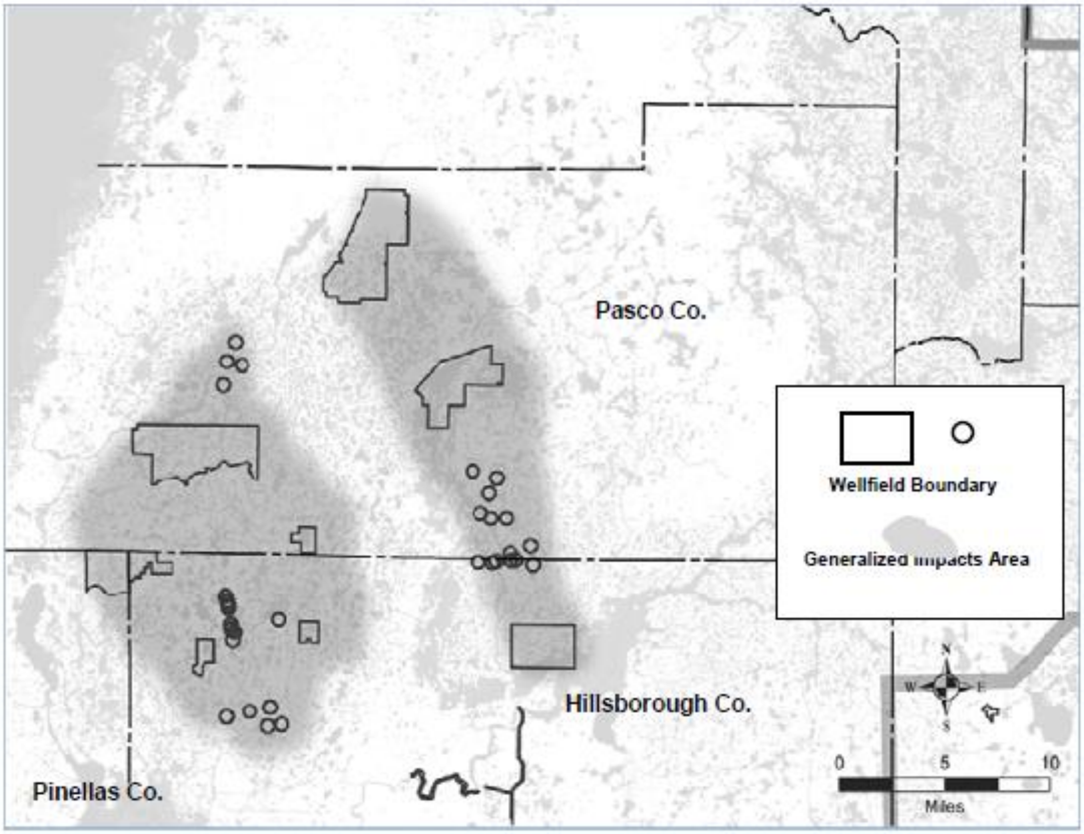

Figure 5.1: Generalized Area of Surficial Aquifer Impacts as of 1998

5.3.1 Initial Area of Investigation

The definition of this area was the initial technical work of the Recovery Assessment Plan and was the primary focus through late 2013. After initial discussions with District staff on how to define this geographic area, Tampa Bay Water staff completed a groundwater modeling and Geographic Information Systems (GIS) assessment to propose reasonable geographic limits within which wetlands and lakes would be evaluated and recovery from previous hydrologic stress assessed.

The groundwater modeling tool used was the Unit Response Matrix (URM) which was derived from the Integrated Northern Tampa Bay (INTB) model, an application of the Integrated Hydrologic Model (IHM) [see Section 3.14.5 for additional details]. The URM is the result of a stochastic analysis of the individual pumping well responses under a full temporal and spatial distribution of INTB basin rainfall (Tampa Bay Water, 2009c). For this analysis using the URM, Tampa Bay Water created two sets of modeling scenarios to account for historical and possible future pumping conditions. The level of wellfield pumping from January 2008 through December 2012 was selected to represent the historical period. This data set represents a period of time when the wellfield pumping rotation was generally stable and was after 10 of the 11 wellfields were fully interconnected to the Regional Supply System and could realize reductions in pumping. The Northwest Hillsborough Wellfield was the exception. Five individual model realizations were generated, one for each calendar year from 2008 through 2012 to account for any minor variations in wellfield pumping rotation. The average pumping from the 11 wellfields for each of these five years was less than 90 mgd so the pumping data were rescaled to an annual calendar year average of 90 mgd and are described in Tampa Bay Water (2009c).

The URM analysis also considered three potential future scenarios of wellfield pumping distribution (Scenarios A, B, and C). These three scenarios accounted for the potential abandonment of the Cosme-Odessa and North Pasco wellfields and the redistribution in pumping that might occur if either of these two wellfields were ever permanently removed from service. Like the five historical pumping realizations, the annual average pumping from the 11 wellfields equaled 90 mgd for each of the three potential future scenarios. The historical pumping realizations were rescaled to 90 mgd and the potential future scenarios each averaged 90 mgd in order to be able to assess the recovery attributable to a long-term average pumping of 90 mgd from the 11 wellfields as required by the renewed Consolidated Permit. Since the wellfields have not pumped at an annual average of 90 mgd for any particular year, it was important to predict the potential impacts at this average permitted pumping rate.

The five scaled historical pumping time series were assessed with the URM to obtain model cell drawdown time series. The temporal median drawdown was calculated from the drawdown time series for each cell in each of the five historical realizations. The 2-foot predicted drawdown contour in the surficial aquifer was chosen for this analysis, similar to the hydrologic screening criteria used in the Candidate Sites Evaluation Study (Berryman & Henigar, 2000) for the establishment of an investigation area for impact analysis and recovery prediction. Five realizations of drawdown contours were produced from cell median drawdowns where 2-foot surficial aquifer drawdown contours could be delineated. To summarize the five historic realizations of pumping, the maximum extent of the 2-foot surficial aquifer drawdown envelopes was developed. This produced a single set of drawdown contours that represented the maximum 2-foot predicted contour in the surficial aquifer for all five historical realizations.

The three potential scenarios of wellfield pumping were assessed in a similar manner. The three future scenarios each produced a time series of predicted drawdown in the surficial aquifer and the maximum extent of the 2-foot contours were plotted on a single figure. A GIS project was developed to incorporate the predicted drawdown contours from the historic and future pumping scenarios as separate layers. A kriging analysis was performed to establish the maximum drawdown under either scenario (historical distribution or potential future distribution of pumping). This URM analysis is presented in a report entitled “Defining Areas of Investigation for Recovery Analysis” (Tampa Bay Water, 2013). The resulting map from the kriging analysis shows a single set of predicted 2-foot drawdown contours representing the maximum predicted drawdown in the surficial aquifer from Consolidated Permit wellfield pumping at 90 mgd. This predicted drawdown map was submitted to the District on January 23, 2014, as Figure 1 of that submittal and is included here as Figure 5.2. This URM analysis report was included with the submittal submitted to the District and is attached here as Appendix 5.3.

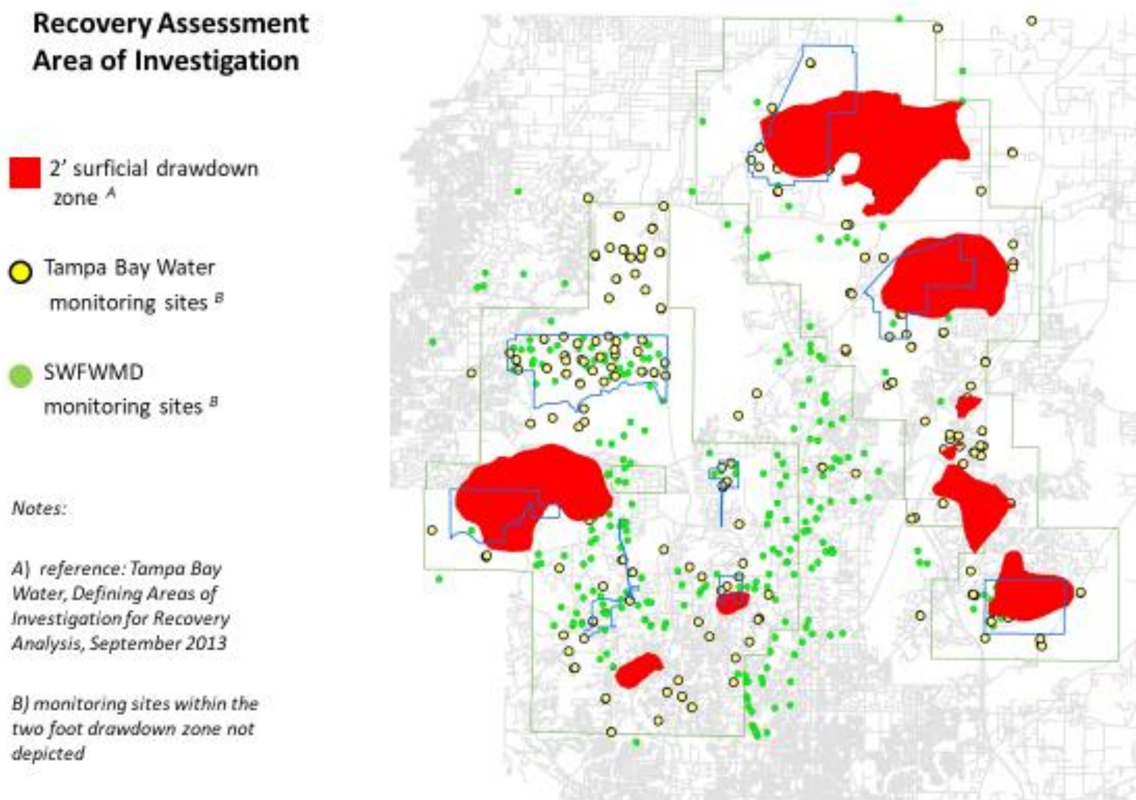

Figure 5.2: Initial Recovery Assessment Area of Investigation

With the January 2014 submittal letter, Tampa Bay Water proposed using the modeled 2-foot drawdown contour in the surficial aquifer as the Area of Investigation for the Recovery Assessment Plan. Tampa Bay Water committed to assess monitored lake and wetland sites using empirical (hydrologic) data against metrics to be developed and to attempt the assessment of recovery for unmonitored wetlands and lakes within this defined Area of Investigation. Staff further committed to develop final lists of monitored lakes and wetlands for evaluation in consultation with District staff following approval of this proposed approach. The District considered these requests and approved the proposed Area of Investigation for use in the Recovery Assessment Plan in a letter dated May 22, 2014 (included in Appendix 5.3).

5.3.2 Area of Investigation Updates (2013-2016)

Tampa Bay Water staff compiled monthly pumping data from each of the 11 wellfields at the end of calendar year 2016 to determine if the wellfield pumping distribution since 2012 had changed from what was assessed through the original Area of Investigation analysis. The actual annual average pumping rate for each of the 11 wellfields for calendar years 2013 through 2016 was compared to the maximum annual average pumping values for each wellfield from the original analysis. The analysis showed that during one or more years between 2013 and 2016, the annual average pumping rate exceeded the maximum annual average pumping quantity previously modeled for the Cosme-Odessa, Morris Bridge, and North Pasco wellfields. The cumulative average pumping rate from the 11 wellfields was less than 90 mgd for each of the recent years but the distribution of pumping between wellfields had changed from the previously modeled distribution. Therefore, staff updated the modeling assessment to see if the Area of Investigation should be modified to account for these increased pumping values for the identified wellfields.

The URM was again used to produce predicted surficial aquifer drawdown data for each calendar year from 2013 through 2016. The actual pumping rate from each production well was used in this update analysis and the total average annual pumping values for the 11 wellfields were not scaled upward to 90 mgd. For each cell in the model, the maximum predicted drawdown data in the surficial aquifer for each of the four years (2013 – 2016) was kriged and a new predicted 2-foot drawdown contour was created. This new drawdown contour was compared to the 2-foot drawdown contour that defined the original Area of Investigation. There were slight differences in most of the contours with some areas expanding and some areas shrinking as was expected. When compared to the original model, a small 2-foot drawdown contour was predicted in the center of the Starkey Wellfield and the 2-foot drawdown contour was no longer present at the Northwest Hillsborough Wellfield where recent pumping had been substantially reduced. Figure 5.3 shows a comparison of the original and updated predicted 2-foot drawdown contours in the surficial aquifer.

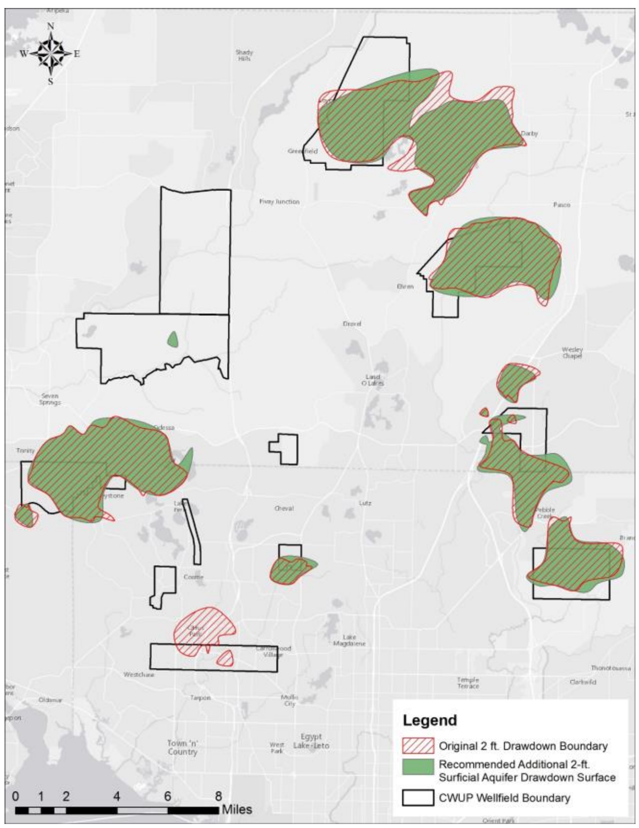

Figure 5.3: Area of Investigation – comparison of original and revised 2-foot drawdown contours in the surficial aquifer

The process for this updated analysis and the results of the contour comparison were submitted to the District on November 2, 2017 (Appendix 5.4). Tampa Bay Water proposed to modify the Area of Investigation to include the maximum extent of the two sets of drawdown contours since he Recovery Assessment Plan is designed to analyze wetland recovery or health related to potential impacts from the wellfields. The original Area of Investigation contours did not shrink; they expanded to include all new areas of predicted drawdown in the surficial aquifer based on the recent pumping distribution. The District reviewed this proposal and approved the 2017 Updated Area of Investigation on December 6, 2017 (included in Appendix 5.4). The predicted surficial aquifer drawdown data from calendar years 2003 through 2016 based on actual wellfield pumping was part of the URM model output from this updated analysis. This predicted drawdown data for each cell in the model was preserved for later use in assessing the recovery of monitored lakes and wetlands.

5.3.3 Area of Investigation Update (2017-2018)

Tampa Bay Water staff compiled monthly pumping data from each of the 11 wellfields for the years 2017 and 2018 to determine if the wellfield pumping distribution had again changed from the prior analyses. The actual annual average pumping rate for each of the 11 wellfields for calendar years 2017 and 2018 was compared to the maximum annual average pumping values for each wellfield from the original and updated analyses. The current analysis showed that during these two additional years, the annual average pumping rate exceeded the maximum annual average pumping quantity previously modeled for the Cosme-Odessa, Section 21, and Starkey wellfields. The cumulative average pumping rate from the 11 wellfields was less than 90 mgd for both of the recent years but the distribution of pumping between wellfields had changed from the previously modeled distributions. Therefore, staff determined that updated modeling should be performed again to adjust the 2017 Updated Area of Investigation, if necessary, to account for these changes in pumping distribution.

The URM was used as previously described for the 2013 – 2016 update analysis to produce predicted surficial aquifer drawdown data for calendar years 2017 and 2018. The actual pumping rate from each production well was used in this update analysis and the total average annual pumping values for the 11 wellfields were not scaled upward to 90 mgd. The maximum predicted drawdown data in the surficial aquifer for each cell in the model was generated for 2017 and 2018. This data was kriged and a new predicted 2-foot drawdown contour was created and compared to the 2-foot drawdown contour that defined the 2017 Updated Area of Investigation. As before, there were slight differences in most of the contours with some areas expanding and some areas shrinking based on the slightly different pumping distribution. When compared to the 2017 Updated Area of Investigation, the predicted 2-foot drawdown contours increased to the north of the Eldridge-Wilde Wellfield and to the northeast of the Section 21 Wellfield; the predicted 2-foot drawdown contour at the Cross Bar Ranch Wellfield was greatly reduced from the prior updated analysis. Figure 5.4 shows a comparison of the first update (2017) and this most recent assessment of the predicted 2-foot drawdown contours in the surficial aquifer.

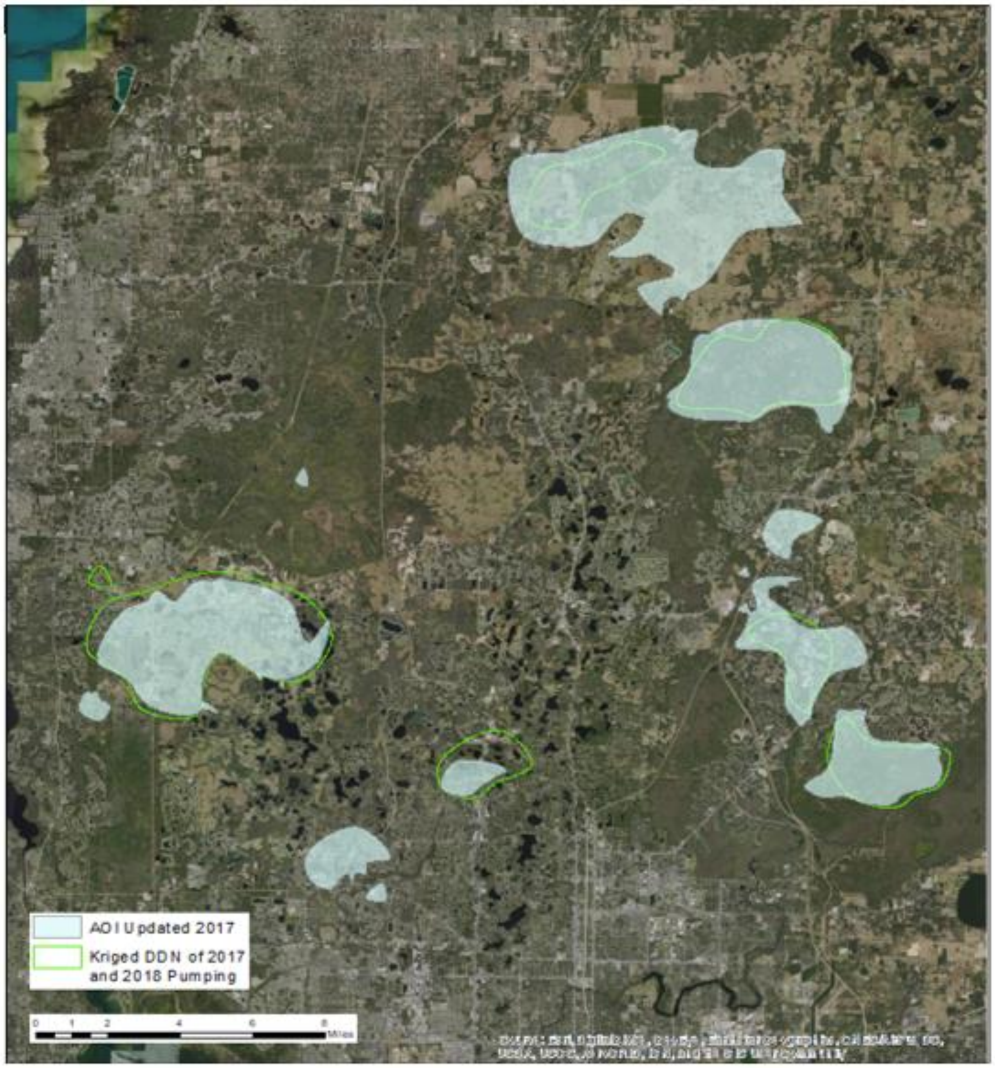

Figure 5.4: Comparison of the 2013 – 2016 and 2017 – 2018 revised 2-foot drawdown contours in the surficial aquifer

The process used in this second (2019) update and a comparison of results between this and the 2017 update are described in a technical memorandum dated June 5, 2019 (Appendix 5.5). The last map in the technical memo shows the final (2019) Area of Investigation for the Recovery Assessment Plan (included here as Figure 5.5). These areas represent the maximum extent of the surficial aquifer drawdown contours as compiled from the original Area of Investigation, the 2013 – 2016 update and the 2017 – 2018 update analyses. The updated Area of Investigation contours did not shrink, they expanded to include any new areas of predicted drawdown in the surficial aquifer based on the recent pumping distribution. Due to the timing of the final report preparation, it was only possible to analyze the distribution of pumping through 2018; the calendar year 2019 pumping data could not be analyzed and processed until early 2020 and staff were finalizing analyses for the Recovery Assessment Plan.

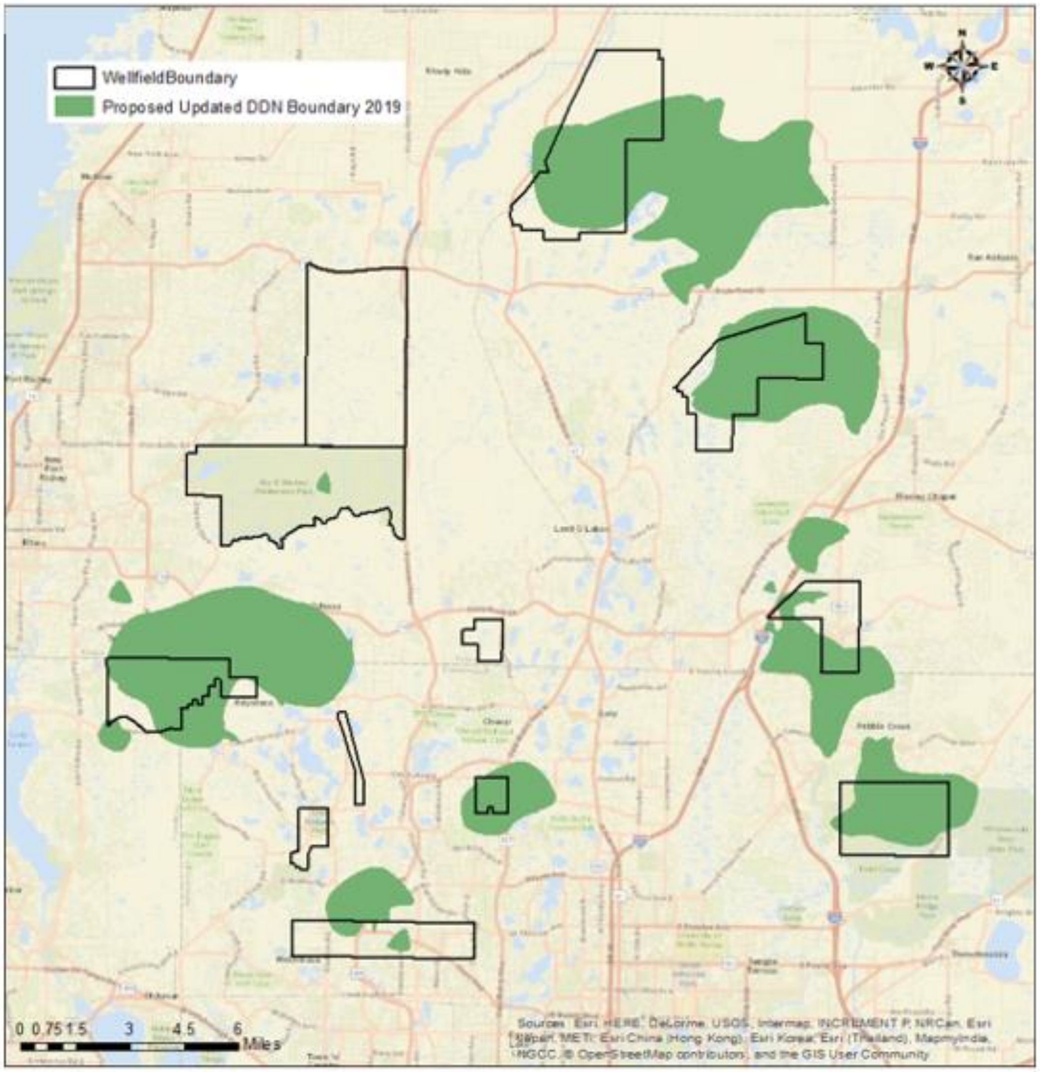

Figure 5.5: Final Recovery Assessment Plan Area of Investigation

5.3.4 Application of the Area of Investigation

Tampa Bay Water and the District had agreed to assess recovery at all monitored lakes and wetlands so the original and updated Area of Investigation were used to identify other environmental features near the wellfields. Unmonitored lakes and wetlands within the maximum extent of the predicted 2-foot drawdown contours could potentially be affected by continued wellfield pumping at an annual average of 90 mgd, so these unmonitored sites were identified for analysis. The identification of these unmonitored sites will be discussed in Section 5.4.4 of this report. Each time the Area of Investigation was updated, Tampa Bay Water identified any unmonitored lakes and wetlands within any new areas covered by the predicted 2-foot drawdown contours and added them to the unmonitored site list. The Area of Investigation was used to ensure Tampa Bay Water was evaluating any lake or wetland that could potentially be impacted by continued wellfield; this provides the comprehensive assessment approach identified in the Initial Work Plan and Schedule.

5.4 Specific Environmental Features to be Evaluated

Tampa Bay Water continued developing the fundamental components of the Recovery Assessment Plan by working with the District to develop lists of specific lakes and wetlands where recovery would be assessed. In the submittal letter for the first Area of Investigation study, Tampa Bay Water committed to assess monitored lakes and wetlands using empirical data and discussions with District staff became focused on identifying all monitored sites. Between the two agencies, water level data from hundreds of individual lakes and wetlands in the northern Tampa Bay area have been collected. Agency staff agreed that the Recovery Assessment Plan should include all lakes and wetlands on or near the 11 wellfields that had historical water level information. Historical water level information was defined as data that covered significant portions of the time periods before and after the wellfield pumping was reduced. Having data in both time periods would allow analysis of the data on a site-by-site basis to evaluate the environmental recovery that is attributable to the reduction in pumping as required by the renewed Consolidated Permit.

5.4.1 Initial Lists of Monitored Lakes and Wetlands

Tampa Bay Water staff compiled lists of monitored lakes and wetlands that are associated with the environmental monitoring programs at each of the 11 wellfields. The District staff compiled lists of all monitored wetlands and lakes on or near the wellfields, including sites with adopted Minimum Levels. Both agencies performed a quality control review of the data entered in the lists and duplicate site entries were eliminated. The individual lists included much more information that just the site name and location; the additional data included database reference numbers, the type of wetland system, which agency performed monitoring, the type of data collected, and the data period of record. Information from both agencies was combined into two lists, one for monitored lakes and one for monitored wetlands, and Tampa Bay Water began to review the spatial coverage of the monitored sites. These discussions began in late 2012 and continued through the end of 2014 to develop separate lists of monitored lakes and monitored wetlands for assessment.

The monitored wetland list that was compiled included the wetland type as identified in the various monitoring programs of Tampa Bay Water or the District. In late 2014, Tampa Bay Water and District staff met in a series of focused meetings to create a standard naming system for the Recovery Assessment Plan wetland types. During those meetings, each wetland was assigned to one of those standard wetland types based on their current morphology and vegetation type. As the list was developed, staff was aware that a numeric metric of health or recovery would have to be developed along with a method to assess the recovery of each type of wetland. The Recovery Assessment Wetland Types are: Isolated Cypress, Isolated Marsh, Connected Wetland, Other, Undetermined, and Lake. By the end of 2014, all wetlands on the draft list had been assigned a standard Recovery Assessment Wetland Type.

Tampa Bay Water submitted the lists of monitored lakes and monitored wetlands for inclusion in the Recovery Assessment Plan to the District on January 26, 2015 (see Appendix 5.6). These two lists of monitored sites represented the best available information from both agencies and were proposed as the starting point for the site-specific recovery analyses. In this submittal letter, Tampa Bay Water also asked for concurrence that the Recovery Assessment Plan would not include an assessment of compliance with Minimum Levels in the Upper Floridan Aquifer. This assessment and an evaluation of saltwater intrusion potential will be addressed separately with the renewal application for the Consolidated Permit. The District responded in writing on June 19, 2015 agreeing with the lists of monitored lakes and wetlands and the commitment to address the Upper Floridan Aquifer issues separately from the Recovery Assessment Plan (included in Appendix 5.6).

5.4.2 Final List of Monitored Lakes

The initial list of lakes in the Recovery Assessment Plan included 141 individual lakes located on or near the 11 wellfields. As progress was made on the initial assessment of recovery for these lakes, staff noted changes that needed to be made to the list of lakes that had been previously approved by the District. These changes were discussed with the District on April 13, 2017 and a resolution on each recommended change was reached. The changes to the Recovery Assessment Plan lake list are summarized in a submittal letter dated May 1, 2017 which includes a table showing each change to be made and the reason for those changes (Appendix 5.7). The changes included the addition of one lake, the deletion of four lakes, and minor changes to site-specific information for a few lakes. The May 1, 2017 submittal also contains the proposed initial recovery status for each of the lakes on the revised list; this information will be discussed in Chapter 8 of this report. The District reviewed the submittal and approved the proposed changes to the Recovery Assessment Plan lake list on May 30, 2017 (included in Appendix 5.7).

Tampa Bay Water staff continued assessing the recovery status of the listed lakes and submitted the findings for ten lakes on July 11, 2018; results will be discussed in Chapter 8 of this report. There are issues with the water level data record for Raft Lake but it remained on the monitored lake list and was assessed using a weight-of-evidence approach. An assessment of one lake on the monitored lake list (Lake Velburton in Northwest Hillsborough County) was not possible due to a lack of water level data. Only five water level data readings are available for this lake which occurred before the reduction in groundwater pumping from the 11 wellfields. During the September 13, 2018 meeting with the District, it was agreed to delete this lake from the monitored lake list due to lack of available data. A summary report of the attempted assessment of Velburton Lake and a request to delete this lake from the monitored lake list was submitted to the District on November 28, 2018 and is attached as Appendix 5.8. This summary report confirms that there is no hydrologic or vegetative stress to the lake based on a review of available historical aerial photography. The report further concludes that based on this historical photographic data, water level fluctuation in the lake is minimal between years. Velburton Lake has been deleted from the monitored lake list as confirmed by a District letter dated December 20, 2018 (included in Appendix 5.8).

With this final change, a total of 137 individual lakes are included on the Recovery Assessment Plan monitored lake list. The final list of lakes is shown in Table 5.1 and the location of the lakes in relation to the Consolidated Permit Wellfields is shown in Figure 5.6.

Table 5.1. Recovery Assessment Monitored Lake List - Final

Wetland ID	TBW Wetland ID	Site Name	County	aka	District Site ID	associated wetland	SAS drawdown zone	POR Begin	POR End	MFLs?	MFL Reevaluation?	Management Level
601		Alice Lake	Hillsborough		19874			Jun-71	current	MFL	Reevaluated	No
602		Allen Lake	Hillsborough		19834/773919			Jun-71	current	MFL	Reevaluated	No
28	4890	Alligator Pond	Pasco	CBR Q31	n/a			May-99	current			No
118	4962	Amelia Lake	Hillsborough	W272717	n/a	W272717		May-84	current			No
603		Ann-Parker Lake	Pasco		19718		1	Oct-69	current	MFL		No
120		Armistead Lake	Hillsborough		19800/19590			May-77	current			Yes
604		Artillery Lake	Hillsborough		19893/841333		2	Dec-74	current			Yes
600		Avis Lake	Hillsborough		19737			Mar-87	current			Yes
605		Bass (Holiday) Lake	Pasco		19720		1	Oct-83	current			Yes
606		Bell Lake	Pasco		19134/18510			Jul-77	current	MFL		No
15	4877	Big Fish Lake	Pasco	CBR Q18	20474		2	Jun-80	current	MFL	Reevaluated	No
607		Big Lake Vienna	Pasco		19132			May-86	current			Yes
608		Bird Lake (Hillsborough)	Hillsborough		19793	S21-262718-dropped	1	Apr-77	current	MFL	Yes	No
609		Bird Lake (Pasco)	Pasco		19100			Feb-78	current	MFL	Reevaluated	No
610		Black Lake	Pasco		22145			Oct-73	current			No
611		Boat lake	Hillsborough		19743			Mar-77	current			Yes
414	5412	Bonnet Lake	Pasco	S-008	n/a			Mar-83	current			No
612		Brant Lake	Hillsborough		19837			Jun-71	current	MFL	Reevaluated	No
613		Brooker Lake	Hillsborough		19831			Mar-77	current			Yes
615		Browns Lake	Hillsborough		19817			Jun-71	current			Yes
616		Buck Lake	Hillsborough		19854			Jul-72	current			Yes
617		Burrell Lake	Hillsborough		19169			Jan-78	current			Yes
618		Calm Lake	Hillsborough		19879	C142717-dropped		Jan-65	current	MFL	Scheduled	No
620		Camp Lake	Pasco		19638			Apr-68	current	MFL	Reevaluated	No
621		Carroll Lake	Hillsborough		19740/19742/670728			May-46	current	MFL		No
622		Catfish Lake	Pasco		19101			Feb-88	current			Yes
623		Cedar Lake East	Hillsborough		670725/670726			Sep-07	Feb-14			No
		Cedar Lake West	Hillsborough					Jun-07	Nov-16			No
624		Chapman Lake	Hillsborough		19795			Aug-82	current			Yes
625		Charles Lake	Hillsborough		19836/756262		1	Jun-71	Sep-14	MFL	Scheduled	No
626		Church Lake	Hillsborough		19858			Jun-31	current	MFL	Scheduled	No
3	4865	Clear Lake	Pasco	CBR Q03	n/a		2	Jul-77	current			No
627		Commiston Lake	Hillsborough		19830			Sep-89	current			Yes
629		Cooper Lake	Hillsborough		19832	S21-NE112718-dropped		May-46	current			Yes
630		Cow (East) Lake	Pasco		19111			Jul-76	current			Yes
631		Crenshaw Lake	Hillsborough		19839		1	Jun-71	current	MFL		No
632		Crescent Lake	Hillsborough		19892	COS-102717-dropped	2	May-81	current	MFL		No
25	4887	Crews Lake	Pasco	CBR Q28	20506/777811			Apr-81	current	MFL		Yes
633		Crystal Lake	Hillsborough		19827/19828			Jul-99	current	MFL	Reevaluated	No

Wetland ID	TBW Wetland ID	Site Name	County	aka	District Site ID	associated wetland	SAS drawdown zone	POR Begin	POR End	MFLs?	MFL Reevaluation?	Management Level
634		Curve Lake	Pasco		19142			Jul-76	current			No
636		**Cypress Lake**	**Hillsborough**		**19804**			Feb-93	current	MFL	Scheduled	No
252	**4980**	**Dan Lake**	**Hillsborough**	**SW062717**	**19723/759897**	ELW-SW062717	2	Mar-80	current	MFL	Reevaluated	No
368	4984	Darby Lake	Hillsborough	202718	n/a	S21-202718		Feb-83	current			No
637		**Deer Lake**	**Hillsborough**		**19818/ 18813**			Aug-77	current	MFL	Reevaluated	No
638		**Dosson Lake**	**Hillsborough**		**19846/797348**			Jun-71	current	MFL	Reevaluated	No
639		**Echo Lake**	**Hillsborough**		19856			Sep-57	current	MFL	Scheduled	No
640		Eckels Lake	Hillsborough		19241			Mar-78	current			Yes
642		Elaine Lake	Hillsborough		19739			Dec-80	current			Yes
643		Elizabeth Lake	Hillsborough		19881			Apr-77	current			Yes
644		Ellen Lake	Hillsborough		19930716761		1	Jun-82	Jan-16			No
645		**Fairy (Maureen) Lake**	**Hillsborough**		**19821**			Aug-77	current	MFL		No
646		Fern Lake	Hillsborough		19884			Aug-77	current			Yes
647		Floyd Lake	Pasco		19126			Feb-78	current			Yes
648		Flynn Lake	Hillsborough		19170			May-01	current			No
649		**Garden (Thomas) Lake**	**Hillsborough**		**19813**			May-77	current	MFL	Scheduled	No
651		Gass Lake	Hillsborough		19727		1	May-77	current			Yes
653		George (Hillsborough) Lake	Hillsborough		19744			Mar-77	current			Yes
37	4897	Goose Lake	Pasco	CBR T04	n/a		2	Dec-77	current			No
655		Gooseneck Lake	Pasco		19106			Mar-78	current			Yes
657		**Green Lake**	**Pasco**		**20417**			Apr-81	Sep-14	MFL		No
658		**Halfmoon Lake**	**Hillsborough**		**19789**			Apr-77	current	MFL	Scheduled	No
659		Halls Lake	Hillsborough		19755			Oct-83	current			Yes
660		**Hanna Lake**	**Hillsborough**		**19178/ 19177**			Jun-46	current	MFL		Yes
661		**Harvey Lake**	**Hillsborough**		**19815**			Apr-70	current	MFL	Reevaluated	No
662		**Helen Lake**	**Hillsborough**		**19848/723923**			Feb-93	current	MFL		No
663		Hiawatha Lake	Hillsborough		19722		1	May-81	current			Yes
665		**Hobbs Lake**	**Hillsborough**		**19816**			Jun-46	current	MFL	Yes	No
666		Hog Island Lake	Hillsborough		19190			Mar-78	current			Yes
119		**Horse Lake**	**Hillsborough**	**WC262717**	**19866/815809/827842**	WC262717-dropped		May-30	current	MFL	Reevaluated	No
667		Island Ford Lake	Hillsborough		19888/20004/19880		1	Jun-71	current			Yes
392	**5005**	**Jackson Lake**	**Hillsborough**	**NW212718**	**19812/735159**	S21-NW212718	1	May-73	current	MFL	Scheduled	No
669		James Lake	Hillsborough		19878	COS-NC262717		Dec-83	current			Yes
670		Jo Ann Lake	Pasco		19104			Feb-88	current			Yes
671		Josephine Lake	Hillsborough		19798			Dec-86	current			Yes
672		Joyce (Hog) Lake	Pasco		19112			May-84	current			Yes
673		**Juanita Lake**	**Hillsborough**		**19806/827032/ 827848/827849**	COS-EC222717		Aug-82	current	MFL	Reevaluated	No
674		**Keene Lake**	**Hillsborough**		**19189**			Nov-48	current	MFL		Yes
675		**Kell Lake**	**Hillsborough**		**19301/ 19300**			Jun-71	current	MFL		Yes
676		Keystone Lake	Hillsborough		19877/19876/19889			Apr-46	current			Yes
678		**King Lake (West) at Drexel**	**Pasco**		**19135**			Jul-76	current	MFL		No

Wetland ID	TBW Wetland ID	Site Name	County	aka	District Site ID	associated wetland	SAS drawdown zone	POR Begin	POR End	MFLs?	MFL Reevaluation?	Management Level
679		LeClare Lake	Hillsborough		19791			Oct-77	current			Yes
680		Linda Lake	Pasco		19122			Oct-69	current	MFL	Scheduled	No
681		Lipsey Lake NR Sulphur Springs	Hillsborough		19741/670234/19736/ 19735			Oct-83	current			Yes
683		Little Lake	Hillsborough		19805			Jun-31	current			Yes
684		Little Moon Lake	Hillsborough		19895			Oct-77	current	MFL	Reevaluated d	No
685		Little Moss (Como) Lake	Pasco		19635			May-86	current			Yes
686		Long Lake	Hillsborough		19726			Feb-77	current			Yes
687		Magdalene Lake	Hillsborough		19751/19750/19752/ 19753			May-46	current			Yes
688		Marlee Lake	Hillsborough		19857			Apr-94	current			No
689		Merrywater Lake	Hillsborough		19841/825768	S21-EC222718-?	1	Apr-94	current	MFL	Reevaluated	No
472	5476	Moon Lake (Pasco)	Pasco	STK SC-32	20798/827805/759472			Sep-90	current	MFL	Reevaluated	No
692		Moss Lake	Pasco		19636			May-86	Sep-11			Yes
693		Mound Lake	Hillsborough		19883			Jul-72	current	MFL		No
695		Mud Lake (Geneva Lake)	Pasco		22146			Apr-81	current			Yes
696		Myrtle Lake	Pasco		19103			Feb-88	current			Yes
697		Noreast Lake	Hillsborough		670727			Oct-07	current			No
698		Osceola Lake	Hillsborough		19894		2	Oct-89	current			Yes
699		Padgett Lake	Pasco		19130/ 19127			Jul-85	current	MFL	Reevaluated	No
32	4892	Pasco Lake	Pasco	CBR Q35	20525/782682/777863		2	Jul-86	current	MFL	Scheduled	No
701		Pierce Lake	Pasco		20426			Apr-81	current	MFL	Reevaluated	No
702		Platt Lake	Hillsborough		19728			May-46	current	MFL		No
703		Pretty Lake	Hillsborough		19873/19799/19796/ 19870/19801/19802/ 19799			Jul-71	current	MFL		No
24	4886	Raft Lake	Pasco	CBR Q27	n/a		2	Oct-80	current			No
704		Rainbow Lake	Hillsborough		19807			Jun-71	current	MFL	Yes	No
705		Raleigh Lake	Hillsborough		19861			Sep-30	current	MFL	Reevaluated	Yes
706		Reinheimer Lake	Hillsborough		19824		1	Aug-77	current	MFL		No
709		Rogers Lake	Hillsborough		19863/20007/19862/ 778393/778395/ 778396			Apr-95	current	MFL	Reevaluated	No
710		Round Lake	Hillsborough		19840		1	Jan-65	current	MFL	Reevaluated	No
364	9548/5401	Ryals Lake	Pasco	Ryals Lake (NP-31)/NP-35	n/a			Oct-89	current			No
711		Saddleback Lake	Hillsborough		19838		1	Jun-71	current	MFL	Reevaluated	No
712		Sapphire Lake	Hillsborough		19826			Feb-93	current	MFL	Scheduled	No
714		Saxon Lake	Pasco		19110			Jan-83	current			Yes
741		Seminole Lake	Pasco		19717		1	Oct-69	current			Yes
715		Simmons Lake	Hillsborough		n/a			Oct-85	current			No
161	6097	Stanford Lake	Pasco	CYC C03	n/a			May-00	current			No
717		Starvation Lake	Hillsborough		19842			Jun-61	current	MFL		Yes

Wetland ID	TBW Wetland ID	Site Name	County	aka	District Site ID	associated wetland	SAS drawdown zone	POR Begin	POR End	MFLs?	MFL Reevaluation?	Management Level
718		**Stemper Lake**	**Hillsborough**		**19303/ 19304**			May-46	current	MFL	Reevaluated	No
719		**Strawberry Lake**	**Hillsborough**		**19883**			Jun-71	current	MFL	Reevaluated	No
720		**Sunset Lake**	**Hillsborough**		**19811**		1	Jul-72	current	MFL	Reevaluated	No
721		**Sunshine (Sunrise) Lake**	**Hillsborough**		**19981**			Feb-04	current	MFL	Reevaluated	No
722		Tampa (Turtle) Lake	Pasco		19099			Mar-78	current			Yes
723		**Taylor Lake**	**Hillsborough**		**19875**			Jun-71	current	MFL		No
724		Thomas Lake	Hillsborough		19835			Jul-71	current			Yes
725		Thorpe Lake	Hillsborough		19860			Jan-93	Oct-97			
726		Toni Lake	Pasco		19102			Feb-88	current			Yes
727		Turkey Ford Lake	Hillsborough		19850	S21-E182718-?		Apr-70	current			Yes
729		Twin Lake (Pasco)	Pasco		19107/798662			Apr-78	current			
730		Unnamed Lake 1B14	Hillsborough		19784		2	Jun-79	current			?
731		Unnamed Lake 2B14	Hillsborough		19787		2	Dec-83	current			?
732		**Unnamed Lake 22 (Loyce)**	**Pasco**		**20508/783541**		2	Oct-83	current	MFL		No
157	3897	Unnamed Lake 26	Pasco	CYB C18	19105			Feb-88	current			Yes
734		Van Dyke Lake	Hillsborough		19851			Mar-70	Jun-98			
736		**Virginia Lake**	**Hillsborough**		**19814**			Sep-77	current	MFL	Reevaluated	No
737		Wastena Lake	Hillsborough		19895		2	Feb-93	Oct-97			
738		White Trout Lake	Hillsborough		19240/670230			Jul-71	current			Yes
739		Wistaria Lake	Pasco		19139			May-86	current			Yes
740		Wood Lake	Hillsborough		19886/20001/19882			Oct-97	current			No

Bold Text – MFL Lake
Proposed Pretty-Josephine-Rock Lake Group (analyze together)
Proposed Helen-Ellen-Barbara Lake Group (analyze together)

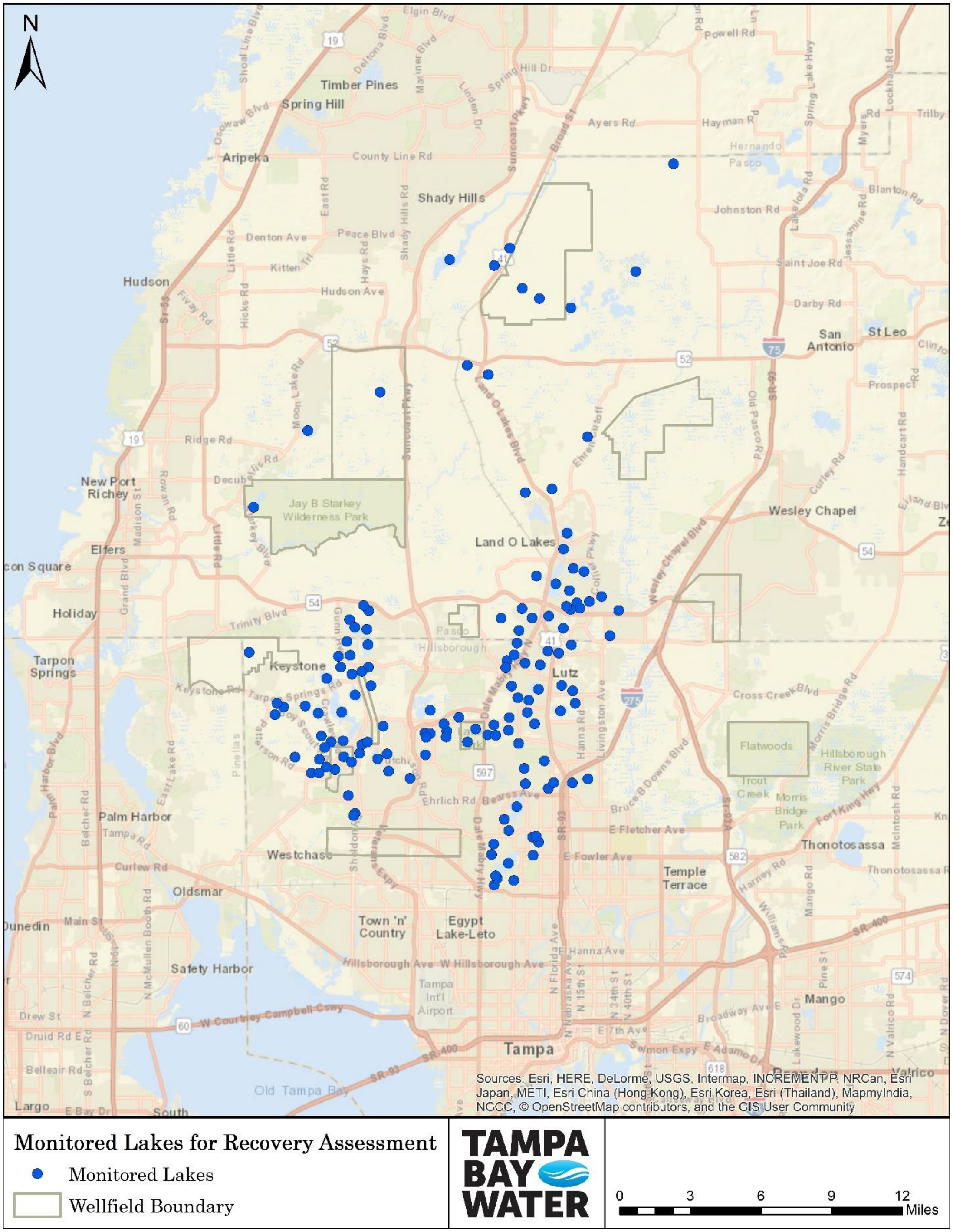

Figure 5.6: Monitored Lakes to be Assessed

5.4.3 Final List of Monitored Wetlands

The initial list of wetlands in the Recovery Assessment Plan included 399 individual wetlands located on or near the 11 wellfields. Tampa Bay Water performed preliminary assessments of recovery for each listed wetland on a wellfield-by-wellfield basis and a discussion of this process and the individual assessment reports are presented in later sections of this report. Tampa Bay Water and District staff worked collaboratively to review each preliminary assessment to keep track of the collective changes that were needed to the monitored wetland list. These changes included the addition and deletion of sites, as well as modifications to wetland site attributes on the table. All of the proposed changes were summarized in a submittal letter dated April 23, 2018 and included a strike-through and underline version of the initial monitored wetland list showing all proposed changes (Appendix 5.9). The District staff reviewed the proposed changes and responded on June 27, 2018 (included in Appendix 5.9) with questions about some of the proposed changes and they proposed additional changes (both wetland sites and attributes) that Tampa Bay Water had not included in the April 23, 2018 submittal. Some sites were erroneously included on the initial monitored wetland list or duplicate listings existed for the same wetland; these erroneous table entries were deleted as summarized in the April 23, 2018 submittal.

Tampa Bay Water and District staff discussed all of the proposed changes at the July 12, 2018 meeting and consensus was reached on all changes that needed to be made to the monitored wetland list. The agreed-upon changes were submitted to the District on July 20, 2018 (Appendix 5.10). The proposed changes included the addition of two wetlands (inadvertently omitted from the original list), the deletion of 10 wetlands (wetlands which no longer exist, wetlands impacted by multiple causes, insufficient water level data, and wetlands far from the wellfield areas), and changes to the Recovery Assessment wetland type for a few sites. The District approved the modified wetland list on August 3, 2018 (included in Appendix 5.10).

The July 20, 2018 proposal of changes to the monitored wetland list included a recommendation for wetland CYC C-30, which is a ditched stream tributary to Cypress Creek north of the Cypress Creek Wellfield. It was agreed to change the Recovery Assessment wetland type for this site from “Other” to “Connected Wetland” and try to assess the recovery of the site with the Connected Wetland method and metric (discussed in Section 6.3.5 of this report). It was also agreed that if this approach was inconclusive due to lack of data following the pumping reduction from the wellfields, Tampa Bay Water would submit a summary of the assessment attempts and delete this site from the list of monitored wetlands. Tampa Bay Water staff attempted to assess this wetland using the connected wetland method but the period of record data for this wetland ended in February 2003, just after the reduction in wellfield pumping. The elevations of the water level monitoring devices at this site were never surveyed so all available data are relative to land surface. The monitoring devices were destroyed many years ago and there is no opportunity to update these data. Based on the lack of usable data and little data in the post-pumping cutback period, staff were unsuccessful at evaluating the recovery of this wetland. A summary of the assessment attempts was submitted to the District as part of the report “Recovery Assessment of Previously Unbinned Monitored Wetlands and Monitored Wetlands Previously Binned as “More Detailed Analysis Needed” at Seven Consolidated Water Use Permit Wellfields” which was submitted on December 19, 2018 (attached as Appendix 9.4). This wetland has now been removed from the monitored wetland list.

The December 19, 2018 submittal for More Detailed Assessment Needed and Unbinned Wetlands (Appendix 9.4) also included a request to delete site CYC C22 from the monitored wetland list. This wetland was bisected by the construction of State Road 54 in southern Pasco County; the portion of the wetland named C22 is located on the south side of the road and the portion of the wetland named C22A is located on the north side of the road. Tampa Bay Water assessed site C22A with the unmonitored wetlands (Section 6.5) since water level monitoring was terminated in 2010 and no recent data exists. The portion of the wetland named C22 was never monitored and this site has now been removed from the monitored wetland list.

With these final changes, a total of 378 individual wetlands are now included on the Recovery Assessment Plan monitored wetland list. The final list of wetlands is shown in Table 5.2 and the location of the wetlands in relation to the Consolidated Permit Wellfields is shown in Figure 5.7.

Table 5.2: Recovery Assessment Monitored Wetland List - Final

TBW Wetland Site ID	Wetland ID	Associated Wellfield	TBW Name 1	SWFWMD Name 1	Wetland Type	TBW Wetland Type (if different)	RA Wetland type	Historically Hydrologically Monitored By	Currently Hydrologically Monitored By	MFL?	Historic WAP?	Listed as Active in TBW Site Manager?	Current WAP?	comment	POR
4863	1	CBR	CBR Q01	CBARWF Q-1	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1990-current
4864	2	CBR	CBR Q02		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1990-current
4866	4	CBR	CBR Q04	Duck Pond	Marsh Isolated		Isolated Marsh	Both	Both		Both	yes	Both		1977-current
4867	5	CBR	CBR Q05		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1990-current
4868	6	CBR	CBR Q06		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1990-current
4869	7	CBR	CBR Q07		Marsh Isolated		Other	TBW	TBW		TBW	yes	TBW		1990-current
4870	8	CBR	CBR Q08		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1985-current
4871	9	CBR	CBR Q10		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1990-current
4872	10	CBR	CBR Q12		Cypress Marsh Isolated		Other	TBW	TBW		TBW	yes	TBW		1990-current
4873	11	CBR	CBR Q14		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1990-current
4874	12	CBR	CBR Q15		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1990-current
4875	13	CBR	CBR Q16		Marsh Isolated	Lake/Marsh	Isolated Marsh	TBW	TBW		TBW	yes	TBW		1980-current
4876	14	CBR	CBR Q17		Marsh Isolated	Lake/Marsh	Isolated Marsh	TBW	TBW		TBW	yes	TBW		1983-current
~~4884~~	16	CBR	C25		Cypress Marsh Isolated	Marsh	Isolated Cypress	TBW	None		TBW	yes	None	TBW Site Manager lists Q19 as inactive	1981-current
4879	17	CBR	CBR Q20		Cypress Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1985-current
4880	18	CBR	CBR Q21		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1999-current
4882	20	CBR	CBR Q23		Borrow Pond		Other	TBW	None		None	no	None		1985-2011
4883	21	CBR	CBR Q24	CBARWF TQ-1 West	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1999-current
4884	22	CBR	CBR Q25	CBARWF Stop #7	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1999-current
4885	23	CBR	CBR Q26		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1999-current
6176	31	CBR	CBR Q34		Cypress Marsh Isolated		Isolated Cypress	TBW	None		None	no	None		1999-2005
4894	34	CBR	CBR T01		Marsh Isolated	Pond/Marsh	Isolated Marsh	TBW	TBW		TBW	yes	TBW		1977-current
4895	35	CBR	CBR T02A		Marsh Isolated	Lake/Marsh	Isolated Marsh	TBW	TBW		TBW	yes	TBW		1980-current
4896	36	CBR	CBR T03	CBARWF T-3	Cypress Isolated		Undetermined	Both	SWFWMD	Yes	Both	yes	Both		1977-current
4898	38	CBR	CBR T08A		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1986-current
4899	39	CBR	CBR T10		Cypress Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1990-current
26218	40	CBR	CBR T11		Cypress Marsh Isolated		Isolated Cypress	TBW	None		None		None		1994-2005
	41	CBR		Ann Denker	Cypress Continuous		Connected Wetland	SWFWMD	SWFWMD						1983-current
	42	CBR		Pasco Trails	Isolated Cypress		Connected Wetland	SWFWMD	SWFWMD						1984-current
204	542	CBR	Lost Lake		Lake		Lake	TBW	TBW		None		None		1977-current
261	543	CBR	Spring Lake		Lake		Lake	TBW	TBW		None		None		1977-2017

TBW Wetland Site ID	Wetland ID	Associated Wellfield	TBW Name 1	SWFWMD Name 1	Wetland Type	TBW Wetland Type (if different)	RA Wetland type	Historically Hydrologically Monitored By	Currently Hydrologically Monitored By	MFL?	Historic WAP?	Listed as Active in TBW Site Manager?	Current WAP?	comment	POR
208	544	CBR	Cross Bar 6		Lake		Lake	TBW	TBW		None		None		1999-2017
4955	103	COS	102717		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW	In ELW 2' DD not COS	1986-current
4958	104	COS	162717		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1986-current
4967	105	COS	C042817		Cypress Isolated		Connected Wetland	TBW	TBW		TBW	yes	TBW		1998-current
4956	106	COS	C142717		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current
4959	107	COS	EC222717		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1998-current
4964	108	COS	EC332717		Cypress Isolated		Connected Wetland	TBW	TBW		TBW	yes	TBW		1986-current
4960	109	COS	NC242717		Cypress Marsh Isolated		Isolated Cypress	TBW	None		TBW	no	None	Lost access Feb 2013	1984-2013
4961	110	COS	NC262717		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current
4968	111	COS	NW042817		Cypress Isolated		Isolated Cypress	TBW	None		None	no	None		1989-2005
4965	112	COS	NW332717		Hardwood Isolated		Other	TBW	TBW		TBW	yes	TBW		1984-current
4963	113	COS	SC272717	Cosme WF Wetland	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1986-current
4966	114	COS	SC332717		Cypress Isolated		Connected Wetland	TBW	TBW		TBW	yes	TBW		1986-current
4954	115	COS	SE012717		Cypress Isolated		Isolated Cypress	TBW	None		TBW	no	None		1983-2007
4957	116	COS	SE142717		Mixed Floodplain	Mixed Contiguous	Connected Wetland	TBW	TBW		TBW	yes	TBW		1986-current
3874	121	CYB	CYB 1		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1988-current
3875	122	CYB	CYB 2		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1988-current
3876	123	CYB	CYB 3		Hardwood Isolated		Other	TBW	TBW		TBW	yes	TBW		1988-current
3877	124	CYB	CYB 4	CBRWF #4	Cypress Isolated		Isolated Cypress	TBW	SWFWMD	Yes	Both	yes	Both		1988-current
9534	125	CYB	CYB 5		Mixed Continuous		Isolated Cypress	TBW	TBW		None	yes	None		1988-current
3878	126	CYB	CYB 6		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1988-current
3879	127	CYB	CYB 9		Hardwood Isolated		Other	TBW	TBW		TBW	yes	TBW		1988-current
9535	128	CYB	CYB 11		Mixed Continuous	Floodplain Swamp	Connected Wetland	TBW	TBW		None	yes	None		1988-current
3880	129	CYB	CYB 12		Marsh Isolated		Isolated Marsh	TBW	None		TBW	no	None		1988-2010
3881	130	CYB	CYB 13		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1988-current
3882	131	CYB	CYB 14		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1988-current
3883	132	CYB	CYB 15		Cypress Isolated		Other	TBW	TBW		TBW	yes	TBW		1988-current
3884	133	CYB	CYB 16	CBRWF #16	Cypress Isolated		Isolated Cypress	TBW	SWFWMD	Yes	Both	yes	Both		1988-current
3885	134	CYB	CYB 17		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1988-current
9536	135	CYB	CYB 18		Mixed Continuous	Floodplain Swamp	Connected Wetland	TBW	TBW		None	yes	None		1988-current
3887	138	CYB	CYB 21		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	None		1988-current
9537	139	CYB	CYB 22		Mixed Floodplain		Connected Wetland	TBW	TBW		None	yes	None		1988-current

TBW Wetland Site ID	Wetland ID	Associated Wellfield	TBW Name 1	SWFWMD Name 1	Wetland Type	TBW Wetland Type (if different)	RA Wetland type	Historically Hydrologically Monitored By	Currently Hydrologically Monitored By	MFL?	Historic WAP?	Listed as Active in TBW Site Manager?	Current WAP?	comment	POR
3888	140	CYB	CYB 23		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1988-current
3889	141	CYB	CYB 24		Cypress Isolated		Other	TBW	None		TBW	yes	None		1988-2010
3890	142	CYB	CYB 25	CBRWF #25	Cypress Isolated		Isolated Cypress	TBW	SWFWMD	Yes	Both	yes	Both		1988-current
9538	143	CYB	CYB 26		Mixed Continuous	Floodplain Swamp	Connected Wetland	TBW	TBW		None	yes	None		1988-current
26220	144	CYB	CYB 27		Mixed Floodplain		Connected Wetland	TBW	None		None		None		1988-2003
9539	145	CYB	CYB 28		Mixed Floodplain	Floodplain Swamp	Connected Wetland	TBW	TBW		None	yes	None		1988-current
9540	146	CYB	CYB 29		Mixed Floodplain	Mixed Contiguous	Connected Wetland	TBW	None		None	no	None		1988-2010
3891	147	CYB	CYB 30		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1988-current
9541	148	CYB	CYB 31		Mixed Floodplain		Connected Wetland	TBW	TBW		None	yes	none		1992-current
3892	149	CYB	CYB 32	CBRWF #32	Cypress Isolated		Isolated Cypress	TBW	SWFWMD	Yes	Both	yes	Both		1992-current
3893	150	CYB	CYB 33		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1992-current
3894	151	CYB	CYB 34		Marsh Isolated		Isolated Marsh	TBW	None		TBW	yes	None		1992-current
9542	152	CYB	CYB 37		Cypress Continuous	Floodplain Swamp	Connected Wetland	TBW	TBW		None	yes	None		1998-current
3895	153	CYB	CYB A	CBRWF A	Cypress Isolated		Isolated Cypress	TBW	SWFWMD	Yes	Both		Both		2001-current
9543	154	CYB	CYB C10		Mixed Floodplain	Mixed Contiguous	Connected Wetland	TBW	TBW		None	yes	None		1998-current
9544	155	CYB	CYB C12		Mixed Floodplain	Floodplain Swamp	Connected Wetland	TBW	TBW		None	yes	None		1998-current
3896	156	CYB	CYB C16			Marsh	Undetermined	TBW	TBW		TBW	yes	TBW	outside Phase 1 area	1998-current
50001	158	CYB		New River Cypress	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50009	159	CYB		New River Marsh	Marsh Isolated		Isolated Marsh	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
6096	160	CYC	C01		Mixed Floodplain	Creek Swamp	Connected Wetland	TBW	None		None	no	None		1978-2010
3768	162	CYC	C06		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1981-current
6098	163	CYC	C08		Mixed Floodplain	Creek Swamp	Connected Wetland	TBW	None		None	yes	None		1978-2010
3773	164	CYC	C11		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1978-current
3774	166	CYC	C14		Hardwood Isolated		Other	TBW	TBW		TBW	yes	TBW		1979-current
6100	167	CYC	C15		Marsh Isolated		Isolated Marsh	TBW	None		None	no	None		1983-2005
6101	168	CYC	C16		Cypress Isolated		Other	TBW	None		None	no	None		1998-2005
6103	169	CYC	C19		Mixed Floodplain	Floodplain Swamp (C19)	Connected Wetland	TBW	TBW		None	yes	None	TBW Site Manager lists C18 as inactive	1996-current
6104	170	CYC	C20		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		2011-current
26221	171	CYC	C22		Marsh Isolated		Other	TBW	None		None		None		
6105	172	CYC	C22A		Marsh Isolated		Other	TBW	None		None	no	None		2003-2010
3775	173	CYC	C23		Cypress Isolated		Isolated Cypress	TBW	None		TBW	no	None		1980-2010

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3776	174	CYC	C24		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1980-current
6106	176	CYC	C33		Mixed Continuous	Creek Swamp	Connected Wetland	TBW	TBW		None	yes	None		1983-current
6107	177	CYC	C39		Mixed Continuous	Creek Swamp	Connected Wetland	TBW	TBW		None	yes	None		1985-current
6108	178	CYC	C40		Mixed Floodplain	Creek Swamp	Connected Wetland	TBW	TBW		None	yes	None		1986-current
6109	179	CYC	C100		Mixed Floodplain	Floodplain Swamp	Connected Wetland	TBW	TBW		None	yes	None		1989-current
6124	180	CYC	W25		Mixed Floodplain		Connected Wetland	TBW	TBW		None	yes	None		1978-current
3769	181	CYC	C101		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1994-current
3770	182	CYC	C102	Quail Hollow Elementary School	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1994-current
6111	183	CYC	C103	Cypress Creek Floodplain	Cypress Floodplain	Creek Swamp	Connected Wetland	TBW	TBW		None	yes	None		1997-current
3771	184	CYC	C104		Cypress Isolated		Isolated Cypress	TBW	None		TBW	yes	None		2000-2012
3772	185	CYC	C105		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		2000-current
6112	186	CYC	C106		Mixed Floodplain	Creek Swamp	Connected Wetland	TBW	None		None	no	None		2004-2010
6113	187	CYC	W01		Mixed Floodplain		Connected Wetland	TBW	TBW		None	yes	None		1979-current
3778	188	CYC	W02A		Cypress Isolated		Isolated Cypress	TBW	None		TBW	yes	None	Site Manager has no W02A, but has a W02	1985-2010
3779	189	CYC	W03	CCWF W-3 Marsh	Marsh Isolated		Isolated Marsh	Both	Both		Both	yes	Both		1979-current
3780	190	CYC	W04	CCWF "E"	Marsh Isolated		Isolated Marsh	Both	SWFWMD		Both	yes	SWFWMD		1978-current
6115	191	CYC	W05	CCWF "A"	Cypress Isolated		Isolated Cypress	Both	Both		Both	yes	Both		1978-current
6118	192	CYC	W06/ W07/ W08		Mixed Floodplain	Mesic Forest	Connected Wetland	TBW	None		None	no	None		1978-2010
6119	193	CYC	W09		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1978-current
3781	194	CYC	W10		Cypress Marsh Continuous	Cypress Isolated	Connected Wetland	TBW	TBW		TBW	yes	TBW		1978-current
3782	195	CYC	W11	CC W-11	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1978-current
3783	196	CYC	W12	CC W-12 Sentry Wet'l.	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1979-current
6121	197	CYC	W14	CCS-2	Mixed Continuous	Floodplain Swamp	Connected Wetland	Both	Both		None	yes	None		1978-current
3784	198	CYC	W16	CCWF "D"	Marsh Isolated		Isolated Marsh	Both	SWFWMD		Both	yes	SWFWMD		1978-current
3785	199	CYC	W17	CC W-17 Sentry Wet'l.	Cypress Isolated		Isolated Cypress	TBW	SWFWMD	Yes	Both	yes	Both		1978-current
3786	200	CYC	W19	W-19	Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1978-current
3787	201	CYC	W20		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1979-current
6122	202	CYC	W21N	Cypress Creek North of Structure	Mixed Floodplain	Creek Swamp	Connected Wetland	TBW	TBW		None	yes	None	Site Manager has no W21N, but has a W21	"CYC W21" 1978-current

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6122	203	CYC	W21S	Cypress Creek South of Structure	Mixed Floodplain	Creek Swamp	Connected Wetland	TBW	TBW		None	yes	None	Site Manager has no W21S, but has a W21	"CYC W21" 1978-current
3788	204	CYC	W23		Cypress Continuous	Cypress Isolated	Undetermined	TBW	TBW		TBW	yes	TBW		1978-current
6125	205	CYC	W27		Cypress Marsh Isolated	Marsh	Isolated Cypress	TBW	TBW		TBW	yes	TBW		1979-current
3789	206	CYC	W29	W-29 (Rattlesnake Marsh)	Marsh Isolated		Isolated Marsh	Both	TBW		TBW	yes	TBW		1979-current
6126	207	CYC	W30N		Mixed Floodplain	Floodplain Swamp	Connected Wetland	TBW	TBW		None	yes	None	Site Manager has no W30N, but has a W30	"CYC W30" 1979-current
6126	208	CYC	W30S		Mixed Floodplain	Floodplain Swamp	Connected Wetland	TBW	TBW		None	yes	None	Site Manager has no W30S, but has a W30	"CYC W30" 1979-current
3790	209	CYC	W31		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1979-current
3791	210	CYC	W32		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1979-current
3792	211	CYC	W33		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1980-current
6127	212	CYC	W34		Mixed Floodplain	Floodplain Swamp	Connected Wetland	TBW	None		None	no	None		1980-2010
6128	213	CYC	W36		Cypress Marsh Isolated	Cypress Isolated	Isolated Cypress	TBW	TBW		TBW	yes	TBW		1980-current
6129	214	CYC	W37	CCWF "C"	Cypress Marsh Isolated	Cypress Isolated	Isolated Cypress	Both	Both		Both	yes	Both		1981-current
3793	215	CYC	W39		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1980-current
3794	216	CYC	W40	CCWF X-1	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1981-current
3795	217	CYC	W41	CCWF W-41	Cypress Isolated		Isolated Marsh	Both	Both	Yes	Both	yes	Both		1981-current
6130	218	CYC	W42		Mixed Floodplain	Mesic Hammock	Connected Wetland	TBW	None		None	no	None		1981-2005
6131	220	CYC	W43	East Tributary	Mixed Floodplain	Creek Swamp	Connected Wetland	TBW	TBW		None	yes	None		1981-current
6132	221	CYC	W44	CCS-3 Snake Crossing	Mixed Floodplain	Floodplain Swamp	Connected Wetland	Both	Both		None	yes	None		1982-2013
3796	222	CYC	W45	CCWF X-2	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1982-current
3797	223	CYC	W46	CCWF "B"	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1982-current
6134/6135	225	CYC	W48/W49		Mixed Floodplain	Floodplain Swamp	Connected Wetland	TBW	None		None	no	None	TBW Site Manager lists W48 as inactive	1983-2010/1983-2012
6136	226	CYC	W50	CCWF X-3	Cypress Marsh Isolated	Cypress Isolated	Isolated Cypress	TBW	SWFWMD		Both	yes	SWFWMD		1983-current
6137	227	CYC	W51		Cypress Floodplain	Cypress Isolated	Connected Wetland	TBW	None		TBW	yes	None		1983-2010
3798	228	CYC	W52		Marsh Isolated		Undetermined	TBW	TBW		TBW	yes	TBW		1984-current
3799	229	CYC	W55		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1993-current
5491	230	CYC	W56	CCWF "G'	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1976-current
6139	231	CYC	W57		Mixed Floodplain	Floodplain Forest	Connected Wetland	TBW	TBW		None	yes	None		2003-current
6140	232	CYC	W58 (RSH) C-20 (Terra)		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		2006-current

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50035	233	CYC		CCS-5	Mixed Floodplain		Connected Wetland	SWFWMD	SWFWMD		None		None		
50030	234	CYC		CCWF "F"	Marsh Isolated		Isolated Marsh	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50028	235	CYC		Conners Cypress Marsh	Cypress Marsh Isolated		Isolated Marsh	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50014	236	CYC		Conners Marsh 1	Marsh Isolated		Isolated Marsh	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50015	237	CYC		Conners Marsh 2	Marsh Isolated		Isolated Marsh	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50036	238	CYC		Conners Wet Prairie	Wet Prairie Isolated		Other	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50012	239	CYC		Correctional Facility Cypress	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50013	240	CYC		Correctional Facility Cypress Marsh	Cypress Marsh Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50037	241	CYC		Mertz Riverine	Mixed Floodplain		Connected Wetland	SWFWMD	SWFWMD		None		None		
50020	242	CYC		Pheasant Run (Quail Hollow) Cypress	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
4974	243	ELW	C132716		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1999-current
4971	244	ELW	EC112716	EWWF 1	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1999-current
4975	245	ELW	NC222716/C-15	Pine Ridge Cypress Dome	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1999-current
4972	246	ELW	NNW122716	EWWF 5	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1999-current
4969	247	ELW	NW022716	EWWF Salls/10S/10D	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1999-current
4978	248	ELW	NW052717	EWWF 11/Wet Prairie	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1999-current
4979	249	ELW	NW062717	EWWF East (Lk. Dan) Cypress	Cypress Isolated		Other	Both	SWFWMD		Both	yes	TBW		1999-current
4973	250	ELW	NW122716	EWWF West Cypress	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1999-current
4976	251	ELW	SC272716	Lansbrook East	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1999-current
4980	252	ELW	SW062717		Lake Fringe Cypress Isolated	Cypress Isolated	Other	TBW	TBW		TBW	yes	TBW	SW Lake Dan	1999-current
4981	253	ELW	SW082717		Mixed Continuous		Connected Wetland	TBW	None		None	no	None		1999-2003
4977	254	ELW	SW272716	Lansbrook West	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1999-current
4970	255	ELW	WC102716		Hardwood Isolated		Connected Wetland	TBW	TBW		TBW	yes	TBW		1999-current
	256	ELW		EWWF 3	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		None		None		1989-current
6165	257	MBR	MBR 09		Cypress Floodplain	Riverine	Connected Wetland	TBW	TBW		None	yes	None		1995-current
6069	258	MBR	MBR 10		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1991-current
6070	259	MBR	MBR 11		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1989-current
6071	260	MBR	MBR 14	MBWF X-2	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1989-current

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6072	261	MBR	MBR 16	MBWF "Unnamed"	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		2002-current
6073	262	MBR	MBR 29	MBWF South Cypress Marsh	Cypress Marsh Isolated		Undetermined	Both	SWFWMD		Both	yes	SWFWMD		1986-current
6074	263	MBR	MBR 30		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
6075	264	MBR	MBR 35	MBWF Entry Dome	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1989-current
6170	265	MBR	MBR 36		Mixed Floodplain	Riverine	Connected Wetland	TBW	TBW		None	yes	None		2000-current
6076	266	MBR	MBR 37		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		2000-current
6077	267	MBR	MBR 42	MBWF Well Marsh	Marsh Isolated		Isolated Marsh	Both	SWFWMD		Both	yes	SWFWMD		2000-current
6171	268	MBR	MBR 60	MBWF X-5	Cypress Floodplain	Riverine	Connected Wetland	Both	SWFWMD		None	yes	None		1985-current
6172	269	MBR	MBR 79	MBWF Sawgrass Marsh	Marsh Continuous	Riverine	Connected Wetland	Both	SWFWMD		TBW	yes	None		1991-current
6173	270	MBR	MBR 80		Cypress Floodplain	Riverine	Connected Wetland	TBW	TBW		None	yes	None		1989-current
26224	271	MBR	MBR 81		Cypress Marsh Isolated		Isolated Cypress	TBW	None		None		None		1989-2003
26225	272	MBR	MBR 86		Cypress Isolated		Isolated Cypress	TBW	None		None		None		1995-2000
6078	273	MBR	MBR 88	MBWF Clay Gully Cypress	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD	Yes	Both	yes	Both		1977-current
6079	274	MBR	MBR 89	MBWF X-4	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD	Yes	Both	yes	Both		1985-current
6080	275	MBR	MBR 90		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
6081	276	MBR	MBR 91		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
6082	277	MBR	MBR 93		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
6083	278	MBR	MBR 94		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
6084	279	MBR	MBR 96		Cypress Marsh Isolated		Other	TBW	TBW		TBW	yes	TBW	outside Phase 1 area	1989-current
6085	280	MBR	MBR 97		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
6086	281	MBR	MBR 98		Marsh Isolated		Isolated Marsh	TBW	TBW		TBW	yes	TBW		1989-current
6166	282	MBR	MBR 100		Mixed Continuous	Riverine	Connected Wetland	TBW	None		None	no	None		1995-2010
6174	283	MBR	MBR 102		Mixed Floodplain	Riverine	Connected Wetland	TBW	TBW		None	yes	None		2000-current
6167	284	MBR	MBR 103		Mixed Floodplain	Riverine	Connected Wetland	TBW	TBW		None	yes	None		2000-current
6175	285	MBR	MBR 104		Mixed Floodplain	Riverine	Connected Wetland	TBW	TBW		None	yes	None		2000-current
6168	286	MBR	MBR 105		Cypress Floodplain	Riverine	Connected Wetland	TBW	TBW		None	yes	None		2000-current
6169	287	MBR	MBR 106		Cypress Floodplain	Riverine	Connected Wetland	TBW	TBW		None	yes	None		2000-current
50038	288	MBR		MBWF Clay Gully Site	Mixed Floodplain		Connected Wetland	SWFWMD	SWFWMD		None		None		
50039	289	MBR		East Branch Clay S RD	Mixed Floodplain		Connected Wetland	SWFWMD	SWFWMD		None		None		
50040	290	MBR		East Branch Clay Gully	Mixed Floodplain		Connected Wetland	SWFWMD	SWFWMD		None		None		
50029	291	MBR		MBWF East Cypress Marsh	Cypress Marsh Isolated		Isolated Marsh	SWFWMD	SWFWMD		SWFWMD		SWFWMD		

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50031	292	MBR		MBWF Trout Creek Marsh	Marsh Isolated		Isolated Marsh	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50021	293	MBR		MBWF West Cypress	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50041	294	MBR		MBWF Wild Hog Slough	Mixed Floodplain		Connected Wetland	SWFWMD	SWFWMD		None		None		
50022	295	MBR		MBWF X-1	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50032	296	MBR		MBWF X-3	Marsh Isolated		Isolated Marsh	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50023	297	MBR		MBWF X-6	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50024	312	None		Cypress Creek ELAPP Cypress	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50033	313	None		Cypress Creek ELAPP Marsh	Marsh Isolated		Isolated Marsh	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50042	314	None		Cypress Creek ELAPP Riverine	Hardwood Floodplain		Connected Wetland	SWFWMD	SWFWMD		None		None		
5369	336	NOP	NP-01		Marsh Isolated	Marsh	Isolated Marsh	TBW	TBW		TBW	yes	TBW		1989-current
5370	337	NOP	NP-02		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
5371	338	NOP	NP-03	NPWF #3	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1989-current
5372	339	NOP	NP-04		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
5373	340	NOP	NP-05		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
5374	341	NOP	NP-06		Cypress Marsh Isolated		Isolated Cypress	TBW	None		TBW	no	None		1989-2010
5375	342	NOP	NP-07		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
5376	343	NOP	NP-08		Mixed Floodplain	Mixed Contiguous	Connected Wetland	TBW	None		None	no	None		1989-2010
5377	344	NOP	NP-09		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
5378	345	NOP	NP-10		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
5379	346	NOP	NP-11		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
5381	347	NOP	NP-13/CYB C17		Cypress Marsh Isolated		Other	TBW	None		TBW	no	None		1989-2010
5383	348	NOP	NP-15		Cypress Continuous	Cypress Contiguous	Other	TBW	None		TBW	no	None		1989-2010
5384	349	NOP	NP-16		Hardwood Isolated		Other	TBW	SWFWMD		None	no	None		1989-2010
5385	350	NOP	NP-17		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
5386	351	NOP	NP-18		Cypress Marsh Isolated	Cypress Marsh Contiguous	Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
5389	352	NOP	NP-21	NPWF #21	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1989-current
5390	353	NOP	NP-22		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
5393	354	NOP	NP-25		Cypress Isolated		Isolated Cypress	TBW	None		TBW	no	None		1989-2010

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5394	355	NOP	NP-26		Cypress Floodplain	Cypress Contiguous	Connected Wetland	TBW	None		TBW	no	None		1989-2010
5395	356	NOP	NP-27		Cypress Continuous	Cypress Contiguous	Connected Wetland	TBW	None		None	no	None		1989-2006
5397	357	NOP	NP-29		Cypress Isolated		Isolated Cypress	TBW	None		None	no	None		1989-2003
5398	358	NOP	NP-30		Cypress Isolated		Other	TBW	TBW		TBW	yes	TBW		1989-current
5400	360	NOP	NP-32		Cypress Marsh Continuous	Cypress Marsh Contiguous	Connected Wetland	TBW	None		None	no	None		1997-2010
5402	362	NOP	NP-36		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		2002-current
4987	365	NWH	112817		Cypress Isolated		Isolated Cypress	TBW	None		TBW	no	None		1984-2010
4988	366	NWH	132817		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1990-current
4989	367	NWH	142817		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1984-current
4999	369	NWH	302818		Cypress Isolated		Isolated Cypress	TBW	None		None	no	None		1983-2004
4997	370	NWH	C162818		Cypress Continuous		Connected Wetland	TBW	None		TBW	no	None		1983-2010
4994	372	NWH	EC072818		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1985-current
4990	373	NWH	EC232817	Bellamy School	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1989-current
4991	374	NWH	NC042818		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
4998	375	NWH	NC182818		Cypress Continuous		Connected Wetland	TBW	None		TBW	no	None		1989-2010
4985	377	NWH	NW012817		Mixed Floodplain	Mixed Contiguous	Connected Wetland	TBW	TBW		TBW	yes	None		1983-current
4995	378	NWH	NW072818		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1984-current
4992	379	NWH	SC042818		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
4993	380	NWH	SC062818		Mixed Floodplain	Mixed Contiguous	Connected Wetland	TBW	TBW		TBW	yes	None		1985-current
4996	381	NWH	SW082818		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1992-current
4986	382	NWH	WC102817		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1985-current
4983	371	S21	E182718		Mixed Continuous		Other	TBW	TBW		TBW	yes	TBW	Turkey Ford swamp	1989-current
4982	376	S21	NE132717	Brooker Creek Headwaters	Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1999-current
5009	383	S21	272718		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1984-current
5011	384	S21	322718		Cypress Continuous		Connected Wetland	TBW	TBW		TBW	yes	None		1990-current
5003	385	S21	CW212718	S21 WF NW-53 East	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1989-current
5002	386	S21	EC162718		Cypress Isolated		Isolated Cypress	TBW	TBW		None	yes	None		1986-current
5008	387	S21	EC222718		Cypress Isolated		Other	TBW	TBW		TBW	yes	TBW		1986-current
5000	388	S21	NC092718		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current
7780	389	S21	NE112718		Cypress Isolated		Isolated Cypress	TBW	None		None	no	None		1983-2005
5004	390	S21	NE-212718		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current
5001	391	S21	NW112718		Cypress Marsh Isolated		Isolated Cypress	TBW	None		None	no	None		1990-2010

TBW Wetland Site ID	Wetland ID	Associated Wellfield	TBW Name 1	SWFWMD Name 1	Wetland Type	TBW Wetland Type (if different)	RA Wetland type	Historically Hydrologically Monitored By	Currently Hydrologically Monitored By	MFL?	Historic WAP?	Listed as Active in TBW Site Manager?	Current WAP?	comment	POR
5006	393	S21	SE212718		Cypress Isolated		Connected Wetland	TBW	TBW		TBW	yes	TBW		1999-current
5010	394	S21	SW292718		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
5007	395	S21	WC212718		Cypress Isolated		Other	TBW	TBW		TBW	yes	TBW		1983-current
5012	396	S21	WC342718		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1986-current
5013	397	SOP	NE152618		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW	outside Phase 1 area	1999-current
5015	398	SOP	PC282618	SPWF - 1	Cypress Continuous		Connected Wetland	Both	Both		TBW	yes	None		1991-current
5019	399	SOP	PT322618	SPWF - 3	Cypress Continuous		Connected Wetland	Both	SWFWMD		TBW	yes	TBW		1991-current
5021	400	SOP	PTC332618		Cypress Continuous		Connected Wetland	TBW	TBW		TBW	yes	None		1991-current
5017	401	SOP	PSW282618		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1991-current
5019	402	SOP	PC332618	SPWF South Cypress	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD	Yes	Both	yes	Both		2001-current
5016	403	SOP	PSE282618	SPWF - 6	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1991-current
5020	404	SOP	PSW332618		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1992-current
5018	405	SOP	PTE332618	SPWF - 2	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	None??	No WAP I think	1991-current
5014	406	SOP	SC162618		Cypress Isolated		Connected Wetland	TBW	TBW		TBW	yes	TBW	outside Phase 1 area	1999-current
50010	407	SOP		RT. 54 Aprile	Cypress Isolated		Isolated Cypress	SWFWMD	None		SWFWMD		None		
50011	408	SOP		Rt. 54 Nelson	Cypress Marsh Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50026	409	STK	CYB C14	J.B. Starkey 1	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD	No CYB C14 in TBW database	
5408	410	STK	S-004		Hardwood Floodplain	Hardwood Contiguous	Connected Wetland	TBW	None		None	no	None		1983-2010
5409	411	STK	S-005	STWF A	Marsh Isolated	Marsh (Deep)	Isolated Marsh	Both	SWFWMD		Both	yes	TBW		1983-current
5410	412	STK	S-006	STWF Q	Cypress Marsh Isolated		Isolated Cypress	Both	TBW		TBW	yes	TBW		1983-current
5413	415	STK	S-010	STWF CC	Cypress Isolated		Isolated Cypress	Both	TBW		TBW	yes	TBW		1983-current
5415	417	STK	S-013		Marsh Isolated	Marsh	Isolated Marsh	TBW	None		TBW	no	None		1983-2010
5417	418	STK	S-016		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current
5418	419	STK	S-018	Mud Lake			Lake	TBW	TBW			yes			1983-current
5419	420	STK	S-020	STWF E	Marsh Isolated	Marsh	Isolated Marsh	Both	SWFWMD		Both	yes	SWFWMD		1983-current
5420	421	STK	S-023	STWF H	Cypress Marsh Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	Both		1983-current
5421	422	STK	S-024	S-024/STWF B (Grass Prairie West)/STWF G (Grass Prairie East)	Marsh Isolated	Marsh	Isolated Marsh	Both	SWFWMD		Both	yes	Both	Grass Prairie - one Wetland ID?	1983-current
5423	423	STK	S-030	STWF U	Cypress Marsh Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1983-current
5424	424	STK	S-031		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current

TBW Wetland Site ID	Wetland ID	Associated Wellfield	TBW Name 1	SWFWMD Name 1	Wetland Type	TBW Wetland Type (if different)	RA Wetland type	Historically Hydrologically Monitored By	Currently Hydrologically Monitored By	MFL?	Historic WAP?	Listed as Active in TBW Site Manager?	Current WAP?	comment	POR
5425	425	STK	S-035		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current
5426	426	STK	S-036A		Cypress Isolated		Isolated Cypress	TBW	None		TBW	no	None		1983-2010
5427	427	STK	S-038	STWF J	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1983-current
5428	428	STK	S-039		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current
5429	429	STK	S-042		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current
5430	430	STK	S-044	Starkey Western	Cypress Isolated		Isolated Cypress	TBW	SWFWMD		TBW	yes	TBW		1983-current
5431	431	STK	S-046		Wet Prairie Isolated	Wet Prairie	Other	TBW	TBW		TBW	yes	TBW		1983-current
5432	432	STK	S-051	STWF AA	Cypress Continuous		Connected Wetland	Both	SWFWMD		TBW	no	None		1983-2010
5433	433	STK	S-052		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current
5434	434	STK	S-053		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current
5435	435	STK	S-054	STWF L	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	Both		1983-current
5436	436	STK	S-055		Cypress Continuous	Cypress Contiguous	Other	TBW	TBW		TBW	yes	None	WAP available 2007-2010	1983-current
5437	437	STK	S-056		Cypress Isolated		Isolated Cypress	TBW	None		None	no	None		1983-2006
5439	438	STK	S-062		Wet Prairie Isolated	Wet Prairie	Other	TBW	TBW		TBW	yes	TBW		1983-current
5440	439	STK	S-063		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current
5441	440	STK	S-064		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current
5442	441	STK	S-065	STWF S	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1983-current
5443	442	STK	S-067	STWF P	Mixed Floodplain	Mixed Contiguous	Connected Wetland	Both	SWFWMD		TBW	yes	None	WAP available 2007-2008	1983-current
5444	443	STK	S-068	STWF DD	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1983-current
5445	444	STK	S-069	STWF M	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	SWFWMD		1979-current
5446	445	STK	S-070		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current
5447	446	STK	S-072		Marsh Isolated	Marsh	Isolated Marsh	TBW	None		TBW	no	None		1984-2010
5448	447	STK	S-073	STWF Eastern	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1984-current
5449	448	STK	S-074		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1984-current
5450	449	STK	S-075	STWF S-75	Cypress Isolated		Isolated Cypress	Both	SWFWMD	Yes	Both	yes	Both		1984-current
5451	450	STK	S-076	STWF R	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1984-current
5452	451	STK	S-080		Wet Prairie Isolated	Wet Prairie	Other	TBW	TBW		TBW	yes	TBW		2001-current
5453	452	STK	S-082		Cypress Isolated		Isolated Cypress	TBW	None		None	no	None		1984-2011
5454	453	STK	S-083		Cypress Continuous	Cypress Contiguous	Other	TBW	None		None	no	None		1984-2006
5455	454	STK	S-084		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1984-current
5456	455	STK	S-085	STWF South Central	Cypress Marsh Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	SWFWMD		1984-current
5457	456	STK	S-089		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1984-current
5458	457	STK	S-090	Starkey Bay	Hardwood Isolated		Other	Both	SWFWMD		Both	yes	Both		1984-current

TBW Wetland Site ID	Wetland ID	Associated Wellfield	TBW Name 1	SWFWMD Name 1	Wetland Type	TBW Wetland Type (if different)	RA Wetland type	Historically Hydrologically Monitored By	Currently Hydrologically Monitored By	MFL?	Historic WAP?	Listed as Active in TBW Site Manager?	Current WAP?	comment	POR
5459	458	STK	S-094		Cypress Isolated		Other	TBW	None		None	no	None		1986-2006
5460	459	STK	S-095		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1986-current
5461	460	STK	S-096		Cypress Isolated		Isolated Cypress	TBW	None		TBW	no	None		1986-2010
5462	461	STK	S-097		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1987-current
5463	462	STK	S-099		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1989-current
5464	463	STK	S-101		Cypress Isolated		Isolated Cypress	TBW	None		None	no	None		1989-2006
5465	464	STK	S-108		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1988-current
5466	465	STK	S-109	STWF FF	Cypress Isolated		Isolated Cypress	Both	SWFWMD		Both	yes	Both		1989-current
5467	466	STK	S-111		Mixed Floodplain	Floodplain Swamp	Connected Wetland	TBW	None		None	no	None		1993-2010
5468	467	STK	S-112	Starkey Wetland Coniferous Forest	Hardwood Isolated	Cypress Contiguous	Other	Both	SWFWMD		Both	yes	SWFWMD		2001-current
5469	468	STK	S-113		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		2001-current
50043	469	STK	SC-01		Mixed Floodplain		Connected Wetland	TBW	None		None	no	None		1983-2003
5473	470	STK	SC-11		Cypress Marsh Isolated	Cypress/Marsh Isolated	Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current
5475	471	STK	SC-30		Marsh Isolated	Marsh (Deep)	Isolated Cypress	TBW	TBW		TBW	yes	TBW		1983-current
5477	473	STK	SC-33		Marsh Isolated	Marsh	Isolated Marsh	TBW	None		None	no	None		1983-2003
5478	474	STK	SC-46		Hardwood Continuous	Hardwood Contiguous	Other	TBW	None		None	no	None		1983-2003
5480	475	STK	SC-58		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1986-current
5481	476	STK	SC-59		Cypress Isolated	Cypress Isolated	Isolated Cypress	TBW	TBW		TBW	yes	TBW		1986-current
5482	477	STK	SC-62		Cypress Continuous	Cypress Contiguous	Other	TBW	None		TBW	no	None		1994-2012
5483	478	STK	SC-67		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		2001-current
5484	479	STK	SC-68		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		2001-current
5485	480	STK	SC-69		Cypress Continuous	Cypress Contiguous	Other	TBW	None		TBW	no	None		2001-2010
5486	481	STK	SC-70		Cypress Isolated		Isolated Cypress	TBW	None		TBW	no	None		2001-2010
5487	482	STK	SC-71		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		2001-current
5488	483	STK	SC-92		Cypress Marsh Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1985-current
5404	484	STK	STWF-Central-01	STWF Central	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD	Yes	SWFWMD	yes	Both		1985-current
5405	485	STK	STWF-D	STWF D	Cypress Isolated		Other	SWFWMD	SWFWMD	Yes	SWFWMD	yes	Both		1975-current
5406	486	STK	STWF-N	STWF N	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD	Yes	SWFWMD	yes	Both		1979-current
5407	487	STK	STWF-Z	STWF Z	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD	Yes	SWFWMD	yes	Both		1983-current
5470	488	STK	T-07		Cypress Isolated		Isolated Cypress	TBW	TBW		TBW	yes	TBW		1987-current
5471	489	STK	T-09		Wet Prairie Isolated	Wet Prairie	Other	TBW	TBW		TBW	yes	TBW		1987-current
5472	490	STK	T-10		Mixed Floodplain	Mixed Contiguous	Connected Wetland	TBW	TBW		None	yes	None		1987-current
50044	491	STK		Anclote South Wet Prairie	Wet Prairie Isolated		Other	SWFWMD	SWFWMD		SWFWMD		SWFWMD		

TBW Wetland Site ID	Wetland ID	Associated Wellfield	TBW Name 1	SWFWMD Name 1	Wetland Type	TBW Wetland Type (if different)	RA Wetland type	Historically Hydrologically Monitored By	Currently Hydrologically Monitored By	MFL?	Historic WAP?	Listed as Active in TBW Site Manager?	Current WAP?	comment	POR
50045	492	STK		J.B. Starkey 2	Cypress Isolated		Other	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50017	493	STK		J.B. Starkey 3	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50002	494	STK		J.B. Starkey 4	Cypress Marsh Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50018	495	STK		River Ridge High School	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50046	496	STK		Starkey Wet Prairie	Wet Prairie Isolated		Other	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50003	497	STK		STWF BB	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50004	498	STK		STWF C	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50005	499	STK		STWF EE	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50006	500	STK		STWF GG	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50007	501	STK		STWF K	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50047	502	STK		STWF O	Mixed Continuous		Other	SWFWMD	SWFWMD		None		None		
50008	503	STK		STWF T	Cypress Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50048	504	STK		STWF V	Mixed Continuous		Other	SWFWMD	SWFWMD		None		None		
50027	505	STK		STWF W	Cypress Marsh Isolated		Isolated Cypress	SWFWMD	SWFWMD		SWFWMD		SWFWMD		
50049	506	STK		STWF X	Mixed Continuous		Other	SWFWMD	SWFWMD		None		None		

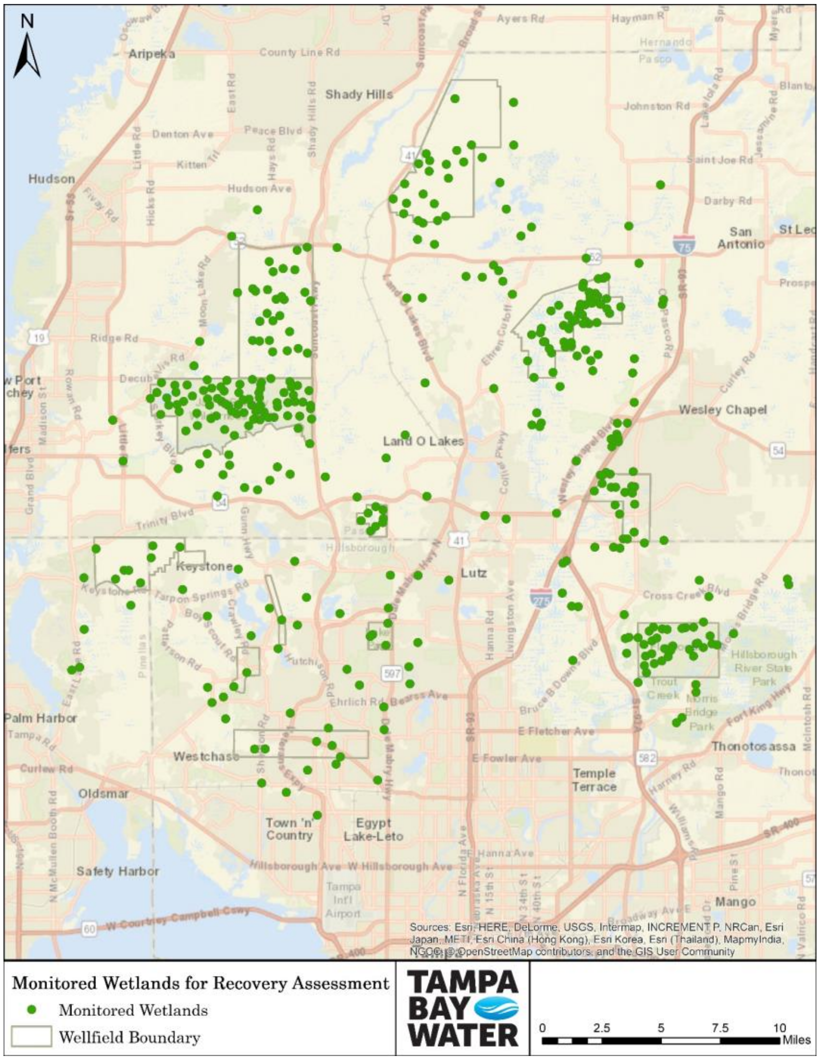

Figure 5.7: Monitored Wetlands to be Assessed

5.4.4 Unmonitored Sites within the Area of Investigation

The Recovery Assessment Work Plan stated the need to identify all wetlands and lakes within a specific geographic area of potential impact and attempt to assess their degree of recovery or health following the reduction in wellfield pumping. The assessment of recovery at monitored and unmonitored wetlands and lakes is necessary to meet the Criteria for Issuance of a Water Use Permit found in Chapter 40D-2.301, F.A.C. This Rule requires that an applicant demonstrate that their withdrawals do not cause harm to the water resources of the area including wetlands and other surface waters. Tampa Bay Water agreed with District staff that an area of potential impact resulting from the wellfield pumping at an average of 90 mgd should be identified and the unmonitored wetlands and lakes within this area also be identified. As stated in the Recovery Assessment Work Plan, Tampa Bay Water will attempt to assess the environmental recovery or degree of health at these unmonitored wetlands and incorporate the results of the unmonitored wetland evaluations with the assessments of monitored lakes and wetlands to fully meet this permitting requirement.

The Area of Investigation was developed to define the areas where recovery should be evaluated and to define the area in which unmonitored wetlands and lakes would be identified for assessment. Tampa Bay Water retained the services of Greenman-Pedersen, Inc. to develop a list of wetlands within the defined Area of Investigation with each wetland polygon having a unique identifying number. The data sources and methods used by the consultant are described in a February 25, 2016 memo to Tampa Bay Water and this memo is included in our February 26, 2016 submittal to the District (Appendix 5.11). This submittal also contains a table identifying each wetland inside of the original Area of Investigation and maps showing the location of those wetlands.

The consultant performed a thorough Quality Control review of the initial datasets used to define wetland polygons to make sure that the list of sites was comprehensive. The consultant’s final list of unmonitored wetlands and lakes excluded any sites within the Area of Investigation that either Tampa Bay Water or the District currently monitors and also excluded any upland-cut anthropogenic ponds and wetlands commonly used as stormwater retention systems. The full areal extent of any wetland polygon representing isolated wetlands that intersect the outer extent of the Area of Investigation was fully included in the final list of unmonitored sites. For floodplain or flow-through wetland systems that intersected the outer extent of the Area of Investigation, the polygons were extended to a 0.5-mile distance outside of the Area of Investigation and truncated at this line per agreement with the District. These unmonitored wetland polygons were incorporated into a GIS shapefile which was used to create the maps in the February 26, 2016 submittal. The District staff reviewed the submitted information and approved the initial tables and maps of unmonitored sites on January 26, 2017 (included in Appendix 5.11). This initial list contained 684 individual unmonitored wetlands within the Area of Investigation.

Tampa Bay Water analyzed the 2017 Updated Area of Investigation map that was developed using actual pumping data for calendar years 2013 – 2016 (Section 5.3.2). Any additional unmonitored wetlands that fell within the expanded areas were added to the list of unmonitored wetlands for assessment. This 2017 Update to the Area of Investigation increased the number of unmonitored sites from 684 to 749 lakes and wetlands. After the final (2019) update to the Area of Investigation based on actual pumping data for calendar years 2017 – 2018 (Section 5.3.3), the additional unmonitored wetlands that fell within any of the expanded areas were added to the site list. This final assessment resulted in a total of 845 lakes and wetlands within the final Area of Investigation. An updated list of unmonitored wetlands within the revised Area of Investigation was prepared and is presented as Table 5.3 and the location of these unmonitored wetlands is shown in Figure 5.8. Detailed maps showing the locations of the 845 unmonitored wetlands and lakes to be assessed are shown on wellfield-scale maps and discussed in Section 10.4 of this report.

Table 5.3: Recovery Assessment Unmonitored Wetland list - Final

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
1121	wetland	68.82	Mesic	Northwest Hillsborough
1133	wetland	12.59	Mesic	Northwest Hillsborough
1145	wetland	5.80	Mesic	Northwest Hillsborough
1166	wetland	5.35	Xeric	Northwest Hillsborough
1186	wetland	11.06	Xeric	Northwest Hillsborough
1201	wetland	4.71	Mesic	Northwest Hillsborough
1217	wetland	67.01	Xeric	Northwest Hillsborough
1218	wetland	8.75	Xeric	Northwest Hillsborough
1221	wetland	1.59	Xeric	Northwest Hillsborough
1222	wetland	1.06	Mesic	Northwest Hillsborough
1226	wetland	0.85	Xeric	Northwest Hillsborough
1228	wetland	1.05	Xeric	Northwest Hillsborough
1229	wetland	7.13	Xeric	Northwest Hillsborough
1235	wetland	14.68	Mesic	Northwest Hillsborough
1246	wetland	1.53	Xeric	Northwest Hillsborough
1248	wetland	2.59	Mesic	Northwest Hillsborough
1254	wetland	1.33	Xeric	Northwest Hillsborough
1259	wetland	2.38	Xeric	Northwest Hillsborough
1262	wetland	1.61	Xeric	Northwest Hillsborough
1264	wetland	1.90	Mesic	Northwest Hillsborough
1270	wetland	1.79	Mesic	Northwest Hillsborough
1274	wetland	10.43	Mesic	Northwest Hillsborough
1283	wetland	1.38	Mesic	Northwest Hillsborough
1291	wetland	3.11	Mesic	Northwest Hillsborough
1292	wetland	1.40	Mesic	Northwest Hillsborough
1304	lake	0.72	Mesic	Northwest Hillsborough
1416	wetland	1.17	Mesic	Section 21
1436	wetland	1.59	Mesic	Section 21
1437	wetland	1.57	Mesic	Section 21
1438	wetland	1.56	Mesic	Section 21
1444	wetland	1.75	Mesic	Section 21
1452	wetland	0.93	Mesic	Section 21
1455	wetland	2.16	Mesic	Section 21
1459	wetland	0.67	Mesic	Section 21
1474	wetland	4.73	Mesic	Section 21
1477	wetland	1.01	Mesic	Section 21
1481	wetland	5.31	Xeric	Section 21

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
1491	wetland	6.56	Mesic	Section 21
1494	wetland	3.11	Mesic	Section 21
1498	wetland	4.10	Mesic	Section 21
1506	wetland	43.96	Mesic	Section 21
1512	wetland	9.23	Mesic	Section 21
1513	wetland	0.64	Mesic	Section 21
1523	wetland	0.76	Mesic	Section 21
1532	wetland	2.25	Mesic	Section 21
1551	wetland	1.51	Mesic	Section 21
1556	wetland	2.49	Mesic	Section 21
1574	wetland	1.16	Mesic	Section 21
1575	wetland	3.91	Mesic	Section 21
1579	wetland	1.14	Mesic	Section 21
1591	wetland	5.98	Mesic	Section 21
1593	wetland	5.37	Mesic	Section 21
1605	wetland	15.36	Xeric	Section 21
1606	wetland	4.40	Xeric	Section 21
1607	wetland	0.59	Mesic	Section 21
1627	wetland	0.86	Mesic	Section 21
1640	wetland	5.19	Mesic	Section 21
1642	wetland	4.91	Xeric	Section 21
1657	wetland	1.75	Mesic	Section 21
1680	wetland	4.66	Mesic	Section 21
1683	lake	11.01	Mesic	Section 21
1707	wetland	12.83	Mesic	Section 21
1738	wetland	2.80	Mesic	Eldridge-Wilde
1746	wetland	0.97	Mesic	Eldridge-Wilde
1749	wetland	2.27	Mesic	Eldridge-Wilde
1756	wetland	0.66	Mesic	Eldridge-Wilde
1767	wetland	0.52	Mesic	Eldridge-Wilde
1768	wetland	164.93	Xeric	Eldridge-Wilde
1775	wetland	0.81	Xeric	Eldridge-Wilde
1776	wetland	1.48	Xeric	Eldridge-Wilde
1800	wetland	3.31	Xeric	Eldridge-Wilde
1805	wetland	0.66	Xeric	Eldridge-Wilde
1806	wetland	3.60	Mesic	Eldridge-Wilde
1817	wetland	0.61	Xeric	Eldridge-Wilde
1821	wetland	20.00	Xeric	Eldridge-Wilde
1822	wetland	0.56	Xeric	Eldridge-Wilde

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
1825	wetland	1.35	Xeric	Eldridge-Wilde
1832	wetland	2.40	Xeric	Eldridge-Wilde
1838	wetland	13.75	Mesic	Eldridge-Wilde
1841	wetland	1.59	Mesic	Eldridge-Wilde
1853	wetland	0.83	Xeric	Eldridge-Wilde
1859	wetland	2.60	Mesic	Eldridge-Wilde
1860	wetland	7.94	Xeric	Eldridge-Wilde
1879	wetland	0.98	Mesic	Eldridge-Wilde
1890	wetland	6.73	Mesic	Eldridge-Wilde
1891	wetland	0.51	Mesic	Eldridge-Wilde
1900	wetland	4.30	Xeric	Eldridge-Wilde
1904	wetland	1.95	Mesic	Eldridge-Wilde
1910	wetland	0.64	Xeric	Eldridge-Wilde
1923	wetland	3.50	Mesic	Eldridge-Wilde
1925	wetland	0.89	Mesic	Eldridge-Wilde
1927	wetland	2.20	Xeric	Eldridge-Wilde
1937	wetland	8.16	Mesic	Eldridge-Wilde
1940	wetland	0.57	Xeric	Eldridge-Wilde
1945	wetland	3.34	Mesic	Eldridge-Wilde
1946	wetland	2.56	Mesic	Eldridge-Wilde
1952	wetland	20.92	Xeric	Eldridge-Wilde
1955	wetland	1.94	Xeric	Eldridge-Wilde
1959	wetland	0.84	Xeric	Eldridge-Wilde
1962	wetland	0.58	Xeric	Eldridge-Wilde
1963	wetland	0.54	Xeric	Eldridge-Wilde
1965	wetland	1.26	Xeric	Eldridge-Wilde
1966	wetland	1.67	Xeric	Eldridge-Wilde
1969	wetland	2.44	Mesic	Eldridge-Wilde
1979	wetland	3.38	Xeric	Eldridge-Wilde
1989	wetland	0.53	Xeric	Eldridge-Wilde
1993	wetland	3.07	Mesic	Eldridge-Wilde
2003	wetland	2.11	Mesic	Eldridge-Wilde
2008	wetland	1.01	Mesic	Eldridge-Wilde
2016	wetland	2.52	Mesic	Eldridge-Wilde
2022	wetland	0.73	Mesic	Eldridge-Wilde
2026	wetland	10.43	Mesic	Eldridge-Wilde
2033	wetland	4.42	Mesic	Eldridge-Wilde
2044	wetland	65.06	Mesic	Eldridge-Wilde
2059	wetland	8.08	Mesic	Eldridge-Wilde

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
2063	wetland	1.77	Xeric	Eldridge-Wilde
2064	wetland	2.35	Mesic	Eldridge-Wilde
2069	wetland	11.84	Mesic	Eldridge-Wilde
2070	wetland	8.20	Xeric	Eldridge-Wilde
2072	wetland	2.04	Xeric	Eldridge-Wilde
2073	wetland	1.21	Xeric	Eldridge-Wilde
2074	wetland	1.12	Mesic	Eldridge-Wilde
2075	wetland	62.01	Xeric	Eldridge-Wilde
2077	wetland	0.57	Xeric	Eldridge-Wilde
2080	wetland	3.14	Mesic	Eldridge-Wilde
2083	wetland	12.88	Mesic	Eldridge-Wilde
2086	wetland	2.18	Xeric	Eldridge-Wilde
2095	wetland	2.19	Xeric	Eldridge-Wilde
2098	wetland	7.01	Mesic	Eldridge-Wilde
2099	wetland	1.24	Xeric	Eldridge-Wilde
2100	wetland	15.74	Xeric	Eldridge-Wilde
2105	wetland	3.40	Xeric	Eldridge-Wilde
2106	wetland	1.42	Mesic	Eldridge-Wilde
2109	wetland	0.64	Xeric	Eldridge-Wilde
2115	wetland	1.78	Mesic	Eldridge-Wilde
2118	wetland	1.57	Mesic	Eldridge-Wilde
2126	wetland	0.59	Mesic	Eldridge-Wilde
2130	wetland	3.07	Mesic	Eldridge-Wilde
2133	wetland	9.90	Mesic	Eldridge-Wilde
2135	wetland	2.03	Mesic	Eldridge-Wilde
2136	wetland	0.55	Mesic	Eldridge-Wilde
2137	wetland	2.99	Mesic	Eldridge-Wilde
2139	wetland	1.77	Mesic	Eldridge-Wilde
2140	wetland	2.02	Mesic	Eldridge-Wilde
2141	wetland	3.72	Mesic	Eldridge-Wilde
2146	lake	81.83	Mesic	Eldridge-Wilde
2149	wetland	4.44	Mesic	Eldridge-Wilde
2150	wetland	0.60	Mesic	Eldridge-Wilde
2153	wetland	0.71	Mesic	Eldridge-Wilde
2157	wetland	4.98	Xeric	Eldridge-Wilde
2158	wetland	1.32	Mesic	Eldridge-Wilde
2161	wetland	2.82	Xeric	Eldridge-Wilde
2162	wetland	1.29	Mesic	Eldridge-Wilde
2163	wetland	2.95	Mesic	Eldridge-Wilde

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
2165	wetland	1.23	Xeric	Eldridge-Wilde
2168	wetland	4.73	Mesic	Eldridge-Wilde
2170	wetland	0.60	Mesic	Eldridge-Wilde
2172	wetland	3.80	Mesic	Eldridge-Wilde
2174	wetland	2.01	Mesic	Eldridge-Wilde
2176	wetland	0.81	Mesic	Eldridge-Wilde
2177	wetland	0.74	Xeric	Eldridge-Wilde
2182	wetland	13.87	Mesic	Eldridge-Wilde
2185	wetland	0.54	Mesic	Eldridge-Wilde
2186	wetland	7.89	Mesic	Eldridge-Wilde
2190	wetland	1.32	Xeric	Eldridge-Wilde
2191	wetland	1.75	Mesic	Eldridge-Wilde
2193	wetland	0.87	Mesic	Eldridge-Wilde
2195	wetland	1.04	Xeric	Eldridge-Wilde
2203	wetland	3.23	Mesic	Eldridge-Wilde
2210	wetland	3.13	Xeric	Eldridge-Wilde
2216	wetland	0.64	Mesic	Eldridge-Wilde
2218	wetland	1.24	Mesic	Eldridge-Wilde
2221	wetland	0.81	Mesic	Eldridge-Wilde
2223	wetland	7.14	Mesic	Eldridge-Wilde
2225	wetland	1.21	Mesic	Eldridge-Wilde
2229	wetland	0.99	Mesic	Eldridge-Wilde
2239	wetland	2.52	Mesic	Eldridge-Wilde
2242	wetland	4.87	Mesic	Eldridge-Wilde
2245	wetland	39.42	Mesic	Eldridge-Wilde
2249	wetland	1.79	Mesic	Eldridge-Wilde
2254	wetland	0.92	Xeric	Eldridge-Wilde
2255	wetland	0.87	Mesic	Eldridge-Wilde
2256	wetland	10.94	Mesic	Eldridge-Wilde
2263	wetland	8.12	Xeric	Eldridge-Wilde
2270	wetland	1.30	Mesic	Eldridge-Wilde
2271	wetland	4.13	Mesic	Eldridge-Wilde
2277	wetland	0.83	Mesic	Eldridge-Wilde
2278	wetland	0.75	Mesic	Eldridge-Wilde
2279	wetland	3.40	Mesic	Eldridge-Wilde
2285	wetland	2.41	Mesic	Eldridge-Wilde
2312	wetland	3.21	Mesic	Eldridge-Wilde
2315	wetland	0.71	Mesic	Eldridge-Wilde
2317	wetland	1.65	Mesic	Eldridge-Wilde

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
2321	wetland	4.82	Mesic	Eldridge-Wilde
2326	wetland	0.48	Xeric	Eldridge-Wilde
2328	wetland	0.61	Mesic	Eldridge-Wilde
2330	wetland	4.23	Mesic	Eldridge-Wilde
2332	wetland	2.09	Mesic	Eldridge-Wilde
2334	wetland	3.06	Xeric	Eldridge-Wilde
2336	wetland	0.82	Xeric	Eldridge-Wilde
2341	wetland	8.85	Mesic	Eldridge-Wilde
2351	wetland	14.79	Mesic	Eldridge-Wilde
2352	wetland	16.60	Mesic	Eldridge-Wilde
2356	wetland	4.20	Mesic	Eldridge-Wilde
2357	lake	12.98	Xeric	Eldridge-Wilde
2360	wetland	1.30	Mesic	Eldridge-Wilde
2362	wetland	10.19	Mesic	Eldridge-Wilde
2365	wetland	6.81	Mesic	Eldridge-Wilde
2367	wetland	16.28	Mesic	Eldridge-Wilde
2369	wetland	14.82	Mesic	Eldridge-Wilde
2373	wetland	12.69	Mesic	Eldridge-Wilde
2374	wetland	0.57	Mesic	Eldridge-Wilde
2375	wetland	0.59	Mesic	Eldridge-Wilde
2377	wetland	1.30	Xeric	Eldridge-Wilde
2380	wetland	1.19	Mesic	Eldridge-Wilde
2381	wetland	2.95	Xeric	Eldridge-Wilde
2382	wetland	3.79	Mesic	Eldridge-Wilde
2386	wetland	1.56	Mesic	Eldridge-Wilde
2391	wetland	2.47	Xeric	Eldridge-Wilde
2395	wetland	2.51	Mesic	Eldridge-Wilde
2397	wetland	0.57	Xeric	Eldridge-Wilde
2399	wetland	16.44	Xeric	Eldridge-Wilde
2400	wetland	6.25	Mesic	Eldridge-Wilde
2404	wetland	1.27	Mesic	Eldridge-Wilde
2418	wetland	2.94	Mesic	Eldridge-Wilde
2425	wetland	0.99	Mesic	Eldridge-Wilde
2439	wetland	1.43	Xeric	Eldridge-Wilde
2440	wetland	4.28	Xeric	Eldridge-Wilde
2448	wetland	0.98	Mesic	Eldridge-Wilde
2457	wetland	0.74	Mesic	Eldridge-Wilde
2458	wetland	0.55	Mesic	Eldridge-Wilde
2463	wetland	13.31	Mesic	Eldridge-Wilde

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
2473	wetland	0.62	Mesic	Eldridge-Wilde
2488	wetland	6.88	Mesic	Eldridge-Wilde
2491	wetland	11.23	Mesic	Eldridge-Wilde
2492	wetland	12.86	Mesic	Eldridge-Wilde
2505	wetland	2.64	Mesic	Eldridge-Wilde
2506	wetland	5.61	Mesic	Eldridge-Wilde
2510	wetland	3.00	Mesic	Eldridge-Wilde
2511	wetland	7.41	Mesic	Eldridge-Wilde
2516	wetland	8.50	Mesic	Eldridge-Wilde
2522	wetland	3.07	Mesic	Eldridge-Wilde
2523	wetland	2.32	Mesic	Eldridge-Wilde
2531	wetland	3.97	Mesic	Eldridge-Wilde
2535	wetland	2.85	Mesic	Eldridge-Wilde
2536	wetland	1.12	Mesic	Eldridge-Wilde
2541	wetland	0.43	Mesic	Eldridge-Wilde
2548	wetland	2.92	Mesic	Eldridge-Wilde
2549	wetland	3.02	Mesic	Eldridge-Wilde
2550	wetland	3.57	Mesic	Eldridge-Wilde
2551	wetland	1.59	Mesic	Eldridge-Wilde
2567	wetland	57.93	Mesic	Eldridge-Wilde
2569	wetland	5.97	Mesic	Eldridge-Wilde
2570	wetland	90.78	Mesic	Eldridge-Wilde
2571	wetland	4.85	Mesic	Eldridge-Wilde
2578	wetland	4.00	Mesic	Eldridge-Wilde
2583	wetland	1.23	Mesic	Eldridge-Wilde
2593	wetland	7.09	Mesic	Eldridge-Wilde
2604	wetland	0.82	Mesic	Eldridge-Wilde
2636	wetland	14.47	Mesic	Eldridge-Wilde
3039	wetland	69.89	Mesic	Eldridge-Wilde
3044	wetland	65.50	Mesic	Eldridge-Wilde
3046	wetland	8.43	Mesic	Eldridge-Wilde
3047	wetland	8.41	Mesic	Eldridge-Wilde
3048	wetland	22.58	Mesic	Eldridge-Wilde
3049	wetland	3.12	Mesic	Eldridge-Wilde
3050	wetland	1.21	Mesic	Eldridge-Wilde
3051	wetland	0.89	Xeric	Eldridge-Wilde
3052	wetland	0.68	Xeric	Eldridge-Wilde
3053	wetland	3.94	Mesic	Eldridge-Wilde
3054	wetland	19.41	Mesic	Eldridge-Wilde

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
3059	wetland	16.37	Mesic	Eldridge-Wilde
3060	wetland	22.97	Mesic	Eldridge-Wilde
3061	wetland	0.72	Xeric	Eldridge-Wilde
3065	wetland	2.50	Mesic	Eldridge-Wilde
3066	wetland	1.57	Mesic	Eldridge-Wilde
3067	wetland	1.97	Mesic	Eldridge-Wilde
3070	wetland	1.37	Mesic	Eldridge-Wilde
3071	wetland	15.59	Mesic	Eldridge-Wilde
3075	wetland	66.84	Xeric	Eldridge-Wilde
3077	wetland	22.83	Mesic	Eldridge-Wilde
3080	wetland	11.01	Mesic	Eldridge-Wilde
3081	wetland	20.47	Mesic	Eldridge-Wilde
3082	wetland	0.65	Mesic	Eldridge-Wilde
3085	wetland	2.80	Mesic	Eldridge-Wilde
3087	wetland	2.85	Xeric	Eldridge-Wilde
3088	wetland	2.26	Xeric	Eldridge-Wilde
3089	lake	0.72	Mesic	Eldridge-Wilde
3091	wetland	8.92	Mesic	Eldridge-Wilde
3092	wetland	0.95	Mesic	Eldridge-Wilde
3094	wetland	1.81	Mesic	Eldridge-Wilde
3095	lake	1.05	Mesic	Eldridge-Wilde
3096	wetland	1.28	Xeric	Eldridge-Wilde
3100	wetland	235.80	Mesic	Eldridge-Wilde
3101	wetland	7.09	Mesic	Eldridge-Wilde
3102	wetland	16.33	Mesic	Eldridge-Wilde
3103	wetland	17.75	Mesic	Eldridge-Wilde
3104	wetland	71.31	Xeric	Eldridge-Wilde
3105	wetland	10.59	Mesic	Eldridge-Wilde
3106	wetland	7.14	Xeric	Eldridge-Wilde
3107	wetland	34.03	Mesic	Eldridge-Wilde
3108	wetland	1.63	Xeric	Eldridge-Wilde
3109	wetland	35.12	Xeric	Eldridge-Wilde
3110	wetland	3.63	Mesic	Eldridge-Wilde
3111	wetland	9.05	Xeric	Eldridge-Wilde
3112	wetland	1.37	Xeric	Eldridge-Wilde
3113	wetland	6.86	Xeric	Eldridge-Wilde
3114	wetland	3.84	Xeric	Eldridge-Wilde
3115	wetland	3.66	Mesic	Eldridge-Wilde
3116	wetland	8.50	Mesic	Eldridge-Wilde

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
3117	wetland	3.89	Mesic	Eldridge-Wilde
3118	wetland	1.66	Mesic	Eldridge-Wilde
3119	wetland	0.89	Xeric	Eldridge-Wilde
3120	wetland	2.23	Xeric	Eldridge-Wilde
3121	wetland	36.18	Mesic	Eldridge-Wilde
3122	wetland	37.72	Mesic	Eldridge-Wilde
3123	wetland	11.32	Mesic	Eldridge-Wilde
3124	wetland	6.33	Mesic	Eldridge-Wilde
3125	wetland	31.51	Mesic	Eldridge-Wilde
3126	wetland	53.76	Mesic	Eldridge-Wilde
3127	wetland	1.69	Mesic	Eldridge-Wilde
3128	wetland	5.06	Mesic	Eldridge-Wilde
3130	lake	7.62	Xeric	Eldridge-Wilde
3131	lake	9.84	Xeric	Eldridge-Wilde
3133	wetland	1.42	Xeric	Eldridge-Wilde
3134	wetland	52.24	Mesic	Eldridge-Wilde
3136	wetland	4.39	Mesic	Section 21
3140	wetland	6.15	Xeric	Northwest Hillsborough
3143	wetland	0.61	Xeric	Northwest Hillsborough
3144	wetland	2.74	Mesic	Northwest Hillsborough
3145	wetland	8.75	Mesic	Northwest Hillsborough
3331	wetland	0.77	Mesic	Starkey
3361	wetland	1.61	Mesic	Starkey
3390	wetland	2.26	Mesic	Starkey
3399	wetland	1.32	Mesic	Starkey
3420	wetland	3.11	Mesic	Starkey
3461	wetland	8.75	Mesic	Starkey
3489	wetland	1.56	Mesic	Starkey
3881	wetland	0.68	Mesic	Cypress Creek
3898	wetland	11.17	Mesic	Cypress Creek
3903	wetland	2.35	Mesic	Cypress Creek
3939	wetland	1.50	Mesic	Cypress Creek
3955	wetland	1.98	Mesic	Cypress Creek
3961	wetland	3.99	Mesic	Cypress Creek
3962	wetland	2.38	Mesic	Cypress Creek
3975	wetland	1.12	Mesic	Cypress Creek
3991	wetland	2.73	Mesic	Cypress Creek
4008	wetland	5.34	Mesic	Cypress Creek
4009	wetland	3.50	Mesic	Cypress Creek

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
4043	wetland	6.11	Mesic	Cypress Creek
4064	wetland	1.04	Mesic	Cypress Creek
4079	wetland	2.06	Mesic	Cypress Creek
4081	wetland	1.60	Mesic	Cypress Creek
4086	wetland	0.50	Xeric	Cypress Creek
4087	wetland	3.43	Mesic	Cypress Creek
4097	wetland	1.55	Mesic	Cypress Creek
4102	wetland	4.22	Mesic	Cypress Creek
4112	wetland	2.38	Mesic	Cypress Creek
4123	wetland	0.74	Mesic	Cypress Creek
4128	wetland	3.93	Mesic	Cypress Creek
4148	wetland	1.01	Mesic	Cypress Creek
4236	wetland	2.49	Mesic	Cypress Creek
4271	wetland	0.53	Mesic	Cypress Creek
4283	wetland	3.75	Mesic	Cypress Creek
4286	wetland	0.55	Mesic	Cypress Creek
4336	wetland	3.52	Mesic	Cypress Creek
4355	wetland	0.71	Mesic	Cypress Creek
4392	wetland	1.16	Mesic	Cypress Creek
4405	wetland	0.59	Mesic	Cypress Creek
4423	wetland	1.44	Mesic	Cypress Creek
4439	wetland	46.43	Mesic	Cypress Creek
4442	wetland	7.58	Mesic	Cypress Creek
4465	wetland	0.67	Mesic	Cypress Creek
4468	wetland	1.69	Mesic	Cypress Creek
4474	wetland	1.66	Mesic	Cypress Creek
4489	wetland	1.84	Mesic	Cypress Creek
4491	wetland	0.65	Mesic	Cypress Creek
4501	wetland	1.42	Mesic	Cypress Creek
4503	wetland	0.73	Mesic	Cypress Creek
4504	wetland	1.42	Mesic	Cypress Creek
4512	wetland	1.58	Xeric	Cypress Creek
4514	wetland	6.27	Mesic	Cypress Creek
4538	wetland	7.00	Mesic	Cypress Creek
4543	wetland	2.37	Mesic	Cypress Creek
4558	wetland	1.02	Mesic	Cypress Creek
4562	wetland	165.37	Mesic	Cypress Creek
4574	wetland	12.92	Mesic	Cypress Creek
4578	wetland	4.15	Mesic	Cypress Creek

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
4613	wetland	13.56	Mesic	Cypress Creek
4682	wetland	123.55	Mesic	Cross Bar Ranch
4802	wetland	73.14	Mesic	Cross Bar Ranch
4822	wetland	40.62	Mesic	Cross Bar Ranch
4832	wetland	18.36	Mesic	Cross Bar Ranch
4848	wetland	0.55	Xeric	Cross Bar Ranch
4871	wetland	1.88	Mesic	Cross Bar Ranch
4884	wetland	5.52	Mesic	Cross Bar Ranch
4893	wetland	8.76	Mesic	Cross Bar Ranch
4924	wetland	34.30	Mesic	Cross Bar Ranch
4959	wetland	46.00	Mesic	Cross Bar Ranch
4963	wetland	1.99	Mesic	Cross Bar Ranch
4977	wetland	4.24	Mesic	Cross Bar Ranch
4985	wetland	2.65	Mesic	Cross Bar Ranch
4990	wetland	1.22	Mesic	Cross Bar Ranch
5003	wetland	5.12	Mesic	Cross Bar Ranch
5004	wetland	14.11	Mesic	Cross Bar Ranch
5006	wetland	28.19	Mesic	Cross Bar Ranch
5010	wetland	1.24	Mesic	Cross Bar Ranch
5011	wetland	30.79	Xeric	Cross Bar Ranch
5012	wetland	122.35	Mesic	Cross Bar Ranch
5019	wetland	0.58	Xeric	Cross Bar Ranch
5021	wetland	82.35	Xeric	Cross Bar Ranch
5025	wetland	11.51	Xeric	Cross Bar Ranch
5027	wetland	1.49	Xeric	Cross Bar Ranch
5031	wetland	10.53	Xeric	Cross Bar Ranch
5032	wetland	1.41	Xeric	Cross Bar Ranch
5036	lake	1.69	Mesic	Cross Bar Ranch
5038	wetland	0.94	Xeric	Cross Bar Ranch
5040	wetland	3.59	Xeric	Cross Bar Ranch
5041	wetland	3.74	Mesic	Cross Bar Ranch
5043	wetland	3.29	Xeric	Cross Bar Ranch
5046	wetland	44.14	Xeric	Cross Bar Ranch
5049	wetland	12.03	Xeric	Cross Bar Ranch
5051	wetland	0.72	Xeric	Cross Bar Ranch
5054	wetland	0.88	Mesic	Cross Bar Ranch
5057	wetland	39.54	Mesic	Cross Bar Ranch
5058	wetland	1.51	Mesic	Cross Bar Ranch
5059	wetland	2.84	Mesic	Cross Bar Ranch

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
5060	wetland	1.32	Xeric	Cross Bar Ranch
5061	wetland	10.92	Xeric	Cross Bar Ranch
5063	wetland	1.47	Mesic	Cross Bar Ranch
5064	wetland	2.02	Mesic	Cross Bar Ranch
5065	wetland	4.94	Xeric	Cross Bar Ranch
5066	wetland	5.64	Xeric	Cross Bar Ranch
5067	wetland	0.78	Xeric	Cross Bar Ranch
5068	wetland	10.91	Xeric	Cross Bar Ranch
5070	wetland	0.89	Mesic	Cross Bar Ranch
5071	wetland	0.73	Xeric	Cross Bar Ranch
5073	wetland	41.27	Xeric	Cross Bar Ranch
5074	wetland	5.20	Mesic	Cross Bar Ranch
5075	wetland	0.55	Mesic	Cross Bar Ranch
5076	wetland	1.00	Xeric	Cross Bar Ranch
5077	wetland	1.68	Mesic	Cross Bar Ranch
5078	wetland	0.86	Mesic	Cross Bar Ranch
5080	wetland	2.97	Xeric	Cross Bar Ranch
5081	wetland	1.01	Mesic	Cross Bar Ranch
5082	wetland	0.50	Xeric	Cross Bar Ranch
5083	wetland	0.63	Mesic	Cross Bar Ranch
5084	wetland	3.75	Xeric	Cross Bar Ranch
5086	wetland	4.21	Xeric	Cross Bar Ranch
5087	wetland	1.06	Xeric	Cross Bar Ranch
5088	wetland	6.16	Mesic	Cross Bar Ranch
5090	wetland	5.23	Xeric	Cross Bar Ranch
5091	wetland	8.12	Xeric	Cross Bar Ranch
5092	wetland	0.61	Xeric	Cross Bar Ranch
5093	wetland	2.14	Xeric	Cross Bar Ranch
5094	wetland	3.33	Xeric	Cross Bar Ranch
5095	wetland	4.98	Xeric	Cross Bar Ranch
5099	wetland	2.40	Xeric	Cross Bar Ranch
5100	wetland	3.05	Xeric	Cross Bar Ranch
5101	wetland	1.28	Xeric	Cross Bar Ranch
5102	wetland	14.68	Xeric	Cross Bar Ranch
5103	wetland	0.67	Xeric	Cross Bar Ranch
5104	wetland	2.93	Xeric	Cross Bar Ranch
5105	wetland	2.32	Xeric	Cross Bar Ranch
5106	wetland	5.23	Xeric	Cross Bar Ranch
5107	wetland	1.17	Mesic	Cross Bar Ranch

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
5108	wetland	71.38	Xeric	Cross Bar Ranch
5109	wetland	6.56	Xeric	Cross Bar Ranch
5110	wetland	39.12	Xeric	Cross Bar Ranch
5111	wetland	1.47	Xeric	Cross Bar Ranch
5114	wetland	3.34	Xeric	Cross Bar Ranch
5115	wetland	0.57	Xeric	Cross Bar Ranch
5116	wetland	1.74	Xeric	Cross Bar Ranch
5117	wetland	1.01	Xeric	Cross Bar Ranch
5118	wetland	27.65	Xeric	Cross Bar Ranch
5119	wetland	1.24	Xeric	Cross Bar Ranch
5120	wetland	2.23	Xeric	Cross Bar Ranch
5123	wetland	1.63	Xeric	Cross Bar Ranch
5124	wetland	36.97	Xeric	Cross Bar Ranch
5125	wetland	1.45	Xeric	Cross Bar Ranch
5126	wetland	10.81	Mesic	Cross Bar Ranch
5129	wetland	2.03	Xeric	Cross Bar Ranch
5131	wetland	1.15	Xeric	Cross Bar Ranch
5133	wetland	0.50	Mesic	Cross Bar Ranch
5134	wetland	5.09	Xeric	Cross Bar Ranch
5136	wetland	8.73	Xeric	Cross Bar Ranch
5137	wetland	1.05	Xeric	Cross Bar Ranch
5138	wetland	1.36	Xeric	Cross Bar Ranch
5139	wetland	1.08	Xeric	Cross Bar Ranch
5140	wetland	4.03	Xeric	Cross Bar Ranch
5141	wetland	2.00	Xeric	Cross Bar Ranch
5143	wetland	8.93	Xeric	Cross Bar Ranch
5144	wetland	9.84	Xeric	Cross Bar Ranch
5148	wetland	1.23	Xeric	Cross Bar Ranch
5149	wetland	0.58	Xeric	Cross Bar Ranch
5150	wetland	5.99	Xeric	Cross Bar Ranch
5151	wetland	0.87	Xeric	Cross Bar Ranch
5152	wetland	4.17	Xeric	Cross Bar Ranch
5153	wetland	12.59	Xeric	Cross Bar Ranch
5155	wetland	2.20	Xeric	Cross Bar Ranch
5156	wetland	1.35	Xeric	Cross Bar Ranch
5157	wetland	1.80	Xeric	Cross Bar Ranch
5158	wetland	0.67	Xeric	Cross Bar Ranch
5159	wetland	0.75	Xeric	Cross Bar Ranch
5160	wetland	0.62	Xeric	Cross Bar Ranch

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
5161	wetland	1.73	Xeric	Cross Bar Ranch
5162	wetland	1.72	Xeric	Cross Bar Ranch
5163	wetland	9.65	Xeric	Cross Bar Ranch
5166	wetland	2.24	Xeric	Cross Bar Ranch
5168	wetland	0.93	Xeric	Cross Bar Ranch
5169	wetland	0.79	Xeric	Cross Bar Ranch
5170	wetland	4.05	Xeric	Cross Bar Ranch
5171	wetland	0.55	Xeric	Cross Bar Ranch
5172	wetland	1.54	Xeric	Cross Bar Ranch
5174	wetland	40.34	Xeric	Cross Bar Ranch
5177	wetland	16.29	Xeric	Cross Bar Ranch
5178	wetland	7.75	Xeric	Cross Bar Ranch
5179	wetland	1.57	Xeric	Cross Bar Ranch
5182	wetland	15.67	Xeric	Cross Bar Ranch
5194	wetland	2.63	Xeric	Cross Bar Ranch
5195	wetland	45.07	Xeric	Cross Bar Ranch
5196	wetland	5.41	Xeric	Cross Bar Ranch
5198	wetland	4.20	Xeric	Cross Bar Ranch
5203	wetland	21.97	Xeric	Cross Bar Ranch
5208	wetland	45.28	Xeric	Cross Bar Ranch
5210	wetland	5.40	Xeric	Cross Bar Ranch
5214	wetland	31.91	Xeric	Cross Bar Ranch
5215	wetland	9.21	Xeric	Cross Bar Ranch
5217	wetland	11.08	Mesic	Cross Bar Ranch
5218	wetland	11.53	Xeric	Cross Bar Ranch
5221	wetland	14.14	Xeric	Cross Bar Ranch
5222	wetland	7.53	Xeric	Cross Bar Ranch
5236	wetland	15.60	Mesic	Cross Bar Ranch
5237	wetland	2.73	Mesic	Cross Bar Ranch
5238	wetland	4.16	Mesic	Cross Bar Ranch
5239	wetland	3.90	Xeric	Cross Bar Ranch
5245	wetland	0.66	Xeric	Cross Bar Ranch
5246	wetland	1.82	Xeric	Cross Bar Ranch
5247	wetland	12.45	Xeric	Cross Bar Ranch
5248	wetland	4.62	Xeric	Cross Bar Ranch
5259	wetland	1.39	Xeric	Cross Bar Ranch
5270	lake	0.69	Xeric	Cross Bar Ranch
5271	lake	1.56	Xeric	Cross Bar Ranch
5279	wetland	0.57	Xeric	Cross Bar Ranch

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
5286	wetland	1.23	Xeric	Cross Bar Ranch
5308	wetland	0.86	Xeric	Cross Bar Ranch
5309	wetland	0.77	Xeric	Cross Bar Ranch
5320	wetland	5.51	Mesic	Cypress Creek
5323	wetland	11.80	Mesic	Cypress Creek
5347	wetland	2.13	Mesic	Cypress Creek
5348	wetland	4.12	Mesic	Cypress Creek
5357	wetland	1.18	Mesic	Cypress Creek
5366	wetland	1.12	Mesic	Cypress Creek
5367	wetland	2.32	Mesic	Cypress Creek
5488	wetland	2.22	Mesic	Morris Bridge
5493	wetland	0.68	Mesic	Morris Bridge
5496	wetland	4.08	Mesic	Morris Bridge
5497	wetland	6.11	Mesic	Morris Bridge
5499	wetland	37.46	Mesic	Morris Bridge
5501	wetland	0.74	Mesic	Morris Bridge
5506	wetland	3.63	Mesic	Morris Bridge
5508	wetland	0.76	Mesic	Morris Bridge
5513	wetland	1.23	Mesic	Morris Bridge
5515	wetland	5.10	Mesic	Morris Bridge
5516	wetland	1.40	Mesic	Morris Bridge
5518	wetland	0.53	Mesic	Morris Bridge
5521	wetland	1.41	Mesic	Morris Bridge
5522	wetland	2.81	Mesic	Morris Bridge
5523	wetland	1.78	Mesic	Morris Bridge
5524	wetland	2.41	Mesic	Morris Bridge
5527	wetland	2.98	Mesic	Morris Bridge
5528	wetland	2.84	Mesic	Morris Bridge
5529	wetland	0.87	Mesic	Morris Bridge
5530	wetland	0.53	Mesic	Morris Bridge
5531	wetland	2.53	Mesic	Morris Bridge
5535	wetland	2.43	Mesic	Morris Bridge
5536	wetland	0.70	Mesic	Morris Bridge
5538	wetland	0.70	Mesic	Morris Bridge
5539	wetland	1.12	Mesic	Morris Bridge
5540	wetland	0.60	Mesic	Morris Bridge
5543	wetland	0.56	Mesic	Morris Bridge
5545	wetland	0.73	Mesic	Morris Bridge
5546	wetland	3.09	Mesic	Morris Bridge

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
5549	wetland	0.77	Mesic	Morris Bridge
5550	wetland	2.36	Mesic	Morris Bridge
5551	wetland	1.48	Mesic	Morris Bridge
5554	wetland	1.23	Mesic	Morris Bridge
5557	wetland	0.60	Mesic	Morris Bridge
5559	wetland	1.93	Mesic	Morris Bridge
5560	wetland	1.17	Mesic	Morris Bridge
5563	wetland	9.28	Mesic	Morris Bridge
5567	wetland	5.58	Mesic	Morris Bridge
5568	wetland	0.75	Mesic	Morris Bridge
5572	wetland	0.80	Mesic	Morris Bridge
5573	wetland	1.31	Mesic	Morris Bridge
5578	wetland	1.28	Mesic	Morris Bridge
5580	wetland	1.83	Mesic	Morris Bridge
5581	wetland	0.68	Mesic	Morris Bridge
5583	wetland	0.69	Mesic	Morris Bridge
5584	wetland	4.19	Mesic	Morris Bridge
5587	wetland	0.93	Mesic	Morris Bridge
5589	wetland	9.72	Mesic	Morris Bridge
5593	wetland	9.75	Mesic	Morris Bridge
5594	wetland	0.80	Mesic	Morris Bridge
5595	wetland	19.51	Mesic	Morris Bridge
5599	wetland	0.61	Mesic	Morris Bridge
5605	wetland	1.33	Mesic	Morris Bridge
5608	wetland	9.60	Mesic	Morris Bridge
5610	wetland	1.59	Mesic	Morris Bridge
5612	wetland	0.80	Mesic	Morris Bridge
5613	wetland	1.75	Mesic	Morris Bridge
5614	wetland	2.39	Mesic	Morris Bridge
5617	wetland	2.46	Mesic	Morris Bridge
5618	wetland	0.95	Mesic	Morris Bridge
5619	wetland	0.85	Mesic	Morris Bridge
5623	wetland	0.99	Mesic	Morris Bridge
5624	wetland	1.35	Mesic	Morris Bridge
5626	wetland	2.20	Mesic	Morris Bridge
5629	wetland	2.45	Mesic	Morris Bridge
5634	wetland	1.25	Mesic	Morris Bridge
5635	wetland	2.92	Mesic	Morris Bridge
5636	wetland	5.50	Mesic	Morris Bridge

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
5640	wetland	1.42	Mesic	Morris Bridge
5643	wetland	1.07	Mesic	Morris Bridge
5646	wetland	0.57	Mesic	Morris Bridge
5648	wetland	5.54	Mesic	Morris Bridge
5649	wetland	5.88	Mesic	Morris Bridge
5653	wetland	0.61	Mesic	Morris Bridge
5654	wetland	5.08	Mesic	Morris Bridge
5657	wetland	1.36	Mesic	Morris Bridge
5662	wetland	1.94	Mesic	Morris Bridge
5664	wetland	3.54	Mesic	Morris Bridge
5667	wetland	2.63	Mesic	Morris Bridge
5669	wetland	1.35	Mesic	Morris Bridge
5670	wetland	4.29	Mesic	Morris Bridge
5671	wetland	0.91	Mesic	Morris Bridge
5672	wetland	2.08	Mesic	Morris Bridge
5673	wetland	5.26	Mesic	Morris Bridge
5674	wetland	1.12	Mesic	Morris Bridge
5683	wetland	1.50	Mesic	Morris Bridge
5684	wetland	2.89	Mesic	Morris Bridge
5685	wetland	4.32	Mesic	Morris Bridge
5692	wetland	0.96	Mesic	Morris Bridge
5701	wetland	4.05	Mesic	Morris Bridge
5710	wetland	17.09	Mesic	Morris Bridge
5713	wetland	8.18	Mesic	Morris Bridge
5720	wetland	0.65	Mesic	Morris Bridge
5728	wetland	0.86	Mesic	Morris Bridge
5731	wetland	4.64	Mesic	Morris Bridge
5733	wetland	11.58	Mesic	Morris Bridge
5739	wetland	1.17	Mesic	Cypress Bridge
5744	wetland	7.51	Mesic	Morris Bridge
5749	wetland	12.48	Mesic	Cypress Bridge
5757	wetland	0.70	Mesic	Cypress Bridge
5768	wetland	2.89	Mesic	Cypress Bridge
5771	wetland	5.70	Mesic	Morris Bridge
5772	wetland	1.22	Mesic	Morris Bridge
5813	wetland	0.80	Mesic	Morris Bridge
5819	wetland	5.53	Mesic	Morris Bridge
5826	wetland	26.23	Mesic	Cypress Bridge
5827	wetland	3.05	Mesic	Cypress Bridge

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
5833	wetland	0.58	Mesic	Morris Bridge
5844	wetland	0.60	Mesic	Morris Bridge
5850	wetland	1.52	Mesic	Cypress Bridge
5865	wetland	20.46	Mesic	Morris Bridge
5866	wetland	24.84	Mesic	Morris Bridge
5890	wetland	4.06	Mesic	Cypress Bridge
5908	wetland	0.99	Mesic	Cypress Bridge
5909	wetland	1.62	Mesic	Cypress Bridge
5918	wetland	0.58	Mesic	Cypress Bridge
5958	wetland	12.23	Mesic	Cypress Bridge
6000	wetland	3.15	Mesic	Cypress Bridge
6010	wetland	1.05	Mesic	Cypress Bridge
6014	wetland	9.98	Mesic	Cypress Bridge
6033	wetland	3.59	Mesic	Cypress Bridge
6036	wetland	2.44	Mesic	Cypress Bridge
6037	wetland	2.46	Mesic	Cypress Bridge
6041	wetland	2.87	Mesic	Cypress Bridge
6043	wetland	0.60	Mesic	Cypress Bridge
6046	wetland	5.08	Mesic	Cypress Bridge
6047	wetland	0.59	Mesic	Cypress Bridge
6048	wetland	1.01	Mesic	Cypress Bridge
6049	wetland	7.78	Mesic	Cypress Bridge
6050	wetland	1.85	Mesic	Cypress Bridge
6051	wetland	1.23	Mesic	Cypress Bridge
6054	wetland	0.51	Mesic	Cypress Bridge
6055	wetland	2.88	Mesic	Cypress Bridge
6056	wetland	1.90	Mesic	Cypress Bridge
6059	wetland	10.51	Mesic	Cypress Bridge
6060	wetland	1.29	Mesic	Cypress Bridge
6061	wetland	10.67	Mesic	Cypress Bridge
6062	wetland	85.86	Mesic	Cypress Bridge
6064	wetland	0.97	Mesic	Cypress Bridge
6069	wetland	0.52	Mesic	Cypress Bridge
6072	wetland	0.82	Mesic	Cypress Bridge
6073	wetland	53.48	Mesic	Cypress Bridge
6074	wetland	1.97	Mesic	Cypress Bridge
6075	wetland	21.45	Mesic	Cypress Bridge
6076	wetland	0.58	Mesic	Cypress Bridge
6077	wetland	2.07	Mesic	Cypress Bridge

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
6079	wetland	2.44	Mesic	Cypress Bridge
6080	wetland	0.76	Mesic	Cypress Bridge
6083	wetland	3.30	Mesic	Cypress Bridge
6084	wetland	1.07	Mesic	Cypress Bridge
6085	wetland	5.17	Mesic	Cypress Bridge
6086	wetland	0.58	Mesic	Cypress Bridge
6087	wetland	4.66	Mesic	Cypress Bridge
6088	wetland	1.22	Mesic	Cypress Bridge
6089	wetland	13.40	Mesic	Cypress Bridge
6090	wetland	5.82	Mesic	Cypress Bridge
6091	wetland	35.00	Mesic	Cypress Bridge
6092	wetland	2.40	Mesic	Cypress Bridge
6093	wetland	16.26	Mesic	Cypress Bridge
6094	wetland	1.34	Mesic	Cypress Bridge
6095	wetland	1.35	Xeric	Cypress Bridge
6097	wetland	0.61	Mesic	Cypress Bridge
6098	wetland	1.05	Mesic	Cypress Bridge
6099	wetland	3.38	Mesic	Cypress Bridge
6100	wetland	2.05	Mesic	Cypress Bridge
6101	wetland	3.10	Mesic	Cypress Bridge
6102	wetland	0.72	Xeric	Cypress Bridge
6103	wetland	11.14	Mesic	Cypress Bridge
6104	wetland	0.73	Mesic	Cypress Bridge
6106	wetland	3.21	Xeric	Cypress Bridge
6107	wetland	2.94	Mesic	Cypress Bridge
6108	wetland	2.04	Mesic	Cypress Bridge
6109	wetland	3.77	Mesic	Cypress Bridge
6110	wetland	1.38	Mesic	Cypress Bridge
6111	wetland	0.67	Xeric	Cypress Bridge
6112	wetland	1.40	Xeric	Cypress Bridge
6115	wetland	1.18	Mesic	Cypress Bridge
6121	wetland	1.84	Mesic	Cypress Bridge
6123	wetland	1.28	Mesic	Cypress Bridge
6124	wetland	0.72	Mesic	Cypress Bridge
6125	wetland	6.37	Mesic	Cypress Bridge
6137	wetland	1.34	Mesic	Cypress Bridge
6139	wetland	3.48	Mesic	Cypress Bridge
6143	wetland	4.36	Mesic	Cypress Bridge
6147	wetland	5.72	Mesic	Cypress Bridge

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
6149	wetland	9.67	Mesic	Cypress Bridge
6153	wetland	1.83	Mesic	Cypress Bridge
6154	wetland	8.47	Mesic	Cypress Bridge
6157	wetland	0.88	Mesic	Cypress Bridge
6159	wetland	7.09	Mesic	Cypress Bridge
6160	wetland	3.61	Mesic	Cypress Bridge
6163	wetland	1.48	Mesic	Cypress Bridge
6165	wetland	0.76	Mesic	Cypress Bridge
6168	wetland	2.54	Mesic	Cypress Bridge
6169	wetland	6.06	Mesic	Cypress Bridge
6172	wetland	17.56	Mesic	Cypress Bridge
6200	wetland	3.36	Mesic	Cypress Bridge
6202	wetland	3.15	Mesic	Cypress Bridge
6203	wetland	0.98	Mesic	Cypress Bridge
6204	wetland	3.65	Mesic	Cypress Bridge
6205	wetland	1.98	Mesic	Cypress Bridge
6206	wetland	2.85	Mesic	Cypress Bridge
6207	wetland	100.21	Mesic	Cypress Bridge
6214	wetland	0.67	Mesic	Cypress Bridge
6217	wetland	1.17	Mesic	Cypress Bridge
6225	wetland	11.99	Mesic	Cypress Bridge
6232	wetland	61.33	Mesic	Cypress Bridge
6246	wetland	1.72	Mesic	Cypress Bridge
6247	wetland	1.78	Mesic	Cypress Bridge
6251	wetland	7.70	Mesic	Cypress Bridge
6252	wetland	17.13	Mesic	Cypress Bridge
6253	wetland	23.74	Mesic	Cypress Bridge
6254	wetland	0.96	Mesic	Morris Bridge
6258	wetland	0.63	Mesic	Morris Bridge
6259	wetland	0.83	Mesic	Morris Bridge
6260	wetland	6.31	Mesic	Morris Bridge
6262	wetland	1.78	Mesic	Morris Bridge
6266	wetland	3.96	Mesic	Morris Bridge
6268	wetland	10.53	Mesic	Morris Bridge
6280	wetland	2.34	Mesic	Morris Bridge
6281	wetland	0.64	Mesic	Morris Bridge
6282	wetland	0.78	Mesic	Morris Bridge
6296	wetland	60.36	Mesic	Morris Bridge
6298	wetland	9.15	Mesic	Cypress Bridge

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
6299	wetland	6.27	Mesic	Morris Bridge
6304	wetland	1.12	Mesic	Cypress Bridge
6305	wetland	1.81	Mesic	Cypress Bridge
6309	wetland	2.12	Mesic	Cypress Bridge
6310	wetland	4.68	Mesic	Cypress Bridge
6311	wetland	1.64	Mesic	Cypress Bridge
6312	wetland	7.77	Mesic	Cypress Bridge
6313	wetland	0.85	Mesic	Cypress Bridge
6314	wetland	1.09	Mesic	Cypress Bridge
6315	wetland	0.55	Mesic	Cypress Bridge
6316	wetland	3.49	Mesic	Cypress Bridge
6317	wetland	10.56	Mesic	Cypress Bridge
6318	wetland	0.58	Mesic	Cypress Bridge
6320	wetland	5.71	Mesic	Cypress Bridge
6322	wetland	1.35	Mesic	Cypress Bridge
6325	wetland	2.77	Mesic	Cypress Bridge
6328	wetland	2.34	Mesic	Cypress Bridge
6331	wetland	0.95	Mesic	Cypress Bridge
6333	wetland	25.55	Mesic	Cypress Bridge
6334	wetland	1.16	Mesic	Cypress Bridge
6336	wetland	4.06	Mesic	Cypress Bridge
6339	wetland	3.66	Mesic	Section 21
6358	wetland	147.15	Xeric	Cross Bar Ranch
6410	wetland	54.55	Mesic	Eldridge-Wilde
6411	wetland	138.94	Mesic	Eldridge-Wilde
6413	wetland	279.22	Mesic	Eldridge-Wilde
6415	wetland	56.29	Mesic	Eldridge-Wilde
6480	wetland	167.71	Xeric	Cross Bar Ranch
6481	wetland	1258.17	Xeric	Cross Bar Ranch
6489	wetland	159.99	Mesic	Cross Bar Ranch
6494	wetland	32.18	Xeric	Cross Bar Ranch
6498	wetland	108.79	Mesic	Cross Bar Ranch
6499	wetland	4.09	Xeric	Cross Bar Ranch
6500	wetland	4.59	Mesic	Cypress Creek
6579	wetland	27.06	Xeric	Eldridge-Wilde
6670	wetland	34.22	Mesic	Section 21
6671	wetland	0.57	Mesic	Section 21
6673	wetland	1.53	Mesic	Section 21
6675	lake	1.08	Mesic	Section 21

Unmonitored Wetland ID	Type	Acres	Xeric/Mesic	Associated Wellfield
6676	lake	46.91	Mesic	Section 21
6681	wetland	2.49	Mesic	Section 21
6683	wetland	3.52	Mesic	Section 21
6774	wetland	15.48	Xeric	Eldridge-Wilde
6776	wetland	3.63	Mesic	Eldridge-Wilde
6777	wetland	3.00	Mesic	Eldridge-Wilde
6780	wetland	88.86	Mesic	Eldridge-Wilde
6783	wetland	13.45	Mesic	Eldridge-Wilde
6804	wetland	0.56	Xeric	Eldridge-Wilde
6805	wetland	3.97	Xeric	Eldridge-Wilde
6806	wetland	1.35	Xeric	Eldridge-Wilde
6988	wetland	11.71	Xeric	Northwest Hillsborough
7007	wetland	73.16	Mesic	Cross Bar Ranch
7012	wetland	209.69	Mesic	Cypress Bridge
7013	wetland	16.29	Mesic	Morris Bridge
7044	wetland	121.54	Mesic	Eldridge-Wilde
7102	wetland	9.75	Mesic	Morris Bridge
8121	wetland	1.73	Mesic	Eldridge-Wilde
10045	lake	0.77	Mesic	Eldridge-Wilde
11000	wetland	2.11	Mesic	Cypress Creek
11001	lake	0.58	Xeric	Eldridge-Wilde
11002	lake	0.75	Xeric	Eldridge-Wilde
12001	lake	0.53	Mesic	Section 21
12002	lake	0.93	Mesic	Section 21
12003	lake	10.56	Xeric	Eldridge-Wilde
12004	lake	25.60	Mesic	Eldridge-Wilde
12005	wetland	1.78	Mesic	Eldridge-Wilde
12006	lake	1.20	Mesic	Eldridge-Wilde

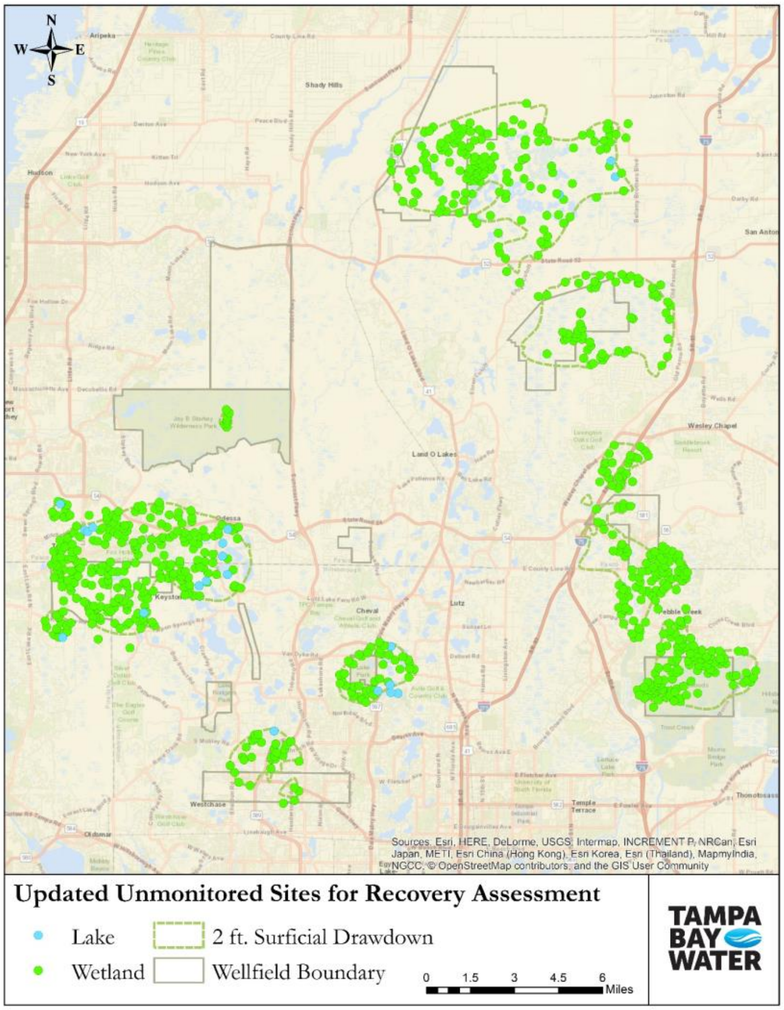

Figure 5.8: Unmonitored Lakes and Wetlands to be Assessed.

5.5 Data Used in This Assessment

The completion of the Recovery Assessment Plan is possible only because of the wealth of environmental data that has been collected in the Tampa Bay area for many decades. Water level data has been collected from some lakes in the northwest Hillsborough County area beginning in the early 1930's. In some cases, water level data from monitoring wells, lakes, and wetlands was collected before nearby wellfields were developed. In almost all cases, water level data has been collected from the monitored wetlands and lakes included in the Recovery Assessment Plan both before and after the wellfield pumping reduction. These data form the foundation for assessing recovery of the water resources and environmental systems as required by the renewed Consolidated Permit.

The United States Geological Survey (USGS) collected historical water level data prior to the formation of the District and these data are contained in the District's database and are available from the USGS. Tampa Bay Water and the District have well-documented data collection programs with multiple types of data collected on a regular frequency and subjected to rigorous quality assurance/quality control processes. Both agencies have well-designed and maintained databases for the organization and storage of groundwater pumping, rainfall, water level, and other types of environmental data. Tampa Bay Water and District staffs agreed that the Tampa Bay Water database (Data Mart) will be the primary source of data used for the Recovery Assessment Plan and this data will be supplemented with District water level data as appropriate (see District letter dated May 22, 2014 – Appendix 5.3). Throughout the Recovery Assessment Plan analyses, data from the Tampa Bay Water database has been used for all sites that Tampa Bay Water monitors and historical data for those wetlands and lakes with data from the District's database have been added, when available. Tampa Bay Water has used the District's database (Water Management Information System or WMIS) as the source of water level and wetland vegetation data for those sites monitored only by the District.

A fundamental goal of the Recovery Assessment Plan was to assemble a collection of high-quality data that has been subject to rigorous quality control evaluation and to make that collection of data fully usable by Tampa Bay Water and District staff. This has resulted in an understanding that the data that both agencies are using for Recovery Assessment Plan analyses is the best available data and staffs have been able to focus our attention on the analyses of recovery. In early 2019, the District inadvertently began to transmit their water level data to Tampa Bay Water referencing a different elevation datum, NAVD 1988. This data was routinely uploaded into Data Mart for several months before the shift in datum was discovered. The Information Technology staffs of both agencies worked to replace the NAVD 1988 data with water level data referenced to the NGVD 1929 datum to match the other water level data in the Tampa Bay Water database. Staff believes that all of the data used in our final Recovery Assessment analyses is referenced to the NGVD 1929 vertical datum; however, it is possible that some of the NGVD 1988 data remains in Data Mart. All water level data used in the final Recovery Assessment Plan analyses has been archived for later examination, if necessary. The following sections introduce the different types of data that have been used in the Recovery Assessment analyses presented later in this report.

5.5.1 Hydrologic Data

5.5.1.1 Aquifer Water Level Data

The Recovery Assessment Plan is designed to assess the recovery of lakes and wetlands attributed to the reduction in groundwater pumping from the Consolidated Permit wellfields. Pumping from the groundwater production wells has the most direct effect on the potentiometric surface of the Upper Floridan Aquifer since all of our production wells are drilled into this aquifer. Drawdown of the potentiometric surface in turn, influences the surficial aquifer and to a lesser degree, the water level in lakes and wetlands near the wellfields. To assist in assessment of recovery at individual lakes and wetlands, a reference list of monitor wells with available water level data was developed so that nearby aquifer monitor well data could be located. Tampa Bay Water worked with District staff to compile four tables of monitor wells in the area of the Consolidated Permit wellfields and some reference monitor wells distant from the wellfields. The four reference tables include:

- Upper Floridan and surficial aquifer monitor wells grouped by the associated wellfield name,
- Upland (surficial aquifer) monitor wells associated with wetlands monitored by Tampa Bay Water as part of the Consolidated Permit environmental monitoring program,
- Upland (surficial aquifer) and wetland monitor wells associated with wetlands monitored mostly by the District both near the 11 wellfields and at distant locations, and
- Upper Floridan and surficial aquifer monitor wells generally located outside of the wellfield area (can be used as reference water level sites).

All reference tables show well names, database site ID numbers, the owner of the well, what entity collects data from each site, the aquifer monitored by the well, location, well construction specifications, and vertical elevation. These reference monitor well tables were submitted to the District on March 24, 2016, and the submittal is contained in Appendix 5.12. The District reviewed this information and provided some additional information in a response dated January 26, 2017 (included in Appendix 5.12). The water level data from these wells are collected by Tampa Bay Water, the District, or the USGS and the data used from any of these monitor wells were obtained from the database of the agency that collected the data. All water level monitor well data are subject to the data collection and quality control/quality assurance protocols of the collecting agency and are referenced to the NGVD 1929 datum. The locations of the reference monitor wells are shown in Figure 5.9.

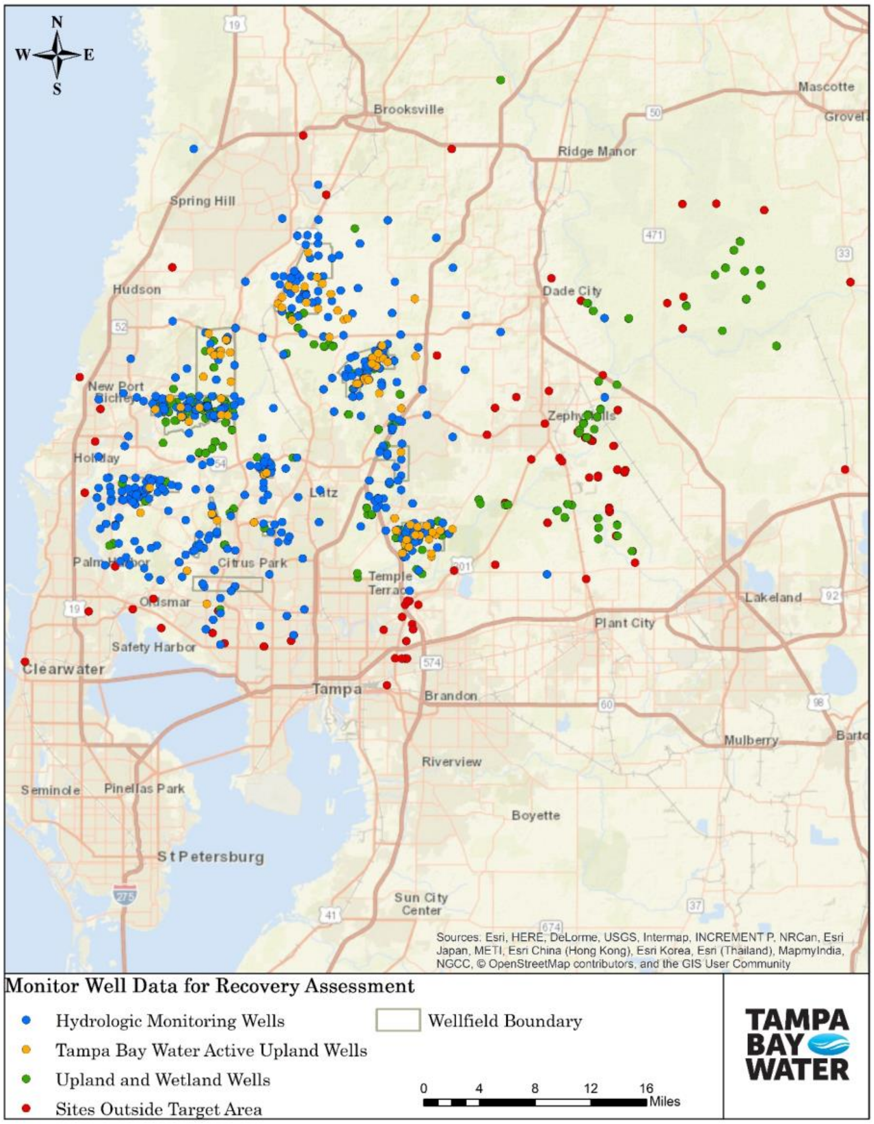

Figure 5.9: Monitor Wells with Available Data for Recovery Assessment Analyses

5.5.1.2 Wetland Water Level Data

The Recovery Assessment Plan contains 378 monitored wetlands with the oldest site (wetland STWF-D at the Starkey Wellfield) having period of record data extending back to 1975. Tampa Bay Water currently monitors 197 of these wetlands and has historical water level data for 62 additional sites that are no longer monitored. There are many reasons why monitoring ended including: loss of site access, wetland elimination, monitoring device destruction, redundant monitoring (Tampa Bay Water and the District), and the changes in monitoring programs over time. For these 259 wetlands, the water level data used in the Recovery Assessment Plan was downloaded from the Tampa Bay Water database. There are 54 wetlands in the Recovery Assessment Plan that have been monitored by the District throughout their periods of record. The data analyzed for these sites were downloaded from the District database. There are an additional 65 wetlands that Tampa Bay Water monitored in the past and the District began monitoring them when Tampa Bay Water stopped collecting water level data at those sites. The data used in Recovery Assessment analyses for these sites are a combination of Tampa Bay Water and District data.

The Tampa Bay Water wetland water level data analyzed in the Recovery Assessment Plan has undergone a comprehensive quality control (QC) review. Prior to 2005, the wetland water level data for each wellfield monitoring program were kept in separate databases or spreadsheets by the individual wellfield monitoring consultants. In 2005, these separate data sources were compiled and reviewed prior to the establishment of a centralized database maintained by Tampa Bay Water. This was an extensive process since many sites had more than 30 years of data that predated the creation of Tampa Bay Water's central database. The QC process involved carefully matching the consultant's data for specific monitoring devices with the appropriate Tampa Bay Water monitoring device, as well as adjusting the measurements for any discrepancies in survey elevation or conversion factor for the monitoring device. Conversion factors were applied to water level data to standardize the data against a known elevation datum (NGVD 1929). Attempts to analyze these data, including simple graphing, revealed problems in the data ranging from issues with full data sets for a site to errors involving single data points. Issues involving whole data sets often resulted from inaccuracies with a site's survey, so one portion of the review focused on the elevation and location characteristics of each monitoring device, as well as the system of benchmarks and procedures used in surveying these devices. This led to an expansion of Tampa Bay Water's in-house surveying capabilities and resulted in an increase in the frequency and accuracy of the survey procedures.

The remainder of the data QC review focused on the water level measurements (data points) from each wetland monitoring device. Observed individual and group erroneous data were investigated to determine if the error was in the field measurement, the date, or the conversion factor used; the data were corrected where possible. This last phase continues as necessary, since sources of error that affect the quality of the wetland water level data are still encountered. Beginning in late 2009, wetland water level data have been collected and entered into the database solely by Tampa Bay Water staff, and quality assurance (QA) procedures are in place to ensure accurate data are entered into Tampa Bay Water's central database.

The wetland water level data collection devices (staff gages and piezometers) have been surveyed to both the NGVD 1929 vertical datum and the NAVD 1988 vertical datum. For the purposes of the Recovery Assessment Plan, all data presented and analyzed are referenced to the NGVD 1929 datum for long-term consistency since some of the analyses began before all sites were surveyed to the NAVD 1988 datum. The Recovery Assessment Plan analyses have been completed using data referenced to the NGVD 1929 datum for continuity.

A key component of isolated wetland monitoring is the establishment of a normal pool elevation within each wetland. The normal pool elevation of a wetland is an elevation datum established to standardize measured water levels to facilitate a comparison among wetlands. This is generally an elevation within a wetland that represents an annual high-water elevation that occurs near the end of a summer rainy season, or a "full wetland condition" elevation assuming that the wetland is not impacted by any anthropogenic influence. The normal pool elevation is established using vegetative indicators as described in the Wetland Assessment Procedure (WAP) Instruction Manual for Isolated Wetlands (SWFWMD and Tampa Bay Water, 2005). This document is included in Exhibit C of the renewed Consolidated Permit (Appendix 3.4). This wetland-specific elevation is used to establish the zones for WAP monitoring (described in

Section 5.5.2) and is the reference elevation used in multiple wetland metrics that have been developed for the Recovery Assessment Plan (described in Section 6.3).

Establishing a correct normal pool elevation in isolated wetlands is performed by environmental scientists using best professional judgement of the vegetative indicators. The vegetation indicators yield a range of elevations for normal pool in each wetland creating some uncertainty in establishing a single elevation for each wetland. The marked elevation (an average or median of the individual indicator elevations) is then surveyed to an established vertical datum and all water level data from the wetland can then be assessed against the normal pool elevation. The elevation data are surveyed to both the NGVD 1929 and NAVD 1988 datum but for the purposes of the Recovery Assessment analyses, all data are referenced to the NGVD 1929 datum. Tampa Bay Water and District staff have spent much time evaluating the quality of the individual wetland normal pool elevations during the course of the Recovery Assessment Plan work. More accurate normal pool elevations have been obtained at some sites by reassessing the ecological indicators or installing new benchmarks near all of the monitored wetlands; any updated elevations have been noted in the respective databases of both agencies. Review of the normal pool data and site-specific wetland analyses have prompted multiple site reviews to confirm the elevation or establish an updated elevation. Staff have used the best-available normal pool elevations for the assessments presented in this report. The analyses in this final Recovery Assessment Report use the updated normal pool elevations and represent the best available site data at the time of this report preparation.

5.5.1.3 Lake Water Level Data

The Recovery Assessment Plan contains 137 monitored lakes with variable amounts of data. Two of the lakes have period of record data extending back to 1930 (Lakes Horse and Raleigh located in the Cosme-Odessa Wellfield area). The District currently monitors 127 of these lakes, 61 of which have established Minimum Levels. Lake water level data collected prior to the existence of the District was collected by the United States Geological Survey (USGS); this data is contained within the database maintained by the USGS and has been added to the District hydrologic database. Tampa Bay Water monitors the remaining ten lakes as part of the environmental monitoring program for the Consolidated Permit wellfields. The lake water level data are collected according to the data collection and quality control/quality assurance programs of both agencies and stored in respective agency databases. Similar to the monitored wetlands, all of the lake water level monitoring devices have been surveyed to both the NGVD 1929 and NAVD 1988 datums but for the purpose of the Recovery Assessment Plan analyses, the data referenced to NGVD 1929 has been used through the completion of the assessments.

Tampa Bay Water acquired the period of record data for all District-monitored lakes in February 2015 in a single data transfer. To complete annual update assessments for lake levels since that time, Tampa Bay Water has obtained the more recent data for each of the lakes monitored by the District by downloading the data from the District’s website. To complete the final analyses of lake level recovery, Tampa Bay Water obtained another large water level data transfer from the District for calendar year 2015 through September 2019. Staff have used the water level data from the Tampa Bay Water database for the 10 lakes that Tampa Bay Water monitors.

Throughout the period of record for each lake, the frequency of water level data collection has varied. Daily data is available for some lakes through the use of continuous recording devices. Water level data is available for most lakes throughout the period of record at least monthly with variable frequency in the past due to special studies or data needs. In order to prevent bias in the analyses, Tampa Bay Water has assessed water level data from lakes on a monthly time scale by calculating a monthly average water level for each lake when data is available at a greater frequency in that month. This prevents the skewing of results by treating all time periods as equal in importance.

5.5.1.4 Rainfall data

Rainfall is a principal driver of the hydrologic cycle and these data are an important part of the Recovery Assessment Plan analyses. Rainfall data are collected by Tampa Bay Water, the District and the National Oceanic and Atmospheric Administration (NOAA) and stored in the respective databases of each agency. The longest-term rainfall gages are maintained by the NOAA and these are often used as long-term reference sites. The rainfall gages maintained by the District and Tampa Bay Water have shorter periods of record but the agencies have more rainfall gages than maintained by the NOAA. The Tampa Bay Water rainfall gages are also located on or near the agency water supply facilities, including the wellfield areas included in this study. Rainfall is highly variable, even over short distances, so when rainfall data are used in Recovery Assessment analyses, the gages at or closest to the wellfields were generally selected for use. Annual rainfall data are discussed in Sections 3.9 and 3.16 of this report on both a regional and wellfield-specific basis. Rainfall data are included in the specific wetland assessment reports that form the basis for the preliminary and final assessments of wetland recovery and are contained in report appendices discussed in Chapter 9. These reports contain descriptions of the rainfall data included in the analysis and how the data were managed and used.

5.5.1.5 Pumping Data

Tampa Bay Water records the daily flow volume from each production well at all wellfields. This daily data is subject to a quality control review before it is stored in the agency central database. This daily pumping data is available for the full period of record for all of the wellfields that were developed and operated by Tampa Bay Water from the initiation of pumping at those facilities. Tampa Bay Water acquired other wellfields from its member governments in 1998. For these wellfields, historical monthly average pumping data per production well have been acquired from the District as historic daily pumping data at each production well is not available. Other wellfields were developed by Tampa Bay Water as regional supply sources, but some of the production wells had been owned and operated by other entities before the facilities became regional wellfields. For these wellfields, historical monthly average pumping data per production well have been acquired from the District. A summary of the pumping data available from each wellfield is summarized in the table below:

Table 5.4: Historic Wellfield Pumping Data Sources

Wellfield	Monthly Pumping Data (District)	Daily Pumping Data (Tampa Bay Water)
Cosme-Odessa	January 1931 – September 1999	October 1999 – present
Eldridge-Wilde	June 1957 – May 2001	June 2001 – present
Section 21	February 1963 – April 1984	May 1984 – present
South Pasco	March 1973 – April 1984	May 1984 – present
Starkey	June 1974 – September 1983	October 1983 – present
Cypress Creek	N/A	April 1976 – present
Northwest Hillsborough	July 1977 – September 1984	October 1984 – present
Morris Bridge	April 1978 – September 1998	October 1998 – present
Cross Bar Ranch	N/A	October 1979 – present
Cypress Bridge	January 1982 – September 1988	October 1988 – present
North Pasco	N/A	October 1991 – August 2017

N/A – all pumping data available at daily frequency from Tampa Bay Water database

A description of the history of the development and operation of each wellfield is presented in Chapter 3 of this report.

5.5.2 Ecologic Data

5.5.2.1 Historic Vegetation Data

Tampa Bay Water and the District have collected wetland vegetation data at selected wetlands since the 1970s in addition to wetland water level data. The vegetation data was collected and analyzed to evaluate the health of wetland systems and identify impacts related to wellfield pumping. Tampa Bay Water staff and ecological consultants collected wetland vegetation data at the wellfields that were developed and operated by the regional water authority. These monitoring programs were specific to individual wellfields although the methodology between wellfield monitoring programs was generally the same. The District collected the same type of data at some of the same wellfields and at wellfields that were originally developed and operated by Tampa Bay Water member governments.

The early wetland monitoring programs included the collection of both quantitative and qualitative vegetation data. Quantitative monitoring was performed at a subset of the monitored wetlands within an individual wellfield monitoring program to detect significant changes in the composition of the wetland communities. Semiannual herbaceous vegetation (groundcover) data was collected at fixed quadrats along a linear transect extending from the edge toward the center of each wetland. Within each quadrat, the percent cover of each species was estimated for the herb stratum. Shrub plots were established for each of the qualitatively monitored wetlands that corresponded to the end, middle, and center of the herbaceous vegetation transects. The percent cover of the shrub species present within the fixed plots were estimated annually. A permanent tree plot or transect was also established at each of these monitored wetlands where trees existed. Annual monitoring was performed to document tree species, recruitment, mortality and treefall. Tree growth was measured at tagged trees within the transect by measuring the diameter at breast height (dbh) of the trees during the annual monitoring event.

Qualitative monitoring was performed at all of the wetlands within each wellfield monitoring program. At each of these wetlands, surface and groundwater levels (when available) were collected on a biweekly interval along with the sighting of vertebrate animals or other signs of their presence. Site photographs at monumented photo stations were collected semiannually and quarterly monitoring was performed to document vegetative species dominance, species cover changes, foliar conditions, soil characteristics, and other vegetation observations. Soil subsidence and the presence of sinkholes were documented during site visits as observed.

5.5.2.2 Environmental Management Plan (EMP)

District permitting rules were revised in October 1989 and included a requirement that Water Use Permit holders mitigate any adverse impact to environmental features or off-site land uses that occurred as a result of withdrawals of water from the environment. The individual wellfield Water Use Permits issued to Tampa Bay Water after October 1989 contained requirements for environmental mitigation plans for wellfield pumping impacts. Tampa Bay Water developed an Environmental Management Plan (EMP) for all agency wellfields in February 1994 to meet regulatory requirements of the District's Water Use Permitting rules.

The EMP was developed to address the management of the Agency's regional wellfields with the intent of monitoring for detection of adverse impacts, reducing potential impacts caused by wellfield pumping, and outlining how impacts would be addressed and mitigated if detected. It uses a decision-making flow chart rationale to determine how impacts are detected and what steps are taken to correct or account for impacts that are caused by wellfield pumping. The EMP was developed through an expert committee formed with a representative all of Tampa Bay Water's environmental monitoring consultants and included Dr. Ronnie Best and Dr. Patricia Dooris. Dr. Dooris chaired a hydrologic impacts committee that developed definitions of hydrologic impact and hydroperiod ranges for different types of wetlands located on and near Tampa Bay Water wellfields. Dr. Best chaired a vegetative/wildlife committee that developed criteria to assess function of wetland systems so that lost function could be quantified when an impact was identified. This committee also recommended changes to the vegetative monitoring program used in 1994 to upgrade the quality of the monitoring and evaluation programs.

The 1994EMP provided standards for the collection and analysis of hydrologic and ecologic data in wetlands. Semi-annual assessments were established with guidelines for how the collected data would be evaluated to determine if hydrologic or vegetative changes were present. If an impact was detected, a process was presented to determine if that impact was related to wellfield pumping and if so, guidance was given on how to assess the functional habitat loss and develop mitigation options.

The 1994 EMP was included as Exhibit B of the original Consolidated Permit (Appendix 3.1). Special Condition 7.A of the original Consolidated Permit required Tampa Bay Water to revise the EMP to include all 11 wellfields covered by the permit, update the list of monitored sites covered by the EMP, update the requirements for hydrologic data collection devices, and develop a methodology of assessing adverse impacts to wetland systems. The 1994 EMP was revised by a committee made up of Tampa Bay Water, District, member governments, and staff from the Environmental Protection Commission of Hillsborough County (EPCHC). A series of 16 committee meetings were held and a revised EMP was submitted to and approved by the District; this EMP was finalized in March 2000 (Appendix 5.13).

The intent of the revised EMP (2000) was to monitor and identify adverse environmental impacts near the Consolidated Permit wellfields, reduce observed environmental stresses by reducing or rotating wellfield pumping, and investigate mitigation alternatives where adverse impacts persist related to wellfield pumping. An updated series of flow charts provide the processes for identifying impacts to wetlands, lakes, and streams. The revised EMP included new standards for hydrologic and ecologic data collection including standardized water level data collection from a staff gage and upland piezometer at the edge of each wetland. A Wetland Assessment Procedure (WAP) was developed to replace the quantitative and qualitative ecologic data collection programs and is described in additional detail in Section 5.5.2.3. At the request of the EPCHC, quantitative data collection at vegetation transects continued at the Northwest Hillsborough, Cosme-Odessa, Section 21, South Pasco, and Morris Bridge wellfields every two years in the spring and fall of those years.

The revised EMP (2000) contained extensive guidance on statistical techniques and procedures to assess the collected data to identify adverse impacts to environmental features. The link between environmental monitoring/assessment and the OROP were included in the revised EMP as well as guidance on the development of mitigation options if an adverse impact related to wellfield pumping could not be resolved with pumping rotation within the OROP. The EMP was revised before the reduction in wellfield pumping had been realized and another goal of the program was to collect appropriate data to measure environmental recovery due to the reduction in wellfield pumping and monitor for any new impacts due to shifting patterns of wellfield pumping. The semi-annual wetland impact assessments are reviewed and recurring impacts to lakes and wetlands are evaluated. If these wetland impacts are potentially related to wellfield pumping, this information is used to inform pumping rotation decisions to attempt to alleviate the environmental stress (this EMP/OROP protocol is discussed in Section 3.14.7).

Tampa Bay Water and District staff completed a study in 2004 to reevaluate the wetland data collection portion of the EMP to determine the effectiveness of the monitoring methodology. This evaluation indicated that the data had documented the existing environmental condition on the wellfields but in a controlled test, the results of the ecological data using the existing methodology were highly variable. Since this ecological data is used by Tampa Bay Water for both wellfield-specific monitoring and analyses of environmental recovery and by the District for the creation and reevaluation of minimum levels, staff determined that the wetland monitoring portion of the EMP should be revised to develop a methodology that will yield consistent, verifiable data for all purposes.

Tampa Bay Water staff met with the District, member governments, and the EPCHC in late 2004 and early 2005 to review the WAP methodology that was established in the EMP in 2000. A discussion of the updated WAP methodology is found in Section 5.5.2.3. Two major changes were made to the EMP; the revision of the WAP methodology and the deletion of the quantitative data collection from vegetation transects at the Consolidated Permit wellfields located in Hillsborough County. This quantitative data had been collected since 2000 and analyzed in the annual reports for these specific wellfields. A consensus was reached among the District, ecological monitoring consultants, the EPCHC staff, and Tampa Bay Water that the quantitative vegetation data did not add benefit to Tampa Bay Water's environmental monitoring program. The requirement for quantitative data collection was deleted from the 2005 EMP (Appendix 5.14).

Additional modifications were made to the EMP in 2011 which is included as Exhibit C of the renewed Consolidated Permit (Appendix 3.4). The 2011 EMP specifically references the revised hydrologic and ecologic monitoring sites contained in the renewed Consolidated Permit, updated data collection requirements, and how monitoring devices will be installed, maintained, and surveyed. The methodology for assessing hydrologic and ecologic data was updated along with the procedure to determine wetland

and lake impacts. The 2005 updated WAP manual is also included as an attachment to the 2011 EMP. This latest version of the EMP has been in place since January 2011 and is the process that Tampa Bay Water continues to follow. As required by Condition 8 of the renewed Consolidated Permit, Tampa Bay Water developed a methodology to assess potential wellfield pumping impacts to streams and flow-through wetlands (Ormiston, et al., 2014). Tampa Bay Water has been following this additional methodology under the EMP since receiving verbal District approval in 2014. This assessment method will be included in an updated version of the EMP to be submitted with the application to renew the Consolidated Permit in 2020.

5.5.2.3 Wetland Assessment Procedure (WAP) Data

The 2000 EMP contained a Wetland Assessment Procedure (WAP) to replace the existing quantitative and qualitative ecologic monitoring programs. The objective of the WAP is to collect vegetation, hydrologic, and soils characteristics to characterize the current biological condition and health of the wetlands. The data collection method was designed to be repeatable so that data could be evaluated over time to document wetland recovery or deterioration. The composition, cover, and zonation of the most common tree, shrub, groundcover, vines and weedy species are assessed with respect to hydrology. It is assumed that normal cover and zonation of species is a result of normal wetland hydrology. Altered hydrology is assumed to affect composition, plant zonation and cover. Vegetation data is collected along a strip transect from the edge of a wetland into the interior/deep zone of the wetland. The transects are divided into two zones, deep and transitional. The collected data is categorized into a 3-point scale with a score of 1 assigned to sites with inappropriate vegetation composition or zonation and a score of 3 assigned to represent appropriate vegetation composition or zonation. Tree health and soil condition are also included in the WAP data collection. A uniform data assessment form was created to record and summarize the collected data and assign scores for multiple categories.

In 2004, Tampa Bay Water and District staff assessed the quality of the data collected using the WAP methodology between 2000 through 2003 and found that the results were highly variable. Tampa Bay Water staff met with the District, member governments, and the EPCHC in late 2004 and early 2005 to revise the WAP methodology since it was not successful in identifying and quantifying wellfield-related impacts or recovery. This working group revised the WAP methodology with consensus among all participants and the document was finalized in March 2005 (Southwest Florida Water Management District and Tampa Bay Water, 2005a). To alleviate the concern of future inconsistencies in the application of the revised WAP methodology, District and Tampa Bay Water staff have conducted annual training exercises for all staff and consultants who conduct this monitoring for either agency.

The revised WAP uses a new methodology based on each individual wetland plant species' typical location within a wetland with respect to depth below the wetland's normal pool (NP) elevation. A set of indicator species was chosen, and their location information researched in the field at non-impacted wetland sites. The method requires the establishment of a transect from the wetland edge to the wetland interior, usually ending at a staff gage or monitor well. The transect consists of three zones: Transitional (wetland edge to NP-6 inches), Outer Deep (NP-6 inches to NP-12 inches), and Deep (NP-12 inches and greater, to the end of the transect). Hydrologic impacts to wetlands are identified when indicator plants are found growing outside their normal zone (see Figure 3.54). A zonation score of 5 indicates normal zonation, and downrated scores of 4 to 1 can be given depending on the degree of encroachment of indicator plants into improper zones. Separate zonation scores are given for groundcover, shrubs, and trees at each wetland.

The revised WAP has proven more useful than previous vegetation assessment methods. Impacted sites can be identified by lower zonation scores, and changes in a wetland's hydrology often lead to changes in WAP score. However, due to the nature of vegetation and vegetation monitoring, the collection of WAP data is subjective, and WAP scores do not respond to the same degree or react as quickly as water level change data. A high degree of recovery in wetland water levels may produce only a minor improvement in WAP score, or in some cases no change in WAP score, due to the persistence of well-established vegetation in an inappropriate WAP zone. Despite these limitations, WAP data are considered useful factors in evaluating the overall health and recovery status of monitored wetlands and have been used in the wetland-specific assessments presented later in this report. The period of record WAP data collected by Tampa Bay Water are contained in the Agency's database and the period of record WAP data for all monitored wetlands in the Northern Tampa Bay area are contained in the District's database.

There is a substantial difference in the scoring framework between the original and revised WAPs and the transects contain a different number of zones in the two versions. The annual reports developed for all of the Consolidated Permit wellfields contain WAP data beginning in 2005, the first year in which the revised WAP was implemented. Tampa Bay Water has used the WAP data to both analyze the health of wetlands under the environmental monitoring programs and to aid in the development of recovery metrics for wetland types other than isolated wetlands in a mesic landscape (discussed in Section 6.3). The WAP data has also been used in the weight-of-evidence approach for assessing recovery at individual wetlands as discussed in Section 6.6 and Chapter 9 of this report. Given the limitations of the data (significant time lag between hydrologic change and vegetative change, data subject to professional interpretation, and no data using the current methodology from the time period before pumping reduction) the WAP data is not considered to be primary evidence of environmental recovery; however, it is useful for assessing trends in wetland condition and separating wetlands (temporal or spatial) into stressed or unstressed condition for metric development. One final concern with the use of WAP data for explicitly assessing the health or recovery of wetlands is that the methodology and scoring framework have not been correlated with the District's regulatory criteria used to define wetland impacts; WAP scores cannot be directly used to assess the presence or absence of adverse impacts.

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5.5.3 Five-Year Wetland Health Assessment Data

The District in 1997 and 1998 performed an assessment of regional wetland health across the Northern Tampa Bay Area, including all of the Consolidated Permit wellfields. This assessment included the mapping and determination of relative wetland health for a network of approximately 400 wetlands. This assessment was completed in the time period leading up to the issuance of the initial Consolidated Permit to collect baseline data on regional wetland conditions before the reduction in groundwater pumping from the wellfields. The wetlands selected for this effort were largely in addition to the wetlands monitored by the District or Tampa Bay Water to expand the spatial extent of wetland health information. Given the large number of wetlands assessed, the method of collecting data was relatively quick and included evaluation of wetland vegetation, hydrology, and soil condition. This wetland health assessment (WHA) used a 3-point scale to indicate an overall rating of relative wetland health, with "3" being not significantly changed and "2" and "1" assigned to significantly changed and severely changed wetlands, respectively.

This assessment of wetland health has been repeated approximately every five years with additional assessments in 2004, 2009, and 2016. This periodic evaluation provides a regional snapshot of wetland health at the time of the assessment, which allows the identification of areas of wetland impact. This can then be compared to previous WHAs to see where recovery or other changes have occurred. The three subsequent WHAs have used a 5-point scale instead of the 3-point scale used in the initial study. This expanded scale provides additional resolution; for example, sites that may not appear pristine but are still healthy enough to be considered not significantly impacted can receive a rating of "4". This is helpful in measuring recovery, which may exhibit considerable time lag in the change of vegetation communities compared to water levels. The WHA scores are particularly helpful in assessing unmonitored sites in the Recovery Assessment Plan, as the WHA wetlands match some of the wetlands included in the list of unmonitored sites to be assessed. The proximity of unmonitored sites to a WHA site provided supplemental information about wetland recovery in the vicinity of the unmonitored wetlands within the defined Area of Investigation.

The most recent update to the WHA database was completed in 2016 as a joint effort between the District and Tampa Bay Water. Both agencies retained the services of Vanasse, Hangen, Brustlin, Inc. (VHB) to collect the data for this update which included WHA data from 383 individual wetlands. Tampa Bay Water funded the collection of data from 123 of these wetlands that fell within the original Area of Investigation to provide qualitative environmental data to use in the assessment of a significant number of the listed unmonitored wetlands. The District funded the collection of data from the other 260 wetlands that were located near the 11 wellfields but outside of the original Area of Investigation and at some reference sites remote from the 11 wellfields.

The staff of VHB designed a tablet-based data collection template and used this application to collect field data and photographs of all wetlands they assessed. VHB compiled a database of all collected data and photographs for this WHA update. An additional component of the study collected all available data and photographs from the three prior WHA monitoring events and incorporated the prior and current WHA data into a web-based GIS application. This new tool provides the ability to quickly reference all WHA data and photographs for specific sites, compare changes at specific sites or regions over time, and draw conclusions about the relative health and recovery of wetlands. VHB detailed the WHA data collection work and all of the historical WHA data in a Story Map Journal format within the GIS application. Since this work was performed jointly for Tampa Bay Water and the District and the work products were delivered to both agencies, Tampa Bay Water did not submit these data, report, or GIS application to the District as part of the Recovery Assessment Plan. A printed copy of the report from the GIS application is included in Appendix 5.15. The tables and figures referenced in this report are included following the report text. Tampa Bay Water and the District will collect this WHA data in 2020 to continue the periodic assessment of wetlands in the Northern Tampa Bay area.

5.5.4 Time Series of Potentiometric Surface Maps of Upper Floridan Aquifer

The United States Geological Survey (USGS) completed a study (USGS, 2014) on behalf of the District that produced a map time series of the potentiometric surface of the Upper Floridan Aquifer for the area encompassing the 11 wellfields of the Consolidated Permit. This time series was created to assess the hydrologic condition of both the aquifer and the overlying streams and wetlands. The USGS collated water level data from 260 monitoring wells in the Northern Tampa Bay Area and created a continuous time series of daily potentiometric surface observations for 197 of the monitoring wells. These data were used to create monthly average potentiometric-surface elevation maps in the Upper Floridan Aquifer for a 10-year period between January 2000 and December 2009. The USGS also performed analyses to define the error and uncertainty in the interpolated elevations. The text portion of this report is included as Appendix 5.16 and the full report with appendices and data can be obtained from the USGS website through the web link in the References section of this report.

Tampa Bay Water realized that this information would be very useful in the Recovery Assessment analyses but the time period of the original investigation was only ten years long (2000 – 2009). The available time series covered less than three years of the higher wellfield production period and ended at the time when wellfield pumping was reduced and sustained below the 90 mgd annual average permitted quantity (see Figure 3.69). Tampa Bay Water retained the two authors of the original USGS investigation, Terrie Lee and Dr. Geoff Fouad, to reproduce their original work and expand the length of the time series to 26 years. Using all but two of the original set of monitor wells in the Northern Tampa Bay Area, the authors created a continuous monthly time series of potentiometric surface data and maps for the Upper Floridan Aquifer from January 1990 to December 2015. As in the original study, the authors analyzed the uncertainty associated with the interpolated water level surfaces for the expanded time period. This longer time series enabled staff to better evaluate the effects of climate variation and different rates of wellfield pumping on the Upper Floridan Aquifer potentiometric surface. The text portion of this report is included as Appendix 5.17 and the multiple time series of data are available from Tampa Bay Water or the District. This 26-year time series of monthly data provides a robust line of hydrologic evidence for evaluating the effects of changing groundwater pumping on wetlands and lakes in the Northern Tampa Bay Area.

Lee and Fouad continued their work for Tampa Bay Water by using the 26-year potentiometric surface time series to describe changes in the groundwater conditions beneath a regional population of wetlands in the Northern Tampa Bay area. They examined the hydrologic response of wetlands to the reduction in groundwater pumping, both throughout the Northern Tampa Bay area and within a smaller population of wetlands that are part of the Recovery Assessment Plan. One component of this extension was the comparison of a pre-development potentiometric surface map with the potentiometric surface data generated from the prior study to assess the current levels of the Upper Floridan Aquifer versus the pre-development condition. Using available Light Detection and Ranging (LiDAR) land surface elevation data, Lee and Fouad compared the potentiometric surface time series to the bottom elevations of Recovery Assessment Plan wetlands to describe the change in potentiometric surface elevation difference in the pre-and post-pumping cutback periods.

The populations of regional and local wetlands were classified as recharging or discharging depending on the elevation of the potentiometric surface relative to the bottom elevation of the wetlands. A time series of monthly maps was produced showing those wetlands in a discharging condition and the depth of the potentiometric surface beneath the remaining wetlands. An example map from this work is presented in Figure 5.10 which shows the discharging and recharging groundwater conditions in the Northern Tampa Bay area for September 2015. Lee and Fouad presented their information in multiple formats and assessed the population of data in several different ways, some of which are discussed in Chapter 11 of this report. As the work products from this continued investigation are spatial in nature, they were very useful in the assessment of both monitored and unmonitored wetlands as described later in this report. The text portion of this report is included as Appendix 5.18 and the time series data are available from Tampa Bay Water.

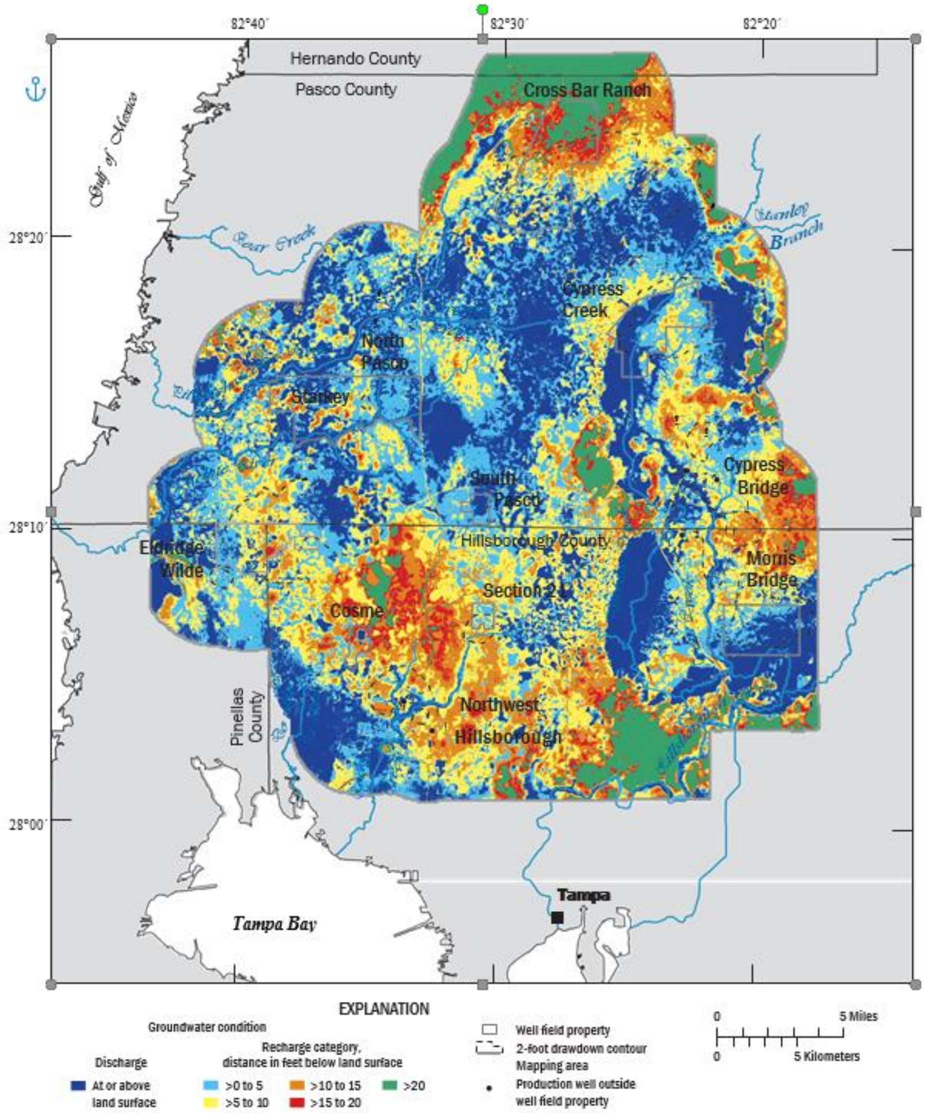

Figure 5.10: Discharging and Recharging Groundwater Condition in the Northern Tampa Bay area in September 2015

5.5.5 Aerial/Satellite Photography

Tampa Bay Water has acquired aerial imagery of various types under various contracts from the fall of 1982 to the present. The requirement for this acquisition began in some of the individual Water Use Permits for individual wellfields prior to the formation of Tampa Bay Water. This requirement has persisted through the initial and renewed Consolidated Permits. The permits have specified that the photography be collected twice per year, in the spring (April – May) and fall (October – November) seasons using, originally, false-color infrared (FCIR) 9”x9” film, at an approximate scale of 1:24,000. Due to changing technology, Tampa Bay Water transitioned to digital four-band multispectral satellite imagery starting in the fall of 2001. The one-meter resolution imagery with four color bands (Red, Green, Blue, and Near Infrared) is capable of being displayed either as true color or as FCIR. Starting in the fall of 2006, collection transitioned again from the satellite imagery to 0.5-meter, four-band multispectral (Red, Green, Blue, Near Infrared) digital imagery acquired using camera systems flown in aircraft.

The use of FCIR imagery has been maintained throughout the entire period of aerial photography collection as it conveys more information about wetland and soil inundation/moisture and vegetation condition than true-color imagery. In FCIR imagery, the water in ponds and lakes typically appears black and wet ground appears more bluish than dry ground. Vegetation reflects most light in the Near Infrared wavelengths. The primary purpose for the acquired aerial photography is for visual inspection by analysts to assess the hydrological and vegetation conditions of lakes and wetlands in the areas of interest around each water supply facility. Aerial Photo Interpretation (API) reports are submitted to the District as part of Tampa Bay Water's annual wellfield reports. The current Consolidated Permit requires submittal of API reports for all wellfields every three years with the most recent reports submitted with the annual wellfield reports for Water Year 2018 (submitted in June 2019).

Tampa Bay Water has maintained an archive for the aerial imagery collected from the fall of 1982 to the present. The imagery is in a mixture of film and digital formats, depending on when the imagery was collected. Tampa Bay Water has recently scanned all of the historical FCIR film aerial photography in order to provide for long-term digital storage and backup, and to improve the accessibility of the imagery for various uses including use within GIS applications.

In addition to the permit-required imagery regularly collected since 1982, Tampa Bay Water has acquired digital versions of historic imagery in order to support the work associated with the Recovery Assessment and other agency tasks. At least one set of imagery covering the Tampa Bay Water area of interest has been acquired for each decade from the 1930s to the beginning of Tampa Bay Water collection in the 1980s. Digital copies of historic aerial photography are available through a number of agencies including the Florida Department of Environmental Protection (FDEP), Florida Department of Transportation (FDOT), United States Geological Survey (USGS), as well as some for-profit companies. However, the most comprehensive, and the most easily searched, collection of imagery from the 1930s to the 1990s outside of the national archives is the University of Florida (UF) Map & Imagery Library, part of the George A. Smathers Libraries (https://cms.uflib.ufl.edu/maps/Index.aspx).

Scanned images can be useful as individual frames to view specific areas; however, the most powerful use of the historic imagery is after it has been processed (georeferenced). After the imagery is georeferenced, it is located at the proper location and scale when imported into Geographic Information Systems (GIS) applications or other image viewing software that can layer multiple geographical and imagery features. Tampa Bay Water has developed the Recovery Assessment GIS application (discussed in Chapter 7), which links many types of data pertinent to the Recovery Assessment work including site data for wetlands, lakes, and wells, imagery and other geographic information, and other environmental and analytical data. The georeferenced historical imagery combined with more recent imagery allows rapid focus on specific locations or larger areas and enables convenient comparison of the same area at different periods in time. It is vitally important for the Recovery Assessment and other evaluations of environmental conditions to understand how a site or area has changed over time with respect to land use/development, drainage, and ecological conditions. Understanding the past and present influences on a site helps explain its present condition and provides insight into how the site may respond to continued or different influences in the future.

Tampa Bay Water retained consultants to georeference the digitized aerial imagery, including the sets of photography derived from the FCIR film aerial photography from years collected by Tampa Bay Water, and the historic B&W aerial photography from previous decades collected from the UF Map & Imagery Library. Imagery collected by Tampa Bay Water since fall 2001 has been collected by digital cameras/sensors and orthorectified so that it was ready for use in GIS applications upon delivery. Since this imagery is collected twice per year, it allows users to observe annual and seasonal changes. The addition of the older imagery allows comparisons with conditions during decades before significant wellfield production, and in some areas prior to any significant development. A discussion of land use changes on and surrounding each Consolidated Permit wellfield is included in Chapters 3 and 12 of this report, supported by examples of historical and current aerial imagery. All of this photography is stored in digital format by Tampa Bay Water and is available for use by other parties upon request, given any copyright restrictions placed on the original photography.

6: Recovery Assessment Plan Implementation

6. Recovery Assessment Plan Implementation

Wetland impacts are usually assessed on relatively natural systems. Water management scientists can determine the potential impact that an activity (groundwater pumping or land surface alterations) may cause in adjacent lakes or wetlands. Tampa Bay Water and the District were faced with making this determination in reverse. Environmental impacts from pumping had already occurred and in some cases, had occurred many years ago. Tampa Bay Water was tasked with determining how to assess the recovery of lakes and wetlands in the absence of data from the time before they were impacted. To make the problem more challenging, environmental regulations and the local landscape have changed since the time of the original impacts. Tampa Bay Water and the District staffs needed to determine what is the appropriate level of recovery for each type of wetland and how to account for influences other than groundwater pumping in the technical assessments.

Implementation of the Recovery Assessment Plan was a very complex and multi-faceted effort directed by Tampa Bay Water staff with multiple analyses completed by our agency staff, District staff, and professional consultants. The work began in 2011 with the development of the Recovery Assessment Work Plan and Schedule (described in Section 5.2) and progressed through numerous individual but related efforts. When Tampa Bay Water developed the Work Plan and Schedule, staff expected that the work would be relatively sequential; however, this was not the case. After the District approved the initial list of sites for assessment and the two staffs identified the data that would be used, Tampa Bay Water began to develop metrics of recovery for different wetland types and tools to aid in the assessment of wetlands and lakes. Staff also performed preliminary assessments of recovery for different wetland types and different wellfields in an overlapping manner. The information presented in this report is laid out in a relatively linear narrative for ease in report preparation and review. This chapter presents the development of recovery metrics for different wetland types and the general processes followed to assess the recovery of lakes and wetlands.

6.1 Collaborative Approach, Meetings, and Process

Tampa Bay Water and the District staff acknowledged in our earliest discussions that close coordination between staffs was essential to successfully complete this work in a timely manner. This coordination has been necessary due to the complex nature of the issues, the extensive number of sites to be assessed, the vast quantity of data included in the analyses, and the multiple, overlapping and related work products.

Tampa Bay Water and District staff began meeting in late 2012 to define the work necessary to implement the Work Plan and Schedule. The working group included Tampa Bay Water staff and District staff from the Regulatory and Resource Management divisions; consultants joined the meetings to present and discuss their work as it was being developed. The meeting frequency increased to at least monthly in early 2014 as staffs began to work through specific issues and assessments. At these technical coordination meetings, staffs discussed the overall progress and schedule and every study and assessment completed under the Recovery Assessment Plan. An open and collaborative environment was created where all of the concepts and assessments were fully vetted. Through the discussions, staffs explored all aspects of each proposed and completed analysis and decisions to make sure that the staff of both agencies fully understood the technical nature of the work and the ramifications to the Recovery

Assessment Plan process, the current and the future Consolidated Permit. A list of the 132 technical meetings and field reviews and the topics discussed at each meeting is presented in Appendix 5.2. This summary of meeting dates and topics gives a clear indication of the number of issues addressed and the simultaneous work efforts that were completed.

During the earliest coordination meetings, Tampa Bay Water and the District recognized that the work required to complete this assessment would be sequential with each analysis or discussion dependent on the decisions and conclusions reached in the previous step. The staffs agreed that as each study or assessment was completed, Tampa Bay Water would develop a written document for the District staff to review. These submittals gave the District staff all of the information used to complete each assessment and time to fully review the analyses. Tampa Bay Water submitted each of these written documents to the District for consideration and written concurrence; all the technical submittals are included in this report as appendices. The District staff have reviewed each submittal and provided written concurrence or a list of questions/issues to be resolved. Tampa Bay Water considered the District questions on each issue before moving to the next step in the process. Responses to District questions have been answered in updated assessment reports, in the technical coordination meetings, and in this final Recovery Assessment report.

This iterative process has strengthened the technical reports and has furthered the collaborative working environment between staffs. Numerous site visits were included in the work process so that Tampa Bay Water and District staff could review proposed wetland classifications and confirm that the results of the technical assessments were appropriate before Tampa Bay Water submitted recommendations in writing. This iterative assessment process has also established a written record of all work performed and the decisions made. Since Tampa Bay Water staff has discussed each decision and analysis with the District and considered technical review comments before moving forward, the agencies have avoided fundamental disagreements on the basic assumptions or premises that form the base of the Recovery Assessment Plan; this has avoided costly delays in the process. Submitting each written document as it was developed kept the District staff fully informed on each aspect of the work, making the timely review of the preliminary report and this final report of findings possible for the District.

6.2 Development of Recovery Classifications or “Bins”

Given the large number of lakes and wetlands included in the Recovery Assessment Plan and the potential for the recovery “status” of a site to change over time, Tampa Bay Water determined that it would be beneficial to develop groups or classifications of recovery status based on the results of the technical evaluations. Being able to classify the recovery status of individual wetlands helped staff organize and track the sites as assessments were performed. Assigning a status to each assessed wetland also allowed Tampa Bay Water to evaluate recovery on a spatial basis and summarize the recovery assessment results on both a wellfield and regional basis.

Tampa Bay Water staff developed five classifications or “bins” for wetlands and lakes and discussed this proposal with District staff in late 2015. The concept for these bins is based upon a weight-of-evidence analysis of whether or not a site met its metric of recovery, the degree to which the site was assessed to be below its metric of recovery and whether or not there was significant post-cutback improvement in hydrologic conditions. Future actions were developed for each of the recovery bins to guide the site evaluations following the initial assessments of recovery. Based on these 2015 discussions, Tampa Bay

Water submitted a table of Recovery Assessment Bins and future actions for use in the assessment of both monitored and unmonitored lakes and wetlands (Appendix 6.1). The initial bins were:

- Never Impacted – Analyses show no evidence that a lake or wetland was ever impacted by wellfield pumping,
- Recovered – A wetland or lake with water levels that meet its defined metric in the post-pumping reduction period,
- Improved, Not Fully Recovered – A wetland or lake that has water levels below the defined metric in the post-pumping reduction period but with water levels that continued to increase within this time period,
- Not Fully Recovered, Continued Impact – Wetland or lake water levels are substantially below the defined metric in the post-pumping reduction period even though water levels may have improved. Evidence exists that continued wellfield pumping at predicted quantities will prevent the lake or wetland from meeting its defined recovery metric, and
- More Detailed Analysis Needed – Temporary bin for wetlands or lakes that either did not have an established recovery metric at the time of assessment or the weight-of-evidence screening analysis was inconclusive about the degree of water level recovery or continuing wetland impact. This was a temporary holding bin that was used for tracking the continued assessments and was used in the Preliminary Report of Findings. There are no wetlands with this designation in this final Recovery Assessment Report; all sites have been assigned to one of the other bins.

The District reviewed this submittal and agreed with this approach in a letter dated January 27, 2016 (included in Appendix 6.1). Tampa Bay Water began using these preliminary bins in the site assessments.

6.2.1 Revised List of Bin

Tampa Bay Water and the District revisited the topic of Recovery Assessment bins as staff worked through the preliminary assessment of wetlands in multiple wellfields. Tampa Bay Water identified two additional bins that were necessary to fully capture the results of the recovery analyses. During the October and November 2017 technical meetings with District staff, the language associated with these new bins was discussed:

- No Cutback, Meets Metric – This bin was necessary for wetlands associated with the Cypress Bridge Wellfield since there has not been a reduction in pumping at this wellfield. This bin is analogous to the “Recovered” bin in that the water levels in these wetlands or lakes meet their defined metric of health, and
- Impacted Due to Other Causes – Lake or wetland water levels in these sites are below their defined metric due to causes unrelated to Tampa Bay Water pumping. This assessment has been made through the weight-of-evidence approach for a site where wetland or lake water levels are below their defined metric in the post-pumping reduction period and obvious causes of impact are visible such as direct ditching or other physical alteration of the

wetland or its contributing watershed. This bin is not designed to assign the impact to another cause or entity but to simply identify those sites that are below their defined metric in the post-pumping reduction period and will likely not recover to their defined metric due to physical factors unrelated to wellfield pumping.

Tampa Bay Water submitted the revised Recovery Assessment bin names, meanings and future actions to the District on December 15, 2017 (Appendix 6.2). The District considered this revised information and concurred with use of the revised bins for the Recovery Assessment analyses (District letter included in Appendix 6.2).

The revised Recovery Assessment bin names, meanings, and future actions for monitored lakes and wetlands are presented in Table 6.1 of this report. Tampa Bay Water has used these classification bins to categorize and track the progress of lake and wetland analyses in the Recovery Assessment Plan. The ArcGIS Online application (discussed in Chapter 7) also incorporates the Recovery Assessment results at each site by using these bins to create a spatial presentation of the final results.

Table 6.1: Final Recovery Assessment "Bins" for Lakes and Wetlands

Recovery "Bin" Name	Recovery "Bin" Meaning	Future Actions
Never Impacted	No evidence that the lake or wetland was ever adversely impacted by wellfield pumpage.	No future analysis or action.
No Cutback, Meets Metric	Wetlands that exist on or near a wellfield that has not experienced a cutback and meets the appropriate wetland health metric.	Annual assessment to confirm the designation of "meets metric" using the screening analysis that determined this categorization. If site no longer meets relevant wetland health metric, assess if the change is due to wellfield pumpage or other factors before reconsidering designation.
Recovered	Wetland or lake meets defined recovery metric in post-pumpage reduction period.	Annual assessment to confirm the designation of "recovered" using the screening analysis that determined this categorization. If site no longer meets recovery metric, assess if the change is due to wellfield pumpage or other factors before reconsidering designation.
Improved, Not Fully Recovered	Wetland or lake water levels continue to increase but are below the defined metric in post-pumpage reduction period.	Perform field investigation to assess current health status of the wetland or lake using weight-of-evidence approach. If wetland appears to be healthy or recovering, perform an annual assessment using the screening analyses to determine wetland status. No detailed site-specific analyses required at this time.
Not Fully Recovered, Continuing Wellfield Impact	Wetland or lake water levels are substantially below the defined metric in post-pumpage reduction period even though water levels may have improved. Evidence that continued wellfield pumpage at predicted quantities will prevent the lake or wetland from meeting the defined recovery metric. For Cypress Bridge Wellfield, wetland or lake water levels are below the define metric. Evidence that continued wellfield pumpage at predicted quantities will prevent the lake or wetland from meeting the defined metric.	Perform site visit to determine potential causes of wetland impact and current wetland health. Develop site-specific analyses to determine if wellfield pumpage is the cause of the continued impact and if this impact is predicted to continue at a degree where the wetland or lake is unlikely to meet its metric. If the adverse impact is not predicted to persist, take no further action. If the site cannot meet its metric absent pumpage due to structural alterations that are not wellfield related, document condition and move wetland to Impacted Due to Other Causes bin. Sites with this designation at the end of the Recovery Assessment Period will be candidates for potential mitigation.

Recovery "Bin" Name	Recovery "Bin" Meaning	Future Actions
Impacted Due to Other Causes	Wetland and lake water levels are below the defined metric due to causes unrelated to Tampa Bay Water pumpage.	Document the source of wetland impacts in the recovery assessment report. Consider dropping monitoring requirements.
More Detailed Analysis Needed	Wetland or lake for which no recovery metric has been developed **or** weight-of-evidence approach and screening analyses are inconclusive about the degree of water level recovery or continuing wetland impact. For Cypress Bridge Wellfield, wetland or lake for which no metric has been developed or screening analysis is inconclusive about the degree to which water levels are impacted.	Perform site visit to determine current wetland health, potential causes of wetland impact, and determine if any features exist that can be used to develop a metric. If wetland or lake appears to be impacted, determine causes of impact through site-specific analyses. If continued adverse impact is related to continued level of wellfield pumpage, reconsider site status. If all results are inconclusive, document condition and all analyses performed and assess whether or not the site should continue to be monitored and assessed in the future.

It is important to note that these bin classification names mean that a monitored site meets or does not meet its applicable metric based on an assessment of water levels through the weight-of-evidence approach. For example, it does not imply that an "Improved" site has experienced a loss in wetland function or an adverse impact as defined in Chapter 40D-2, F.A.C. Assigning lakes and wetlands to these classifications represents the best available information at the time of the final assessment and is a convenient way to categorize and discuss an extensive population of sites in a relatively concise manner.

6.2.2 Bins for Unmonitored Sites

Tampa Bay Water staff expected that these bin categories would be applied to all sites included in the Recovery Assessment Plan, both monitored and unmonitored sites. Staff proceeded to assess the unmonitored sites in late 2018 and included these results in the Preliminary Report of Findings that was submitted to the District on December 27, 2018 (Tampa Bay Water, 2018b). In that report, the unmonitored wetlands were characterized as Recovered/Meets Metric, Improved, or More Detailed Analysis Necessary as discussed in Chapter 10 of this report. Discussions with District staff led to additional analyses of the unmonitored sites and the screening method used to assess their status. Based on the uncertainty in the data used in analyzing unmonitored sites and a revised approach for addressing the unmonitored sites in the final report (Chapter 10), Tampa Bay Water created a new set of bins for the unmonitored sites and a process by which to assess them.

The final bin categories for unmonitored sites are presented in Table 6.2. There is little or no empirical data available for these sites and the data used to assess their condition are statistically-derived and interpolated data sets based on data from nearby monitored sites. Based on the level of error and uncertainty in the data sets and analyses, Tampa Bay Water proposed only two bins; a high degree and a low degree of certainty of wetland health. This is a qualitative assessment which is appropriate given that these are unmonitored sites with no available monitoring data. Following the final assessment, all unmonitored sites have been assigned a high or low degree of certainty of health based on the number of predictive factors that pass their respective thresholds as explained in the table. These qualitative results have been mapped along with the results of the monitored lakes and wetlands and are presented in Chapters 12 and 14 of this report. The results from the unmonitored site assessment have been used to inform the final discussion of recovery and can help estimate the level of uncertainty in the final results and guide decisions on future monitoring needs.

Table 6.2: Unmonitored Sites – Recovery "Bin" Names and Meanings

Recovery "Bin" Name	Recovery "Bin" Meaning	Process of "Bin" Assignment
High Degree of Certainty of Wetland Health	The weight of the predicted or interpolated hydrologic and ecologic information suggests that there is a high degree of certainty in the prediction of wetland or lake health*.	• Two or more predictive factors used in the GIS assignment model for unmonitored sites indicate that a wetland meets its applicable metric of health/recovery. • Assessment performed for the post-pumping reduction period (or since 2008 for the CYB**). • If a field review of the wetland is performed, the wetland vegetation appears to be generally healthy and appropriate (species and zonation) for the wetland type, given the landscape surrounding the wetland and any physical alterations to or within the wetland.
Low Degree of Certainty of Wetland Health	The weight of the predicted or interpolated hydrologic and ecologic information suggests that there is a moderate or low degree of certainty in the prediction of wetland or lake health*.	• One or no predictive factors used in the GIS assignment model for unmonitored sites indicate that a wetland meets its applicable metric of health/recovery. • Assessment performed for the post-pumping reduction period (or since 2008 for the CYB**). • If a field review of the wetland is performed, the wetland vegetation shows signs of stress or inappropriate species and zonation for the wetland type, given the landscape surrounding the wetland and any physical alterations to or within the wetland.

**Wetland/lake health is defined as lack of an adverse impact associated with wellfield pumping in the post-pumping reduction period (or since 2008 at the Cypress Bridge Wellfield).*

***Hydrologic data (predicted or interpolated) for unmonitored wetland and lakes begins in 2008; this is considered to be the current period at the Cypress Bridge Wellfield and is the period of highest pumping at this wellfield.*

Tampa Bay Water has agreed with District staff that the final Recovery Assessment Plan report will not contain any mitigation action for any of the unmonitored sites given the error and uncertainty in this data and analysis. During the term of the renewed Consolidated Permit, if a landowner contacts Tampa Bay Water or the District alleging that low water levels in one of the unmonitored wetlands is due to wellfield pumping, Tampa Bay Water will perform a site-specific evaluation of that wetland or lake to determine if wellfield pumping is the cause of the low water levels. This site-specific investigation assumes that access to the site will be granted by the property owner and may include the collection of water level or vegetation data over time. If Tampa Bay Water and the District agree that wellfield pumping is causing an adverse impact to the subject wetland or lake, Tampa Bay Water will take appropriate action at that time to remedy the adverse impact, subject to agreement with the District and the property owner. The application package for renewal of the Consolidated Permit will contain recommended permit condition language to this effect.

6.3 Recovery Metrics for Monitored Wetlands

The Recovery Assessment Work Plan identified the need to establish metrics of health/recovery for each type of wetland to be assessed under the Plan. The establishment of metrics was identified as a technical issue in the Work Plan because a specific limit or threshold against which to compare the available data from each site is needed. It is also a regulatory issue since Tampa Bay Water will be relying on the results of wetland assessments to demonstrate compliance with the Criteria for Issuance of a Water Use Permit found in Chapter 40D-2, F.A.C.

As Tampa Bay Water and District staff developed the list of monitored wetlands to be assessed, the different types of wetlands in the list were defined because each type of wetland needed an independent, established metric. A sufficient sample size of wetlands, with both control and treatment examples, is required in order to attempt to set a metric based on wetland health criteria. Table 5.2 shows both the "Wetland Type" from the monitoring program of Tampa Bay Water or the District and the "RA Wetland Type". This RA Wetland Type is the aggregated grouping classification of monitored wetlands based on their current morphology and vegetation type, creating appropriate wetland sample sizes for metric development. The final Recovery Assessment Wetland Types are: Isolated Cypress, Isolated Marsh, Connected Wetland, Other, Undetermined, and Lake. Previous work completed for the Phase 1 Mitigation Plan – Candidate Sites Evaluation Study (Berryman & Henigar, Inc. 2000), concluded that wetlands in a xeric landscape had significantly different hydrologic characteristics as compared to wetlands situated in the more dominant mesic landscape in the northern Tampa Bay area. Tampa Bay Water agreed to undertake the research necessary to determine if a different recovery metric could be reasonably derived for these xeric landscape-associated wetlands.

Early in the Recovery Assessment Plan process, Tampa Bay Water staff attempted to correlate the wetland vegetation data and water level data. This work was performed for wetlands where both types of data were available to determine if the wetland vegetation data could be directly used as a screening tool or metric of wetland health/recovery. Staff was unable to derive any statistically significant or meaningful correlations from the available vegetation and water level data but the historical vegetation data were useful in the establishment of wetland metrics. Ecological data and qualitative evaluations of wetland condition were used as grouping variables in these analyses to establish specific recovery/health metrics for each wetland type. The hydrologic data for the groups were then used to calculate a numeric metric based on the water level data. This approach followed the approach used by the District to establish the Minimum Level metric for isolated cypress wetlands as summarized in Section 6.3.2 of this report. Each metric that was developed relied on empirical water level data to assess the health or degree of recovery in each wetland system. This satisfies the regulatory and technical issues from the Recovery Assessment Work Plan that call for the establishment of quantitative metrics for different types of wetlands and the use of empirical hydrologic data to make assessments of wetland recovery.

The metrics that were developed and used in this Recovery Assessment Plan are tools for screening the health or recovery of identified wetlands in a consistent manner for a large number of specific sites. As discussed in the following sections and the technical appendices describing how each metric was developed, there is uncertainty and error present in the underlying data and all analyses. Factors other than wellfield pumping directly and indirectly influence wetland health: many of these factors cannot be assessed due to lack of specific correlating data. The results of the site-specific assessments of recovery as reported in Chapters 8 and 9 should not be interpreted to mean that a specific site does or does not exhibit an adverse impacted as defined in Chapter 40D-2, F.A.C. The site-specific results are discussed on a wellfield-scale in Chapter 12 and on a regional basis in Chapter 13 of this report as these specific analyses are brought together to describe the current environmental condition with respect to the renewal of the Consolidated Permit.

The following sections describe the metrics that have been established for each of the identified wetland types.

6.3.1 Mesic and Xeric Landscapes - Description

The term mesic means related to or adapted to an environment having a balanced supply of moisture while the term xeric means related to or adapted to a dry environment. Soils and ecosystems in Florida can be characterized as mesic (Myakka fine sand is a mesic soil, pine flatwoods are mesic habitats) or xeric (Adamsville fine sand is a xeric soil, sandhill is a xeric habitat). The Candidate Sites Evaluation Study (Berryman & Henigar, 2000) analyses noted a distinct hydrologic difference in isolated wetlands in the Northern Tampa Bay area based on whether they occurred in mesic or xeric settings. Wetlands in the predominant mesic landscape, such as surrounded by pine flatwoods, displayed subsurface water levels that were only weakly correlated to water levels in the surrounding surficial aquifer. This was contrasted by the smaller group of wetlands, with significant amounts of xeric soils and habitats in the surrounding uplands, which displayed subsurface water levels that showed a clear relationship to water levels in the surrounding surficial aquifer. In addition to the strength of the relationship between subsurface wetland water levels and nearby SAS monitor well levels, there was a difference in slope of the relationship. Dry season declines in the subsurface levels below wetlands in xeric landscapes approximated the declines in nearby SAS wells, while the water level declines in wetlands surrounded by flatwoods (i.e. those in mesic settings) were significantly less. Analyses contained in the Candidate Sites Evaluation Study indicated a roughly three to one ratio – for every three-foot surficial aquifer water level decline, the wetland water level for mesic-associated wetlands only declined a foot.

Upland soils are mapped in sufficient detail to use their distribution as a predictor of likely geologic conditions affecting the wetland/surficial aquifer water level relationship. The Candidate Sites Evaluation Study mapped mesic and xeric soils in the Northern Tampa Bay Area. The analyses concluded that a wetland containing less than 27% xeric soils within a 500-foot buffer around that wetland displayed characteristics of a wetland whose underlying soils retain moisture even as the surrounding water table declines. This is typical of most wetlands in the Northern Tampa Bay area that display water levels with relatively small vertical ranges. These wetlands were classified as “mesic-associated”. Mesic-associated wetlands tend to overflow above a certain elevation, either through a surface connection or into the surrounding landscape. Wetlands containing greater than 27% xeric soils within a 500-foot buffer display characteristics of a wetland that drains relatively quickly as water levels in the surrounding water table decline. These wetlands were classified as “xeric-associated”. Many of the xeric-associated wetlands are located in the very sandy or sandhill areas typical of the Cross Bar Ranch or western Starkey Wellfield areas. These sites are often internally-drained without a natural pop-off point and display a wide vertical range in water level elevation, both above and below ground. The designations of mesic-associated and xeric-associated wetlands continued into the Recovery Assessment Plan discussions as Tampa Bay Water examined the need for different recovery metrics for these two wetland types.

6.3.2 Isolated Cypress Wetlands – Mesic Associated

The Florida Legislature amended Section 373.02 of the Florida Statutes in 1996 which directed the District to establish minimum flows and levels for priority water bodies in the Northern Tampa Bay area due to the environmental stress documented in this area. Minimum Levels are defined as the minimum level of an aquifer or surface water body below which additional withdrawals would cause significant harm to the water resources of the area. The District convened a committee of stakeholders and subject matter experts in 1996 to create a scientifically-defensible process to establish Minimum Levels for wetlands in the northern Tampa Bay area. The work of this committee is presented in the Northern Tampa Bay Minimum Flows & Levels White Papers – Isolated Cypress Wetlands (SWFWMD, 1999b) and this document in included as Appendix 6.3 for reference.

The committee investigated the relationship that exists between ecological and hydrological parameters in wetlands. They examined the water level or stage in wetlands as well as the duration of time water occurs at each stage. Their working hypothesis was that lowered water levels in the surficial aquifer have a negative influence on wetland water levels and hydroperiods and that changes in wetland vegetation and soil condition can occur as a result of sustained drawdown in the surficial aquifer. The objective was to identify a hydrologic threshold, expressed as a water level, beyond which it would be reasonable to expect that significant harm would occur in a wetland. This threshold could then be used as a Minimum Level for wetlands.

The committee chose to use existing data as the primary source of information based on the imposed time constraints. Ecologic and hydrologic data had been collected at several hundred sites in the northern Tampa Bay area and the committee evaluated data collected during the prior two decades. The committee focused on isolated cypress wetlands because the majority of available data were collected from this wetland type and isolated cypress wetlands are abundant throughout this area. The time period of Water Years 1989 through 1995 was chosen for analysis; the committee thought this period was long enough to be representative of long-term conditions and a multi-year period lessened the effect of a single year with very wet or dry conditions. The committee used multiple criteria to select 36 of the original study set of wetlands to serve as reference wetlands. Water level data and categorical ratings of nine ecological assessment criteria were used in the subsequent analyses.

The ecological assessment criteria were used to define the condition of the 36 reference wetlands as not significantly changed, significantly changed, or severely altered. A normal pool elevation was established for each of the reference wetlands (if one had not already been established) to standardize the water levels among the reference sites. Stage frequencies were calculated for each reference wetland and the stage duration curves were graphed for assessment. There was similarity in the stage duration curves for the wetlands classified as having little or no alteration and these wetlands showed the least departure from the normal pool elevation (as measured by long-term median water levels). The stage duration curves for the wetlands classified as significantly changed or severely altered showed a higher degree of dispersion and a much wider range of lower long-term P50 (i.e. median) values. The difference in the long-term P50 elevation and the elevation of normal pool (called the “normal pool offset” or NPO) appeared to be a useful threshold statistic for distinguishing water levels between sites in good versus poor ecological health.

The committee applied statistical tests to this conclusion and developed a threshold statistic that distinguishes between the wetlands that were not significantly altered and the wetlands classified as altered. The threshold statistic is the median NPO and this threshold occurs between 1.8 and 1.9 feet below the normal pool elevation. This threshold or metric was subject to scientific peer review and the District Governing Board subsequently adopted Minimum Levels for 41 wetlands in the Northern Tampa Bay Area based on this threshold. According to this metric, a wetland is determined to be below its minimum level if the median stage, based on a long-term stage record, is below the adopted minimum level. Unlike lake Minimum Levels where there are multiple established levels, there is a single Minimum Level established in Rule 40D-8 for each wetland. This Rule also includes the methodology by which the

Minimum Levels were established. During the course of the Recovery Assessment analyses, it was determined that all of the MFL wetlands are mesic-associated wetlands based on their mesic/xeric soil ratio except for wetland NPWF-03 (NOP-03) at the North Pasco Wellfield.

This metric was developed for isolated cypress wetlands and applies only to that wetland type. Tampa Bay Water agreed that since the District had already performed site-specific research and adopted Minimum Levels for isolated cypress wetlands, this metric of 1.8 feet below the wetland normal pool elevation would be used for all isolated cypress wetlands in the Recovery Assessment Plan. Within the Recovery Assessment Plan, the term “mesic metric” is used to describe the metric of health for isolated cypress wetlands other than those wetlands specifically listed in Rule 40D-8 by applying the same 1.8-foot below normal pool standard. The logic is that since the Minimum Levels were established to prevent significant harm to isolated cypress wetlands, if a wetland of this type is meeting its level on a long-term basis, there is no significant harm to that wetland and it can be considered “recovered”. However, if the long-term water level of a wetland falls below the 1.8-foot mesic metric, that does not necessarily mean that a loss of wetland function or an adverse impact has occurred. A site investigation is necessary to make that determination.

There are 195 wetlands with a Recovery Assessment wetland type of “Isolated Cypress” within the Recovery Assessment Plan and 31 of them have adopted Minimum Levels. There are three additional wetlands on the Recovery Assessment monitored wetland list with Minimum Levels established using this isolated mesic cypress methodology. The wetland types assigned to these three wetlands for the Recovery Assessment Plan are “Isolated Marsh”, “Other” and “Undetermined”. These three wetlands will be assessed with wetlands of similar type in the Recovery Assessment analyses.

The District retained HSW Engineering, Inc. (HSW) in 2011 to evaluate more recent hydrologic and ecologic data collected for additional wetlands and apply the original procedure used to establish the minimum level for isolated cypress wetlands. The study re-evaluated the response of isolated cypress wetlands in light of the reduction in groundwater pumping from the wellfields and re-examined hydrologic and ecologic health parameters related to impacts and overall wetland health. HSW evaluated 33 isolated cypress wetlands, seven of which were part of the original set of wetlands used to create this minimum level metric. The wetlands were characterized as severely changed, changed, and unchanged based on ecological criteria and data and the three groups were tested to determine if they were statistically different from one another. In all tests performed, the severely changed wetlands were statistically different from the population of changed and unchanged wetlands. Cumulative distribution plots were prepared for the P50 departure values (i.e. NPO) for each wetland health category (or composite category) along with plots of the associated cumulative normal distribution function for each wetland health category (or composite category). The results showed that the maximum P50 water level offset for the recent study was much less than in the wetlands analyzed in the original study (approximately 4.6 feet versus 9 feet in the original study). The authors stated that it appeared that the hydrologic environment of the severely changed wetlands in the updated study was more favorable than for the severely changed wetlands in the original study even though some ecological stress was still apparent.

The recent study found that there was no significant hydrologic difference between the changed and unchanged wetlands as compared to the original study where the changed and severely changed wetlands were combined into one category of stress based on the data evaluated. The recent study compared the cumulative frequency distributions of the P50 water level (i.e. NPO) data for the changed/unchanged wetland group and the severely changed wetland group. This was done to estimate the minimum long-term water level that could result in significant harm as denoted as a departure from normal pool elevation similar to the original study used to set a minimum level for isolated cypress wetlands. The recent study concluded that the minimum level for this type of wetland (based on the sites and the time period evaluated) was 2.5 feet below the wetland normal pool elevation with a 9% misclassification error. The methods and analyses are presented in the report "Re-Examination of the Palustrine Cypress Wetland MFM Method" (HSW Engineering, Inc., 2012b).

It is clear from the recent study that overall, wetlands near the wellfields have improved hydrology in the period of reduced wellfield pumping as demonstrated by the smaller range in P50 water levels between impact groups. For the seven wetlands that were evaluated in both the original and recent studies, the P50 water levels improved at all sites; however, the stress rating of two wetlands decreased from changed to severely changed. This may indicate there is a lag time between improvement in water levels and improved wetland health. While the two studies reached different conclusions with respect to a numeric value for an isolated cypress wetland minimum level using the same methodology (1.8 feet versus 2.5 feet below normal pool elevation), the District did not consider this to be an exhaustive re-evaluation and they did not revise the metric for isolated cypress wetland health. In the Recovery Assessment Plan analyses, Tampa Bay Water has retained the District's original isolated cypress wetland metric of 1.8 feet below normal pool elevation. However, the HSW study points out the lag in ecologic improvement following hydrologic recovery and the uncertainty associated with establishing metrics of wetland health using ecological data and an offset from a wetland's normal pool elevation.

6.3.3 Isolated Marsh Wetlands – Mesic Associated

Since the establishment of a minimum level metric for isolated cypress wetlands, Tampa Bay Water and the District have assumed that isolated cypress wetlands and isolated marshes hydrologically behave in the same manner. Both agencies have conducted analyses assuming that the 1.8-foot below normal pool metric can also be applied to isolated wetlands; however, this assumption had never been tested. As part of this effort to establish metrics of health/recovery for each wetland type on the monitored wetland list, Tampa Bay Water analyzed isolated marsh data to determine what would be the best metric to use for these wetlands in the Recovery Assessment Plan. There are 51 isolated marsh wetlands on the monitored wetland list which represent 13.5% of the total population of monitored wetlands to be assessed by the Recovery Assessment Plan. Of these 51 isolated marshes, 31 were classified as occurring in a mesic landscape setting and the remaining 20 occurring in a xeric landscape setting and the metric for this subset of marshes will be discussed in the next section.

Tampa Bay Water staff based the analysis of marsh data on the methodology used by the District (SWFWMD, 1999b) to establish an isolated cypress wetland metric and set Minimum Levels for a number of isolated cypress wetlands in the northern Tampa Bay area. The available data from the isolated marshes in a mesic landscape setting were summarized and the wetlands were grouped by wetland condition based on their WAP scores between 2008 and 2015 (representing a post-pumping cutback period of long-term average rainfall). Water level data for the marshes was normalized by subtracting the data from a normal pool elevation which had previously been established for each wetland (i.e. by using the NPO). The long-term median water levels were compared between the stressed and unstressed groups and a threshold value distinguishing the two groups was calculated. The comparative analyses were performed four times on the marsh data using slightly different grouping criteria to test the sensitivity of the analysis to different variables.

The long-term median normal pool offset threshold separating stressed and unstressed isolated mesic marshes varied between -1.4 feet and -2.0 feet in the four analyses. These results bracket the 1.8-foot below normal pool metric for isolated cypress wetlands. In addition, one of the study analyses (which removed marshes with suspect normal pool elevations) resulted in a normal pool offset of 1.8 feet below normal pool. Tampa Bay Water subsequently recommended using a metric of 1.8 feet below normal pool elevation to determine health/recovery of isolated mesic marshes in the Recovery Assessment Plan. The details of this metric development analysis were submitted to the District on November 13, 2018 and this submittal is included as Appendix 6.4. Tampa Bay Water began applying this metric following verbal concurrence from District staff during our October 13, 2016 technical coordination meeting. At this meeting, Tampa Bay Water and the District agreed that the 1.8-foot below normal pool metric is appropriate for use in the Recovery Assessment Plan for isolated marshes in a mesic landscape setting.

6.3.4 Isolated Cypress and Marsh Wetlands – Xeric Associated

The Recovery Assessment Work Plan identified the need to investigate the similarities and differences of isolated wetlands in a xeric versus a mesic landscape; if these two wetland types are found to be hydrologically different, a separate recovery metric would need to be developed for isolated xeric wetlands. The basis for this investigation comes from the Candidate Sites Evaluation Study (Berryman & Henigar, Inc. 2000) which was completed as a requirement of the initial Consolidated Permit. In that study, the authors noted a distinct hydrologic difference in these two types of isolated wetlands when the wetland water levels recede below the bottom of the wetland. The authors determined that these two types of wetlands generally had different soils surrounding them and the upland soils were grouped into either a mesic or xeric soil type. The Candidate Site Evaluation Study concluded that wetlands in a xeric landscape had significantly different hydrologic characteristics as compared to wetlands situated in the more dominant mesic landscape in the northern Tampa Bay Area. As part of the Recovery Assessment Plan, Tampa Bay Water agreed to undertake the research necessary to determine if a different recovery metric could be reasonably derived for xeric landscape-associated wetlands. Until the time of this Recovery Assessment Plan study, Tampa Bay Water and the District had assessed all isolated wetlands using the 1.8-foot below normal pool metric established by the District for isolated wetlands in a mesic landscape.

6.3.4.1 Original Proposed Metric

Tampa Bay Water retained the services of Greenman-Pedersen, Inc. to establish a recovery metric for isolated wetlands in a xeric landscape and the preliminary evaluation of data and discussions began with the District in mid-2014. The United States Department of Agriculture-National Resources Conservation Service has performed extensive soil type mapping across the United States and these data were the basis for this evaluation. Each soil type in the northern Tampa Bay area was classified as either mesic or xeric based on six different characteristics and the soil classification data were compiled into a GIS data layer for analysis. The consultant concluded that the soils within a 500-foot buffer of a wetland can be used to determine the wetland type (mesic or xeric) and that a wetland that has greater than a 27% xeric ratio of soils within this buffer can be classified as xeric-associated. The study also noted that xeric wetlands show a wide fluctuation in water levels, are generally internally drained and do not flood the surrounding landscape during high-water events and are more directly connected to the water table and the underlying Upper Floridan Aquifer than mesic wetlands.

Ecological health classifications of the xeric-associated study wetlands, performed by an experienced plant ecologist familiar with the sites, were used to classify the sites as stressed or non-stressed for different time periods. The water level data for these wetlands were examined for a period of time prior to the reduction in wellfield pumping and a time period of similar length after the wellfield pumping reduction. The non-stressed xeric-associated wetlands had significantly higher median water levels than the stressed wetlands and the authors identified a statistical threshold separating the two wetland groups. This study followed the same general method used by the District to establish a metric for isolated cypress wetlands. The authors recommended that a metric of 3.1 feet below the wetland normal pool be used to assess the health/recovery of isolated xeric wetlands. Xeric-associated wetlands whose median water levels are less than 3.1 feet below the normal pool elevation (closer to land surface) can be considered as recovered. The report detailing the research completed to reach these conclusions was submitted to the District on August 10, 2016 and is included as Appendix 6.5. This study also produced GIS data layers of soil types and a designation of mesic or xeric type for monitored and unmonitored wetlands included in the Recovery Assessment Plan.

The District reviewed the submitted report and agreed that the proposed metric for xeric-associated wetlands was appropriate for assessing the recovery of these wetlands (letter dated June 20, 2017 included with Appendix 6.5). Tampa Bay Water proceeded to use the proposed metric of 3.1-foot below normal pool elevation for the preliminary assessment of findings report submitted to the District in 2018 (Tampa Bay Water, 2018b). This preliminary assessment was made with the understanding that the xeric wetland metric could change and any revised metric would be applied to the xeric-associated wetlands in the final Recovery Assessment Plan report. Tampa Bay Water chose to apply this 3.1-feet below normal pool metric for marshes in a xeric landscape in the preliminary assessment report submitted in 2018 since the population size of marshes in a xeric landscape was insufficient for a rigorous analysis of a separate metric for these marshes. An attempt to set a separate xeric marsh metric was not pursued.

In subsequent sections of this report and in individual wetland assessment reports, the terms “mesic wetlands” and “xeric wetlands” frequently appear as descriptive terms for wetland types. The terms mesic and xeric specifically refer to the prevalence of classified soil types surrounding the wetlands and not the wetlands themselves; however, the descriptive terms “mesic wetlands” and “xeric wetlands” are used for brevity.

6.3.4.2 Revised Metric

The District raised several questions and provided recommendations for further study in their June 20, 2017 response letter on the original xeric wetland metric that was submitted to the District on August 10, 2016. In response to this input, Greenman-Pedersen, Inc. (GPI) conducted additional analyses and developed a revised recovery metric for xeric-associated wetlands (Appendix 6.6).
One recommendation provided was to investigate the distribution of soil types within the wetland buffer to examine the hypothesis that xeric soils adjacent to a wetland had greater influence than those elsewhere in the buffer. Other recommendations included adding wetland soil acreage in the

denominator when calculating percent xeric soils in the surrounding buffer, examining the normal pool elevations for the study wetlands, and using additional wetlands to increase the population of study sites on which to base the metric of recovery. The final recommendation was to consider a sliding scale metric that depended on the percent xeric soils in the 500-foot buffer surrounding a wetland – presumably a higher percentage of xeric soils would result in a lower required offset from a reference elevation.

GPI staff discussed their responses and additional analyses with Tampa Bay Water and District staff at interagency recovery assessment meetings between November 2018 and August 2019. Minutes for these agenda items are included in Appendix 6.7.

Specific results of additional work by GPI include:

- No evidence was found that a consideration of the spatial distribution of soil types in the wetland buffer affects the establishment of a recovery metric. Wetlands with similar xeric soil ratios in their 500-foot buffers but differing in whether or not areas of xeric soils were immediately adjacent, had similar hydrology as determined by examination of a number of sample statistics (e.g. period-of-record standard deviation and period-of-record water level range),

- Including wetland soils in the calculation of percent xeric soils would be problematic. The alignment of wetland soil types and wetland limits from separate sources is inexact and would result in significant errors. Wetland soils from the wetland itself could be included in the buffer calculation, to a greater or lesser degree depending on the extent of the misalignment of the soils and wetland layers. In addition, the threshold created for assignment of a wetland as xeric-associated comes from a previous study which only considered surrounding upland soils (Berryman & Henigar, 2000). Tampa Bay Water and GPI continue to support that limiting the evaluation to upland soils in the wetland buffer is justifiable and appropriate,

- The revised recovery metric for xeric-associated wetlands does not use normal pool elevation as a reference elevation (see below), so there was no need to examine or re-evaluate the normal pool elevations used in the original study,

- As suggested, additional wetlands were added to the test group used in metric development. The original study used 43 wetlands. Fifty-one wetlands were added, resulting in 94 wetlands being considered for use in the analyses supporting the establishment of a revised xeric-associated wetlands recovery metric. Ultimately, 126 unique time series were selected from 89 wetlands with sufficient, appropriate data for establishing the revised metric, and

- The relationship between percent xeric soils in the wetland buffer and median offsets from a reference elevation was investigated, but the results did not support establishing lower offsets with higher xeric ratios. This result may have been due to a lack of unstressed wetlands with high xeric ratios in the study sample.

GPI completed their re-evaluation of the recovery metric for xeric-associated wetlands in January 2020 (Greenman Pedersen, Inc., 2020). The xeric-associated wetlands analyzed in the re-evaluation were categorized as being stressed or unstressed for the pre and post-cutback time periods studied. Initial stress categories (e.g. stressed, unstressed) were determined based on review of interpolated Wetland Health Assessment (WHA) scores (Greenman Pedersen, Inc., 2018), Wetland Assessment Procedure (WAP) scores, and information contained in wellfield monitoring reports. Preliminary stress categories were presented and discussed at the interagency recovery assessment meetings. Final stress categories used in the reevaluation were based on the preliminary review and the input subsequently received from District and Tampa Bay Water staff.

In order to develop a revised recovery metric that does not rely on an established normal pool elevation, higher water level percentile values were examined for pre and post-cutback periods. The P0 percentile exceedance value (i.e. the maximum) to P10 percent exceedance values for the xeric-associated study wetlands were compared for pre-cutback (1996-2002) and post-cutback (1998-2019) periods. The goal was to find a percent exceedance value that varied little with changes in pumping. Such a value could be used as a reference elevation for standardizing wetland time series for comparison, equivalent to how normal pool elevations are used in the analysis of wetland hydrology for mesic-associated wetlands. For the xeric-associated wetlands studied, the median of the P50 (median) water level change between pre and post-cutback periods was a two foot increase. The P03 level barely changed – the post-cutback median P03 was 0.03 foot higher than the pre-cutback P03. The P03 level was therefore chosen as a reference elevation for xeric-associated wetlands. Recognizing the possibility of slightly lower P03 elevations in the higher production period at some sites, GPI selected the higher elevation of either the post-cutback 2008-2019 P03 or the POR P03 as the reference elevation.

Sample statistics were developed for the wetland water level time series identified as stressed and unstressed. Sample groups excluded nonrepresentative time series as discussed in the recovery assessment meetings, including series with insufficient data, those associated with a period of unusually high water levels (2003-2007), and those sites classified as stressed but occurring in low surficial aquifer system drawdown zones (i.e., less than or equal to one foot). Empirical cumulative distribution functions (ECDF) of median offsets from the P03 reference elevation were developed for both stressed and unstressed groups. Using the Crossing Point Method, the offset associated with minimizing the overlap between the ECDF of the unstressed wetland group and 1-ECDF of the stressed group was calculated. The result was 3.7 feet below the reference elevation. Therefore, a median water level within 3.7 feet of the reference P03 elevation was chosen as the new recovery metric for xeric-associated wetlands. Assuming similar long-term rainfall inputs (to both the study sample and between groups), approximately 16% of truly unstressed xeric-associated wetlands would be expected to have long-term median water levels lower than 3.7 feet below the P03 reference elevation. Approximately 15% of truly stressed wetlands would have long-term medians above that threshold.

In order to address the District recommendation for a range of water level metrics and to provide estimates with greater certainty, the offset levels expected to contain 95% of each population were developed. Based on the samples used and the crossing point method employed, only 5% of unstressed wetlands are expected to have offsets below 4.3 feet. For wetlands that would be identified as stressed, it is predicted that only 5% would have offsets above 3.0 feet. Therefore, while the offset at 3.7 feet represents the best single xeric recovery metric, those wetlands with measured offset values either below 4.3 or above 3.0 feet could be assigned to their most likely classifications (stressed and unstressed, respectively) with greater confidence.

6.3.5 Connected or Flow Through Wetlands

The District has adopted Minimum Flows for rivers in the Tampa Bay area (Hillsborough, Anclote, and Pithlachascotee Rivers) but a threshold defining significant harm to other types of connected or flowing wetlands had not been previously established. There are 82 wetlands on the monitored wetland list (Table 5.2) that have been given a Recovery Assessment type of "Connected Wetland". These wetlands represent sites that are part of stream systems, monitored portions of floodplains (cypress or hardwood), or cypress wetlands that are connected by flow-ways to other wetlands or stream systems. Tampa Bay Water and the District agreed that connected wetlands could not be assessed using a metric developed for isolated wetlands due to the lack of reliable normal pool indicators in these wetlands, physical characteristics of the wetlands (they do not occur within closed basins), and the rapid and wide range of water level fluctuations evident in the hydrographs of some of these wetlands. Tampa Bay Water retained the services of Dr. Brian Ormiston and the Flatwoods Consulting Group to examine the connected wetlands and develop a numeric hydrologic threshold screening tool or recovery metric using available ecological and hydrological data.

The consultant team assembled all available ecological information from the connected wetlands and used the data to develop stress categories (severely stressed, moderately stressed, and not stressed). As with the other metrics that have been developed for or incorporated into the Recovery Assessment Plan, water level data were compared for long-term periods at each site before and after the reduction in wellfield pumping. The collected data were analyzed to determine an appropriate hydrologic threshold value that best separated the stressed sites from the sites with moderate or no stress.

Field assessments of stress were completed for a subset of the actively-monitored connected wetlands. The consultants established surveyed transects into 20 of the actively-monitored connected wetlands as a possible surrogate for normal pool elevation in these wetlands; soil type data were also collected along the transects to provide additional data. Although wetland edge elevation showed potential as a surrogate for normal pool, there were no wetland data available for many of the study wetlands. In addition, as demonstrated in wetland jurisdictional determinations, wetland edge elevations may have high variability.

Since normal pool and wetland edge elevations were not available for all study wetlands, water level percentiles were derived from the period of record data for each site to standardize absolute wetland elevation data for analysis across the population of study wetlands. The consultant team chose to examine the 90^{th} percentile for use in computing offset water level data since there is a conceptual association with normal pool elevation and this percentile and the use of a higher percentile can be associated with greater data errors (i.e., inundated water level monitoring devices). Examination of pre and post-cutback percent exceedance curves has indicated that the water elevations at high percentiles are relatively less affected by drawdown (i.e. impacted wetlands generally still reach their flood elevations during times of relatively high rainfall). This makes the use of the higher percentile elevations from connected wetlands a potential "standard" to be used in assessing impact, similar to how normal pool is used in isolated wetlands.

The consultant recommended a water level recovery metric of 2.5 feet below a connected wetland's period of record 90^{th} percentile value and their investigations are contained in a report found in Appendix 6.8. This report was submitted to the District on January 17, 2018 and the District concurred with the approach to assessing connected wetlands (letter dated March 26, 2018 included in Appendix 6.8). In response to questions asked by the District in their March 26, 2018 letter, Tampa Bay Water offers the following discussion on the connected wetland metric.

The raw data used in the development of the metric were the twice-monthly water level data available from the Tampa Bay Water database. The misclassification error (expected discrepancy rate between a wetland's ecological stress classification and whether its median water level offset is above or below the metric) is approximately 15%. The Excel solver function assumes a normal distribution.

With respect to landscape setting, the group of connected wetlands monitored under the Consolidated Permit is very diverse and likely exhibit a wide range of natural hydrologic variation. Additional work could be done in order to refine the metric taking natural variability into account. However, due to the contribution of upstream flow and the adaptation of connected wetlands to a high interannual variability in flow and water levels, the relative susceptibility of connected wetlands to groundwater withdrawal is likely to be generally lower than for most isolated wetlands.

As discussed in the connected wetland metric report (Appendix 6.8), the determination of ecological stress was performed through a combination of historic document review, aerial photointerpretation and field evaluation, and involved multiple team members. This method relies heavily on professional judgment and has inherent advantages (in the full utilization of relevant information and possibly in the accuracy of stress assessments) and disadvantages (perhaps in reproducibility – would another team have determined the same stress categories for the study wetlands?). The choice of stress determination method is a critical aspect of recovery (or wetland health) metric development and Tampa Bay Water has consistently used the best available data and multiple subject matter experts for the development of recovery metric within the Recovery Assessment Plan.

6.3.6 Other/Undetermined Wetland Types

The final list of monitored wetlands included in the Recovery Assessment Plan includes 47 wetlands with a Recovery Assessment Wetland Type of "Other" or "Undetermined". These were catch-all categories used for monitored wetlands that did not clearly fit within one of the other defined wetland types. This group includes hardwood wetlands, wet prairies and one borrow pond. Tampa Bay Water and the District agreed that since there was such a small number of each of these types of wetlands, there were insufficient sample sizes to develop recovery metrics for these wetland types. In the absence of an individual recovery metric for these wetlands, Tampa Bay Water and the District staffs agreed to use the weight-of-evidence assessment approach and apply the most applicable recovery metric to each "Other" or "Undetermined" wetland. Tampa Bay Water applied either the mesic or xeric-associated recovery metric or the connected metric for isolated sites as appropriate. The wellfield-specific assessment reports presented in Chapter 9 discuss how each wetland with an "Other" or "Undetermined" type was assessed.

6.4 Recovery Metrics for Lakes

Most lakes in the Northern Tampa Bay area have levels established by the District. Some of these are guidance levels which were set to inform property owners of potential high and low levels for construction of structures and docks. Other lakes have Minimum Levels which were set based on additional research and are used in the review and issuance of area Water Use Permits. The types of levels and how they have been used as metrics for the Recovery Assessment Plan are discussed below.

6.4.1 Lake Management Levels

The District developed a Lake Levels Program in the mid-1970's to conserve the water storage and recharge capabilities of lakes, provide guidelines for lake-side development, provide levels for operation of lake control structures, and provide information for Water Use Permit activities (SWFWMD, 1996a). The District set four levels using site-specific data collected from each lake and three of these lake levels were adopted into Chapter 40D-8.624(13), F.A.C for over 100 lakes in the northern Tampa Bay area. The three levels are:

- High Level – often regarded as the typical annual high level or the highest level at which a lake is allowed to fluctuate without interference (lakes with management structures),
- Low Level – the normal annual low level. This level is used to regulate lake augmentation and to provide information to regulate groundwater and lake withdrawals affecting the lake level, and
- Extreme Low Level – a normal cyclic level that a lake should reach only periodically for the ecological health of the lake. This level is also used to operate control structures during very low rainfall years.

The District staff performs an annual assessment of the lakes with established Management Levels to determine which of the lakes are fluctuating below a level that is not within a normal range for each lake as determined by long-term indicators. This annual assessment produces a list of lakes that are in a stressed condition which is defined as a chronic fluctuation below the normal range of lake level fluctuations.

6.4.2 Minimum Lake Levels

The Florida Legislature amended Section 373.02 of the Florida Statutes in 1996 which directed the District to establish minimum flows and levels for priority water bodies in the Northern Tampa Bay area due to the environmental stress documented in this area. The District convened a committee of stakeholders and subject matter experts to create a scientifically-defensible process to establish Minimum Levels for three categories of lakes. Category 1 lakes have fringing cypress wetlands where water levels currently rise to an elevation expected to fully maintain the integrity of the fringing wetlands. Category 2 lakes have fringing cypress wetlands but the lake has been structurally altered such that lake water levels do not rise to levels expected to fully maintain the integrity of the fringing wetlands. The methodology used to set levels for Category 1 and 2 Lakes is presented in the Northern Tampa Bay Minimum Flows & Levels White Papers – Category 1 and 2 Lakes (SWFWMD, 1999c) and this document is included as Appendix 6.9 for reference. This methodology was subjected to scientific peer review and the District subsequently adopted Minimum Levels for 15 lakes in the Northern Tampa Bay area.

Category 3 lakes have less than 0.5 acre of fringing cypress wetlands and the District convened a guidance committee in 1999 to establish a process for setting Minimum Levels for this third category of lake. The methodology used to set levels for Category 3 lakes is based on a multi-parameter approach using developed significant change standards. This methodology is described in "A Multiple-Parameter Approach for Establishing Minimum Levels for Category 3 Lakes of the Southwest Florida Water Management District (SWFWMD, 2001) and this document is included as Appendix 6.10 for reference.

This methodology was also subjected to peer review and the District adopted Minimum Levels for 17 additional lakes using this new methodology. This methodology was modified by the District in a peer-reviewed report entitled "Proposed Methodological Revisions Regarding Consideration of Structural Alterations for Establishing Category 3 Lake Minimum Levels in the Southwest Florida Water Management District (SWFWMD, 2006) which is attached as Appendix 6.11.

The District has established Minimum Levels for many lakes in the Northern Tampa Bay Area and these levels and the methods by which they have been established are adopted into Chapter 40D-8, F.A.C. as four separate levels:

- High Guidance Level – an advisory guideline for construction of lake shore development, water dependent structures, and the operations of water management structures,
- High Minimum Lake Level – the elevation that the lake water levels are required to equal or exceed ten percent of the time on a long-term basis,
- Minimum Lake Level – the elevation that the lake water levels are required to equal or exceed fifty percent of the time on a long-term basis, and
- Low Guidance Level – an advisory guideline for water dependent structures, information for lakeshore residents and operation of water management structures.

Part of the District's Minimum Flows and Levels program includes a periodic reevaluation of established Minimum Levels over time to incorporate additional site-specific data and new assessment tools. Reports detailing how Minimum Levels were set or revised for individual lakes can be found on the District's website at http://www.swfwmd.state.fl.us/projects/mfls.

Tampa Bay Water agreed that since the District had already performed site-specific research and adopted Minimum Levels and Guidance Levels for many lakes in the Northern Tampa Bay Area, we would use these established levels as recovery metrics for lakes. The logic is that since the Minimum Levels were established to prevent significant harm to the lake, if a lake is meeting its level on a long-term basis, there is no significant harm to that lake and it can be considered "recovered". There are 137 monitored lakes included in the Recovery Assessment Plan; 61 of the lakes have adopted Minimum Levels, 54 have established Guidance Levels, and 22 have no established levels. In Tampa Bay Water's assessment of recovery of monitored lakes (described in Chapter 8), staff used the established Minimum Levels for a lake if adopted or the Guidance Levels if no Minimum Levels had been adopted. If a lake had neither established Minimum Levels nor Guidance Levels, the best available data was used in a "weight-of-evidence" approach to assess recovery for these remaining lakes.

6.5 Methods of Assessing Unmonitored Lakes/Wetland

Chapter 40D-2.301, F.A.C. outlines the Criteria for Issuance of a Water Use Permit. This Rule of the District requires that an applicant demonstrate that their withdrawals do not cause harm to the water resources of the area including wetlands and other surface waters. Tampa Bay Water staff agreed with District staff to define an area of potential impact resulting from wellfield pumping at an average of 90 mgd and identify the unmonitored wetlands and lakes within this area. Tampa Bay Water defined an Area of Investigation for the Recovery Assessment Plan and the initial Area was updated with actual wellfield pumping data from 2013 through 2018 (Section 5.3). Staff committed to attempt to assess the environmental recovery of all unmonitored wetlands and lakes within this defined area that has been achieved due to the reduction in pumping from the 11 wellfields.

The Updated Area of Investigation contains 845 wetlands and lakes as identified in Table 5.3. In addition to these unmonitored wetlands and lakes, a number of monitored wetlands have truncated data records due to elimination of monitoring for various reasons. In many cases, monitoring at these sites ended before or just after the reduction in wellfield pumping and there is insufficient data to assess these wetlands using the methods of assessment described above for monitored sites. Tampa Bay Water included these additional 27 wetlands in the assessment of unmonitored sites and used any available data in the specific assessment of these wetlands where possible. This section summarizes the process used to describe the expected environmental condition of unmonitored wetlands and lakes within the defined Area of Investigation.

6.5.1 Initial Assessment Method for Unmonitored Sites

Tampa Bay Water and the District began discussing an approach to assess the recovery of the unmonitored wetlands at our September 15, 2016 technical coordination meeting. Staff understood that the assessment of sites with no monitoring data would pose a significant technical challenge and would require much data and multiple approaches. Tampa Bay Water and the District collect hydrological and ecological data from wetlands, lakes, and aquifers in the area of all of the unmonitored wetlands to be assessed and staffs began discussing how to extrapolate the data from monitored sites to the nearby sites with no data. Given that any approach would contain uncertainty in the data used and the spatial nature of any assessment, it was agreed to utilize a weight-of-evidence approach to evaluate the unmonitored wetlands and lakes. Tampa Bay Water retained the staff of Greenman-Pedersen, Inc. (GPI) to assist with developing methods for estimating ecological and hydrological conditions at unmonitored sites and a general approach for applying these methods to assign a level of recovery to each of the unmonitored sites.

The staff of GPI used statistical interpolation in developing methods for applying data from monitored sites to nearby sites with no data. The development of statistical models that will allow inference of recovery at unmonitored wetlands requires the development of large datasets from the nearby monitored sites during appropriate time periods (after pumping reduction). After a review of rainfall data from the 11 wellfields, GPI selected 2008-2014 as a period of time characterized by a range of rainfall conditions with an annual average that matched the long-term annual rainfall average for the Tampa Bay area. This time period was characterized by reduced wellfield pumping with the exception of the Northwest Hillsborough Wellfield (reduced pumping began at this wellfield in 2011) and the Cypress Bridge Wellfield (no reduction in pumping over the period of record). The data from the Five-Year Wetland Health Assessment program was also assembled into datasets based on the years when data were collected under this program and the change in ecological condition at assessed wetlands between the initial assessment period of 1997/1998 and the assessment completed in 2009.

The statistical method of regression-kriging was used to interpolate wetland water levels at the unmonitored sites. This predictive approach was first tested against sites with water level data to see how well the method would predict the water levels in the monitored sites. The model testing found that surficial aquifer drawdown and the ratio of mesic to xeric soils surrounding a wetland were the two most useful variables in predicting the water level in a wetland. GPI recommended that predicted water level data in the form of an offset from the normal pool elevation of a wetland should be produced from the developed model as a primary dataset for assessing recovery at unmonitored wetlands. GPI also recommended that the interpolated Wetland Health Assessment datasets developed for this investigation should be used as a further assessment tool. GPI recommended that historical and recent aerial photography be used only in a verification step in the process to provide additional information where needed. The technical investigations performed by GPI, recommendations for further study, and their recommended approach to the assessment of unmonitored wetlands and lakes was presented in a technical report which is contained in Appendix 6.12. Tampa Bay Water submitted this report to the District on March 27, 2017. The District provided review comments and recommendations to be considered in the development and refinement of this assessment method and datasets in a letter dated June 5, 2017 (included in Appendix 6.12).

Tampa Bay Water again retained GPI to refine their prior assessment methods using additional data and incorporate the comments and recommendations made by Tampa Bay Water and District staff. GPI staff tested and refined their methods and datasets to provide predictions of ecological and hydrological conditions as well as changes in conditions at unmonitored sites between the pre- and post-pumping cutback periods. The Random Forest machine learning algorithm was investigated and determined to be useful in predicting both the hydrological and ecological conditions of wetlands in the time periods before and after pumping reduction; this algorithm performed these analyses better than the regression-kriging method used in the prior study. Machine learning tools have a statistical basis but have different assumptions than classical statistical methods. Machine learning algorithms seek to learn a distribution from the data which is then used to develop a generalizable model that best fits the known data but in a way that avoids overfitting, allowing the model to be used for future or unknown cases. The Random Forest algorithm is a multiple tree-based decision method that can be used for regression or classification, is robust to outliers and data noise, handles datasets for a large number of variables, and provides a conservative error estimate within its predictions.

The Random Forest algorithm provides an estimate of the importance of variables to the prediction outcome. A large number of variables were investigated for their value in predicting ecological conditions and normal pool offsets in wetlands. The most important variables to these predictions were surficial aquifer drawdown, Upper Floridan Aquifer drawdown, the head difference between the wetland or lake historical normal pool elevation and the underlying Upper Floridan Aquifer potentiometric surface, the xeric ratio of soils surrounding the study wetlands, the wetland/lake depth, and the predevelopment potentiometric surface of the Upper Floridan Aquifer. ESRI shapefiles of these and other parameters were provided as work products from this study. The results of the 2016 Wetland Health Assessment survey were included in this study and incorporated into the spatial datasets. Maps of the predicted normal pool offset (NPO) elevations, the NPO changes between the pre-and post-pumping reduction periods, and wetland health predictions (based on predicted WHA scores) were also produced as GIS data products. These GIS data of predicted ecological and hydrological data were produced for use in subsequent analyses as part of the weight-of-evidence analysis of the recovery of unmonitored sites.

The additional work performed by GPI, including their development of the Random Forest machine learning algorithm, is presented in a technical report included as Appendix 6.13. The GPI report was submitted to the District for review on December 21, 2018. Within this technical study, the consultant used the developed algorithm to make predictions of recovery for the 749 unmonitored wetlands and lakes within the Recovery Assessment Plan. The predictions of recovery at the unmonitored wetlands may have conservative bias as the percentage of unmonitored sites that were predicted to be recovered due to the reduction in wellfield pumping was much lower than the percentage of monitored sites that were assessed as recovered in the preliminary report of findings (Tampa Bay Water, 2018b). While the results of this investigation are informative and useful, the results do not accurately represent the condition of recovery that has been observed in monitored wetlands and lakes in the Recovery Assessment Plan. The GIS layers of multiple parameters produced by the model are valuable datasets as they provide interpolated data for the unmonitored wetlands and lakes. These layers were carried forward into a weight-of-evidence assessment approach to make predictions of recovery for the unmonitored sites. The data published in the GPI report is the starting point for subsequent analysis of unmonitored site status.

Tampa Bay Water staff began evaluation of the unmonitored wetlands by classifying each site as isolated or connected and calculating the mesic/xeric soil ratios. The unmonitored wetlands were assessed using the interpolated data sets and the metrics developed for isolated mesic cypress/marsh wetlands (1.8 feet below normal pool elevation), isolated xeric cypress/marsh wetlands (3.1 feet below normal pool elevation), and connected wetlands (2.5 feet below a connected wetland's period of record 90^{th} percentile value). Staff began applying a weight-of-evidence approach to screening unmonitored wetlands on a wellfield-scale. The interpolated datasets available for the unmonitored wetlands included: predicted normal pool offset elevation, potentiometric surface of the Upper Floridan Aquifer including depth below land surface, surficial aquifer recovery data (water level improvement following pumping reduction), surficial aquifer drawdown based on actual wellfield pumping rates and wellfield pumping rates scaled up to 90 mgd, proximity to Five-Year Wetland Health Assessment (WHA) wetlands, recovery assessment results from monitored lakes/wetlands, and water table elevations from nearby monitor wells. This qualitative assessment was performed for all but two of the wellfields which had unmonitored wetlands to be evaluated and the results were discussed with the District staff at meetings between May 10 and October 24, 2018. Each unmonitored wetland and lake were assigned to a recovery assessment bin, similar to the process for the monitored sites.

In late 2018, Tampa Bay Water staff developed a GIS model to assess the unmonitored wetlands using a logic tree/stepwise statements approach and multiple data sets previously described in this report. This model was created to provide a consistent and reproducible method of assigning the unmonitored sites to preliminary recovery bins. The interpolated data was already available in shapefiles, facilitating the unmonitored site assessment using a GIS approach. The model is based on the Select tool within the GIS application where all sites are assessed against a criterion and all sites passing that criterion are classified as Recovered. The sites that do not pass a criterion continue in the model are assessed against subsequent hydrologic criteria. Each site continues through the model until either removed from the model as Recovered or assigned a recovery bin of Improved or More Detailed Assessment Needed in the final model step. The selection steps in the model include: the connected wetland metric, the xeric/mesic isolated wetland metrics, the depth of the Upper Floridan Aquifer potentiometric surface below land surface, the predicted median drawdown in the surficial aquifer beneath each wetland, a comparison of the median Upper Floridan Aquifer potentiometric surface in the post-cutback period to the predevelopment potentiometric surface, and the improvement in normal pool offset for each wetland in the post-cutback period. Additional information about the GIS model construction and implementation is presented in Chapter 10 of this report.

At the completion of the preliminary GIS model analysis, a number of sites were classified as More Detailed Analysis Needed as they did not meet any of the criteria in the model. The individual wetland assessments performed in 2018 for most wellfields, where available, were considered the "more detailed assessments" and the results of these individual evaluations were substituted for the GIS model results for the sites with a classification of More Detailed Analysis Needed. This blended approach for the preliminary assessment of unmonitored sites was discussed with the District at the October 24 and November 8, 2018 technical coordination meetings. The details of the GIS model development, implementation, and results are presented in a technical report submitted to the District on December 21, 2018 and this report is included as Appendix 6.14. The results of this preliminary screening of the unmonitored sites are presented in Chapter 10 of this report.

6.5.2 Final Assessment Method for Unmonitored Sites

Tampa Bay Water and District staff continued discussion of the assessment of unmonitored sites during technical coordination meetings in 2019. Following the initial analysis of the unmonitored sites using the GIS application Select tool (as reported in Appendix 6.14), staff completed an analysis that characterized the error associated with each of the datasets used in the initial GIS analysis. Based on the error in the interpolated datasets used in analyzing unmonitored sites and the uncertainty contained in the assessment process, Tampa Bay Water staff developed a revised approach to assess the unmonitored sites in the final Recovery Assessment Plan report. Since there is little or no empirical data available for these sites and the data used to assess their condition are predominantly statistically-derived, Tampa Bay Water and the District agreed that the unmonitored sites should be assessed on a qualitative basis. Section 6.2.2 describes the two qualitative bins for the final assessment of unmonitored sites: a high degree or a low degree of certainty of wetland health. Tampa Bay Water and the District jointly determined that a qualitative assessment is the most appropriate way to address these sites given that these are unmonitored sites with no available monitoring data.

The revised and final method of assessing the relative degree of health for the unmonitored sites uses many of the same datasets as in the preliminary analysis but the information is evaluated in a different manner. The method is based on a weight-of-evidence approach rather than the stepwise, if/then logic tree that was used in the GIS application Select tool during the preliminary assessment. There were six criteria used in the final assessment of unmonitored sites for the Recovery Assessment:

- Normal Pool Offset (2008-2014)
- Median Depth to Upper Floridan Aquifer (2008-2014)
- Maximum of the median Surficial Aquifer Drawdown (2008-2014)
- Upper Floridan Aquifer Potentiometric Surface (2008-2014) compared to Predevelopment Potentiometric Surface
- Normal Pool Offset Change (2008-2014 minus 1996-2002)
- Wetland Health Assessment score (actual or interpolated for 2016)

Additional information about these six datasets and the screening threshold criteria for each are presented in Section 10.3 and Appendix 10.1. Tampa Bay Water presented the final bin categories and thresholds for assessment of unmonitored sites at the June 13, 2019 technical coordination meeting with the District. Based on the proposal and feedback from the District staff at the meeting, Tampa Bay Water finalized the revised assessment method for unmonitored sites. If an unmonitored site passes the screening threshold for two or more of the six criteria, that site is assigned to the bin of "high degree of certainty of wetland health". If an unmonitored site passes one or no screening threshold, that site is assigned to the bin of "low degree of certainty of wetland health". The results of the final assessment for unmonitored sites are presented in Chapter 10 of this report but it is important to note that the results of this qualitative assessment of wetland health match well with the results of recovery at monitored sites within the wellfields. This validation of the final unmonitored site assessment method is consistent as many of the spatial datasets used to assess unmonitored sites are based on data collected from monitored wetlands in the same vicinity as the unmonitored wetlands.

6.6 Weight of Evidence Approach to Recovery Assessment

Environmental analyses using a single type of data or a single approach rarely produce results with a high degree of confidence when looking for a cause-and-effect relationship. This is due to uncertainty in the collected and available data, multiple influencing factors, assumptions included in the analyses, and the error and uncertainty inherent in all analytical methods. Water level, rainfall, and pumping data provide the highest degree of certainty due to the lack of subjectivity in the recording of this data; the collection of each data value can be repeated at the time of collection and is not subject to professional opinion or interpretation. Other types of data used in the Recovery Assessment Plan include Wetland Assessment Procedure and Wetland Health Assessment data, both of which provide valuable information about the health of a wetland system at a point in time but are subject to professional opinion as the data are collected. The influence of professional opinion is minimized to the extent possible through training and guidance documents for how the data are to be collected; however, uncertainty in these types of data remain.

The results of environmental analyses also contain uncertainty due to the multiple factors that influence natural systems. Water levels in wetlands and lakes influence the health (and the assessment of recovery) of these systems but other factors can also affect wetland health such as runoff water quality, an increase in nutrients, and the introduction of non-wetland or exotic plant species by humans or animals. There are many potential influences on wetland and lake water levels such as changes in drawdown related to groundwater pumping, changes in rainfall and other climate variables, geologic forces (sinkholes), and anthropogenic effects. The time series of historical aerial photographs presented in Chapter 12 of this report clearly demonstrate the significant changes that humans have created on the landscape of the northern Tampa Bay area. Much of Florida was ditched and drained to create land usable for cattle and crops in the past and the influence of these drainage alterations continue to effect wetland and lake water levels. As the population of the Tampa Bay area has continued to grow, extensive stormwater management systems have been constructed to sculpt the landscape and prevent the flooding of houses, businesses, and roadways. All of these changes to the landscape have affected water levels. However, due to the complexity of these systems and the lack of specific monitoring data, it is difficult or impossible to accurately discern the level of water level change that should be attributed to these influences.

Many of the factors influencing the change in water levels are interrelated and examining cause-and-effect relationships becomes difficult when the variables are correlated. Data collected through Tampa Bay Water and the District's environmental monitoring programs has demonstrated the significant time lag between hydrologic improvement and ecological response or the improvement of wetland condition based on vegetation. Many of the transitional or upland plant species recorded through Wetland Assessment Plan monitoring can become established within wetlands during periods of low or absent water levels but some of these plants and trees are adaptable to different inundation conditions. Since they do not readily die following the sustained increase in water level, the demonstration and evaluation of recovery based on the ecology is difficult.

Tampa Bay Water first developed a weight-of-evidence approach in the assessment of wetland recovery on the Starkey Wellfield; this was the first wellfield to be evaluated and it was used as a test case to develop a process of assessing recovery (Section 9.1). The application of this weight-of-evidence approach to the analyses in the Recovery Assessment Plan provides a comprehensive evaluation of wetland health and recovery. Chapters 8 and 9 detail how multiple lines of evidence were applied to assess the recovery of wetlands and lakes due to the reduction in pumping from the 11 northern wellfields. Instead of looking at one type of data or a single analyses, staff created assessment methods that used the wealth of data available from this area. This weight-of-evidence approach was essential in the evaluation of unmonitored sites where little or no direct data was available. The analyses for individual wetlands and lakes have accounted for rainfall variability, data uncertainty, and the inherent error and uncertainty present in all analyses. Multiples lines of evidence are brought together on a wellfield-scale in Chapter 12 as the demonstration of recovery is presented for each wellfield by combining the results of the monitored and unmonitored site assessments with historical aerial photography, a narrative of the history of the wellfield and surrounding area, and a discussion of all variables influencing the area wetlands and lakes.

6.7 Empirical Data Analysis

Tampa Bay Water completed the Candidate Sites Evaluation Study (CSES) under the original Consolidated Permit to predict which lakes and wetlands near the 11 wellfields would recover following the reduction in groundwater pumping to an average of 90 mgd. As described in the project reports and summarized in Section 3.13 of this report, the CSES was a predictive study. Since the pumping from the wellfields had not been reduced at that time, Tampa Bay Water did not have empirical data to analyze at the reduced pumping rate. Numerous conservative assumptions were built into the analyses to avoid under-predicting the impacts to wetlands. As a result of these predictive analysis and conservative assumptions, the number and distribution of wetlands and lakes that were not expected to fully recover were far greater than expected. Tampa Bay Water and the District anticipated that recovery would be greater than predicted and this has been the case as documented by the environmental monitoring programs and the results in this Recovery Assessment Plan. Tampa Bay Water believes that the greater degree of observed recovery is due to the ability to rotate pumping between the wellfields based on current environmental conditions using the Optimized Regional Operations Plan.

Special Condition No. 11 of the renewed Consolidated Permit requires Tampa Bay Water to assess environmental recovery that is attributable to the reduction in wellfield pumping to no more than an annual average of 90 mgd. The Recovery Assessment Plan was designed to focus on analysis of empirical data and not a predictive analysis of recovery like in the CSES. There is now a significant period of time with wellfield pumping below 90 mgd allowing staff to analyze actual water level data during two distinctly different pumping regimes. The water level data collected by Tampa Bay Water and the District is collected under rigorous standard operating procedures, subject to a thorough quality control review, and represents the actual hydrologic condition at that site at that moment in time. The data are collected at a sufficient frequency to characterize the changes in water levels at each site with a high degree of confidence. Given the uncertainty and variability in the collected ecological data and the time lag between hydrologic and ecologic improvement, the District and Tampa Bay Water agreed to focus the Recovery Assessment Plan on hydrologic (water levels) recovery and metrics.

Predictive analyses have been used to support our evaluations where appropriate. The Unit Response Matrix developed through the Integrated Northern Tampa Bay (INTB) model was used to create the Area of Investigation as described in Sections 3.14 and 5.3. This model has also provided predicted drawdown data in the surficial and Upper Floridan aquifers underneath study wetlands to better understand the relationship of water levels to reduced pumping. This supporting evidence is informative to these analyses but this is not the primary line of evidence in the Recovery Assessment Plan. The INTB is the best available model to simulate the local hydrologic system; however, models approximate the dynamics of a physical system and are constrained by data limitations and the understanding of hydrologic relationships. The empirical data is an accurate reflection of the actual physical system dynamics; the actual lake and wetlands water levels are the result of all influences and the underlying geology.

Focusing the Recovery Assessment evaluations on the empirical water level data from the identified lakes and wetlands provides the most direct assessment of environmental health and recovery due to reduction in pumping. This approach minimizes data error by focusing on the most reliable data type as the best predictor of recovery and minimizes the uncertainty associated with predictive analyses. By examining the actual water level and pumping data and combining these assessments with the more qualitative ecological data, lake/wetland conditions and site reviews, staff have determined whether or not an adverse impact still exists at any of the identified sites. The process used in assessing environmental recovery is further outlined in the following section.

6.8 Assessment of Environmental Recovery – General Process

Tampa Bay Water began assessing environmental recovery using the Starkey Wellfield as a test-case since the reduction in pumping at this wellfield was immediate and significant. Pumping from the Starkey Wellfield was reduced in December 2007 after completion of the West Pasco Transmission Main which allows regional water supplies to be delivered to the West Pasco and New Port Richey service areas. Since the annual average pumping rate immediately dropped from approximately 13 mgd to 5 mgd at the Starkey Wellfield and has not increased since the beginning of calendar year 2008, this was an ideal location to test and refine methods of wetland and lake recovery assessment. More information about the specific development of the weight-of-evidence approach at the Starkey Wellfield is contained in Section 9.1 of this report. The following section summarizes the general approach we have used for assessing recovery at all monitored and unmonitored lakes and wetlands.

6.8.1 Initial Screening Analyses

The Recovery Assessment Plan was formulated to evaluate the environmental recovery of wetlands and lakes that is attributable to the reduction in pumping from the Consolidated Permit wellfields. Rainfall is a primary driver of the water balance within a lake or wetland; higher rainfall leads to higher water levels and lower rainfall leads to lower water levels. This relationship is complicated by the effects of groundwater pumping that can increase the amount of water that leaks downward from a lake or wetland into the aquifer system. Since the Recovery Assessment Plan is supposed to assess the environmental recovery only due to the reduction in wellfield pumping, the Work Plan identified the need to develop assessment methods that account for rainfall variability. Assessment methods were needed that factor out changes in rainfall to the greatest degree possible.

The conceptual approach is to separate the wetland and lake water level data into two time periods, before and after the reduction in pumping at each wellfield. The pumping levels at the wellfields were reduced at different times depending on when each wellfield was connected to the regional supply system. The analysis for each wellfield used the pre-cutback and post-cutback time periods that are appropriate for that wellfield. Once the data were separated into these two time periods related to pumping rate, staff assessed the rainfall data at or near each wellfield to find periods of time within the pre-cutback and post-cutback periods where the average annual rainfall was approximately equal, and preferably close to the long-term average rainfall for the region. Multi-year time segments were chosen for both the pre-cutback and post-cutback periods of sufficient lengths to minimize the effects of both annual average rainfall and pumping fluctuations. The logic in this approach is that by comparing water levels for a wetland during a period of time with near-average rainfall and high pumping to water levels during a period of time with near-average rainfall and low pumping, any change in wetland water levels should be predominantly attributable to the reduction in wellfield pumping. By assessing two time periods with approximately equal long-term average rainfall, staff have isolated any change in wetland water levels to the effects of pumping.

Tampa Bay Water applied the weight-of-evidence approach for each monitored wetland by first analyzing the water level data at each wetland against the appropriate metric of health or recovery. If the wetland water level was above the metric in the selected post-pumping reduction (recent) period, the wetland was classified as “Recovered” or “Meets Metric” according to the Recovery Assessment Bins presented in Section 6.2. The wetland recovery metrics were developed to define thresholds above which sites were assumed to be without adverse impact. Therefore, if a wetland had median water levels in the post-pumping reduction period that were above the appropriate metric, that site was considered to be “Recovered” or healthy due to a lack of adverse hydrologic impact related to wellfield pumping. In limited cases, wetlands that met their recovery metric were classified as “Never Impacted” if there was historic evidence to support this conclusion.

If a wetland did not meet its recovery metric or there were questions about the condition of the wetland, staff then looked at other data to make an assessment of the wetland condition and determined whether conditions in the wetland were improving in the post-cutback period. The data evaluated included vegetation (WAP) data, review of period-of-record hydrographs, rainfall data from the nearest gage, water level data from the surficial and Upper Floridan aquifers near the wetland, historical aerial photography, review of the normal pool elevation to see if it is appropriate, and a field inspection of the site in some cases. As part of this additional evaluation, the percent exceedance curves from the wetland data were examined to determine if an improvement in water levels could be determined. Figure 6.1 shows this comparison for one of the mesic-associated wetlands at the Starkey Wellfield. This wetland has a recovery metric elevation (SML – red dashed line) that is 1.8 feet below the normal pool (NP) elevation for the wetland as shown by the light blue dashed line. This SML is used as the recovery metric for this wetland. The solid blue, yellow, and red lines show the wetland water levels for three time periods as the percent of time that the water levels exceed a certain elevation (percent exceedance curves). The blue line shows that the median (50th percentile) water level in the post-cutback period of 2008 – 2014 was below the SML or recovery metric so this wetland was not classified as "Recovered". However, when staff compared the median water level for the 2008 – 2014 period versus two time periods of average rainfall and higher wellfield pumping (red and yellow lines), a water level increase of approximately three feet is apparent from this graph. Since the rainfall variable is held constant between the time periods (average rainfall during all three periods), the conclusion is that water levels have increased in this wetland due to the reduction in wellfield pumping. This wetland was given a preliminary classification of "Improved, Not Fully Recovered" since the median water level in the post-cutback period does not meet its recovery metric but the water levels have substantially improved in the post-cutback period. Based on this additional analyses and other data, staff determined where the weight of the evidence fell and assigned a recovery assessment bin for each wetland based on our reasoned evaluation.

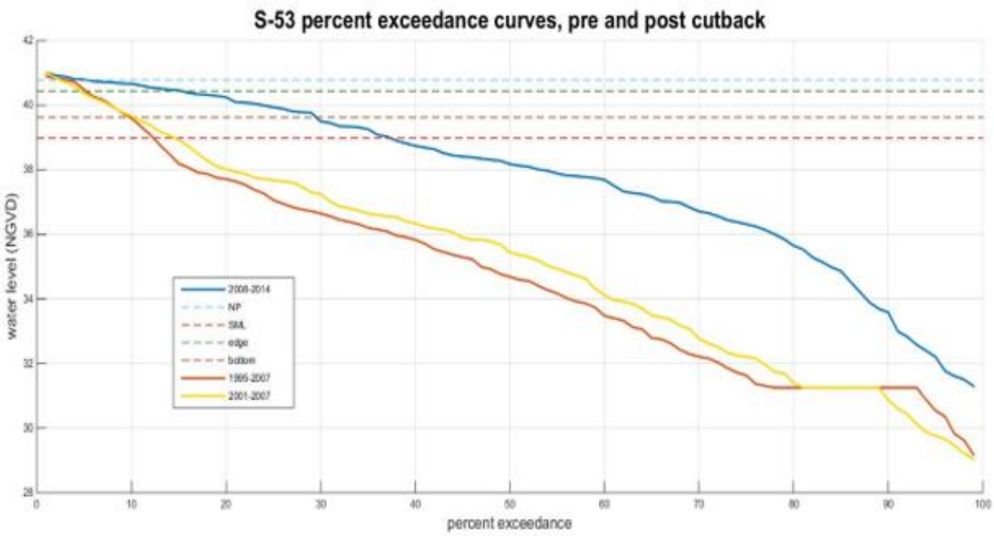

Figure 6.1: Percent Exceedance Curve for Wetland STK S-053

The specific information considered for each monitored wetland was presented to the District in technical coordination meetings before the preparation of wellfield-specific assessment reports summarizing the analyses and conclusions. These reports also contained the preliminary recovery bins for each wetland and the reports were submitted to the District for review, comment, and approval. The preliminary monitored wetland assessment reports are included in Chapter 9 of this report along with the District's comments and questions. The District questions and comments about wetland normal pool elevations have been addressed through the updated normal pool investigations performed by the District and Tampa Bay Water consultants; staff used the most up-to-date data in the preparation of this final Recovery Assessment Plan report. District questions about the preliminary bins assigned to wetlands and lakes were considered in the final analyses for each site and final lake and wetland site bins are presented in this report. Questions pertaining to the development of recovery metrics and assessment processes were addressed in the revision of metrics, such as the final metric for isolated wetlands in a xeric landscape setting and the assessment process for unmonitored sites; these updated metrics and processes are discussed in detail in this report and the attached technical reports. The responses to other District questions on the individual preliminary assessment reports are included in multiple sections of this final Recovery Assessment Plan report.

The same approach of assessing water levels in the post-cutback period was also applied to the assessment of lakes. Additional analyses were performed on the lake water level data to factor out the influence of rainfall and determine the recovery that is due to the reduction in wellfield pumping. The District-established Minimum Levels or guidance levels were used as the recovery metrics for lakes, where available and if the median lake level in the selected post-pumping reduction period met or exceeded the established level, those lakes were designated as “Recovered”. These additional factors and data assessments for monitored lakes are described in Chapter 8 of this report. The unmonitored sites have no monitoring data so staff was unable to explicitly apply this approach to the assessment of these lakes and wetlands; however, as described later in Section 6.5 and Chapter 10 this report, the data used to assess unmonitored sites includes a comparison of pre-cutback and post-cutback periods and considers the recovery status of nearby wetlands and lakes. By inference and spatial interpolation, the assessment of monitored sites using this approach has been used to inform the assessment of the unmonitored sites.

6.8.2 Site-Specific Inspections and Periodic Data Updates

The visual assessment of wetland health and recovery has been an important part of the Recovery Assessment Plan process. Individual sites were visited by Tampa Bay Water and District staff during the creation of the wetland recovery metrics and as individual sites were being assessed. For selected sites, Tampa Bay Water or the District evaluated the appropriateness of existing normal pool elevations and re-set elevations as appropriate. Outflow elevations from wetlands and the effects of ditching and stormwater management systems were evaluated in the field for some sites during or following the preliminary assessments. The additional data collected during these site visits were helpful in assigning a recovery bin to a wetland or correcting an incorrect preliminary bin assignment. All pertinent information has been summarized in technical reports or memos, shared between the agencies, and any new data or revisions have been included in the site or wellfield-specific assessment reports submitted to the District.

Tampa Bay Water has tracked the recovery assessment bin of each monitored wetland and lake in an Access database and in the ArcGIS online application developed for the Recovery Assessment Plan which are discussed in Chapter 7. Tampa Bay Water updated the screening assessments for lakes and isolated wetlands using data through Water Year 2017 and again with updated data through Water Year 2018. These update reports are discussed in Chapters 8 and 9 and were used to update the preliminary bin assignments as appropriate. The preliminary recovery bin assignments for each monitored lake and wetland and all unmonitored sites were presented in the Recovery Assessment Plan Preliminary Report of Findings (Tampa Bay Water, 2018b) and reflected the most up-to-date information at that time.

6.8.3 Final Determination of Recovery

Tampa Bay Water refined the recovery metric for isolated xeric wetlands and the processes for assessing unmonitored sites following the submittal of the Preliminary Report of Findings based on comments from the District. Staff performed additional wetland reviews in the field with District staff for isolated xeric wetlands referencing the new recovery metric, sites of special interest to either agency, and most of the wetlands and lakes that were assigned a preliminary bin of “Improved, Not Fully Recovered”. These “improved” sites were evaluated to determine if evidence of adverse impact was present at any of these wetlands and if the bin of “Improved” was appropriate. Tampa Bay Water also updated the hydrologic screening analyses for all lakes, isolated, and connected wetlands with data through the end of Water Year 2019 (September 30, 2019). This was the cut-off date for the data analyses in the final Recovery Assessment report based on agreement with the District staff. Since the current health of many wetlands was assessed in the field to verify our assessment results, it was important to continue the data assessment through the end of Water Year 2019. The wetland water level data was analyzed for the period of Water Years 2008 through 2019 to match the current period and include a time period that contained variable rainfall. The results of the additional site inspections and updated data analyses are included in the wellfield-specific analyses of wetlands and lakes in Chapters 8 and 9. These chapters present the final assessment of recovery for each of the monitored wetlands and lakes included in the Recovery Assessment Plan.

The qualitative assessment of health for the unmonitored sites is combined with the final assessments for monitored wetlands and lakes on a wellfield-scale in Chapter 12. This chapter contains a section for each wellfield that describes any unique hydrologic and ecologic settings or features, a review of historic land use changes within the drainage basin, a discussion of pumping from the wellfield, rainfall conditions, and the results from the individual Recovery Assessment analyses to examine recovery for each wellfield. This is a critical step since individual wetlands do not exist in a vacuum and all factors that influence the health of a collection of wetlands must be fully examined as a whole. Focusing on each individual wetland and neglecting to consider how the entire system works together can lead to erroneous conclusions. The wellfield-scale discussions are pulled together in Chapter 13 to describe recovery on a regional scale and what the documented environmental recovery means for the Northern Tampa Bay area.

6.9 Baseline Protocol

The renewed Consolidated Permit (2011) requires Tampa Bay Water to develop and implement the Recovery Assessment Plan and to provide options to address any remaining adverse impacts at the time of permit renewal in 2020. The requirement to address remaining adverse impacts presented a challenging question – how to determine what mitigation is required when an impact occurred in the distant past and conditions have since improved. To make matters more complex, the older wellfields were developed prior to the existence of any regulations and the early regulations and permits did not prohibit on-site adverse environmental impacts. Typical wetland mitigation is associated with new impacts; the existing condition of a wetland can be used as a baseline condition against which to compare a future case of wetland impact, yielding a quantifiable difference which can be mitigated. For lakes and wetlands located on or near the Consolidated Permit wellfields, conditions are now much better than when the cumulative pumping from the wellfields was much higher. A process was needed to evaluate the amount of recovery due to the reduction in pumping along with a baseline period to use in assessing mitigation need.

The Recovery Assessment Work Plan identified two regulatory issues associated with this question. The first issue was the need to develop a temporal baseline and process that would consider the timing of historic impacts to wetlands and lakes and how to account for historical/structural impacts in the evaluation of wetland condition in the present day. The second issue was the need to define a baseline condition on which to make an assessment of change in wetland function or health. Through discussions with District staff in 2015 and 2016, it was agreed to assess recovery of wetlands based on the wetland type that exists today, incorporating any historic structural changes to a wetland such as sinkholes, subsurface collapse, and severe soil oxidation/loss. Staff also committed to develop a baseline time period to use in the assessment of recovery and quantify the amount of wetland mitigation necessary at the time of permit renewal.

Tampa Bay Water developed a baseline protocol based on our discussions with District staff. Staffs agreed that the years 1974 and 1989 were key to the discussion of baseline. Prior to 1974, there were no permitting rules or criteria in effect to regulate water use or environmental impacts. Since there were no rules governing water use prior to 1974, a person or entity could pump water from wells on their property and impacts to lakes or wetlands occurred with sustained high pumping levels. There was no regulatory recourse against such environmental impacts although there was significant public opposition in areas such as the Cosme-Odessa Wellfield. While wellfield pumping was not specifically used to create lower water levels in lakes, wetlands, and the surficial aquifer, development encroached on the borders of the wellfields, taking advantage of the sustained low water level conditions (see Sections 3.2 and 3.5 for a summary of the development of lands surrounding older wellfields such as the South Pasco and Cypress Creek Wellfields).

The State rules governing water use adopted in 1974 allowed adverse impacts to wetlands and lakes on property owned by the permittee but adverse impacts were not allowed on adjacent properties (see Section 3.4 for additional information on the initiation of regulations and permits). These rules continued until 1989 when the State and District made fundamental changes to the rules governing the use of water (see Section 3.7). Following the permitting rule changes in 1989, adverse impacts to wetlands and lakes were prohibited, including on property owned or controlled by permittees. By this time, adverse impacts to lakes and wetlands had already been documented at multiple wellfields, both on and off the wellfield properties. During discussions with the District, the year in which pumping began at each wellfield was determined to be important to the development of a baseline protocol, as was the year that pumping increased to a level where environmental impacts related to pumping was possible. For example, pumping began from one or two wells at what became the Cypress Bridge Wellfield began in the early 1980’s but the wellfield was not fully developed and pumped at quantities greater than 2 mgd until 1996. Section 3.9.1 of this report contains graphs of annual pumping from each wellfield and the onset of higher pumping at each wellfield is easily identifiable in these graphs.

The baseline protocol presents a systematic framework and approach to the evaluation of wetlands and lakes under the Recovery Assessment Plan. The protocol defines the process followed to assess the current health of wetlands and lakes, considering the changes in water use regulation and impacts that were allowed under past regulatory regimes. The protocol generally describes how individual sites are evaluated and assigned to categories or bins as described in Section 6.2. Structural alterations to wetlands and lakes (land subsidence, sinkholes, or oxidation of the organic matter in the wetland/lake basin) are to be considered in the evaluation of recovery if these changes occurred prior to 1974 for the older wellfields or prior to 1989 for on-site wetlands and lakes for wellfields where the initiation of high pumping occurred prior to this date. If a wetland or lake was structurally altered due to past pumping levels and that structural alteration prevents the wetland from recovering to its applicable metric of health today, that alteration is considered in the evaluation of recovery if it occurred prior to one of the two baseline years. This assessment protocol is more fully described in Section 1 of the Baseline Protocol document which is attached as Appendix 6.15.

After the final assessment of recovery for each monitored lake and wetland, the sites in the recovery bin of "Not Fully Recovered, Continuing Wellfield Impact" were evaluated to determine if there are any remaining adverse impacts that must be addressed. As this process was developed, staff expected that a number of wetlands would be in the recovery bin of "Improved" after the final assessment of recovery at each site. These are the wetlands that have demonstrated a significant improvement in water levels following the reduction in wellfield pumping although they have not quite recovered to their respective recovery metrics. Tampa Bay Water and District staff agreed that the "Improved" lakes and wetlands would not be considered for mitigation, only those sites with a final bin of "Not Fully Recovered, Continuing Wellfield Impact" (see December 15, 2017 submittal of the revised Recovery Assessment Bins and the District's January 5, 2018 response – Appendix 6.2; also Item 1.f. of the October 26, 2016 submittal of the Baseline Protocol and the District's December 21, 2016 response – Appendix 6.15). These sites are also expected to show ecological functional improvement as compared to the appropriate baseline period (higher water levels lead to improved conditions). Since conditions are better as compared to their condition during the baseline period, no mitigation will be required prior to renewal of the Consolidated Permit in 2020. The steps of the Mitigation Evaluation process, including how to define the appropriate baseline period for each wellfield, are described in Section 2 of the Baseline Protocol (Appendix 6.15).

Mitigation plans will be developed for all "Not Fully Recovered, Continuing Wellfield Impact" wetlands and lakes at the end of the Recovery Assessment Plan if those sites have a current wetland functional condition that is worse than during the applicable baseline period. Tampa Bay Water has developed a mitigation method based on the State Uniform Mitigation Assessment Method (UMAM). The mitigation assessment method developed for use in the Recovery Assessment Plan is called the Functional Assessment of Wetland Recovery (FAWR). This is the method that will be used to compare current wetland conditions to the appropriate baseline period and calculate the amount of wetland mitigation for which Tampa Bay Water is responsible and is described in Chapter 15. To allow all remaining adverse impacts to be resolved under the existing permit and the renewed Consolidated Permit to be issued under the Water Use Permitting Rules of the District (Chapter 40D-2, F.A.C.), Tampa Bay Water will submit specific proposals to mitigate each of the wetlands identified as continuing adverse impact to the District for review and approval before the current Consolidated Permit expires on January 25, 2021.

6.10 Assessment Process Diagrams

The steps outlined in the assessment of lakes and wetlands and the application of the baseline protocol are complex and Tampa Bay Water staff developed process diagrams that show the logical progression of decisions and actions outlined in the baseline protocol. Figure 6.2 presents the general process for assessing monitored wetlands and lakes and assigning each site to the appropriate recovery bin. The annual or periodic reassessment processes are also shown that either confirm the assigned recovery bin for each site or the reasons why a recovery assessment bin designation should change. In this process diagram, there are multiple points where additional information or study is needed in order to assign a site to a recovery bin. Figure 6.3 shows the information considered by staff and the decisions made in order to perform site-specific assessments of recovery for wetlands and lakes, as necessary. This general process allowed Tampa Bay Water to systematically review all applicable site data and conditions and assign each site to the appropriate bin following the detailed assessment. At the end of the process, those sites that remain in the recovery bin of "Not Fully Recovered, Continuing Impact" are subject to a site-specific mitigation evaluation as outlined in Figure 6.4. This final process will yield an answer for each site: no mitigation is required under the current permit or mitigation is required and quantified for subsequent action.

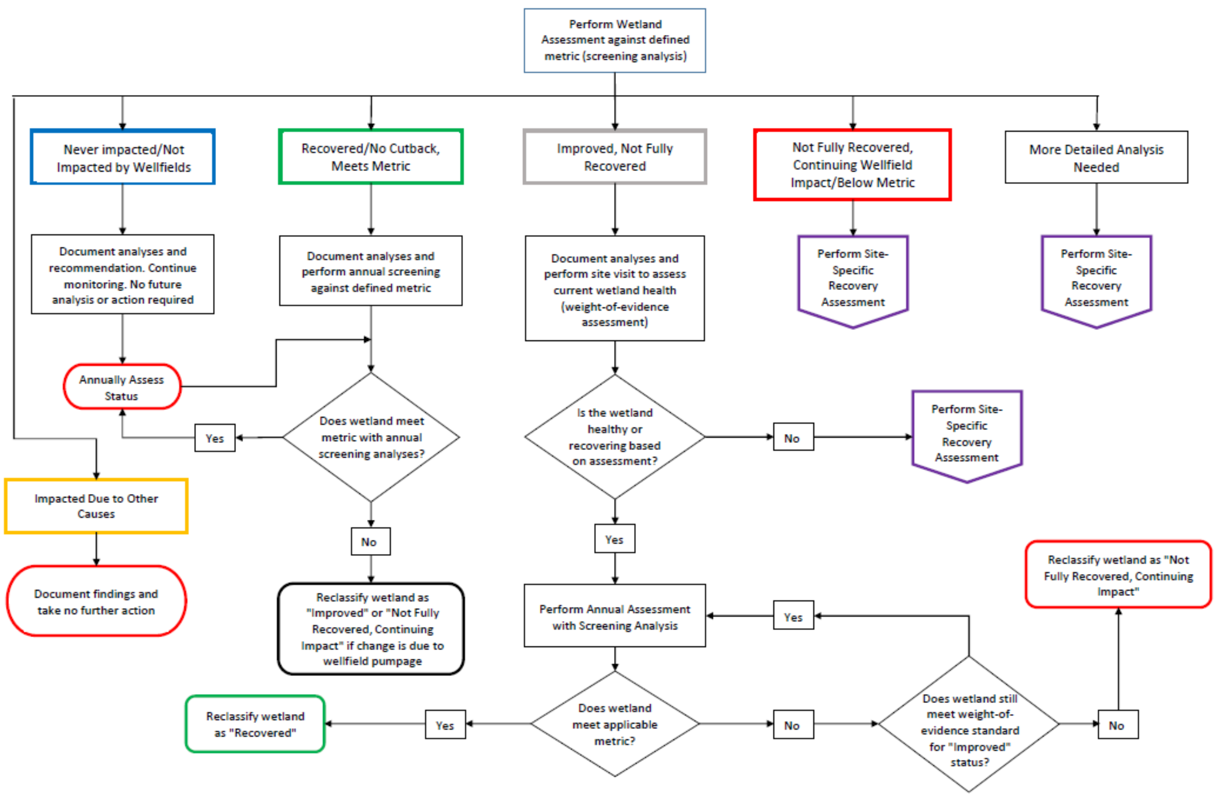

Figure 6.2: Decision flow chart for monitored Recovery Assessment lakes and wetlands

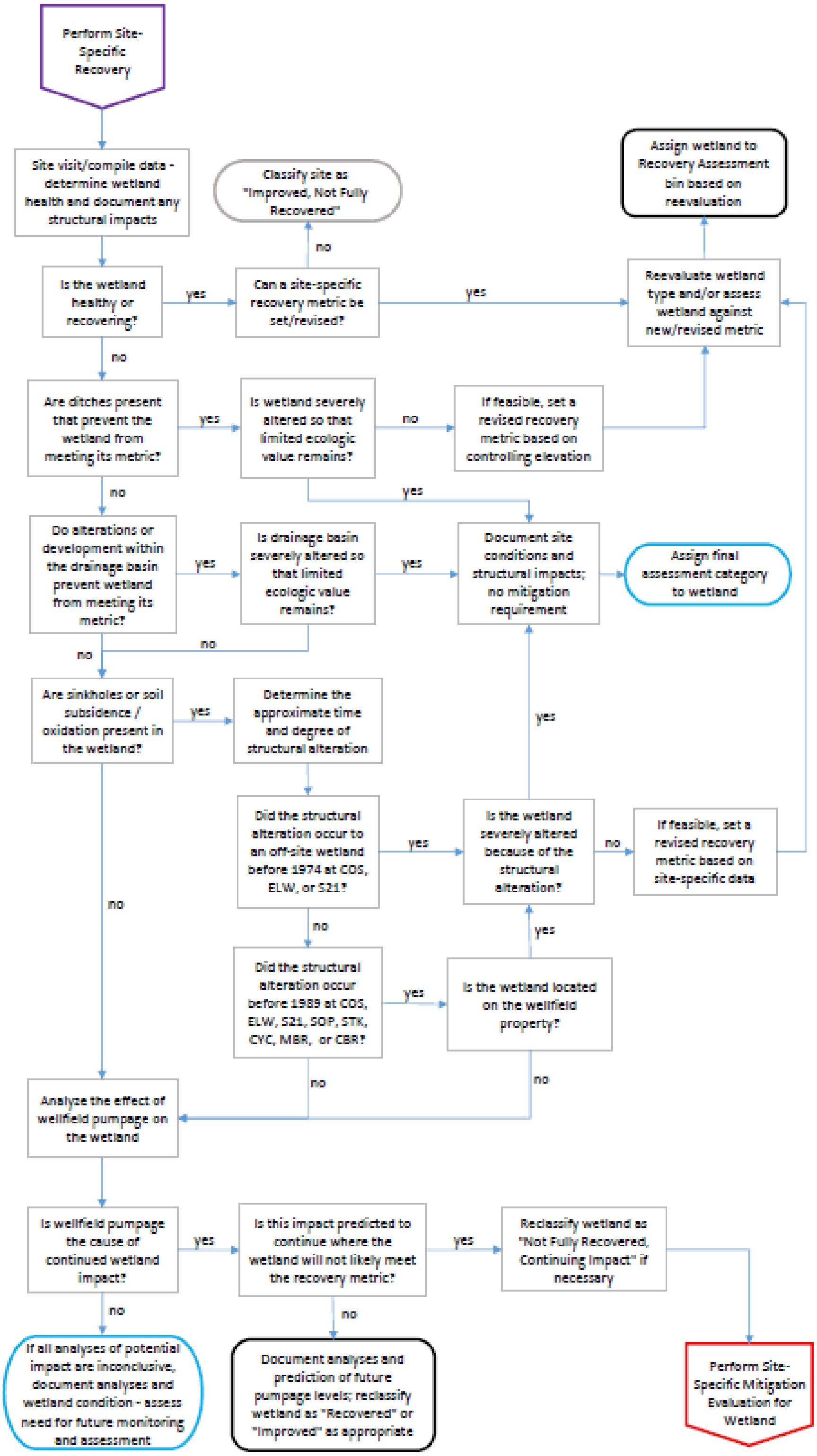

Figure 6.3: Decision flow chart for performing a site-specific assessment

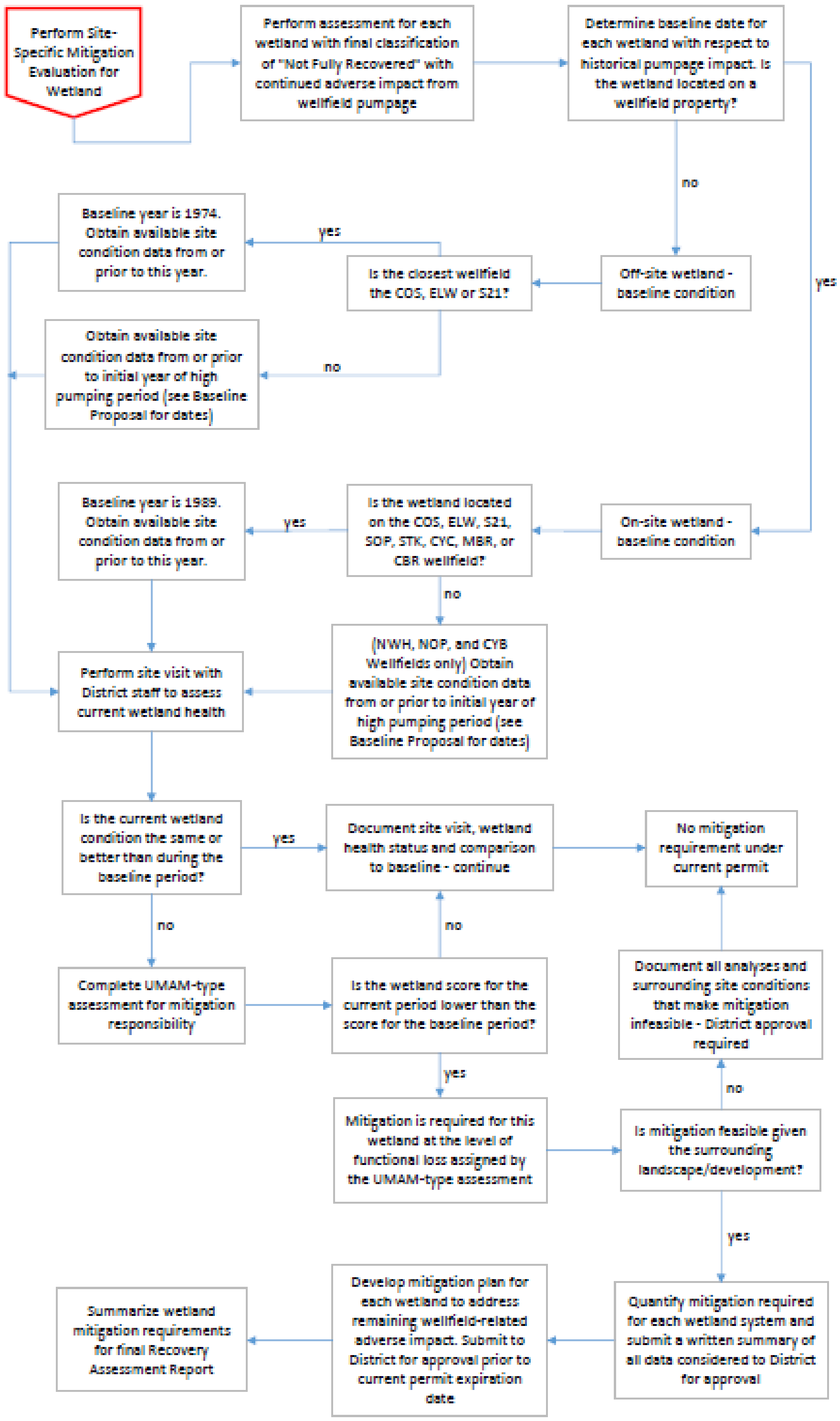

Figure 6.4: Decision flow chart for performing a site-specific mitigation evaluation

7: Recovery Assessment Plan Tools

7. Recovery Assessment Plan Tools

Tampa Bay Water identified the need to spatially display and analyze extensive amounts of data very early in the development process of the Recovery Assessment Plan. Staff began to assemble data for all the lakes and wetlands assessed through this work and realized that a robust database would be necessary to keep track of the data, changes to site characteristics, and the recovery assessment status of each site. The goal was to develop tools that would not only aid in the completion of the Recovery Assessment Plan but could be used to continue to track the recovery or health of these lakes and wetlands in the future. The goal was also to develop tools that could be adaptable for other environmental monitoring programs of the agency. The two primary data management and analysis tools developed for this project, the Recovery Assessment Database and the Recovery Assessment GIS Application, are described in the following sections.

7.1 Recovery Assessment Database

The Recovery Assessment Database is a cloud-based relational database that stores information on site-specific attributes of monitored wetlands and lakes in the Northern Tampa Bay area. While the data are stored, queried and retrieved using SQL Server, the user interface is a Microsoft Access front-end. All of the lakes on the final Recovery Assessment lake list (Section 5.4.2 and Table 5.1) and wetlands on the final Recovery Assessment Wetland List (Section 5.4.3 and Table 5.2) are included in the Recovery Assessment Database.

7.1.1 Database Development

Tampa Bay Water staff initiated work to develop a Recovery Assessment Database in 2015. A Microsoft Access database designed to store relational data for the Recovery Assessment Plan and the Environmental Management Plan (EMP) was initially developed in-house. Due to the complexity of the data relationships and the need to accommodate multiple users and produce reports, it was decided to out-source the completion of the Recovery Assessment Database. Tampa Bay Water retained Applied Ecology, Inc. to begin work on the Recovery Assessment database in 2016. In 2019, Applied Ecology, Inc. began work to integrate the Recovery Assessment Database and the Recovery Assessment GIS Application discussed in Section 7.2. The database and GIS application share numerous fields and integration is necessary for data integrity.

7.1.2 Contents and Purpose

The Recovery Assessment Database contains information on various attributes of the wetlands and lakes covered by the Consolidated Permit Recovery Assessment Plan, including recovery status, wetland type, monitoring status, surrounding soil type (mesic or xeric), minimum level (if applicable) and historical normal pool elevation. Recovery Assessment technical reports, District comments and Tampa Bay Water responses are also tracked. The database contains a query function that allows users to obtain related data from various tables and filter records by select attributes. Automatically generated reports, which cover wetland and lake recovery status, District comments and other topics, are available and can be downloaded in either PDF or Excel format.

The Recovery Assessment Database has been used to track progress of recovery analyses, reporting and District review. It can generate tables on recovery assessment data and perform queries specific to wellfield, recovery status, wetland type or any of the other fields included in the database. The Recovery Assessment Database serves as the repository for information on the Recovery Analysis process and decisions and can be updated throughout the Consolidated Permit permitting process. The EMP feature of the database was retained throughout the development history and the Recovery Assessment Database can be used during the next permit term to document the results of semi-annual analyses, Wellfield Influence Tests and other aspects of wellfield monitoring and reporting.

7.2 Recovery Assessment GIS Application

Geospatial analysis using a Geographic Information System, or GIS, has been instrumental in the ability to assess the recovery of wetlands and lakes in the Northern Tampa Bay area. During the process of developing the Recovery Assessment Work Plan, plan implementation and analysis of lakes and wetlands, sharing this information with the Southwest Florida Water Management District (District) has been a vital part of this effort. The use of GIS has greatly enhanced the ability to communicate the research and our results with the District.

7.2.1 Application Development

Tampa Bay Water began discussing the idea of developing a GIS application for the Recovery Assessment Plan at our October 2012 technical coordination meeting with the District. The agencies continued this discussion during subsequent meetings and Tampa Bay Water (Information Technology staff) developed a conceptual prototype GIS application for review. Staff presented this prototype to District staff in March 2014 and it was agreed this would be an extremely useful tool for our research. Tampa Bay Water retained the services of Greenman-Pedersen, Inc. and Applied Ecology, Inc. in 2014 to begin the development of a full-scale GIS application for use in the Recovery Assessment Plan. The consultant team consolidated data for each of the Recovery Assessment sites and developed the Recovery Assessment Geodatabase (RAGIS) and corresponding RA Feature application (RAGIS App) in 2015 and 2016 to provide access to much of the spatial data and results of these analyses in one location. This tool was created as an ArcGIS Online application and allowed District staff to review the Recovery Assessment work as it progressed and complete their own analyses of the data.

7.2.2 Data Layers

The RAGIS App contains the following data layers:

1. Elevation Marker
2. Five-Year Wetland Health Assessment (WHA) Site
3. Surface Water Gauge

4. Groundwater Well
5. Production Well
6. Rainfall Gauge
7. Stream Gauge
8. Wetland Assessment Procedure (WAP) Transect
9. Drawdown (2 ft. Surficial (SAS) drawdown boundary to be used as the Area of Investigation (AOI)) (Tampa Bay Water, 2017b)
10. Monitored Lake (includes any lake in a monitoring program, not solely for Recovery Assessment)
11. Monitored Wetland (includes any wetland in a monitoring program, not solely for Recovery Assessment)
12. Lake (any water bodies classified as lake according to the Florida Land Use, Cover, and Forms Classification System, or FLUCCS)
13. Wetland (any water bodies classified as any type of wetland according to FLUCCS)

There are three tables of data from the previous three WHAs, the Candidate Sites Evaluation Study (CSES), and the Phase 1 Mitigation Plan Update. There is a layer of Recovery Assessment Soils where wetland types are classified according to the percentages of mesic or xeric-related soil types. Lastly, there is a layer of historic aerial imagery from 1938 through 2018 which can be accessed using the time slider feature.

Wetlands and lakes were denoted if they have been analyzed through the Wetland Assessment Procedure (WAP), Five-Year Wetland Health Assessments (WHA), CSES assessments, the District Minimum Flows and Levels (MFL) program or are augmented (Figure 7.1). Sites are labeled based on the Wetland and Lake IDs developed for the Recovery Assessment Plan, but the databases provide Tampa Bay Water and the District monitoring site/device IDs to connect to data outside of this tool. Time Series ID, Period of Record, Recovery Assessment Wetland Type, degree of connectivity, current Recovery Assessment classification, normal pool elevation, MFL data, percent xeric soils, agency or agencies responsible for current and historic monitoring and WAP data collection are also linked to each site (Figure 7.2).

WetlandID	TBWWetlandID	Wellfield	TBWName	SWFWMDName	MFL	CurrentWAP	CSESSite	AugmentedSite	FiveYrSite
202	6122	Cypress Creek	W21N	Cypress Creek North of Structure	No	None	No	Yes	No
201	3787	Cypress Creek	W20		No	TBW	Yes	No	No
200	3786	Cypress Creek	W19	W-19	No	TBW	Yes	No	No
199	3785	Cypress Creek	W17	CC W-17 Sentry Wet'l.	Yes	TBW/WMD	Yes	No	Yes
198	3784	Cypress Creek	W16	CCWF "D"	No	WMD	Yes	No	Yes
197	6121	Cypress Creek	W14	CCS-2	No	None	No	No	Yes
196	3783	Cypress Creek	W12	CC W-12 Sentry Wet'l.	Yes	TBW/WMD	Yes	No	Yes
195	3782	Cypress Creek	W11	CC W-11	Yes	TBW/WMD	Yes	No	Yes
194	3781	Cypress Creek	W10		No	TBW	No	No	Yes
193	6119	Cypress Creek	W09		No	TBW	Yes	No	Yes
192	6118	Cypress Creek	W06/ W07/ W08		No	None	No	No	Yes
191	6115	Cypress Creek	W05	CCWF "A"	No	TBW/WMD	Yes	Yes	Yes
190	3780	Cypress Creek	W04	CCWF "E"	No	WMD	Yes	No	Yes
189	3779	Cypress Creek	W03	CCWF W-3 Marsh	No	TBW/WMD	Yes	Yes	Yes
187	6113	Cypress Creek	W01		No	None	No	No	No
490	5472	J.B. Starkey	T-10		No	None	No	No	No
489	5471	J.B. Starkey	T-09		Yes	TBW	No	No	Yes

Figure 7.1: Example of some monitoring data included in the RAGIS, as shown in the Monitored Wetland Database. This includes the source of current WAP data, MFL sites, CSES, Augmented, or Five-Year Wetland Health Assessment Sites

WetlandID	TBWWetlandID	CompositeTSID	Wellfield	TBWName	SWFWMDName	RAType	HydroConnection	NPElevNGVD29	MFL	RAXericYN	RAXericPer300	HistoricMonitoredBy	CurrentMonitoredBy
482	5487	3294	J.B. Starkey	SC-71		Isolated Cypress	Isolated	39.10	No	No	0.02	TBW	TBW
481	5486	3293	J.B. Starkey	SC-70		Isolated Cypress	Isolated	35.67	No	No	0.12	TBW	None
480	5485	3292	J.B. Starkey	SC-69		Other	N/A	41.10	No	No		TBW	None
479	5484	3291	J.B. Starkey	SC-68		Isolated Cypress	Isolated	36.54	No	Yes	0.30	TBW	TBW
478	5483	3290	J.B. Starkey	SC-67		Isolated Cypress	Isolated	34.20	No	No	0.15	TBW	TBW
477	5482	3289	J.B. Starkey	SC-62		Other	N/A	49.40	No	No		TBW	None
476	5481	3288	J.B. Starkey	SC-59	STK-SC-59, SC-59	Isolated Cypress	Isolated	19.10	No	Yes	0.33	TBW	None
475	5480	3287	J.B. Starkey	SC-58		Isolated Cypress	Isolated	40.00	No	Yes	0.45	TBW	TBW
474	5478		J.B. Starkey	SC-46		Other	N/A		No	No		TBW	None
114	4966	2966	Cosme-Odessa	SC332717		Isolated Cypress	Isolated	31.80	No	Yes	0.49	TBW	TBW
473	5477	3286	J.B. Starkey	SC-33		Isolated Marsh	Isolated		No	Yes	1.00	TBW	None
471	5475	3284	J.B. Starkey	SC-30		Isolated Cypress	Isolated	41.60	No	Yes	0.56	TBW	TBW
113	4963	2975	Cosme-Odessa	SC272717	Cosme WF Wetland	Isolated Cypress	Isolated	41.30	Yes	Yes	0.34	TBW/WMD	WMD

Figure 7.2: Example of some monitored site data included in the RAGIS, as shown in the Monitored Wetland Database. This includes the RA Type, Degree of site Connection, the Normal Pool, whether Xeric or and MFL site, and the current and historical monitoring agency

7.2.3 Tools and Applications

The RAGIS App is equipped with several tools which allow for analysis without the need to create separate maps or data pulls, which is especially helpful for those unfamiliar with these processes in ArcGIS. The app was developed with several "Quick Access" queries (Figure 7.3) which include selecting monitored wetlands and lakes based on Recovery Assessment Type, Recovery Assessment Status, MFL, WAP, CSES, WHA, and those within the Area of Investigation.

Figure 7.3: Available pre-designed queries within the RAGIS Application

Area summary tools count the number of monitored lakes or wetlands in the current map extent (Figure 7.4), and the Info Summary tool provides that data for groundwater wells, elevation markers, surface water gauges, and stream and rainfall gauges (Figure 7.5). The NearMe tool calculates the number of surface water gauges, groundwater wells, production wells, stream gauges, and monitored wetlands within a set distance of a selected location (Figure 7.6). More involved analyses can also be performed, including locating individual features, creating buffers, extracting data, interpolating between data, and summarizing data within or near a selected location (Figure 7.7). A comment table and the draw tool allow users to highlight and comment on attributes, creating a way to flag and fix errors as data continue to be added and updated after the completion of the Recovery Assessment Plan.

Figure 7.4: Example of the Monitored Wetland RA Status Summary tool, which total the number of sites in the viewing area.

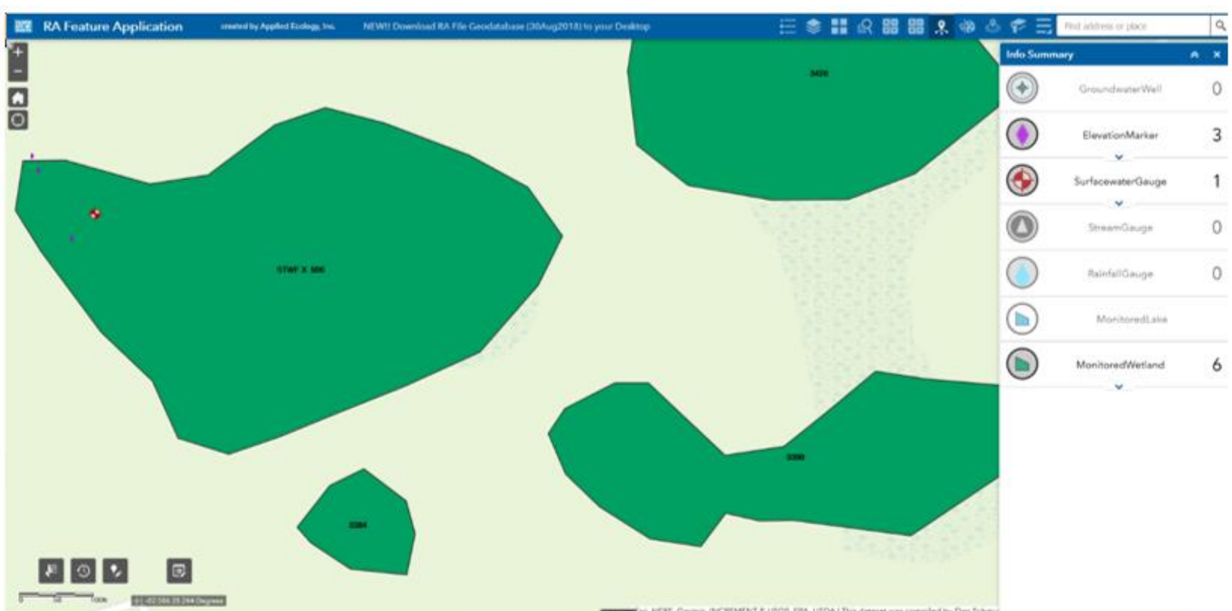

Figure 7.5: Image of the same area as in Figure 7.4 but using the Info Summary Tool to characterize the number of various monitoring sites and devices in the viewing area (which includes behind the info summary table).

Figure 7.6: Example Using the NearMe Tool in the RAGIS Application, Calculating the Number of Gages and Wells Around a Wetland Site on J.B. Starkey Wellfield.

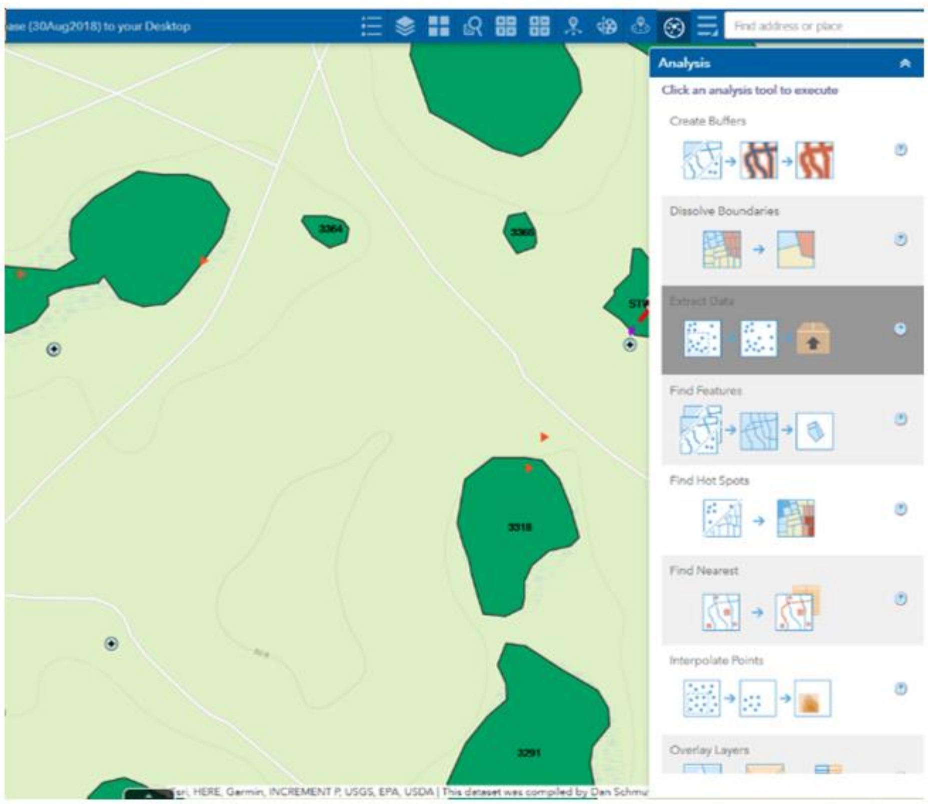

Figure 7.7: A List of Some of the Analysis Tools the RAGIS Application Can Perform with the Data Provided.

7.2.4 Functions and Uses

The intent of this application is for it to be a repository for spatial data beyond the completion of the Recovery Assessment Plan. With this ArcGIS Online platform, new tools can be created as they become needed, maintaining the utility of these data for years to come. Tampa Bay Water is currently integrating the RAGIS App with the Recovery Assessment Database so that as site data is added or updated, it will be modified in the map and any analyses will remain current. Another tool currently in progress is the Soils Calculator. This is a custom tool that will allow users to create a boundary within the landscape and calculate the percentage of xeric soils within that boundary based on the Soil Survey Geographic Database (SSURGO) soil polygon classifications.

Along with the application, a corresponding map was also developed, from which Recovery Assessment group members can make their own copies for their own analyses. These maps can be shared within the Recovery Assessment Group, which includes staff from both Tampa Bay Water, the District and some consultants working on related projects. In these individual maps, users have uploaded and analyzed their own datasets as well as those provided by other consultants. These new layers and analyses include updates to the 2 ft. surficial aquifer drawdown boundaries as well as actual pumping data, timeseries of depth to the Upper Floridan Aquifer analyses conducted for Tampa Bay Water by Lee and Fouad (HSW Engineering, Inc., 2018a), hydrographs for particular sites of interest for easy retrieval, and the most up-to date Recovery Assessment status for all lakes and wetlands. Providing this data has allowed both Tampa Bay Water and District staff to refer to these maps anywhere from the office to the field and locate the closest monitoring data, adjacent data from other analyses, and view the status of sites in question. Using tools like the ArcGIS Explorer app have helped to both locate sites in the field, as well as to recall data quickly which is not on hand directly from a tablet or mobile phone. As a result of these tools, time spent in the field is more effective and efficient.

Spatially viewing the abundance of monitoring data has benefitted the Recovery Assessment work in many ways, but there are two important uses to note. The first is that looking at these disparate data sets in a map view has created a more complete picture of the health of monitored wetlands. The ability to find all wells and staff gauges for a site identifies all possible sources of data for the most complete understanding of wetland recovery. Additionally, proximity to other monitoring wells, production wells, drawdown contours, and other nearby sites can round out an analysis and help to explain trends or answer questions. The second is that the available monitoring data can also be used to interpolate data between known sites to estimate information where monitoring data does not exist. Successful examples of this can be seen the Random Forest Analysis (Greenman-Pedersen, Inc., 2018), potentiometric surface data for the Upper Floridan Aquifer (HSW Engineering, Inc., 2018a), and the updates to the Area of Investigation using historical pumping data (Tampa Bay Water, 2017b and 2019b). These are three pieces of evidence used to estimate wetland health at a total of 845 additional unmonitored sites in the Northern Tampa Bay area. With the application for renewal of the Consolidated Water Use Permit, the network of monitoring data viewed spatially can provide the opportunity to pinpoint locations with redundant or extensive monitoring as well as locations which may be considered for new monitoring sites to answer future questions.

7.2.5 Aerial Imagery

The initial release of the Recovery Assessment GIS Application included six sets of aerial imagery from the historic or pre-1970s period, 1972, 1984, 2002, 2008, and Fall 2014. In early 2020, this aerial imagery collection was expanded to include additional datasets which began collection in years 1938, 1957, 1967, 1985, 1988, 1992, 1998, 2001, 2005, 2016, and 2018. These new imagery datasets allow for a greater understanding of land surface conditions on and surrounding the Consolidated Permit wellfields for critical time periods analyzed in the Recovery Assessment Plan. These time periods include pre-pumping conditions, conditions at baseline periods for the analyses of wetland mitigation requirement, individual wellfield cutbacks, and present-day conditions. They also show human modifications to the land, including roads, agriculture, and development, and how water moved through these systems before substantial human influence. In addition to the Recovery Assessment analyses of pumping and water level data, these images help to provide a more complete picture of the factors affecting lake and wetland health.

8: Recovery Analyses of Monitored Lakes

8. Recovery Analyses of Monitored Lakes

Tampa Bay Water has assessed the recovery of each lake that was included in the final list of monitored lakes in the Recovery Assessment Plan (Section 5.4). This has been a multi-step process that involved the compilation and assessment of complete water level records for each lake and an evaluation of the current condition using a weight-of-evidence approach. The reference elevations used were the established Minimum Levels if adopted by the District or the Guidance Levels if no Minimum Levels have been adopted (described in Section 6.4). For the 22 lakes that have neither established Minimum Levels nor Guidance Levels, staff used the best available data for the weight-of-evidence evaluation of recovery. The Lake Guidance Levels that were used in the Recovery Assessment are found in Table 8-3 of District Rule 40D-8, F.A.C. These lake Guidance Levels were adopted into rule prior to August 7, 2000 and have not been changed since that date. The District began implementing the Minimum Flows and Levels program for lakes after August 7, 2000 by adopting new levels for specific lakes into Rule 40D-8, F.A.C. As Minimum Levels were adopted for individual lakes, the District eliminated the Guidance Levels if they had been previously adopted. A description of the individual levels and the methodology used to establish Minimum Levels for lakes are described in Section 6.4.

The District continued to establish new Minimum Levels for lakes contained in the Recovery Assessment Plan during the course of this evaluation and the Minimum Levels for other lakes have been reevaluated using additional data and newer methods. Staff have used the current adopted levels that are found in Chapter 40D-8, F.A.C. (https://swfwmd.state.fl.us/business/epermitting/rules-and-references) in this assessment of recovery. The Minimum Levels for five lakes were reevaluated during 2019 (Lakes Calm, Charles, Church, Echo, and Sapphire) and the proposed (updated) levels were incorporated in these analyses, pending the completion of the rulemaking process. Six additional lakes are scheduled for reevaluation during 2020 (Lakes Cypress, Garden, Halfmoon, Jackson, Linda, and Strawberry). Any updated Minimum Levels that may result from these District evaluations are not included in the Recovery Assessment Plan due to the time constraints of completing these recovery analyses that must be included in the Consolidated Permit Renewal application in late-2020.

8.1 Compilation and Management of Data

Tampa Bay Water retained Dr. Brian Ormiston and Applied Ecology, Inc. in February 2015 to develop and apply methods of analysis for the recovery of monitored lakes in the Recovery Assessment Plan. The District collects water level data for most of the lakes in the Tampa Bay area; District staff compiled and transferred all available water level data records for the District-monitored lakes on the preliminary monitored lake list to Tampa Bay Water and Dr. Ormiston. The length of the period-of-record data for the District-monitored lakes varies by lake but the data record for the longest-monitored site, Horse Lake in the Cosme-Odessa Wellfield, extends back to May 1930. The data transfer file from the District contained 368,445 individual records. Tampa Bay Water provided the period of record water level data to Dr. Ormiston for the listed lakes that Tampa Bay Water monitors. All lake water level data collected for this initial assessment were through January 2015. The available historic data from lakes is almost exclusively limited to water level data so this has been the focus of the Recovery Assessment analyses. For lakes with established Minimum Levels, the District collected and analyzed environmental data to aid in the establishment of lake-specific levels so environmental factors were considered as these levels were established. It is also important to evaluate the current ecological condition or health of lakes that are not fully meeting their established levels based on Tampa Bay Water's weight-of-evidence analyses to determine whether or not adverse impact conditions exist at the conclusion of the Recovery Assessment Plan analyses, as discussed later in this chapter.

Dr. Ormiston performed additional research to ensure that all available water level data had been assembled and performed a quality control review of the data. Lake water level data have been collected at varying frequencies over the years, so all lake water level data were rescaled to monthly mean values. This step was performed to avoid bias toward the time periods with more frequent data in all subsequent statistical analyses. Some lakes have been monitored at more than one device over time so all device time series associated with each lake were merged into a composite time series for those lakes. Period-of-record data files were prepared for each lake for subsequent analysis by Dr. Ormiston and Tampa Bay Water staff. Trend and period of record statistics were compiled for all lake water level data and a GIS database was created to support data analysis and mapping.

8.2 Preliminary Assessment Methods and Initial Screening

Tampa Bay Water and Dr. Ormiston met with the District in February 2015 to discuss the lake data and the types of analyses that would be helpful in assessing lake recovery. After collecting and organizing the water level data, Dr. Ormiston calculated the median water levels for all lakes during recent 6-year and 10-year periods and the period-of-record and compared these median levels against the applicable Low Guidance Level or Minimum Level for each lake, where available. Period-of-record trend statistics were assembled for each lake and these analyses were discussed with Tampa Bay Water and the District at the July 30, 2015 technical coordination meeting.

Several additional data analyses were identified during the July 30, 2015 meeting which were subsequently performed by Dr. Ormiston. The lake level trends were analyzed for 10-year periods before and after the reduction in wellfield pumping and the rates of water level decline during the annual dry season (before versus after the wellfield pumping reduction) were analyzed to factor out the influence of rainfall on lake levels and assess the degree of lake level recovery due to the reduction in wellfield pumping. Dr. Ormiston also applied a weight-of-evidence approach for lakes lacking Minimum or Management Levels, examining neighboring lakes as surrogates for those without Minimum or Management Levels. An analysis matrix was created with specific hydrologic indicators and criteria for the assessment of lakes to summarize the analyzed data and recommend Recovery Assessment bins for all monitored lakes.

Dr. Ormiston presented these updated analyses to Tampa Bay Water and the District on November 19, 2015 and addressed the combined comments and questions in a final project report. The information contained in this report was presented to Tampa Bay Water and the District on March 1, 2016 and Tampa Bay Water submitted this report to the District on April 16, 2016 (Appendix 8.1). This report contained extensive tables presenting the results of Dr. Ormiston's statistical analysis of the lake water level data, maps of the lakes showing his proposed Recovery Assessment bin for each lake, and one-page summaries of each lake with a map, hydrograph, and key data from the assessment of data for the lake.

District staff provided verbal feedback to Tampa Bay Water on Dr. Ormiston's preliminary lake assessments and staff discussed the status of these lakes during technical coordination meetings in 2016 and early 2017. Staff considered the District comments and suggestions and developed an updated assessment of the monitored lakes in early 2017. This updated assessment was discussed with the District on April 13, 2017 and it included additional water level data through the end of Water Year 2016 (September 30, 2016), additional historical water level data that was located for a few of the lakes, revised Minimum Levels for some of the monitored lakes that the District had adopted into Chapter 40D-8, F.A.C. by early 2017, and the District's latest-available MFL Lake assessment status. Tampa Bay Water submitted this updated lake assessment report to the District on May 1, 2017 (Appendix 5.7) applying a weight-of-evidence approach to the assignment of preliminary Recovery Assessment bins to each lake. This updated lake assessment considered the statistical analyses performed and bin recommendations prepared by Dr. Ormiston in 2016, an evaluation of water level data at each lake through September 2016, and the most recent MFL Lake status assessment performed by the District. Tampa Bay Water staff agreed to use the most-recent District status assessment at that time for MFL lakes since the methods of assessing lake recovery were still being tested. Site-specific issues were identified for a few of the lakes leading to a modification of the monitored lake list and this information is also contained in the May 1, 2017 letter report. The District concurred with these recommended Recovery Assessment bins on May 30, 2017 (letter contained in Appendix 5.7) with the exception of ten lakes discussed below. These recommendations were considered to be the initial lake Recovery Assessment bins.

Tampa Bay Water and the District reviewed the May 1, 2017 proposed lake bins at the May 11, 2017 meeting and identified ten lakes that still needed to be assigned to an initial Recovery Assessment bin. The two staffs agreed that two additional lakes, Turkey Ford and Van Dyke, should be classified as "Recovered" and the District requested that an additional technical memoranda be prepared for each lake summarizing the data and assessment conclusions. Tampa Bay Water asked Dr. Ormiston to prepare assessment memoranda for the ten lakes that still needed an initial bin and the two "Recovered" lakes. Dr. Ormiston developed technical memos for ten of these 12 lakes with an analysis of updated period of record data, aerial photography, and historical lake investigation data from District staff. Technical memoranda for two lakes were not developed. The analysis of data from Raft Lake was inconclusive and staff determined that this lake should be assessed with wetlands at the Cross Bar Ranch Wellfield. There is insufficient water level data for Lake Wastena to complete an analysis and the staffs agreed to assess this lake with the unmonitored sites. Tampa Bay Water submitted these ten technical memos to the District on July 11, 2018 (Appendix 8.2). The District reviewed this information and provided comments by letter dated September 5, 2018 (included in Appendix 8.2).

The District's September 5, 2018 letter contained comments about the proposed Recovery Assessment bin for four of these final lakes (Lakes Buck, Darby, Thorpe and Velburton). Tampa Bay Water and the District discussed these four final lakes in the meeting on September 13, 2018 and agreed that the initial Recovery Assessment bin for Lakes Darby and Thorpe should be "Improved, Not Fully Recovered". Staff agreed that based on all available data, Buck Lake does not appear to have ever been impacted by wellfield pumping and there is so little data available for Velburton lake that it should not have been added to the Recovery Assessment Plan for evaluation. The District requested final technical memoranda for Lakes Buck and Velburton to confirm the assessments. These two final reports were prepared by Dr. Ormiston confirming that the water level in Buck Lake appears to be unimpacted by wellfield pumping and recommending a Recovery Assessment Bin of "Never Impacted by Wellfield Pumping". Dr. Ormiston's review of historical aerial photography for Lake Velburton showed little water level change from year to year and confirmed that the five available data points were insufficient for any assessment of lake health or recovery. Dr. Ormiston also concluded that the lake appears to have no evidence of hydrologic or ecologic stress. Lake Velburton has therefore been removed from the Recovery Assessment monitored lake list. Dr. Ormiston's two final lake assessment memoranda were submitted to the District on November 28, 2018 (Appendix 5.8).

8.3 Annual Lake Assessments and Preliminary Results

Once the lakes were classified into preliminary Recovery Assessment bins, staff began to assess new water level data on an annual basis and provide updated assessments to the District. These annual assessment updates followed the same format used in the initial assessment of lake status through Water Year 2016 (Appendix 5.7). These annual updates to the weight-of-evidence analysis incorporated any lake Minimum Levels that the District had revised during the prior year if those changes had been approved by the Governing Board and adopted into Chapter 40D-8, F.A.C. The District's results from their updated annual MFL Lake status assessments were also factored into Tampa Bay Water's updated assessment reports and staff continued to give them a priority weight during the preliminary assessments since we were still testing our assessment methods. Tampa Bay Water performed the first annual update to the lake level assessment and submitted the letter report to the District on June 29, 2018 (Appendix 8.3). This updated assessment contained lake level data through the end of Water Year 2017 (September 30, 2017) and the District's MFL Lake status assessment through Water Year 2016. This update report also includes Dr. Ormiston's recommended bins for the ten lakes submitted on July 11, 2018. The District responded on September 4, 2018 (letter attached in Appendix 8.3) and concurred with the recommended bins. District staff also included updated assessment recommendations based on their recent MFL Lake reassessments.

Tampa Bay Water completed the updated assessment of lake recovery status with data collected through the end of Water Year 2018 (September 30, 2018), considering the District's MFL Lake status assessment through the end of Water Year 2017. This assessment report was submitted to the District on December 21, 2018 and is contained in Appendix 8.4. The preliminary Recovery Assessment bins for all monitored lakes developed through these technical investigations as modified in the Water Year 2018 update report were presented in the Recovery Assessment Preliminary Report of Findings (Tampa Bay Water, 2018b). The recovery assessments for Raft Lake and Wastena Lake were assessed separately with wetlands in the Preliminary Report of Findings due to the issues previously described. The preliminary results from the December 2018 report are summarized in Figure 8.1 in table and chart format. Table 8.1 presents the preliminary assessment bin for all the 137 monitored lakes as reported in the Preliminary Report of Findings.

Table 8.1: Preliminary Recovery Assessment Findings for Monitored Lakes

Wetland ID	TBW Wetland ID	Site Name	County	District Site ID	POR Begin	POR End	MFL Lake	Initial R.A. Bin
601		**Alice Lake**	**Hillsborough**	**19874**	Jun-71	current	Yes	Recovered
602		**Allen Lake**	**Hillsborough**	**19834/773919**	Jun-71	current	Yes	Recovered
28	4890	Alligator Pond (CBR Q31)	Pasco	n/a	May-99	current		Recovered
118	4962	Amelia Lake (W272717)	Hillsborough	n/a	May-84	current		Recovered
603		**Ann-Parker Lake**	**Pasco**	**19718**	Oct-69	current	Yes	Recovered
120		Armistead Lake	Hillsborough	19800/19590	May-77	current		Recovered
604		Artillery Lake	Hillsborough	19893/841333	Dec-74	current		Recovered
600		Avis Lake	Hillsborough	19737	Mar-87	current		Recovered
605		Bass (Holiday) Lake	Pasco	19720	Oct-83	current		Recovered
606		**Bell Lake**	**Pasco**	**19134/18510**	Jul-77	current	Yes	Recovered
15	**4877**	**Big Fish Lake (CBR Q18)**	**Pasco**	**20474**	Jun-80	current	Yes	Continued Impact Not Fully Recovered
607		Big Lake Vienna	Pasco	19132	May-86	current		Recovered
608		**Bird Lake (Hillsborough)**	**Hillsborough**	**19793**	Apr-77	current	Yes	Improved
609		**Bird Lake (Pasco)**	**Pasco**	**19100**	Feb-78	current	Yes	Recovered
610		Black Lake	Pasco	22145	Oct-73	current		Recovered
611		Boat lake	Hillsborough	19743	Mar-77	current		Recovered
414	5412	Bonnet Lake (STK S-008)	Pasco	n/a	Mar-83	current		Improved
612		**Brant Lake**	**Hillsborough**	**19837**	Jun-71	current	Yes	Improved
613		Brooker Lake	Hillsborough	19831	Mar-77	current		Recovered
615		Browns Lake	Hillsborough	19817	Jun-71	current		Recovered
616		Buck Lake	Hillsborough	19854	Jul-72	current		Not Impacted by Wellfield Pumpage
617		Burrell Lake	Hillsborough	19169	Jan-78	current		Improved
618		**Calm Lake**	**Hillsborough**	**19879**	Jan-65	current	Yes	Improved
620		**Camp Lake**	**Pasco**	**19638**	Apr-68	current	Yes	Improved
621		**Carroll Lake**	**Hillsborough**	**19740/19742/670728**	May-46	current	Yes	Recovered
622		Catfish Lake	Pasco	19101	Feb-88	current		Recovered

Wetland ID	TBW Wetland ID	Site Name	County	District Site ID	POR Begin	POR End	MFL Lake	Initial R.A. Bin
623		Cedar Lake East	Hillsborough	670725/670726	Sep-07	Feb-14		Recovered
		Cedar Lake West	Hillsborough		Jun-07	Nov-16		Recovered
624		Chapman Lake	Hillsborough	19795	Aug-82	current		Recovered
625		**Charles Lake**	**Hillsborough**	**19836/756262**	Jun-71	Sep-14	Yes	Improved
626		**Church Lake**	**Hillsborough**	**19858**	Jun-31	current	Yes	Improved
3	4865	Clear Lake (CBR Q03)	Pasco	n/a	Jul-77	current		Continued Impact Not Fully Recovered
627		Commiston Lake	Hillsborough	19830	Sep-89	current		Recovered
629		Cooper Lake	Hillsborough	19832	May-46	current		Recovered
630		Cow (East) Lake	Pasco	19111	Jul-76	current		Recovered
631		**Crenshaw Lake**	**Hillsborough**	**19839**	Jun-71	current	Yes	Recovered
632		**Crescent Lake**	**Hillsborough**	**19892**	May-81	current	Yes	Recovered
25	**4887**	**Crews Lake (CBR Q28)**	**Pasco**	20506/777811	Apr-81	current	Yes	Recovered
633		**Crystal Lake**	**Hillsborough**	**19827/19828**	Jul-99	current	Yes	Improved
634		Curve Lake	Pasco	19142	Jul-76	current		Recovered
636		**Cypress Lake**	**Hillsborough**	**19804**	Feb-93	current	Yes	Recovered
252	**4980**	**Dan Lake (SW062717)**	**Hillsborough**	**19723/759897**	Mar-80	current	Yes	Improved
368	4984	Darby Lake (202718)	Hillsborough	n/a	Feb-83	current		Improved
637		**Deer Lake**	**Hillsborough**	**19818/ 18813**	Aug-77	current	Yes	Recovered
638		**Dosson Lake**	**Hillsborough**	**19846/797348**	Jun-71	current	Yes	Improved
639		**Echo Lake**	**Hillsborough**	19856	Sep-57	current	Yes	Improved
640		Eckels Lake	Hillsborough	19241	Mar-78	current		Recovered
642		Elaine Lake	Hillsborough	19739	Dec-80	current		Recovered
643		Elizabeth Lake	Hillsborough	19881	Apr-77	current		Recovered
644		Ellen Lake	Hillsborough	19930716761	Jun-82	Jan-16		Recovered
645		**Fairy (Maureen) Lake**	**Hillsborough**	**19821**	Aug-77	current	Yes	Recovered
646		Fern Lake	Hillsborough	19884	Aug-77	current		Improved
647		Floyd Lake	Pasco	19126	Feb-78	current		Recovered
648		Flynn Lake	Hillsborough	19170	May-01	current		Recovered
649		**Garden (Thomas) Lake**	**Hillsborough**	**19813**	May-77	current	Yes	Recovered

Wetland ID	TBW Wetland ID	Site Name	County	District Site ID	POR Begin	POR End	MFL Lake	Initial R.A. Bin
651		Gass Lake	Hillsborough	19727	May-77	current		Recovered
653		George (Hillsborough) Lake	Hillsborough	19744	Mar-77	current		Recovered
37	4897	Goose Lake (CBR T04)	Pasco	n/a	Dec-77	current		Continued Impact Not Fully Recovered
655		Gooseneck Lake	Pasco	19106	Mar-78	current		Recovered
657		**Green Lake**	**Pasco**	**20417**	Apr-81	Sep-14	Yes	Recovered
658		**Halfmoon Lake**	**Hillsborough**	**19789**	Apr-77	current	Yes	Recovered
659		Halls Lake	Hillsborough	19755	Oct-83	current		Recovered
660		**Hanna Lake**	**Hillsborough**	**19178/ 19177**	Jun-46	current	Yes	Recovered
661		**Harvey Lake**	**Hillsborough**	**19815**	Apr-70	current	Yes	Recovered
662		**Helen Lake**	**Hillsborough**	**19848/723923**	Feb-93	current	Yes	Recovered
663		Hiawatha Lake	Hillsborough	19722	May-81	current		Recovered
665		**Hobbs Lake**	**Hillsborough**	**19816**	Jun-46	current	Yes	Improved
666		Hog Island Lake	Hillsborough	19190	Mar-78	current		Recovered
119		**Horse Lake (WC262717)**	**Hillsborough**	**19866/815809/827842**	May-30	current	Yes	Improved
667		Island Ford Lake	Hillsborough	19888/20004/19880	Jun-71	current		Recovered
392	**5005**	**Jackson Lake (NW212718)**	**Hillsborough**	**19812/735159**	May-73	current	Yes	Recovered
669		James Lake	Hillsborough	19878	Dec-83	current		Recovered
670		Jo Ann Lake	Pasco	19104	Feb-88	current		Recovered
671		Josephine Lake	Hillsborough	19798	Dec-86	current		Recovered
672		Joyce (Hog) Lake	Pasco	19112	May-84	current		Recovered
673		**Juanita Lake**	**Hillsborough**	**19806/827032/ 827848/827849**	Aug-82	current	Yes	Improved
674		**Keene Lake**	**Hillsborough**	**19189**	Nov-48	current	Yes	Recovered
675		**Kell Lake**	**Hillsborough**	**19301/ 19300**	Jun-71	current	Yes	Recovered
676		Keystone Lake	Hillsborough	19877/19876/19889	Apr-46	current		Recovered
678		**King Lake (West) at Drexel**	**Pasco**	**19135**	Jul-76	current	Yes	Recovered
679		LeClare Lake	Hillsborough	19791	Oct-77	current		Recovered
680		**Linda Lake**	**Pasco**	**19122**	Oct-69	current	Yes	Improved

Wetland ID	TBW Wetland ID	Site Name	County	District Site ID	POR Begin	POR End	MFL Lake	Initial R.A. Bin
681		Lipsey Lake NR Sulphur Springs	Hillsborough	19741/670234/19736/ 19735	Oct-83	current		Recovered
683		Little Lake	Hillsborough	19805	Jun-31	current		Recovered
684		**Little Moon Lake**	**Hillsborough**	**19895**	Oct-77	current	Yes	Improved
685		Little Moss (Como) Lake	Pasco	19635	May-86	current		Recovered
686		Long Lake	Hillsborough	19726	Feb-77	current		Recovered
687		Magdalene Lake	Hillsborough	19751/19750/19752/ 19753	May-46	current		Recovered
688		Marlee Lake	Hillsborough	19857	Apr-94	current		Recovered
689		**Merrywater Lake**	**Hillsborough**	**19841/825768**	Apr-94	current	Yes	Improved
472	**5476**	**Moon Lake (STK SC-32)**	**Pasco**	**20798/827805/759472**	Sep-90	current	Yes	Recovered
692		Moss Lake	Pasco	19636	May-86	Sep-11		Recovered
693		**Mound Lake**	**Hillsborough**	**19883**	Jul-72	current	Yes	Recovered
695		Mud Lake (Geneva Lake)	Pasco	22146	Apr-81	current		Recovered
696		Myrtle Lake	Pasco	19103	Feb-88	current		Recovered
697		Noreast Lake	Hillsborough	670727	Oct-07	current		Recovered
698		Osceola Lake	Hillsborough	19894	Oct-89	current		Recovered
699		**Padgett Lake**	**Pasco**	**19130/ 19127**	Jul-85	current	Yes	Recovered
32	**4892**	**Pasco Lake (CBR Q35)**	**Pasco**	**20525/782682/777863**	Jul-86	current	Yes	Continued Impact Not Fully Recovered
701		**Pierce Lake**	**Pasco**	**20426**	Apr-81	current	Yes	Recovered
702		**Platt Lake**	**Hillsborough**	**19728**	May-46	current	Yes	Recovered
703		**Pretty Lake**	**Hillsborough**	**19873/19799/19796/ 19870/19801/19802/ 19799**	Jul-71	current	Yes	Recovered
24	4886	Raft Lake (CBR Q27)	Pasco	n/a	Oct-80	current		Improved
704		**Rainbow Lake**	**Hillsborough**	**19807**	Jun-71	current	Yes	Improved
705		**Raleigh Lake**	**Hillsborough**	**19861**	Sep-30	current	Yes	Improved
706		**Reinheimer Lake**	**Hillsborough**	**19824**	Aug-77	current	Yes	Recovered

Wetland ID	TBW Wetland ID	Site Name	County	District Site ID	POR Begin	POR End	MFL Lake	Initial R.A. Bin
709		**Rogers Lake**	**Hillsborough**	**19863/20007/19862/ 778393/778395/ 778396**	Apr-95	current	Yes	Improved
710		**Round Lake**	**Hillsborough**	**19840**	Jan-65	current	Yes	Recovered
364	9548/5401	Ryals Lake (NP-31/NP-35)	Pasco	n/a	Oct-89	current		Recovered
711		**Saddleback Lake**	**Hillsborough**	**19838**	Jun-71	current	Yes	Recovered
712		**Sapphire Lake**	**Hillsborough**	**19826**	Feb-93	current	Yes	Recovered
714		Saxon Lake	Pasco	19110	Jan-83	current		Recovered
741		Seminole Lake	Pasco	19717	Oct-69	current		Recovered
715		Simmons Lake	Hillsborough	n/a	Oct-85	current		Recovered
161	6097	Stanford Lake (CYC C03)	Pasco	n/a	May-00	current		Recovered
717		**Starvation Lake**	**Hillsborough**	**19842**	Jun-61	current	Yes	Recovered
718		**Stemper Lake**	**Hillsborough**	**19303/ 19304**	May-46	current	Yes	Recovered
719		**Strawberry Lake**	**Hillsborough**	**19883**	Jun-71	current	Yes	Recovered
720		**Sunset Lake**	**Hillsborough**	**19811**	Jul-72	current	Yes	Recovered
721		**Sunrise (Sunshine) Lake**	**Hillsborough**	**19981**	Feb-04	current	Yes	Improved
722		Tampa (Turtle) Lake	Pasco	19099	Mar-78	current		Recovered
723		**Taylor Lake**	**Hillsborough**	**19875**	Jun-71	current	Yes	Recovered
724		Thomas Lake	Hillsborough	19835	Jul-71	current		Recovered
725		Thorpe Lake	Hillsborough	19860	Jan-93	Oct-97		Improved
726		Toni Lake	Pasco	19102	Feb-88	current		Recovered
727		Turkey Ford Lake	Hillsborough	19850	Apr-70	current		Recovered
729		Twin Lake (Pasco)	Pasco	19107/798662	Apr-78	current		Recovered
730		Unnamed Lake 1B14	Hillsborough	19784	Jun-79	current		Recovered
731		Unnamed Lake 2B14	Hillsborough	19787	Dec-83	current		Recovered
732		**Unnamed Lake 22 (Loyce)**	**Pasco**	**20508/783541**	Oct-83	current	Yes	Recovered

Wetland ID	TBW Wetland ID	Site Name	County	District Site ID	POR Begin	POR End	MFL Lake	Initial R.A. Bin
157	3897	Unnamed Lake 26 (CYB C18)	Pasco	19105	Feb-88	current		Recovered
734		Van Dyke Lake	Hillsborough	19851	Mar-70	Jun-98		Recovered
736		**Virginia Lake**	**Hillsborough**	**19814**	Sep-77	current	Yes	Recovered
737		Wastena Lake	Hillsborough	19895	Feb-93	Oct-97		Recovered
738		White Trout Lake	Hillsborough	19240/670230	Jul-71	current		Recovered
739		Wistaria Lake	Pasco	19139	May-86	current		Recovered
740		Wood Lake	Hillsborough	19886/20001/19882	Oct-97	current		Recovered

Bold Text - MFL Lake
Proposed Pretty-Josephine-Rock Group (analyze together)
Proposed Helen-Ellen-Barbara Group (analyze together)

Recovery Classes/Bins	Number	Percent
Monitored Lakes	**137**	
Not Affected by Wellfield	1	1%
Recovered/Meets Metric	106	77%
Improved, Not Fully Recovered	26	19%
Not Fully Recovered, Continuing Impact	4	3%
More Detailed Analysis Needed	0	0%
Total	137	100%

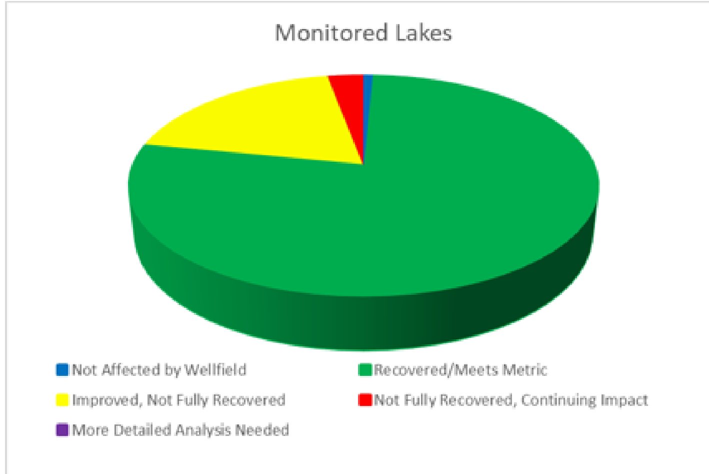

Figure 8.1: Preliminary Assessment Results for Monitored Lakes (through Water Year 2018)

8.4 Subsequent Assessments and Updates

Tampa Bay Water retained Dr. Ormiston in late 2019 to update the lake hydrologic statistics and hydrographs using data collected through the end of September 2019 (end of Water Year 2019). Applied Ecology, Inc. again supported Dr. Ormiston with GIS task elements of this update. Tampa Bay Water obtained monthly lake water level data from the District for those lakes monitored by the District and assembled the monthly lake water level data for those lakes monitored by Tampa Bay Water. This data was transferred in early October 2019 to Dr. Ormiston who updated the period-of-record data for each lake in the prior evaluation through the end of Water Year 2019.

An updated report summarizing the hydrologic statistics for each lake was prepared by Dr. Ormiston in January 2020 and this report is included as Appendix 8.5. This report included any revised Minimum Levels adopted by the District. For those lakes situated in a xeric soil landscape where no Minimum or Guidance level existed, a xeric offset reference elevation was computed using the method developed for the assessment of isolated wetlands in a xeric soil setting. The median water level was calculated for each lake using the most recent 6 and 10-year periods and offsets from each lake's Minimum Level, Low Guidance Level, or estimated minimum level were computed for both time periods. Water level trends in the 10-year periods prior to and after the reduction in wellfield pumping were computed and the trends were tested for statistical significance. The rate of decline analysis was also updated for each lake comparing the dry season rate of water level decline in both the pre- and post-cutback periods. The difference in the two rates of dry season water decline were tested for statistical significance and the reports are presented in the update report. The report includes maps of the lake locations and the 6-year median water level departure from the applicable lake minimum or management level. One-page summary sheets are included for each lake showing a recent aerial photograph, the period of record hydrograph, reference elevations/data and key hydrologic statistics.

Tampa Bay Water staff also updated the prior annual data assessment (Section 8.3) for all monitored lakes with data through September 2019. The additional year of data was collected from the District or

Tampa Bay Water database as applicable and added to the period-of-record water level data file for each lake. As in the prior annual assessments, the P50 and P10 water levels were calculated for each lake for the most recent 6 and 10-year periods, since the reduction in pumping at the closest wellfield, and for the applicable period-of-record; these water level statistics were compared to each lake's minimum, management, or estimated level. The results of this final update were not published in a separate memorandum but are included in the final assessment presented in the following report section.

8.5 Weight of Evidence Approach for Final Lake Results

The assessment of recovery at monitored lakes for this final Recovery Assessment Plan report is based on the weight-of-evidence approach that was also applied to the monitored wetlands and unmonitored sites. This final assessment is slightly different from the approach used in the annual assessments of lakes and the Recovery Assessment Preliminary Report of Findings (Tampa Bay Water, 2018b). The final analysis considers each applicable method of assessing the lake water level data without weighting one approach or type of data higher than any other. The results of the lake recovery assessment are presented in Table 8.2 and the individual data considered for each lake include:

- Reference information – lake name, reference numbers unique to each lake and whether the lake has an adopted Minimum Level
- Reference level – the adopted Minimum Levels, low management level, or estimated level, as appropriate
- District status assessment for MFL lakes – the 2018 status assessment is included as this is the most recent year for which the District analysis has been performed (at the time of preparation of this report)
- P50 (median) and P10 lake levels for multiple time periods – recent 6 and 10-year periods, and since the reduction of pumping at the nearest wellfield
- Rate of dry-season lake level decline before and after the reduction in pumping, the difference in these two values, and test for statistical significance
- Lake water level trend for the 10-year period after pumping reduction at the closest wellfield, slope of the trend line, and test for statistical significance

Table 8.2: Weight of Evidence Summary for Monitored Lakes - Data Through WY 2019

2019 Lake Recovery Analysis
*This spreadsheet contains the results of each of the weights of evidence **through September 2019**, and the final bins for MFL and non-MFL Lakes for the Recovery Assessment*
Data analysis completed by: Brian Ormiston and Erin Hayes
Data compiled here by: Erin Hayes

														Analysis by Brian Ormiston							Supplemental Information			
Wetland ID	**Lake Name**	**Draw-down Zone**	**MFL Lake**	**HMLL***	**MLL***	**LL^**	**Met MFL in 2018****	**10-Year P50**	**6-year P50**	**10-year P10**	**6-year P10**	**Post-Cutback P50**	**Post-Cutback P10**	**Mean 1 ROD MAY PRE-CUT BACK**	**Mean 2 ROD MAY POST-CUTBACK**	**MAY ROD DIFF**	**p Value Diff (t-test)**	**p 10 YR POST CUTBACK TREND**	**Slope (10 yr Post-cut Period)**	**Final Recovery Assessment Bin**	**POR P50**	**POR P10**	**DEV 10YR Median - ML**	**DEV 6YR Median - ML**
601	Alice Lake	0	Yes	40.70	38.90		Yes	40.60	40.81	41.39	41.34	40.20	41.33	-0.57	-0.40	0.175	0.096	**0.000649**	0.000232	Recovered	38.45	40.87	1.7	1.91
602	Allen Lake	1	Yes	62.10	60.70		Yes	60.98	61.02	61.77	61.74	60.75	61.76	-0.40	-0.34	0.060	0.611	0.481196	-0.000045	Recovered	60.59	61.73	0.275	0.3125
28	Alligator Pond	0	No			75.42	N/A	76.70	77.18	78.61	79.02	74.69	78.24	-0.31	-0.30	0.008	0.975	**0.000000**	0.001285	Recovered	73.78	77.9	1.275	1.77
118	Amelia Lake	1	No			35.57	N/A	36.33	36.38	37.29	37.02	35.85	37.10	-0.39	-0.02	0.373	0.559	0.302325	-0.000133	Recovered	34.7	37.198	0.87	0.81
603	Ann-Parker Lake	2	Yes	48.10	46.70		Yes	47.31	47.32	47.97	47.95	47.18	47.94	-0.44	-0.29	0.146	0.089	0.301419	-0.000052	Recovered	46.95	47.9576	0.601054	0.6235
120	Armistead Lake	1	No			40.50	N/A	41.72	41.70	42.49	42.30	41.54	42.42	-0.34	-0.35	-0.005	0.973	0.112549	-0.000087	Recovered	40.9480968	42.2642774	1.218	1.1983
604	Artillery Lake	2	No			40.50	N/A	42.54	42.55	42.83	43.15	42.45	42.79	-0.44	-0.20	0.238	0.135	0.313449	0.000039	Recovered	42.3357692	42.78	2.04	2.0525
600	Avis Lake	0	No			34.50	N/A	35.39	35.44	36.18	36.01	35.46	36.45	-0.75	-0.31	0.442	**0.011**	0.099097	0.000108	Recovered	35.31	36.29	0.89	0.94
605	Bass (Holiday) Lake	2	No			45.75	N/A	47.46	47.51	48.08	48.09	47.27	48.05	-0.18	-0.33	-0.152	0.107	0.740579	0.000017	Recovered	47.0425	47.96	1.71375	1.7575
606	Bell Lake	0	Yes	70.80	69.40		Yes	70.83	70.97	71.61	71.61	70.72	71.59	-0.32	-0.37	-0.044	0.736	0.220698	0.000077	Recovered	70.52	71.575	1.425	1.565
15	Big Fish Lake	2	Yes	75.40	72.80		Yes	72.74	73.88	74.76	75.12	72.22	74.77	-0.31	-0.23	0.088	0.609	**0.000000**	0.001744	Improved, Not Fully Recovered	71.75	75.156	-0.06	1.075
607	Big Lake Vienna	0	No			67.00	N/A	68.41	68.40	69.02	69.01	68.24	68.91	-0.34	-0.35	-0.006	0.963	0.075922	-0.000102	Recovered	68.08	68.88	1.41	1.4
608	Bird Lake (Hillsborough)	1	Yes	50.00	48.80		No	49.53	49.66	50.21	50.25	49.24	50.11	-0.62	-0.34	0.277	0.051	**0.049747**	0.000135	Recovered	48.5066667	49.98	0.73	0.86
609	Bird Lake (Pasco)	0	Yes	66.60	65.20		Yes	66.06	66.13	66.97	67.02	65.93	66.92	-0.43	-0.31	0.120	0.414	0.487163	0.000045	Recovered	65.66	66.8615	0.86	0.925
610	Black Lake	1	No			ND	N/A	49.08	48.90	49.72	49.38	48.93	49.76	-0.63	-0.39	0.244	**0.037**	**0.000012**	-0.000252	Recovered	48.8	49.7		
611	Boat lake	0	No			33.75	N/A	35.41	35.40	36.06	35.78	35.43	36.14	-0.51	-0.27	0.241	0.072	0.428055	-0.000046	Recovered	35.125	36.05	1.66	1.65
414	Bonnet Lake	1	No			27.80	N/A	29.12	29.43	30.45	30.56	28.80	30.42	-0.53	-0.41	0.124	0.209	0.669587	0.000081	Recovered	27.23	30.09	1.3	1.695
612	Brant Lake	1	Yes	58.30	56.70		Yes	57.73	57.87	58.35	58.35	57.47	58.31	-0.23	-0.31	-0.089	0.430	**0.009022**	0.000153	Recovered	56.38	58.152	1.0225	1.1625
613	Brooker Lake	1	No			61.00	N/A	62.58	62.65	63.14	63.04	62.46	63.10	-0.56	-0.31	0.245	0.115	0.307720	0.000047	Recovered	62.26	63.02	1.58	1.645
615	Browns Lake	1	No			60.75	N/A	61.66	61.66	62.86	62.77	61.53	62.60	-0.45	-0.35	0.097	0.511	0.768002	-0.000018	Recovered	61.45	62.4726857	0.91	0.9125
616	Buck Lake	1	No			31.30	N/A	Analyzed separately by Brian Ormiston						-0.62	-0.43	0.192	0.069	**0.000002**	-0.000287	Not Impacted by Wellfield Pumpage			-0.13	-0.27
617	Burrell Lake	0	No			47.50	N/A	48.05	48.59	49.04	49.19	47.51	48.97	-0.46	-0.34	0.114	0.441	**0.000000**	0.001275	Recovered	46.74	49.01	0.55	1.085
618	Calm Lake	1	Yes	49.60	47.70		No	49.67	49.79	50.36	50.39	49.20	50.23	-0.49	-0.33	0.165	0.103	**0.000011**	0.000292	Recovered	47.7573548	49.806	1.9625	2.09
620	Camp Lake	1	Yes	63.40	62.00		No	62.50	62.51	63.46	63.39	61.81	63.29	-0.80	-0.47	0.335	**0.015**	**0.024096**	-0.000184	Recovered	60.76	63.109	0.5	0.505
621	Carroll Lake	0	Yes	36.80	35.40		Yes	36.14	36.26	36.81	36.74	36.26	36.85	-0.57	-0.26	0.304	**0.024**	**0.000010**	0.000272	Recovered	35.53	36.7431765	0.741365	0.8675

622	Catfish Lake	0	No			65.50	N/A	67.07	67.09	67.60	67.61	66.99	67.55	-0.19	-0.23	-0.038	0.783	0.099524	0.000081	Recovered	66.76	67.428	1.565	1.59
623	Cedar Lake East	0	No			ND	N/A	ND	37.04	ND	37.32	36.92	37.33		-0.26	ND		0.213605	0.000183	Recovered	36.7479516	37.195		
	Cedar Lake West	0	No			ND	N/A	38.85	39.03	39.25	39.28	38.95	39.25		-0.26	ND		**0.010269**	0.000269	Recovered	38.65	39.22		
624	Chapman Lake	1	No			49.50	N/A	50.99	50.96	51.31	51.31	50.96	51.35	-0.37	-0.19	0.180	0.168	0.098797	-0.000064	Recovered	50.5216667	51.264	1.49	1.46
625	Charles Lake	1	Yes	53.30	51.90		No	52.10	52.10	53.48	53.40	52.12	53.29	-0.45	-0.15	0.303	0.212	**0.029572**	-0.000161	Recovered	52.06	52.99	0.2	0.2
626	Church Lake	1	Yes	35.20	34.40		Yes	35.34	35.33	35.88	35.75	35.14	35.78	-0.57	-0.33	0.244	0.080	0.290628	-0.000052	Recovered	34.48	36.1702361	0.94	0.925
3	Clear Lake	2	No			66.05	N/A	68.65	69.17	69.53	69.58	68.14	69.47	-0.29	-0.26	0.034	0.858	**0.000000**	0.000516	Recovered	68.05	69.42	2.57	3.1
627	Commiston Lake	0	No			60.50	N/A	62.34	62.40	62.60	62.62	62.18	62.58	-0.58	-0.39	0.194	0.155	0.367100	0.000048	Recovered	61.79	62.6	1.84	1.895
629	Cooper Lake	1	No			59.75	N/A	60.00	59.98	60.66	60.60	59.78	60.59	-0.49	-0.20	0.283	**0.047**	0.469574	-0.000038	Recovered	59.82	61.1938667	0.25	0.225
630	Cow (East) Lake	0	No			76.00	N/A	77.85	77.86	78.16	78.17	77.78	78.14	-0.16	-0.18	-0.015	0.886	0.605668	-0.000020	Recovered	77.64	78.062	1.85	1.86
631	Crenshaw Lake	2	Yes	54.45	53.45		Yes	55.33	55.31	56.28	56.13	55.07	56.25	-0.62	-0.44	0.176	0.217	**0.038026**	-0.000171	Recovered	54.1	55.8629032	1.89	1.88
632	Crescent Lake	2	Yes	41.30	40.30		Yes	41.89	41.90	42.16	42.20	41.75	42.11	-0.48	-0.34	0.135	0.435	0.869504	-0.000007	Recovered	41.59	42.087	1.575	1.585
25	Crews Lake	0	Yes	52.40	51.00		Yes	50.36	51.49	52.73	53.20	50.18	52.57	-0.47	-0.37	0.098	0.656	**0.000000**	0.001502	Recovered	50.6873333	53.4550323	-0.64	0.31
633	Crystal Lake	1	Yes	60.40	59.00		No	59.67	59.78	60.48	60.48	59.49	60.43	-0.46	-0.45	0.011	0.917	0.328608	0.000072	Recovered	58.9766667	60.4188	0.6675	0.775
634	Curve Lake	0	No			ND	N/A	76.64	76.90	77.51	77.55	76.28	77.43	-0.31	-0.33	-0.020	0.865	**0.004066**	0.000194	Recovered	75.7762903	77.087		
636	Cypress Lake	1	Yes	48.89	47.89		Yes	48.75	48.79	49.26	49.27	48.52	49.19	-0.50	-0.28	0.221	0.084	0.899144	0.000006	Recovered	48.185	49.157	0.86	0.895
252	Dan Lake	2	Yes	32.30	30.90		No	30.98	31.42	32.65	32.69	30.16	32.55	-0.54	-0.40	0.140	0.632	**0.000252**	0.000620	Improved, Not Fully Recovered	27.3430645	32.0805	0.175	0.5525
368	Darby Lake	1	No				N/A	Analyzed separately by Brian Ormiston						-0.55	-0.57	-0.022	0.952	**0.000067**	0.000351	Recovered			-0.27	0.32
637	Deer Lake	1	Yes	66.50	65.10		Yes	65.85	66.20	66.74	66.76	65.54	66.67	-0.50	-0.31	0.191	0.153	**0.000000**	0.000445	Recovered	64.92	66.567157	0.745	1.095
638	Dosson Lake	1	Yes	53.90	52.80		No	53.38	53.39	54.09	54.09	53.06	54.03	-0.41	-0.42	-0.009	0.954	0.132147	-0.000110	Recovered	52.48875	53.7244444	0.575	0.59
639	Echo Lake	1	Yes	35.20	34.40		Yes	35.34	35.33	35.88	35.75	35.14	35.78	-0.13	-0.32	-0.186	0.100	0.226279	-0.000061	Recovered	34.48	36.1702361	0.885	0.885
640	Eckles Lake	0	No			30.00	N/A	31.04	31.21	31.71	31.77	31.21	31.74	-0.30	-0.33	-0.036	0.807	**0.001916**	0.000189	Recovered	30.66	31.502	1.035	1.21
642	Elaine Lake	0	No			34.50	N/A	35.47	35.56	36.32	36.12	35.60	36.52	-0.62	-0.37	0.245	0.112	0.056716	0.000139	Recovered	35.37	36.32	0.965	1.06
643	Elizabeth Lake	0	No			51.00	N/A	52.29	52.16	53.40	53.29	52.09	53.38	-0.73	-0.50	0.230	0.109	0.217589	-0.000105	Recovered	51.57	53.235	1.29	1.155
644	Ellen Lake	0	No			ND	N/A	40.61	40.66	40.80	40.79	40.66	40.80	-0.31	-0.14	0.167	0.147	0.588748	0.000078	Recovered	40.3459032	40.7815333		
645	Fairy (Maureen) Lake	1	Yes	33.41	32.41		Yes	32.86	32.83	33.33	33.22	32.84	33.34	-0.52	-0.17	0.350	**0.023**	**0.009675**	-0.000129	Recovered	32.71	33.4	0.44	0.41
646	Fern Lake	1	No			43.00	N/A	42.73	42.76	43.32	43.30	42.48	43.26	-0.40	-0.17	0.234	0.067	0.962760	0.000002	Improved, Not Fully Recovered	42.3696774	43.18	-0.27	-0.24
647	Floyd Lake	1	No			66.00	N/A	67.62	67.63	68.05	68.02	67.50	68.02	-0.26	-0.30	-0.036	0.790	0.729940	-0.000017	Recovered	67.265	67.94	1.62	1.625
648	Flynn Lake	0	No				N/A	Analyzed separately by Brian Ormiston						-0.58	-0.20	0.377	0.303	**0.000000**	0.001361	Recovered				

649	Garden (Thomas) Lake	1	Yes	30.50	29.50		Yes	30.77	31.03	32.00	31.99	30.27	31.87	-0.40	-0.29	0.108	0.565	0.400444	0.000079	Recovered	28.9916667	31.42325	1.27	1.525
651	Gass Lake	1	No			46.25	N/A	47.84	47.93	48.79	49.05	47.74	48.46	-0.42	-0.25	0.163	0.220	**0.000000**	0.000368	Recovered	47.4	48.266	1.59	1.675
653	George (Hillsborough) Lake	0	No			45.00	N/A	45.89	45.93	46.17	46.22	45.91	46.18	-0.58	-0.26	0.314	**0.024**	**0.032673**	0.000088	Recovered	45.48	46.135	0.89	0.925
37	Goose Lake	2	No			70.06	N/A	71.19	72.17	73.60	73.95	70.46	73.16	-0.72	-0.19	0.526	**0.003**	**0.000000**	0.000449	Recovered	70.185	72.444	1.145	2.15
655	Gooseneck Lake	1	No			71.00	N/A	73.32	73.56	74.11	74.13	72.64	74.00	-0.30	-0.33	-0.030	0.834	**0.000618**	0.000281	Recovered	71.95	73.814	2.32	2.56
657	Green Lake	0	Yes	74.20	71.90		Yes	73.47	73.82	74.60	74.66	73.22	74.46	-0.35	-0.37	-0.016	0.877	**0.000000**	0.000513	Recovered	73.01	74.424	1.57	1.915
658	Halfmoon Lake	0	Yes	43.30	42.30		Yes	42.89	42.99	43.38	43.36	42.68	43.38	-0.29	-0.16	0.127	0.523	**0.003104**	0.000168	Recovered	42.32	43.81525	0.59	0.69
659	Halls Lake	0	No			47.50	N/A	49.12	49.16	49.59	49.59	49.15	49.60	-0.51	-0.32	0.188	0.146	**0.043057**	0.000103	Recovered	48.64	49.44	1.62	1.655
660	Hanna Lake	0	Yes	61.50	60.00		Yes	61.10	61.15	61.67	61.78	60.74	61.61	-0.30	-0.34	-0.040	0.729	0.069183	0.000141	Recovered	60.6	61.54	1.10121	1.145548
661	Harvey Lake	1	Yes	62.10	60.70		Yes	60.97	61.00	61.83	61.67	60.80	61.75	-0.54	-0.33	0.206	0.187	0.585899	-0.000033	Recovered	60.58	61.6952258	0.295	0.315
662	Helen Lake	0	Yes	53.15	52.15		Yes	53.20	53.31	53.87	53.87	52.99	53.84	-0.46	-0.37	0.089	0.414	0.614077	-0.000033	Recovered	52.75	53.775	1.05	1.18
663	Hiawatha Lake	2	No			48.00	N/A	49.80	49.86	50.55	50.45	49.74	50.50	-0.45	-0.25	0.197	0.116	0.367293	0.000049	Recovered	49.42	50.3045	1.8	1.86
665	Hobbs Lake	1	Yes	65.70	64.00		No	64.57	65.14	65.82	65.98	64.18	65.72	-0.44	-0.37	0.067	0.449	**0.000000**	0.000843	Recovered	64.1283333	66.2555	0.565	1.14
666	Hog Island Lake	0	No			64.00	N/A	64.89	64.91	65.40	65.39	64.78	65.39	-0.41	-0.26	0.153	0.213	0.601113	-0.000024	Recovered	64.64	65.515	0.885	0.905
119	Horse Lake	1	Yes	44.90	43.90		No	46.12	46.42	47.17	47.20	45.42	47.09	-0.59	-0.42	0.170	0.175	**0.000000**	0.000625	Recovered	45.1	48	2.221452	2.515935
667	Island Ford Lake	1	No			39.00	N/A	40.89	40.91	41.20	41.23	40.78	41.22	0.01	-0.29	-0.300	**0.011**	0.222485	0.000050	Recovered	40.426129	41.1104138	1.89	1.905
392	Jackson Lake	1	Yes	33.00	32.00		Yes	33.07	33.15	33.88	34.00	32.81	33.85	-0.52	-0.44	0.074	0.632	0.965241	0.000003	Recovered	31.986	33.416	1.07	1.1475
669	James Lake	1	No			43.50	N/A	45.38	45.39	45.87	45.77	45.30	45.83	-0.56	-0.26	0.300	**0.029**	0.511667	-0.000026	Recovered	44.7	45.7	1.88	1.89
670	Jo Ann Lake	0	No			65.50	N/A	66.99	67.05	67.50	67.49	66.94	67.42	-0.28	-0.30	-0.016	0.904	0.132589	0.000079	Recovered	66.655	67.29	1.485	1.55
671	Josephine Lake	0	No			42.75	N/A	44.26	44.14	44.73	44.54	44.26	44.74	-0.53	-0.49	0.040	0.816	**0.000001**	-0.000219	Recovered	44.08	44.66	1.51	1.385
672	Joyce (Hog) Lake	0	No			73.50	N/A	75.21	75.24	75.41	75.42	75.15	75.37	-0.14	-0.21	-0.071	0.534	0.694977	-0.000015	Recovered	75.195	75.71	1.705	1.74
673	Juanita Lake	1	Yes	41.80	40.30		No	41.29	41.60	42.22	42.23	40.71	41.96	-0.64	-0.39	0.243	0.064	**0.000000**	0.000631	Recovered	39.81	41.8288889	0.985	1.3
674	Keene Lake	0	Yes	61.50	60.10		Yes	62.26	62.33	62.49	62.48	62.10	62.46	-0.26	-0.24	0.011	0.923	0.190313	0.000064	Recovered	61.855	62.56	2.157	2.230548
675	Kell Lake	0	Yes	65.60	64.20		Yes	65.48	65.53	65.86	65.81	65.40	65.81	-0.31	-0.17	0.136	0.283	0.202131	0.000044	Recovered	65.34	65.898	1.3	1.33
676	Keystone Lake	1	No			39.75	N/A	41.53	41.54	41.78	41.77	41.37	41.75	-0.43	-0.26	0.161	0.125	0.110724	-0.000059	Recovered	40.7477151	41.6265574	1.790145	1.825
678	King Lake (West) at Drexel	0	Yes	72.40	70.80		Yes	71.82	71.93	72.49	72.56	71.77	72.64	-0.30	-0.35	-0.045	0.677	0.053455	0.000116	Recovered	71.51	72.5948	1.02	1.13
679	LeClare Lake	0	No			49.50	N/A	51.03	51.21	51.92	51.91	50.69	51.72	-0.50	-0.28	0.224	0.051	**0.000182**	0.000231	Recovered	50.16	51.4015	1.5275	1.71
680	Linda Lake	1	Yes	66.20	64.70		Yes	65.37	65.47	66.00	65.96	65.12	65.96	-0.56	-0.31	0.251	0.055	0.349671	0.000055	Recovered	64.71	65.8457	0.665	0.77
681	Lipsey Lake NR Sulphur Springs	0	No			39.00	N/A	40.46	40.46	40.74	40.74	40.45	40.74	-0.29	-0.28	0.010	0.958	0.474515	0.000023	Recovered	39.9147667	40.58	1.46	1.46
683	Little Lake	1	No			43.50	N/A	45.32	45.31	45.80	45.74	45.29	45.81	-0.59	-0.23	0.354	**0.009**	0.499204	-0.000031	Recovered	44.9	45.95	1.82	1.805
684	Little Moon Lake	1	Yes	39.60	38.20		No	38.81	39.04	39.74	39.74	38.30	39.62	-0.39	-0.42	-0.030	0.855	**0.000000**	0.000521	Recovered	37.34	39.414	0.6075	0.835
685	Little Moss (Como) Lake	1	No			63.00	N/A	64.99	65.07	65.57	65.67	64.77	65.50	-0.41	-0.27	0.144	0.235	0.152414	0.000071	Recovered	64.69	65.448	1.99	2.065
686	Long Lake	1	No			48.00	N/A	49.98	50.90	51.85	52.18	49.33	51.61	-0.51	-0.38	0.127	0.422	**0.000000**	0.001336	Recovered	47.97	51.165	1.98	2.9

687	Magdalene Lake	1	No			47.50	N/A	49.04	49.05	49.45	49.44	49.05	49.47	-0.42	-0.27	0.142	0.136	0.062761	0.000093	Recovered	48.22	49.3009871	1.539717	1.553946
688	Marlee Lake	1	No			ND	N/A	33.92	34.15	34.77	34.73	33.51	34.67	-0.64	-0.49	0.150	0.217	**0.007365**	0.000216	Recovered	33.04	34.58		
689	Merrywater Lake	2	Yes	57.40	56.00		No	57.31	57.33	57.57	57.57	57.02	57.49	-0.49	-0.04	0.446	0.326	0.841549	-0.000014	Recovered	55.5458333	57.395	1.31	1.33
472	Moon Lake (Pasco)	0	Yes	39.60	38.20		Yes	39.29	39.66	40.16	40.36	38.83	40.12	-0.29	-0.15	0.139	0.124	**0.000053**	0.000388	Recovered	38.43	39.98	1.4	1.46
692	Moss Lake	1	No			61.50	N/A	62.35	62.40	63.20	63.17	62.22	63.16	-0.43	-0.29	0.136	0.343	0.997737	0.000000	Recovered	62.105	63.1	0.995	0.845
693	Mound Lake	0	Yes	50.70	49.30		Yes	49.60	49.45	50.08	49.87	49.61	50.11	-0.43	-0.20	0.232	0.051	**0.000000**	-0.000251	Recovered	49.535	50.1377778	0.3	0.15
695	Mud Lake (Geneva Lake)	1	No			48.00	N/A	49.18	49.18	49.69	49.67	49.08	49.72	-0.54	-0.29	0.251	**0.040**	0.504183	-0.000034	Recovered	49.08	49.75	1.175	1.175
696	Myrtle Lake	0	No			65.50	N/A	66.96	67.01	67.50	67.51	66.87	67.43	-0.24	-0.23	0.003	0.983	0.079574	0.000086	Recovered	66.645	67.302	1.455	1.51
697	Noreast Lake	0	No			ND	N/A	34.81	34.89	35.31	35.36	34.85	35.35		-0.18	ND		0.014755	0.000133	Recovered	34.76	35.244		
698	Osceola Lake	2	No			44.50	N/A	45.83	45.75	46.50	46.33	45.64	46.28	-0.44	-0.18	0.258	0.079	0.061531	-0.000093	Recovered	45.385	46.36775	1.33	1.245
699	Padgett Lake	0	Yes	70.00	68.60		Yes	69.23	69.30	70.14	69.98	69.15	70.15	-0.20	-0.29	-0.087	0.579	0.560843	0.000034	Recovered	69.4288387	70.400871	0.625	0.695
32	Pasco Lake	2	Yes	65.30	61.80		No	60.09	61.78	65.88	65.98	60.00	65.62	-0.58	-0.83	-0.253	0.745	**0.000000**	0.001530	Improved, Not Fully Recovered	59.9	65.8144445	-1.715	-0.02
701	Pierce Lake	0	Yes	71.90	69.80		Yes	71.43	71.77	72.65	72.77	71.33	72.62	-0.42	-0.38	0.037	0.726	**0.000000**	0.000572	Recovered	71.025	72.543	1.63	1.965
702	Platt Lake	1	Yes	49.50	48.10		Yes	49.14	49.20	49.75	49.73	48.94	49.73	-0.51	-0.27	0.243	**0.044**	**0.021221**	0.000134	Recovered	48.5711111	49.722	1.04	1.1
703	Pretty Lake	1	Yes	43.90	42.50		Yes	44.19	44.04	44.57	44.43	44.22	44.59	-0.46	-0.33	0.127	0.391	**0.000000**	-0.000251	Recovered	43.635	44.517	1.695	1.54
24	Raft Lake	2	No			72.42	N/A	72.74	73.62	74.33	74.65	73.31	77.62	-0.23	-0.46	-0.232	0.260	**0.000000**	0.001273	Recovered	73.32	76.152	0.315	1.2
704	Rainbow Lake	1	Yes	39.60	38.20		No	39.03	39.23	39.99	40.00	38.45	39.77	-0.52	-0.43	0.095	0.421	**0.000000**	0.000550	Recovered	36.9575	39.5	0.815	1.015
705	Raleigh Lake	1	Yes	41.10	37.90		No	40.71	41.28	42.86	42.99	40.35	42.25	-0.34	-0.50	-0.157	0.147	**0.000000**	0.001452	Recovered	39.9848387	44	2.8075	3.385
706	Reinheimer Lake	1	Yes	58.90	57.50		Yes	59.00	59.05	59.58	59.58	58.84	59.39	-0.60	-0.23	0.373	**0.008**	0.096281	-0.000087	Recovered	58.18	59.28	1.5	1.545
709	Rogers Lake	1	Yes	38.70	35.60		No	37.44	38.19	41.04	41.85	37.08	39.34	-0.55	-0.44	0.112	0.368	**0.000000**	0.001964	Recovered	37.42125	43.4	1.823516	2.58
710	Round Lake	2	Yes	54.10	53.10		Yes	53.63	53.58	54.66	54.67	53.33	54.58	-0.33	-0.08	0.253	0.204	0.147546	-0.000221	Recovered	53.3351613	54.388	0.415	0.475
364	Ryals Lake	0	No			45.68	N/A	47.92	48.13	48.95	49.00	47.70	48.91	-0.30	-0.39	-0.090	0.458	0.111187	0.000120	Recovered	47.505	48.9213333	2.2375	2.45
711	Saddleback Lake	2	Yes	54.60	53.10		Yes	53.72	53.73	54.62	54.61	53.34	54.49	-0.39	-0.08	0.318	0.057	0.531968	-0.000043	Recovered	53.3671364	54.61	0.615	0.625
712	Sapphire Lake	1	Yes	63.50	61.80		Yes	62.67	62.83	63.63	63.70	62.44	63.55	-0.51	-0.41	0.105	0.462	0.172273	0.000099	Recovered	61.95	63.51	0.87	1.03
714	Saxon Lake	0	No			69.00	N/A	69.28	69.35	70.17	70.15	69.18	70.15	-0.44	-0.28	0.157	0.200	0.490951	0.000044	Recovered	69.265	70.44	0.28	0.345
741	Seminole Lake	2	No			46.00	N/A	47.17	47.21	47.86	47.79	47.02	47.78	-0.41	-0.26	0.148	0.247	0.795326	-0.000013	Recovered	46.91	47.938	1.17	1.21
715	Simmons Lake	2	No			ND	N/A	52.89	53.18	53.72	53.72	52.68	53.69	-0.59	-0.23	0.361	**0.042**	0.061670	0.000247	Recovered	46.2875	53.2153333		
161	Stanford Lake	0	No			71.13	N/A	71.36	72.13	73.33	73.98	70.67	73.35	-1.34	-0.44	0.894	**0.003**	**0.000000**	0.000488	Recovered	69.99	73.21	0.225	1
717	Starvation Lake	2	Yes	52.70	50.40		Yes	52.85	53.14	53.91	53.94	52.31	53.73	-0.73	-0.43	0.300	0.060	0.100664	0.000750	Recovered	49.8242188	53.1745625	2.445	2.735
718	Stemper Lake	0	Yes	60.80	59.40		Yes	60.64	60.69	61.01	61.01	60.36	61.01	-0.52	-0.27	0.243	**0.043**	**0.023012**	0.000149	Recovered	60.22	61.2562	1.24	1.285
719	Strawberry Lake	1	Yes	60.10	59.10		Yes	59.96	59.99	60.60	60.60	59.79	60.54	-0.47	-0.31	0.162	0.219	0.380271	0.000472	Recovered	59.5	60.6004615	0.86	0.885
720	Sunset Lake	1	Yes	33.60	32.30		Yes	32.82	32.95	33.70	33.77	32.68	33.66	-0.43	-0.33	0.096	0.302	0.541875	0.000274	Recovered	32.42	33.33	0.52	0.645
721	Sunshine (Sunrise) Lake	1	Yes	53.90	52.80		No	53.26	53.27	54.00	53.96	52.90	53.95	-0.87	-0.35	0.518	0.066	0.064185	0.000315	Recovered	52.41	53.6615	0.46	0.47

722	Tampa (Turtle) Lake	1	No			63.00	N/A	63.63	63.82	64.47	64.55	63.49	64.45	-0.22	-0.28	-0.060	0.660	**0.000000**	0.000457	Recovered	63.27	64.56	0.63	0.815
723	Taylor Lake	0	Yes	38.20	37.20		Yes	38.18	38.25	39.10	39.08	37.97	39.05	-0.63	-0.41	0.221	0.068	0.568233	0.000037	Recovered	37.3791111	38.627	0.98	1.05
724	Thomas Lake	1	No			61.25	N/A	62.68	62.75	63.17	63.14	62.40	63.12	-0.50	-0.38	0.126	0.236	0.447537	0.000041	Recovered	61.8763889	63.0257	1.43	1.5025
725	Thorpe Lake	1	No				N/A	Analyzed separately by Brian Ormiston						-0.96	-0.59	0.374	0.559	0.290628	-0.000053	Recovered				
726	Toni Lake	0	No			65.50	N/A	66.42	66.46	67.15	67.15	66.33	67.16	-0.25	-0.38	-0.124	0.377	0.420222	0.000053	Recovered	66.215	67.1546667	0.915	0.96
727	Turkey Ford Lake	0	No			51.50	N/A	Analyzed separately by Brian Ormiston						-0.48	-0.28	0.190	0.234	0.538641	-0.000055	Recovered			-0.545	-0.535
729	Twin Lake (Pasco)	1	No			65.00	N/A	68.16	68.44	68.67	68.69	67.06	68.57	-0.24	-0.03	0.210	0.374	**0.000000**	0.000999	Recovered	66.46	68.38	3.05	3.31
730	Unnamed Lake 1B14	2	No				N/A	Analyzed separately by Brian Ormiston						-0.24	-0.11	0.122	0.563	0.400548	0.000048	Recovered			1.56	1.68
731	Unnamed Lake 2B14	2	No				N/A	Analyzed separately by Brian Ormiston						-0.25	-0.30	-0.057	0.746	0.441519	0.000044	Recovered			1.56	1.68
732	Unnamed Lake 22 (Loyce)	2	Yes	59.30	55.80		Yes	59.50	59.82	60.30	60.60	59.20	60.13	-0.24	-0.27	-0.031	0.805	**0.000000**	0.001160	Recovered	57.6175	60.164	3.67	4.02
157	Unnamed Lake 26	0	No			64.18	N/A	66.48	66.54	67.23	67.25	66.37	67.25	-0.39	-0.38	0.012	0.947	0.228468	0.000080	Recovered	66.3	67.306	2.295	2.36
734	Van Dyke Lake	1	No				N/A	Analyzed separately by Brian Ormiston						-0.11						Recovered				
736	Virginia Lake	1	Yes	62.10	60.70		Yes	61.04	61.07	61.88	61.80	60.80	61.84	-0.53	-0.34	0.186	0.145	0.797659	-0.000016	Recovered	60.44	61.62	0.335	0.365
737	Wastena Lake		No				N/A	Analyzed separately by Brian Ormiston												Recovered				
738	White Trout Lake	0	No			34.00	N/A	35.16	35.20	35.86	35.80	35.17	35.87	-0.12	-0.20	-0.085	0.465	0.081969	0.000090	Recovered	34.97	35.748	1.155	1.195
739	Wistaria Lake	0	No			71.00	N/A	72.75	72.79	73.41	73.47	72.60	73.38	-0.48	-0.34	0.132	0.185	0.472098	0.000050	Recovered	72.41	73.38	1.75	1.79
740	Wood Lake	0	No			47.30	N/A	Analyzed separately by Brian Ormiston						-0.65	-0.28	0.367	0.054	0.181083	-0.000057	Recovered			0.605	0.595

WY 2003 - Cross Bar Ranch, Cosme-Odessa, Cypress Bridge, Cypress Creek, Eldridge-Wilde, Morris Bridge, and South Pasco
WY 2005 - Section 21
WY 2008 - J.B. Starkey and North Pasco
WY 2012 - Northwest Hillsborough Regional Wellfield
ROD = Rate of Decline
Any P values provided in bold are statistically significant. P values were considered in conjunction with the data field they analyzed, however they are not considered as an additional piece in the Weight-of-Evidence.

Table 8.2 presents the information listed above for each of the monitored lakes, where such data or analysis could be completed. The data contained in this table was compiled from the Tampa Bay Water and Dr. Ormiston updated analyses of lake levels through September 2019 and the District's 2018 MFL lake status assessment. In the table, the individual spreadsheet cells are color coded; green means that the metric has been exceeded or a trend is positive, yellow means that the computed level was within 0.5 foot below the lake reference elevation, and red means that the computed lake level was greater than 0.5 foot below the lake reference elevation or the metric was not met. The 0.5-foot threshold was selected as a screening level to identify the data values that are below but relatively close to or further below the applicable lake level. When examining the weight of the evidence, the multiple lines of evidence were examined for each lake to determine what the majority of data indicators revealed about its current hydrology and health.

The current Consolidated Permit requires Tampa Bay Water to assess the recovery that is attributable to the reduction in pumping from the northern wellfields; therefore, the analysis was focused on the empirical water level data from the monitored lakes since the reduction in wellfield pumping began. The final status decision (bin) for each lake was based on the data that could demonstrate a difference or change in lake levels following the reduction in wellfield pumping rate. For example, if the water level trend for a lake improved in the period following the pumping reduction (became less negative or changed from negative to positive), that indicates improvement that could be attributed to the lower pumping rate. If the rate of water level decline in the spring dry season was less following the wellfield pumping cutback, that indicates improved water levels likely due to the pumping reductions. Most importantly, if the recorded lake water levels in the recent periods (6 or 10 years) and since the date of pumping reduction at the nearest wellfield are above the specified minimum or management level(s), that strongly indicates water level recovery. None of these factors or data indicators by themselves prove recovery in lake levels due to the reduction in wellfield pumping but if the majority of the indicators show recovery after the time of pumping reduction, that weight-of-evidence strongly supports these conclusions.

The weight-of-evidence approach is appropriate for assessment of the monitored lakes due to the multiple influences on lake water levels including the impact of local-scale hydrogeology, the temporal and spatial extent of wellfield pumping related to the impacts of climate, rainfall variability, and the effects of man's alteration of the surrounding landscape. The empirical water level data from the lakes are collected using robust collection procedures, quality control of the data, and provide the best means of assessing the health and current state of monitored lakes.

In this final assessment of lakes, staff considered the District's 2018 lake status assessment as one line of evidence but the District status assessment was not weighted higher than other lines of evidence. The assessment of empirical water level data since the reduction in wellfield pumping and field assessments of current environmental health were also essential to complete this assessment of recovery at monitored lakes. The most recent status assessment is an important line of evidence but has been given equal weight with all other lines of evidence due to the error and uncertainty contained in the methods used to establish the levels and in the status assessment analytical methods.

The modeling techniques used by the District to establish lake Minimum Levels and then to assess the annual status with respect to those regulatory levels are all approximations of the physical system. They numerically simulate or correlate the interaction between lake levels, rainfall, evaporation, runoff, aquifer levels, and the effects of channel flow into and out of a lake. While the individual models used in the analyses may perform well and generate reasonable data, the data carried forward into subsequent analyses are approximations and contain unquantified error. These multiple error terms may cancel out or compound as subsequent analytical methods are implemented but this inherent error creates an unquantified level of uncertainty both in the established Minimum Levels and the annual status assessment.

Tampa Bay Water and District staff have long discussed the issue of error and uncertainty in the establishment of lake Minimum Levels and the assessment of status or compliance with the Minimum Levels. These potential sources of error include estimations of water leakance through lakebed sediments, the effects of control structures in some lakes and their influence on the lake levels, and the estimated effect of wellfield pumping on lake levels using the Integrated Northern Tampa Bay (INTB) model. This model is used by both Tampa Bay Water and the District for multiple purposes and is considered to be the best available tool to simulate the local hydrologic system. The water level and flow data simulated by the INTB model are approximations of a complex physical system. All models include error which can be quantified by comparing simulated to observed responses at target locations. Although the INTB model includes error as all models do, the model provides robust flow and level responses to changes in stresses (WEST et al. 2013 and Ross, M., and Trout, K., 2017). Model error should be reduced where possible and uncertainty in the model results should be quantified prior to application of model results to subsequent analyses such as MFL development and status assessment. INTB model error was not reduced and uncertainty in aquifer water levels was not quantified by the District within the lake MFL development and status assessment processes to date.

Tampa Bay Water and District staff discussions have included the topic of applying a time-varying drawdown predicted by the INTB model (aquifer drawdown that changes with variable pumping rates) rather than applying a constant value of aquifer drawdown for multiple years based on a long-term average wellfield pumping rate. District staff assessed this issue and found that at least for some lakes, application of time-varying drawdown during the establishment of lake Minimum Levels made a significant difference. This revised method of approximating drawdown was applied during the reestablishment of Minimum Levels for five lakes during 2019 but this issue has not been addressed for the lakes whose levels were initially established or revised prior to 2019. Application of this updated process may result in Lake Minimum Levels that are higher or lower than the levels adopted into Chapter 40D-8, F.A.C.

Uncertainty also exists in the process of establishing a lake High Minimum Level. The water budget models used by the District to develop the Minimum and High Minimum Levels are primarily calibrated to the median (P50) water level which is used to set the Minimum Level for a lake. District staff work to calibrate the water budget model to the extremes of the lake water level hydrograph but there is acknowledged error in the generated P90 (low) and P10 (high) water levels. Since the P10 water level is used to set the High Minimum Level for a lake, this regulatory level contains an unspecified amount of error. There has also been discussion between Tampa Bay Water and the District about the applicability of a High Minimum Level with respect to the influence of ground water pumping. Median and low water levels in a lake may show the influence of nearby ground water pumping but high lake levels are more likely controlled by rainfall and the outfall structures present at most lakes.

The annual lake status assessments are performed by correlating lake level data with rainfall data from the "current" period when hydrologic stresses and structural alterations are reasonably stable and extrapolating the water level time series from this "current" period backward for a total of about 70 years. This statistical analysis is performed by correlating lake levels to historical rainfall data to produce a long-term time series of lake levels to minimize the effect of rainfall variation. This methodology contains an undefined degree of uncertainty associated with the historic rainfall data and the error inherent in the statistical method. District staff are currently working to complete a status assessment method that accounts for the uncertainty in this lake level/rainfall correlation model. This method would apply a band around the lake Minimum Level to determine if the long-term water level departure from the Minimum Level falls within the range of uncertainty defined for the lake model. Since this method was not finalized at the time this report was prepared, Tampa Bay Water included the results of the District's 2018 lake status assessment in the weight-of-evidence analysis for monitored lakes.

Tampa Bay Water has also previously expressed concern about the establishment of a lake Minimum Level using hydrologic data and water level data generated by a series of models. When the lake is assessed by the District to determine if the lake meets the Minimum Level, the modeled data is used without a field investigation of the lake to determine if any adverse impact condition exists. In similar manner, the annual status assessments are made using statistically-derived water level data and the actual ecological conditions of the lakes are not investigated. In some cases, the District assessment of a lake is "not meeting the Minimum Level" yet no adverse impact condition exists at that lake.

The primary benefit of using the annual lake status assessment in our weight-of-evidence approach is that the District's status assessment factors out the effects of rainfall variation to a reasonable degree by using a statistically-derived long-term time series of lake water levels. However, the original lake Minimum Levels and the annual status assessments are still modeled simulations of a complex physical system. In contrast, the empirical water level data is a reflection of the actual interaction of all physical processes that the multiple models attempt to simulate. The actual water level in a lake at any point in time is the response due to prior actual rainfall received, actual evapotranspiration from the lake, actual runoff from surrounding lands including inflow and outflow through ditches and canals, the actual influence of wellfield pumping, plus unknown factors such as lake bottom leakage. While the different methods of assessing this empirical data attempt to remove the effects of variable rainfall, the individual lines of evidence also contain some uncertainty due to their shorter time periods of assessment; they reflect a smaller range of potential rainfall conditions. Tampa Bay Water's method relies on the use of actual data and assessments of the data instead of relying solely on model predictions.

Tampa Bay Water has completed this weight-of-evidence analysis of lake recovery with the understanding that the empirical data does not define a cause and effect assessment of water level change. By assessing all lines of available evidence, this weight-of-evidence approach considers the undefined error and uncertainty in the data and all available assessment methods, the complexity of the physical system, and the multiple factors that affect lake water level and health. It is only by examining all of the available lines of evidence that a determination of whether or not a lake has recovered due to the reduction in wellfield pumping rates can be made; this is the most reasoned approach for the final assessment of recovery given the abundance of empirical data collected before and after the reduction of pumping at the northern wellfields. The final results of the weight-of-assessment of monitored lakes are presented in Table 8.2 which shows the individual lines of evidence and data used to assign a recovery bin to each lake. A regional discussion of the weight-of-evidence approach is included in Chapter 13.

8.6 District Review of “Improved” and “Other” Lakes

The District Regulatory staff performed a site review of many of the lakes that were categorized as “Improved” in the Preliminary Report of Findings (Tampa Bay Water, 2018b). These site reviews were performed in late 2019 and early 2020 to evaluate the current ecological condition of these lakes with respect to adverse impact criteria found in Chapter 40D-2, F.A.C. These site reviews serve multiple purposes since the District’s annual lake status assessments and Tampa Bay Water’s assessment of empirical data and trends are both focused on the hydrology of the monitored lakes. Inherent in both the annual lake status assessment and this analysis of empirical lake data are the established Minimum Lake levels for applicable lakes which assume ecological health if a certain water level is achieved on a “long-term” basis.

The District site reviews provided an ecological assessment of the reviewed lakes to determine if adverse impacts were present based on permitting criteria. This objective review of lake health provides a meaningful verification of the methodology used to assess the recovery or health status of monitored lakes. Performing this assessment at sites previously categorized as “Improved” allows staff to determine if this status is accurate. The field assessment of ecological health can also be used to modify the final proposed recovery bin for a lake. If an adverse impact is observed given the post-cutback wellfield pumping levels, a lake status may be downgraded from “Improved” to “Continued Impact” and the need for mitigation assessed. If a lake showed no sign of impact, the lake status may be upgraded to “Recovered”.

The Recovery Assessment Plan Preliminary Report of Findings (Tampa Bay Water, 2018b) reported 26 lakes with the status bin of “Improved” (Section 8.3). District staff performed a field assessment of 21 of these lakes between August 2019 and March 2020 to examine the current environmental condition of the lakes. District staff did not complete a field review of the remaining “Improved” sites due to lack of site access, flooded conditions preventing access during the time of the field reviews, and some of these sites had previously been visited by Tampa Bay Water and District staff during the review of wetlands for Recovery Assessment analyses. During these site reviews, District staff considered the hydrology, community structure, and location and landscape setting of each assessed lake to determine its ecological condition. The District field review of “Improved” lakes did not use quantitative criteria to assign a numeric score to the lakes but looked at these three factors to determine if an adverse impact was present at the time of the field assessment based on the adverse impact criteria found in Chapter 40D-2, F.A.C.

District staff reviewed historical aerial photography of each lake to understand the changes that have occurred in the surrounding landscape, including any evidence of water control structures or ditches entering or exiting the lake (location and landscape). Current and historic lake water levels and rainfall data were evaluated to inform the hydrology portion of the site assessment. Finally, the vegetation present at the lake was evaluated including plant species, the level of stress within the observed vegetation, and the appropriateness of plant species in relation to the lake and surrounding land uses. District Regulatory staff applied their professional judgement of these multiple factors to render an assessment of the 21 assessed lakes. As part of the assessment, District staff looked for signs of impact and potential causes of any observed stress or impact. The wellfield pumping record was examined as well as drainage changes in or surrounding the lake that could cause or contribute to an observed impact. If an impact was observed in the lake and no physical cause of that impact could be discerned from a review of the data, drainage features, or historical imagery, District staff would attribute the impact to the influence of wellfield pumping.

The sites were assessed as having non-adverse impact, adverse impact, or were designated as “other”. An assessment of non-adverse impact does not mean that no change or stress was present but that any observed impact was judged as non-adverse according to permitting rule criteria; the vegetation community at the lake was appropriate given the surrounding land use. Lakes that were determined to have an adverse impact had significant amounts of vegetation surrounding the lake that was inappropriate for the location, was invasive/exotic in nature, or signs of significant vegetation stress were observed (i.e., lake-fringing systems appeared unhealthy). Those lakes that received a designation of “other” were found to have impacts that were attributed to factors other than wellfield pumping, were significantly altered due to the surrounding upland development, or the predicted level of recovery did not match conditions observed in the field or in surrounding lakes and wetlands.

The data evaluated, photographs and field notes were assembled into individual wetland habitat assessment reports by the District staff for each assessed lake. The 21 lakes for which the District staff completed site assessments are listed on Table 8.3. The individual site assessment reports for the District-evaluated lakes and wetlands are included in Appendix 8.6 along with tables and maps summarizing the available data, location, review status. The field assessment results for these 21 lakes were considered in the final assignment of Recovery Assessment category bins for the monitored lakes. The application of the District field assessments to the final bins for monitored lakes is summarized in Section 8.7 and in Table 8.4.

Table 8.3: Lakes with Completed Habitat Assessments by District Staff

Site Name	County	Assessment Date(s)
Brant Lake	Hillsborough	11/19/2019
Calm Lake	Hillsborough	8/20/2019 and 10/22/2019
Camp Lake	Pasco	11/19/2019
Charles Lake	Hillsborough	10/5/2019
Church Lake	Hillsborough	1/23/2020
Crystal Lake	Hillsborough	10/22/2019
Darby Lake (202718)	Hillsborough	3/12/2020
Dosson Lake	Hillsborough	10/15/2019
Echo Lake	Hillsborough	1/23/2020
Fern Lake	Hillsborough	8/20/2019 and 10/22/2019
Hobbs Lake	Hillsborough	10/22/2019
Horse Lake (WC262717)	Hillsborough	10/15/2019
Juanita Lake	Hillsborough	1/23/2020
Linda Lake	Pasco	10/22/2019
Little Moon Lake	Hillsborough	1/23/2020
Merrywater Lake	Hillsborough	10/15/2019
Rainbow Lake	Hillsborough	1/23/2020

Site Name	County	Assessment Date(s)
Raleigh Lake	Hillsborough	10/5/2019
Rogers Lake	Hillsborough	10/5/2019
Sunrise/Sunshine Lake	Hillsborough	3/12/2020
Thorpe Lake	Hillsborough	1/23/2020

Bold - MFL Lake

Table 8.4: Monitored Lakes where Final Recovery Assessment Bin Differs from Preliminary Assessment Bin

Wetland ID	Lake Name	Preliminary Assessment Bin	Final Assessment Bin	Weight-of-Evidence Basis for Final Assessment Bin
15	**Big Fish Lake**	Continued Impact, Not Fully Recovered	Improved	Big Fish Lake median water levels meet the established Minimum Level (ML) for the past 6 years, are below the ML by 0.06 foot for the past 10 years and are 0.58 foot below the ML since the pumping cutback at the Cross Bar Ranch Wellfield. The recent 10-year increasing water level trend is statistically significant and the District 2018 MFL assessment shows Big Fish Lake as above the Minimum Levels. Significant improvement has been documented at this lake but the weight of all evidence considered indicates the lake is Improved for the purposes of the Recovery Assessment Plan.
608	**Bird Lake (Hillsborough)**	Improved	Recovered	Bird Lake median water levels meet the established ML and High Minimum Level (HML) for all post-cutback time periods. The recent 10-year increasing water level trend is statistically significant. The District 2018 MFL assessment shows Bird Lake as not meeting the Minimum Levels. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
414	Bonnet Lake	Improved	Recovered	Bonnet Lake was re-assessed using the xeric wetland metric due to the percentage of xeric soils surrounding the lake. With the updated assessment, the lake meets the site-specific recovery metric for all post-cutback time periods.
612	**Brant Lake**	Improved	Recovered	Brant Lake median water levels meet the established ML and HML for all post-cutback time periods. The District 2018 MFL assessment shows Brant Lake as above the Minimum Levels. Field review by District regulatory staff indicate the lake does not show signs of adverse impact. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
617	Burrell Lake	Improved	Recovered	Burrell Lake water levels meet the established Low Guidance Level for all post-cutback time periods.
618	**Calm Lake**	Improved	Recovered	Calm Lake median water levels meet the established ML and HML for all post-cutback time periods. The recent 10-year increasing water level trend is statistically significant. The District 2018 MFL assessment shows Calm Lake as not meeting the Minimum Levels. Field review by District regulatory staff indicate the lake does not show signs of adverse impact. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
620	**Camp Lake**	Improved	Recovered	Camp Lake median water levels meet the established ML for the past 6 and 10-year periods and are 0.19 foot below the ML for the post-cutback time period. The improvement in the rate of dry season water decline in the post-cutback period as compared to the pre-cutback period is statistically significant. The District 2018 MFL assessment shows Camp Lake as not meeting the Minimum Levels. Field review by District regulatory staff indicate the lake does not show signs of adverse impact. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
625	**Charles Lake**	Improved	Recovered	Charles Lake median water levels meet the established ML for all post-cutback time periods; the HML was met for the recent 6 and 10-year periods but the post-cutback time period was below the HML by 0.01 foot. The recent 10-year decreasing water level trend is statistically significant; however, this lake has been historically augmented (little or no augmentation during the past 10-year period) and records show that water has been pumped out of the lake during extreme high rainfall events, lowering the median water levels during the post-cutback periods. The District's revised MFL report for this lake (2019) concludes that the lake is currently above the ML and below the HML. Field review by District regulatory staff indicate the lake does not show signs of adverse impact. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
626	**Church Lake**	Improved	Recovered	Church Lake median water levels meet the updated Minimum Levels (ML and HML) for all post-cutback time periods assessed. The District's revised MFL report for this lake (2019) concludes that the lake is currently above the Minimum Levels.
3	Clear Lake	Continued Impact, Not Fully Recovered	Recovered	Clear Lake was re-assessed using the xeric wetland metric due to the presence of xeric soils surrounding the lake. With the updated assessment, the lake meets the site-specific recovery metric for all post-cutback time periods. This lake is augmented.
633	**Crystal Lake**	Improved	Recovered	Crystal Lake median water levels meet the established ML and HML for all post-cutback time periods. The District 2018 MFL assessment shows Crystal Lake as not meeting the Minimum Levels. Field review by District regulatory staff determined that impacts are due to causes other than wellfield pumping. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.

Wetland ID	Lake Name	Preliminary Assessment Bin	Final Assessment Bin	Weight-of-Evidence Basis for Final Assessment Bin
368	Darby Lake	Improved	Recovered	The recent 6-year median water level is 0.32 foot above and the 10-year median water level is 0.27 foot below the estimated minimum guidance level. The estimated guidance level is based on a wetland normal pool elevation that District regulatory staff estimated to be about 2.5 feet too high based on wetland indicators and water levels. No signs of adverse impact to the lake or fringing wetland. Using an updated, estimated normal pool elevation, the lake water level would exceed the estimated guidance level for the recent 6-year and 10-year periods.
638	**Dosson Lake**	Improved	Recovered	Dosson Lake median water levels meet the established ML and HML for all post-cutback time periods. The District 2018 MFL assessment shows Dosson Lake as not meeting the Minimum Levels. Field review by District regulatory staff indicate the lake does not show signs of adverse impact. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
639	**Echo Lake**	Improved	Recovered	Echo Lake median water levels meet the updated Minimum Levels (ML and HML) for all post-cutback time periods assessed. The District's revised MFL report for this lake (2019) concludes that the lake is currently above the Minimum Levels.
37	Goose Lake	Continued Impact, Not Fully Recovered	Recovered	Goose Lake was re-assessed using the xeric wetland metric due to the presence of xeric soils surrounding the lake. With the updated assessment, the lake meets the site-specific recovery metric for all post-cutback time periods. This lake is augmented.
665	**Hobbs Lake**	Improved	Recovered	Hobbs Lake median water levels meet the established ML and HML for all post-cutback time periods. The recent 10-year increasing water level trend is statistically significant. The District 2018 MFL assessment shows Hobbs Lake as not meeting the Minimum Levels. Field review by District regulatory staff determined that impacts are due to causes other than wellfield pumping. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
119	**Horse Lake**	Improved	Recovered	Horse Lake median water levels meet the established ML and HML for all post-cutback time periods. The recent 10-year increasing water level trend is statistically significant. The District 2018 MFL assessment shows Horse Lake as not meeting the Minimum Levels. Field review by District regulatory staff determined that the lake was adversely impacted by wellfield activities prior to the 1970's and the current shoreline has been adversely impacted by upland development. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
673	**Juanita Lake**	Improved	Recovered	Lake Juanita median water levels meet the established ML and HML for all post-cutback time periods. The recent 10-year increasing water level trend is statistically significant. The District 2018 MFL assessment shows Lake Juanita as not meeting the Minimum Levels. Field review by District regulatory staff indicate the lake does not show signs of adverse impact. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
680	**Linda Lake**	Improved	Recovered	Lake Linda median water levels meet the established ML for all post-cutback time periods. The District 2018 MFL assessment shows Lake Linda as above the Minimum Levels. Field review by District regulatory staff indicate the lake does not show signs of adverse impact. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
684	**Little Moon Lake**	Improved	Recovered	Little Moon Lake median water levels meet the established ML and HML for all post-cutback time periods. The recent 10-year increasing water level trend is statistically significant. The District 2018 MFL assessment shows Little Moon Lake as not meeting the Minimum Levels. Field review by District regulatory staff indicate the lake does not show signs of adverse impact. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
689	**Merrywater Lake**	Improved	Recovered	Merrywater Lake median water levels meet the established ML and HML for all post-cutback time periods. The District 2018 MFL assessment shows Merrywater Lake as not meeting the Minimum Levels. Field review by District regulatory staff indicate the lake does not show signs of adverse impact. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
32	**Pasco Lake**	Continued Impact, Not Fully Recovered	Improved	Pasco Lake median water levels are 0.02 foot below the established ML for the past 6 years, and less than two feet below the ML for the past 10 years and since the pumping cutback at the Cross Bar Ranch Wellfield. The HML has been met for all post-cutback time periods. The recent 10-year increasing water level trend is statistically significant and the District 2018 MFL assessment shows Pasco Lake as below the Minimum Level. Improvement in lake water levels has been documented in recent years with the aid of augmentation; the validity of the established Minimum Levels is in question. The weight of all evidence considered indicates the lake is Improved for the purposes of the Recovery Assessment Plan.

Wetland ID	Lake Name	Preliminary Assessment Bin	Final Assessment Bin	Weight-of-Evidence Basis for Final Assessment Bin
24	Raft Lake	Improved	Recovered	Raft Lake was re-assessed using the xeric wetland metric due to the presence of xeric soils surrounding the lake. With the updated assessment, the lake meets the site-specific recovery metric for all post-cutback time periods, even with extensive missing water level data due to inundated monitoring devices and lack of site access due to high water conditions on the wellfield property.
704	**Rainbow Lake**	Improved	Recovered	Rainbow Lake median water levels meet the established ML and HML for all post-cutback time periods. The recent 10-year increasing water level trend is statistically significant. The District 2018 MFL assessment shows Rainbow Lake as not meeting the Minimum Levels. Field review by District regulatory staff indicate the lake does not show signs of adverse impact. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
705	**Raleigh Lake**	Improved	Recovered	Raleigh Lake median water levels meet the established ML and HML for all post-cutback time periods. The recent 10-year increasing water level trend is statistically significant. The District 2018 MFL assessment shows Raleigh Lake as not meeting the Minimum Levels. Field review by District regulatory staff indicate the lake shows signs of adverse impact, mainly due to the presence of Brazilian pepper trees and Melaleuca along the lake edge. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
709	**Rogers Lake**	Improved	Recovered	Rogers Lake median water levels meet the established ML and HML for all post-cutback time periods. The recent 10-year increasing water level trend is statistically significant. The District 2018 MFL assessment shows Rogers Lake as not meeting the Minimum Levels. Field review by District regulatory staff indicate the lake shows signs of adverse impact, mainly due to the presence of Melaleuca, laurel oak, pine, and dogfennel along the lake edge. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
721	**Sunshine (Sunrise) Lake**	Improved	Recovered	Sunshine/Sunrise Lake median water levels meet the established ML and HML for all post-cutback time periods. The District 2018 MFL assessment shows Sunshine/Sunrise Lake as not meeting the Minimum Levels. Field review by District regulatory staff indicate the lake does not show signs of adverse impact. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.
725	Thorpe Lake	Improved	Recovered	Thorpe Lake water levels (limited data) were correlated to adjacent Church Lake water levels. Recent MFL reevaluation of Church Lake concludes that it meets its Minimum Level. District regulatory staff determined that the littoral zone vegetation appeared to be normal for water levels and no signs of adverse impact were noted. The weight of all evidence considered shows the lake to be Recovered for the purposes of the Recovery Assessment Plan.

Bold = MFL Lake

8.7 Discussion of Recovery at Selected Lakes

A few of the monitored lakes have limited period of record data and some of them have no recorded data following the reduction in wellfield pumping. Other lakes have special circumstances and based on discussions with District staff, Tampa Bay Water prepared and previously submitted separate technical analyses in support of the preliminary report of findings. These sites are briefly discussed in this section along with any updated information and the final recovery assessment bin for each lake. The following eleven lakes are those marked as "Analyzed separately by Brian Ormiston" in Table 8.2.

- Buck Lake – Dr. Ormiston prepared a technical memorandum assessing the status of Buck Lake which was submitted to the District on November 28, 2018 (Appendix 5.8). The status bin of "Recovered" had been previously discussed with District staff but there is no increasing trend in lake levels (period of record begins in 1972) following the reduction in pumping from the Cosme-Odessa and Eldridge-Wilde Wellfields. Buck Lake is located approximately one mile west of the Cosme-Odessa Wellfield. Dr. Ormiston correlated rainfall with lake levels and found that rainfall is highly significant in explaining water level changes in the lake and the changes also depend on the antecedent lake stage. Further assessment by Dr. Ormiston led to the conclusion that rainfall is the primary determinant of lake levels and that no long-term temporal trends or response to pumping levels is evident from the data. Dr. Ormiston also reviewed historical aerial photography and noted no discernable impacts to fringing wetland vegetation. This technical assessment formed the basis for our preliminary assessment of this lake with a preliminary recovery bin of "Never Impacted by Wellfield Pumping". Dr. Ormiston included Buck Lake in his updated lake evaluation through WY19 (Appendix 8.5); however, the inclusion of an additional year of water level data revealed no evidence to modify the preliminary assessment bin for the lake. Dr. Ormiston's report contains a period-of-record hydrograph for the lake that shows limited fluctuation over time. Since the lake water levels are primarily dependent on rainfall and no evidence of pumping influence is found in the hydrograph or analysis of water level data, an assessment bin of "Improved" or "Recovered" is not appropriate. The most appropriate and final assessment bin for Buck Lake is "Never Impacted by Wellfield Pumping".

- Darby Lake – The preliminary assessment of Lake Darby was submitted to the District on July 11, 2018 with a recommended recovery bin of "Recovered" (Appendix 8.2). No minimum or management level has been established for this lake. Dr. Ormiston used an estimated Minimum Guidance Level of 53.4 feet NGVD based on historic normal pool indicators at the edge of the lake. In his assessment, the period-of-record water level trend was positive, there was no trend in the rate of decline analysis, and the recent 10-year water level trend was positive. District staff reviewed this preliminary assessment recommendation and suggested that the lake should not be binned as "Recovered" in the preliminary assessment results since District staff determined that nearby MFL Lakes Dosson and Sunshine did not meet their Minimum Levels. (see District letter in Appendix 8.2). The Preliminary Report of Findings (Tampa Bay Water, 2018b) classified Lake Darby with a recovery bin of "Improved" and acknowledged that the final bin would be determined in the final assessment report. Dr. Ormiston included Lake Darby in his updated lake evaluation through WY19 (Appendix 8.5); the recent 6-year median water level was 0.32-foot above the estimated Minimum Guidance Level and the recent 10-year median water level was 0.27-foot below this level. There is no change in the rate of decline analysis since the wellfield pumping reduction began but water levels for the past 10 years (2010 – 2019) show a statistically significant increasing trend. District Regulatory staff performed a field review of the ecological condition of Lake Darby in early March 2020 and their site assessment report is included in Appendix 8.6. The District Regulatory staff concluded that the vegetation within the fringing wetland appeared to have a healthy zonation and the lake did not exhibit signs of adverse impact. District staff also concluded that based on hydrologic indicators and water level data, the normal pool elevation for the lake-fringing wetland was too high (currently set at 55.22 feet NGVD); the normal pool elevation was visually estimated to be approximately 52.6 to 52.7 feet NGVD. Tampa Bay Water will have the normal pool elevation reset and surveyed. However, based on the observations that the normal pool elevation is too high (the basis for the estimated guidance level by Ormiston) and the lack of observed adverse impacts at this lake, staff assigned a final assessment bin of "Recovered" to Lake Darby.

- Flynn Lake – The preliminary assessment of Flynn Lake was submitted to the District on July 11, 2018 with a recommended recovery bin of "Recovered" (Appendix 8.2). This lake is located several miles southeast of the Section 21 Wellfield, outside of the defined Area of Investigation, and in an area with less than one foot of predicted surficial aquifer drawdown from the current pumping rates at the Consolidated Permit Wellfields. No minimum or management level has been established for this lake but a Minimum Guidance Level of 45.0 feet is suggested by the District's Flynn Lake Data Sheet (see Dr. Ormiston's technical assessment memo in Appendix 8.2). District staff concurred with the recommended assessment bin of "Recovered" in September 2018 (see Appendix 8.2). Dr. Ormiston included Flynn Lake in his updated lake evaluation through WY19 (Appendix 8.5); the recent 6-year median water level was 47.57 feet NGVD and the recent 10-year median water level was 46.98 feet NGVD. These two long-term median water levels are both well above the suggested Minimum Guidance Level of 45.0; therefore, the final assessment classification for this lake remains "Recovered".

- Raft Lake – The preliminary assessment of Raft Lake was submitted to the District on December 19, 2018 with a recommended recovery bin of "Improved" (Appendix 9.4). As described in the referenced submittal, this lake has no established minimum or management levels. A normal pool elevation was estimated; however, the lake levels have never been observed to reach this elevation creating uncertainty about the applicability of using a normal pool elevation for this lake. For the preliminary assessment, a normal pool offset level was calculated as 1.8-feet below the estimated normal pool elevation for a mesic wetland. Tampa Bay Water lost access to monitor the staff gage in the lake in August 2003 and the water level record for this lake since that time is from a surficial aquifer monitor well located on the Cross Bar Ranch near the lake. Surficial aquifer water level data is not a reliable indicator of lake or wetland water levels, creating additional uncertainty for any analysis of water level data for this lake. This lake was classified as "Improved" in the

Preliminary Report of Findings (Tampa Bay Water, 2018b) since recent water levels have returned to the same elevation range as in the early 1980's when wellfield pumping was low and there was a significant upward trend in the Upper Floridan Aquifer potentiometric surface beneath the lake during Water Years 2008 – 2014. Dr. Ormiston included Raft Lake in his updated lake evaluation through WY19 (Appendix 8.5) and assessed the status of this lake using a level calculated using the xeric wetland metric due to the presence of xeric soils exceeding the xeric soil criteria for wetlands (Section 6.3.4). Using the new reference elevation of 72.42 feet NGVD, the recent 10-year median water level was 0.32 foot above this level and the 6-year median water level was 1.2 feet above this level. It is important to note that these calculated offset values are based on the available water level data that is collected twice per month. Since December 2014, 34% of the data values are unavailable because the surficial aquifer monitor gage is reported as "inundated". These missing high-water levels are obvious on the recent portion of the hydrograph of Raft Lake that is included in Appendix 8.5. If water level data were available for these gaps in time, the recent 6 and 10-year median water levels would be higher than stated above. Based on the reclassification and assessment of Raft Lake as a surface water feature in a xeric soil landscape and the recent, available water level data, the final assessment bin for Raft Lake is "Recovered".

- Thorpe Lake – The preliminary assessment of Thorpe Lake was submitted to the District on July 11, 2018 with a recommended recovery bin of "Recovered" (Appendix 8.2). Very limited water level data were collected from this lake between 1993 and 1997 with no data after the reduction in wellfield pumping. Dr. Ormiston found a statistically significant relationship between the limited water level for Thorpe Lake and adjacent Church Lake. The period-of-record data for Church Lake was used to create a synthetic time series of water level data for Thorpe Lake using the water level regression relationship. At the time of Dr. Ormiston's technical assessment, the 6-year and 10-year median water levels at Church Lake were above the adopted Minimum Level; therefore, staff recommended a recovery bin of "Recovered". District staff replied that based on the District's 2016 status assessment of MFL lakes, Church Lake was not meeting the Minimum Level and Thorpe Lake should not be classified as "Recovered" at that time (see Appendix 8.2). The Preliminary Report of Findings (Tampa Bay Water, 2018b) classified Thorpe Lake with a recovery bin of "Improved" and acknowledged that the final bin would be determined in the final assessment report. The District's 2018 MFL status assessment report states that Church Lake is meeting its Minimum Level and the District reassessed the Minimum Level for Church and Echo Lakes in 2019 (Appendix 8.7). Based on this updated assessment, the Minimum Level for Church Lake decreased by 0.2 foot and the District's report also concludes that Church Lake water levels were above the revised Minimum and High Minimum Levels. The District staff field review of Thorpe Lake on January 23, 2020 (Appendix 8.6) states that the lake does not show any adverse impacts. Long-term lakeshore residents reported to District staff that water levels have been consistently high over the past two decades when compared to historical levels. Therefore, based on the significant correlation of the adjacent Church Lake levels and the District report that Church Lake meets the established Minimum Levels, the final assessment bin for Thorpe Lake is changed to "Recovered" to match the final assessment bin for Church Lake.

- Turkey Ford Lake – The preliminary assessment of Turkey Ford Lake was submitted to the District on July 11, 2018 with a recommended recovery bin of "Recovered" (Appendix 8.2). The lake was classified as "Recovered" even though the lake was 0.6-foot below the adopted Low Management Level. It is located outside of the Recovery Assessment Area of Investigation in an area of less than one foot of predicted drawdown in the surficial aquifer. The period-of-record data showed no trend over time and there was no response in lake level following the reduction in pumping from nearby and regional wellfields. Dr. Ormiston included Turkey Ford Lake in his updated lake evaluation through WY19 (Appendix 8.5); the recent 6-year median water level was 0.53-foot below the Low Management Level and the recent 10-year median water level was 0.55-foot below this level. There is no statistically significant trend in water level either before or after the reduction in wellfield pumping and the final assessment bin for Turkey Ford Lake remains "Recovered".

- Unnamed Lake 1B14 – The preliminary assessment of Unnamed Lake 1B14 was submitted to the District on July 11, 2018 with a recommended recovery bin of "Recovered" (Appendix 8.2). Limited water level data is available for this lake from the pre-pumping reduction period (late 1994 – 2001). Consistent water level data collection began in early 2003 after the reduction in regional wellfield pumping. The lake assessment performed by Dr. Ormiston concluded that based on a lack of water level trend data, field assessment notes from District staff and a review of historical aerial photography, this lake appears to be healthy. The Preliminary Report of Findings (Tampa Bay Water, 2018b) classified Unnamed Lake 1B14 with a recovery bin of "Recovered". Dr. Ormiston included Unnamed Lake 1B14 in his updated lake evaluation through WY19 (Appendix 8.5); the recent 6-year median water level was 1.68 feet above the Low Management Level and the recent 10-year median water level was 1.56 feet above this level. There is no significant trend in water level either before or after the reduction in wellfield pumping and the final assessment bin for Unnamed Lake 1B14 remains "Recovered".

- Unnamed Lake 2B14 – The preliminary assessment of Unnamed Lake 2B14 was submitted to the District on July 11, 2018 with a recommended recovery bin of "Recovered" (Appendix 8.2). Limited water level data is available for this lake from the pre-pumping reduction period (late 1994 – 2001). Consistent water level data collection began in early 2003 after the reduction in regional wellfield pumping. The lake assessment performed by Dr. Ormiston concluded that based on a lack of water level trend data, field assessment notes from District staff and a review of historical aerial photography, this lake appears to be healthy. The Preliminary Report of Findings (Tampa Bay Water, 2018b) classified Unnamed Lake 2B14 with a recovery bin of "Recovered". Dr. Ormiston included Unnamed Lake 2B14 in his updated lake evaluation through WY19 (Appendix 8.5); the recent 6-year median water level was 1.68 feet above the Low Management Level and the recent 10-year median water level was 1.56 feet above this level. There is no significant trend in water level either before or after the reduction in wellfield pumping and the final assessment bin for Unnamed Lake 2B14 remains "Recovered".

- Van Dyke Lake – The preliminary assessment of Van Dyke Lake was submitted to the District on July 11, 2018 with a recommended recovery bin of "Recovered" (Appendix 8.2). District staff agreed that historical observational evidence suggests that Van Dyke Lake is appropriate in the "Recovered" assessment bin (see Appendix 8.2). No management levels exist for this lake and it has not been monitored for many years. Therefore, the final assessment classification for this lake remains "Recovered".

- Wastena Lake – The preliminary assessment of Wastena Lake was submitted to the District on December 19, 2018 with a recommended recovery bin of "Recovered" (Appendix 9.4). As described in the referenced submittal, this lake has no established minimum or management levels. The water level data record is limited to about a dozen readings between 1993 through 1998 so this lake was assessed based on indirect evidence. These lines of evidence include the significant increase in the Upper Floridan Aquifer potentiometric surface beneath the lake starting in late 2002 (time of the regional wellfield pumping reduction), the estimated recovery in surficial aquifer water levels based on interpolated monitor well data, and a comparison to monitored lakes and wetlands in the vicinity of Wastena Lake. Since there is no water level record for Wastena Lake, this site is not included in the recent lake data assessment update by Dr. Ormiston. Since the monitored sites surrounding Wastena Lake have final assessment classifications of "Recovered" and given the sustained recovery of the Upper Floridan Aquifer in this area, the final assessment bin for Wastena Lake remains "Recovered".

- Wood Lake – The preliminary assessment of Wood Lake was submitted to the District on July 11, 2018 with a recommended recovery bin of "Recovered" (Appendix 8.2). This lake is located outside of the Area of Investigation in an area of less than one foot of predicted drawdown in the surficial aquifer. No minimum or management level has been established for this lake, but Dr. Ormiston estimated a Minimum Guidance Level of 47.3 feet based on a correlation with the water levels in nearby Crescent Lake. (see Dr. Ormiston's technical assessment memorandum in Appendix 8.2). District staff concurred with this preliminary assessment bin for Wood Lake in their September 5, 2018 letter (see Appendix 8.2). Dr. Ormiston included Wood Lake in his updated lake evaluation through WY19 (Appendix 8.5); the recent 6-year median water level was 0.59 foot above the estimated Minimum Guidance Level and the recent 10-year median water level was 0.61 foot above this level. There is no statistically significant trend in water level either before or after the reduction in wellfield pumping and the final assessment bin for Wood Lake remains "Recovered".

There are 28 monitored lakes where the final Recovery Assessment bins differ from the assessment bins reported in the Preliminary Report of Findings (Tampa Bay Water, 2018b). These differences are due to the analysis of additional water level data for Water Year 2019 and/or the change in how they were assessed through the weight-of-evidence approach (Section 8.5). These lakes are listed in Table 8.4 along with the preliminary and final assessment bins and the basis of the weight-of-evidence reasoning for the final bin assignment.

There are 16 lakes on Table 8.4 where the final Recovery Assessment bin differs from the 2018 District status assessment for those MFL lakes. The District analysis indicates that one lake (Big Fish Lake, historically augmented) is meeting its Minimum Levels but our final Recovery Assessment bin is "Improved"; the remaining 15 lakes have District assessments of not meeting the Minimum Levels and our final Recovery Assessment bins are "Recovered". The reasons for the final bin assignments are detailed in this table based on our weight-of-evidence approach. Tampa Bay Water staff acknowledge the

District assessment of these lakes as a valuable part of the evidence for each lake that was considered along with the empirical data collected from those lakes as described in Section 8.5. Each final bin is based on the various data assessment periods and types and weighing of all the evidence, including an assessment of adverse impact on the lake vegetation. The assessment of the empirical data for all lakes is presented in Table 8.2.

There are two lakes of note in Table 8.4, Lakes Raleigh and Rogers at the Cosme-Odessa Wellfield. The District Regulatory staff field assessment of these two lakes documented observed adverse impacts to vegetation. District staff report the presence of Brazilian pepper trees (*Schinus terebinthifolia*) and Melaleuca (*Melaleuca quinquenervia)* along the lake edge of Lake Raleigh. There is no record of when these invasive species became established along the edge of this lake but it was likely during the period of time when the lake was stressed due to the low water levels that can be seen in Figure 8.2. These species can survive in wet environments such as during the past 10 years and require physical or chemical approaches to remove them. The adverse impact noted by District Regulatory staff at Lake Rogers was also vegetative with the presence of Melaleuca, laurel oak (*Quercus laurifolia)*, pine (*Pinus* sp.), and dogfennel (*Eupatorium capillifolium)* along the lake edge. The pine trees along the edge of the lake are dead or stressed due to the presence of higher water levels during much of the post-cutback time period (Figure 8.3). The disturbed nature of the vegetation along the edge of this lake has been observed for many years and much of the upland-type vegetation became established when water levels in this lake were very low. Due to the presence of sustained water levels in both of these lakes above their established Minimum Levels and the strong indications of recovery from the water level data at these lakes, Tampa Bay Water has classified both lakes as “Recovered” for the purposes of this Recovery Assessment Plan. Further environmental field assessments at Lakes Raleigh and Rogers are discussed in Chapter 15.

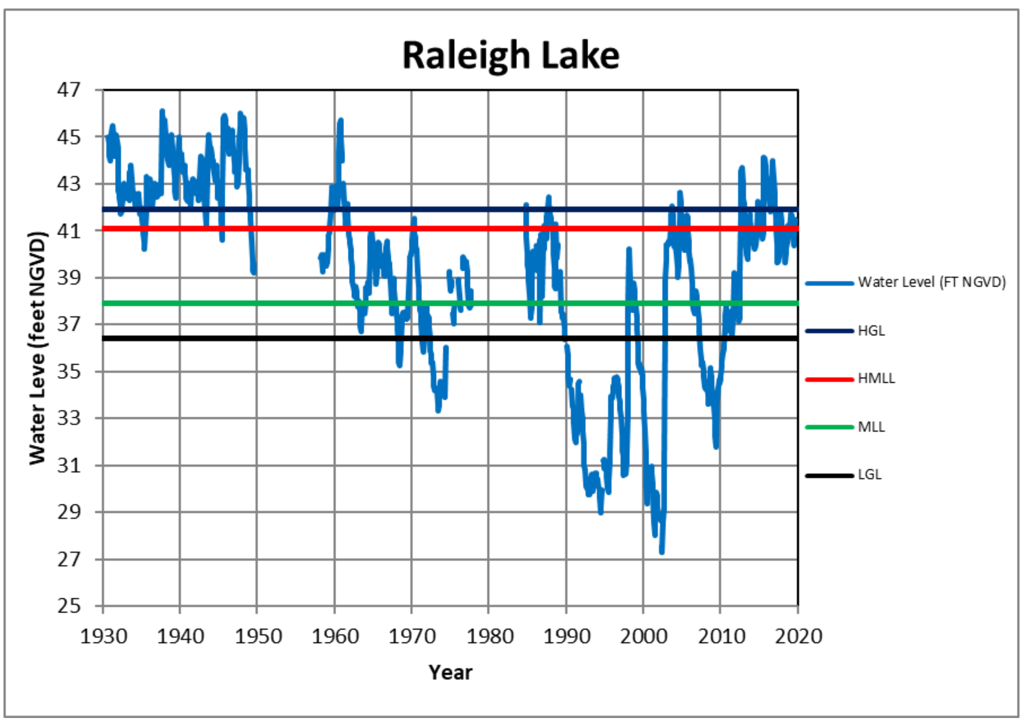

Figure 8.2: Period of Record Water Level for Lake Raleigh

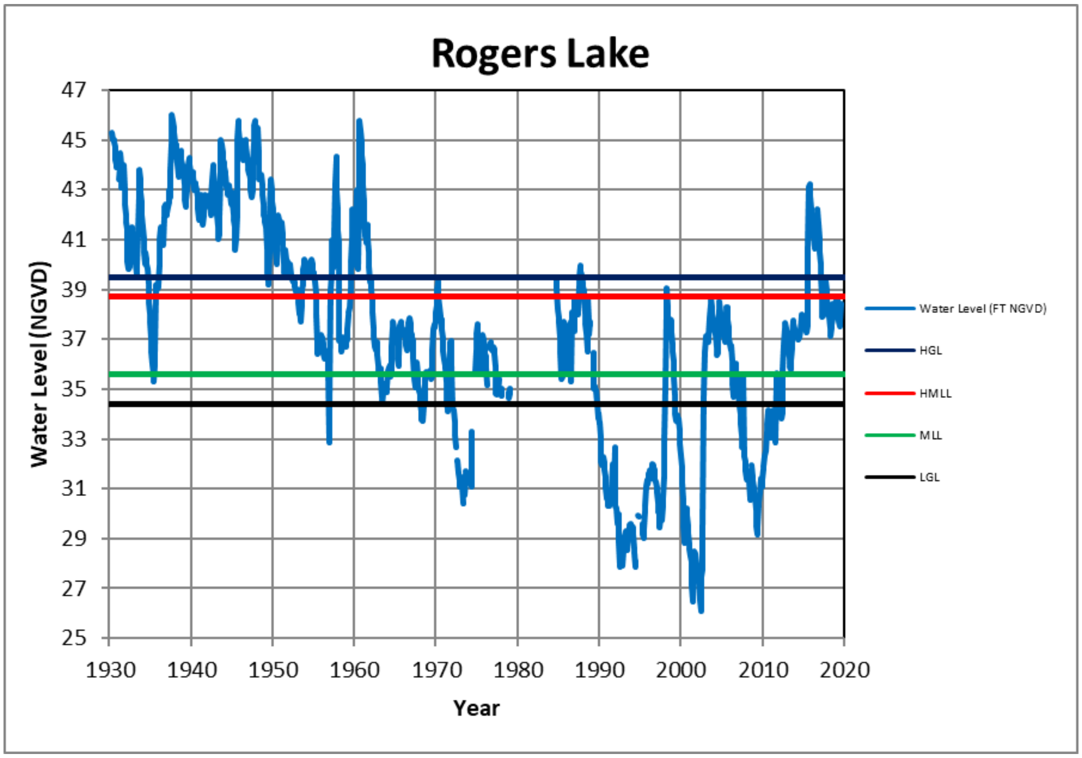

Figure 8.3: Period of Record Water Level for Lake Rogers

Wetland Assessment Status		
Final Bin Designations		
Recovery Classes/Bins	Number	Percent
Monitored Lakes	137	
Not Affected by Wellfield	1	1%
Recovered/Meets Metric	132	96%
Improved, Not Fully Recovered	4	3%
Total	137	100%

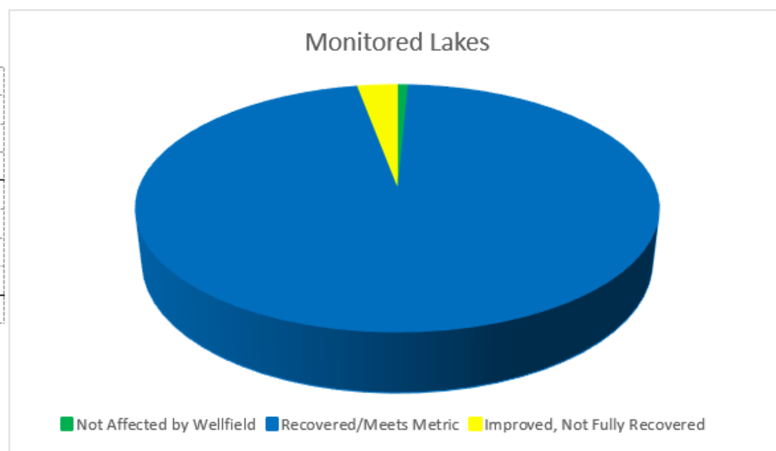

Figure 8.4: Final Assessment Results for Monitored Lakes (through Water Year 2019)

8.8 Final Recovery Assessment Evaluation - Details

The final assessment of recovery for the 137 monitored lakes incorporated all prior studies performed for individual lakes and multiple lines of assessment of lake-specific data for all sites. By evaluating all available data, staff continued the weight-of-evidence approach for assessing environmental recovery and these analyses included data assessments that minimize the effects of rainfall variability. There has been a significant recovery in lake water levels during the years following the reduction in pumping from the Consolidated Permit wellfields. The past several years have been characterized as average to above-average annual rainfall with only seasonal rainfall deficits reported; however, empirical lake water level data has been analyzed since the reduction in wellfield pumping (late-2002 for many wellfields). During this longer post-cutback time period, the region has experienced significant rainfall deficits on a multi-year (2005-2009) and seasonal basis (dry season of 2017). Including these longer time periods into the analyses give greater assurance to the results of lake water level recovery as detailed in this chapter.

The final Recovery Assessment designation or bin for each of the monitored lakes is presented in Table 8.5. These results are compiled into a summary table and chart in Figure 8.4 which shows that 97% of the monitored lakes have recovered or are not affected by wellfield pumping. Only four lakes (3% of the total) show improvement but do not yet meet their recovery target based on our weight-of-evidence assessment. The individual assessment results are presented in map form in Figures 8.5 – 8.11 for the entire wellfield area and each portion of our study area. These final recovery bin designations are largely based on hydrologic data compared to a numeric metric or threshold of individual lake health. These results do not necessarily correspond to the presence or absence of adverse impact; however, District Regulatory staff reviewed the current ecological condition of most of the lakes binned as “Improved” in the Preliminary Report of Findings. These field review observations have been considered as part of the weight-of-evidence as the lakes were assigned to a final recovery bin.

This chapter focused only on the assessment of the monitored lakes. These final assessment results will be combined with the results of the monitored wetlands and unmonitored sites in Chapter 12 to describe environmental recovery on a wellfield-scale. The final results for all monitored and unmonitored sites will also be discussed on a regional scale in Chapter 13 and are summarized in Chapter 14.

Table 8.5: Final Recovery Assessment Findings for Monitored Lakes

Wetland ID	Lake Name	MFL Lake	County	Final Recovery Assessment Bin
601	Alice Lake	Yes	Hillsborough	Recovered
602	Allen Lake	Yes	Hillsborough	Recovered
28	Alligator Pond	No	Pasco	Recovered
118	Amelia Lake	No	Hillsborough	Recovered
603	Ann-Parker Lake	Yes	Pasco	Recovered
120	Armistead Lake	No	Hillsborough	Recovered
604	Artillery Lake	No	Hillsborough	Recovered
600	Avis Lake	No	Hillsborough	Recovered
605	Bass (Holiday) Lake	No	Pasco	Recovered
606	Bell Lake	Yes	Pasco	Recovered
15	Big Fish Lake	Yes	Pasco	Improved, Not Fully Recovered
607	Big Lake Vienna	No	Pasco	Recovered
608	Bird Lake (Hillsborough)	Yes	Hillsborough	Recovered
609	Bird Lake (Pasco)	Yes	Pasco	Recovered
610	Black Lake	No	Pasco	Recovered
611	Boat Lake	No	Hillsborough	Recovered
414	Bonnet Lake	No	Pasco	Recovered
612	Brant Lake	Yes	Hillsborough	Recovered
613	Brooker Lake	No	Hillsborough	Recovered
615	Browns Lake	No	Hillsborough	Recovered
616	Buck Lake	No	Hillsborough	Not Impacted by Wellfield Pumpage
617	Burrell Lake	No	Hillsborough	Recovered
618	Calm Lake	Yes	Hillsborough	Recovered
620	Camp Lake	Yes	Pasco	Recovered
621	Carroll Lake	Yes	Hillsborough	Recovered
622	Catfish Lake	No	Pasco	Recovered
623	Cedar Lake East	No	Hillsborough	Recovered
	Cedar Lake West	No	Hillsborough	Recovered
624	Chapman Lake	No	Hillsborough	Recovered
625	Charles Lake	Yes	Hillsborough	Recovered
626	Church Lake	Yes	Hillsborough	Recovered
3	Clear Lake	No	Pasco	Recovered
627	Commiston Lake	No	Hillsborough	Recovered
629	Cooper Lake	No	Hillsborough	Recovered
630	Cow (East) Lake	No	Pasco	Recovered
631	Crenshaw Lake	Yes	Hillsborough	Recovered

Wetland ID	Lake Name	MFL Lake	County	Final Recovery Assessment Bin
632	Crescent Lake	Yes	Hillsborough	Recovered
25	Crews Lake	Yes	Pasco	Recovered
633	Crystal Lake	Yes	Hillsborough	Recovered
634	Curve Lake	No	Pasco	Recovered
636	Cypress Lake	Yes	Hillsborough	Recovered
252	Dan Lake	Yes	Hillsborough	Improved, Not Fully Recovered
368	Darby Lake	No	Hillsborough	Recovered
637	Deer Lake	Yes	Hillsborough	Recovered
638	Dosson Lake	Yes	Hillsborough	Recovered
639	Echo Lake	Yes	Hillsborough	Recovered
640	Eckles Lake	No	Hillsborough	Recovered
642	Elaine Lake	No	Hillsborough	Recovered
643	Elizabeth Lake	No	Hillsborough	Recovered
644	Ellen Lake	No	Hillsborough	Recovered
645	Fairy (Maureen) Lake	Yes	Hillsborough	Recovered
646	Fern Lake	No	Hillsborough	Improved, Not Fully Recovered
647	Floyd Lake	No	Pasco	Recovered
648	Flynn Lake	No	Hillsborough	Recovered
649	Garden (Thomas) Lake	Yes	Hillsborough	Recovered
651	Gass Lake	No	Hillsborough	Recovered
653	George (Hillsborough) Lake	No	Hillsborough	Recovered
37	Goose Lake	No	Pasco	Recovered
655	Gooseneck Lake	No	Pasco	Recovered
657	Green Lake	Yes	Pasco	Recovered
658	Halfmoon Lake	Yes	Hillsborough	Recovered
659	Halls Lake	No	Hillsborough	Recovered
660	Hanna Lake	Yes	Hillsborough	Recovered
661	Harvey Lake	Yes	Hillsborough	Recovered
662	Helen Lake	Yes	Hillsborough	Recovered
663	Hiawatha Lake	No	Hillsborough	Recovered
665	Hobbs Lake	Yes	Hillsborough	Recovered
666	Hog Island Lake	No	Hillsborough	Recovered
119	Horse Lake	Yes	Hillsborough	Recovered
667	Island Ford Lake	No	Hillsborough	Recovered
392	Jackson Lake	Yes	Hillsborough	Recovered
669	James Lake	No	Hillsborough	Recovered
670	Jo Ann Lake	No	Pasco	Recovered
671	Josephine Lake	No	Hillsborough	Recovered
672	Joyce (Hog) Lake	No	Pasco	Recovered

Wetland ID	Lake Name	MFL Lake	County	Final Recovery Assessment Bin
673	Juanita Lake	Yes	Hillsborough	Recovered
674	Keene Lake	Yes	Hillsborough	Recovered
675	Kell Lake	Yes	Hillsborough	Recovered
676	Keystone Lake	No	Hillsborough	Recovered
678	King Lake (West) at Drexel	Yes	Pasco	Recovered
679	LeClare Lake	No	Hillsborough	Recovered
680	Linda Lake	Yes	Pasco	Recovered
681	Lipsey Lake NR Sulphur Springs	No	Hillsborough	Recovered
683	Little Lake	No	Hillsborough	Recovered
684	Little Moon Lake	Yes	Hillsborough	Recovered
685	Little Moss (Como) Lake	No	Pasco	Recovered
686	Long Lake	No	Hillsborough	Recovered
687	Magdalene Lake	No	Hillsborough	Recovered
688	Marlee Lake	No	Hillsborough	Recovered
689	Merrywater Lake	Yes	Hillsborough	Recovered
472	Moon Lake (Pasco)	Yes	Pasco	Recovered
692	Moss Lake	No	Pasco	Recovered
693	Mound Lake	Yes	Hillsborough	Recovered
695	Mud Lake (Geneva Lake)	No	Pasco	Recovered
696	Myrtle Lake	No	Pasco	Recovered
697	Noreast Lake	No	Hillsborough	Recovered
698	Osceola Lake	No	Hillsborough	Recovered
699	Padgett Lake	Yes	Pasco	Recovered
32	Pasco Lake	Yes	Pasco	Improved, Not Fully Recovered
701	Pierce Lake	Yes	Pasco	Recovered
702	Platt Lake	Yes	Hillsborough	Recovered
703	Pretty Lake	Yes	Hillsborough	Recovered
24	Raft Lake	No	Pasco	Recovered
704	Rainbow Lake	Yes	Hillsborough	Recovered
705	Raleigh Lake	Yes	Hillsborough	Recovered
706	Reinheimer Lake	Yes	Hillsborough	Recovered
709	Rogers Lake	Yes	Hillsborough	Recovered
710	Round Lake	Yes	Hillsborough	Recovered
364	Ryals Lake	No	Pasco	Recovered
711	Saddleback Lake	Yes	Hillsborough	Recovered
712	Sapphire Lake	Yes	Hillsborough	Recovered
714	Saxon Lake	No	Pasco	Recovered
741	Seminole Lake	No	Pasco	Recovered

Wetland ID	Lake Name	MFL Lake	County	Final Recovery Assessment Bin
715	Simmons Lake	No	Hillsborough	Recovered
161	Stanford Lake	No	Pasco	Recovered
717	Starvation Lake	Yes	Hillsborough	Recovered
718	Stemper Lake	Yes	Hillsborough	Recovered
719	Strawberry Lake	Yes	Hillsborough	Recovered
720	Sunset Lake	Yes	Hillsborough	Recovered
721	Sunshine (Sunrise) Lake	Yes	Hillsborough	Recovered
722	Tampa (Turtle) Lake	No	Pasco	Recovered
723	Taylor Lake	Yes	Hillsborough	Recovered
724	Thomas Lake	No	Hillsborough	Recovered
725	Thorpe Lake	No	Hillsborough	Recovered
726	Toni Lake	No	Pasco	Recovered
727	Turkey Ford Lake	No	Hillsborough	Recovered
729	Twin Lake (Pasco)	No	Pasco	Recovered
730	Unnamed Lake 1B14	No	Hillsborough	Recovered
731	Unnamed Lake 2B14	No	Hillsborough	Recovered
732	Unnamed Lake 22 (Loyce)	Yes	Pasco	Recovered
157	Unnamed Lake 26	No	Pasco	Recovered
734	Van Dyke Lake	No	Hillsborough	Recovered
736	Virginia Lake	Yes	Hillsborough	Recovered
737	Wastena Lake	No	Hillsborough	Recovered
738	White Trout Lake	No	Hillsborough	Recovered
739	Wistaria Lake	No	Pasco	Recovered
740	Wood Lake	No	Hillsborough	Recovered

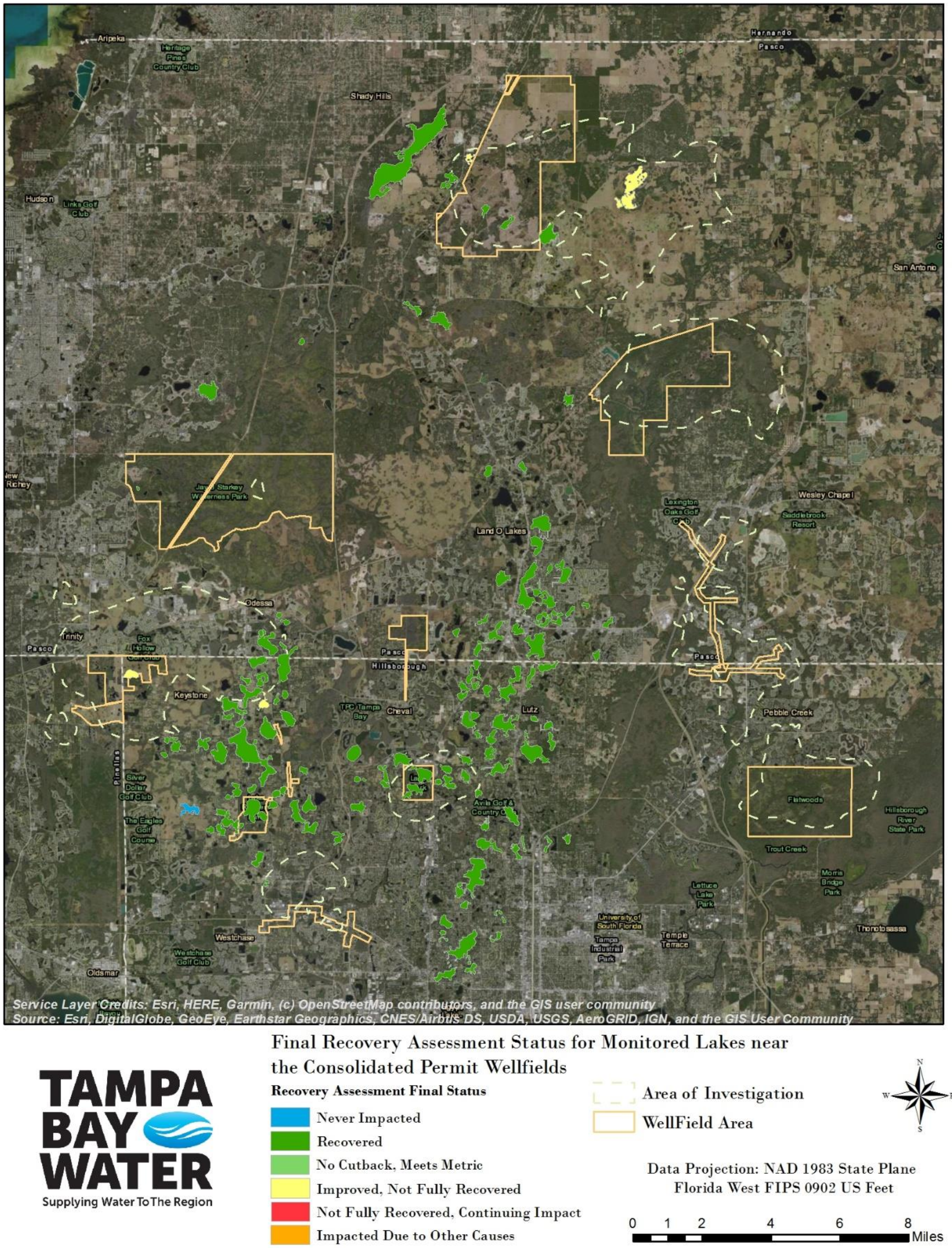

Figure 8.5: Map of Final Lake Assessment Results – All Wellfield Areas

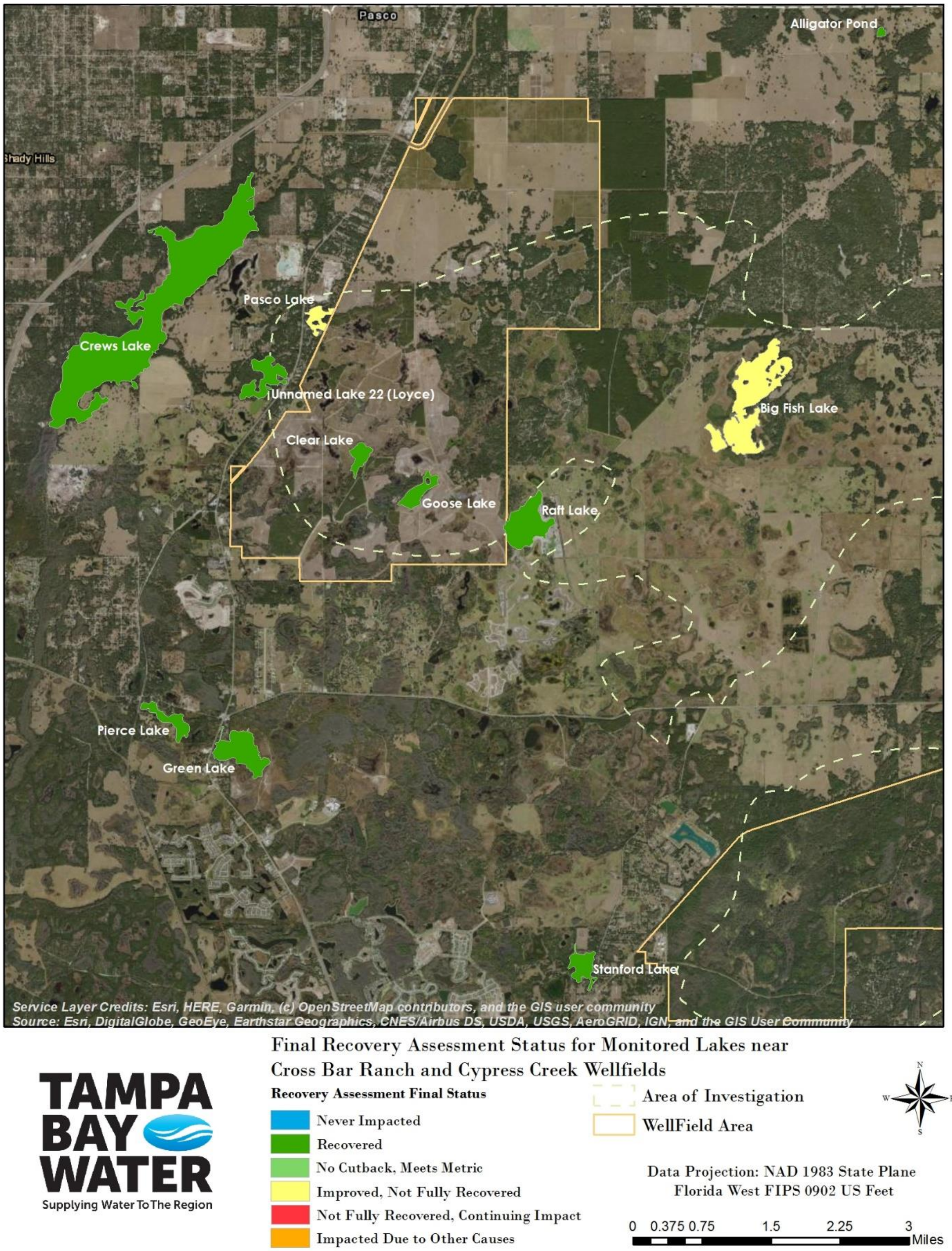

Figure 8.6: Map of Final Lake Assessment Results Near the Cross Bar Ranch and Cypress Creek Wellfields

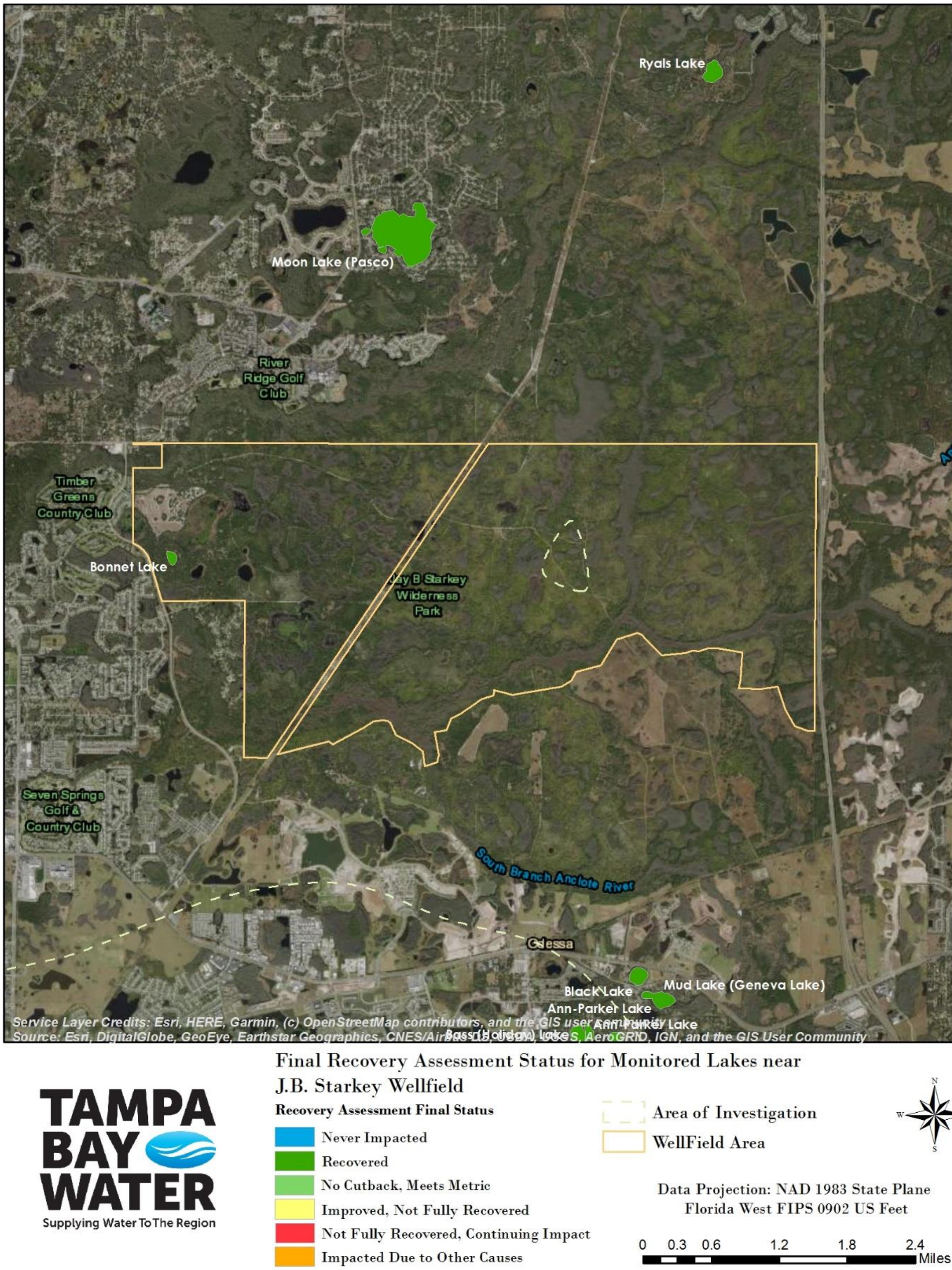

Figure 8.7: Map of Final Lake Assessment Results Near the Starkey and North Pasco Wellfields

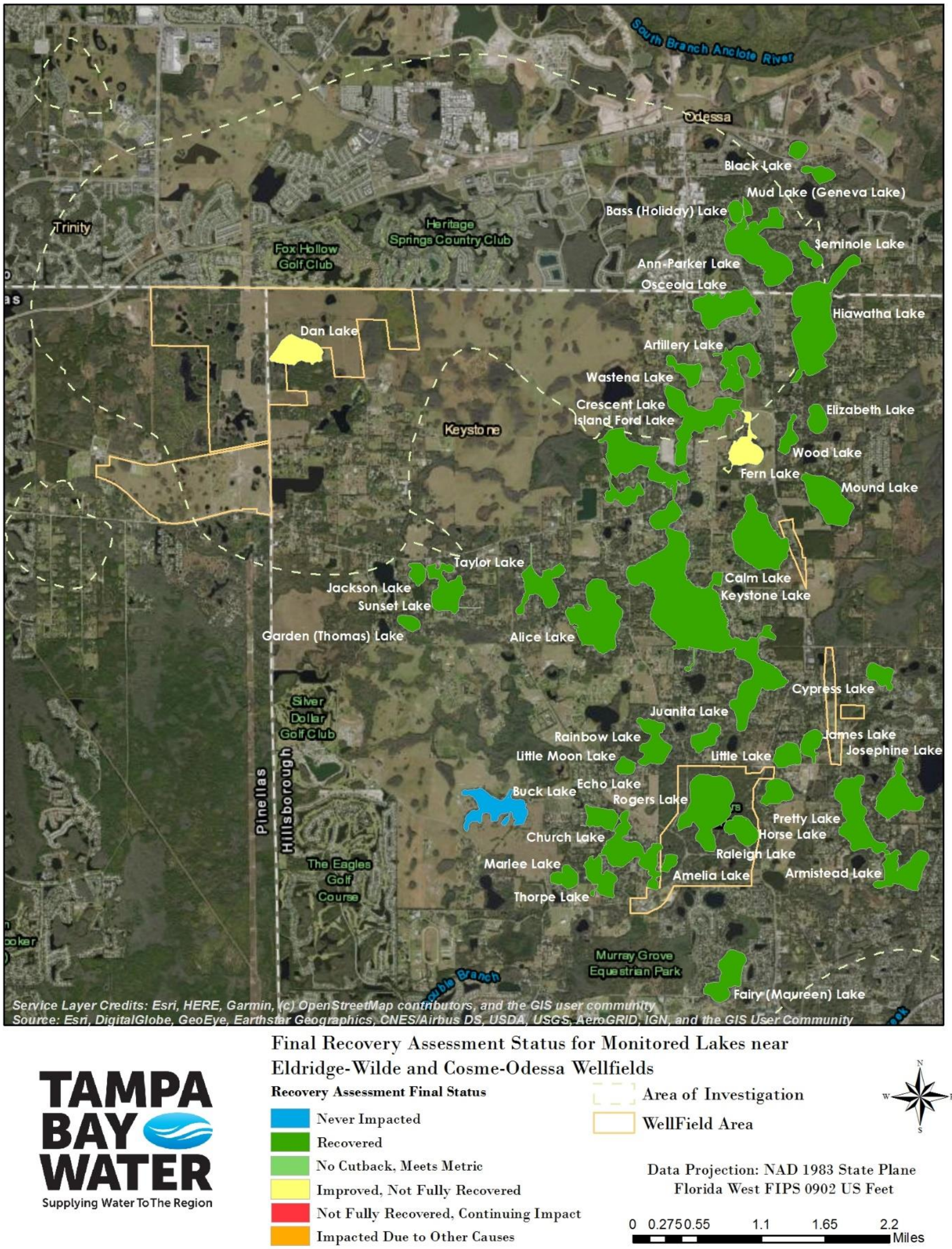

Figure 8.8: Map of Final Lake Assessment Results near the Eldridge-Wilde and Cosme-Odessa Wellfields

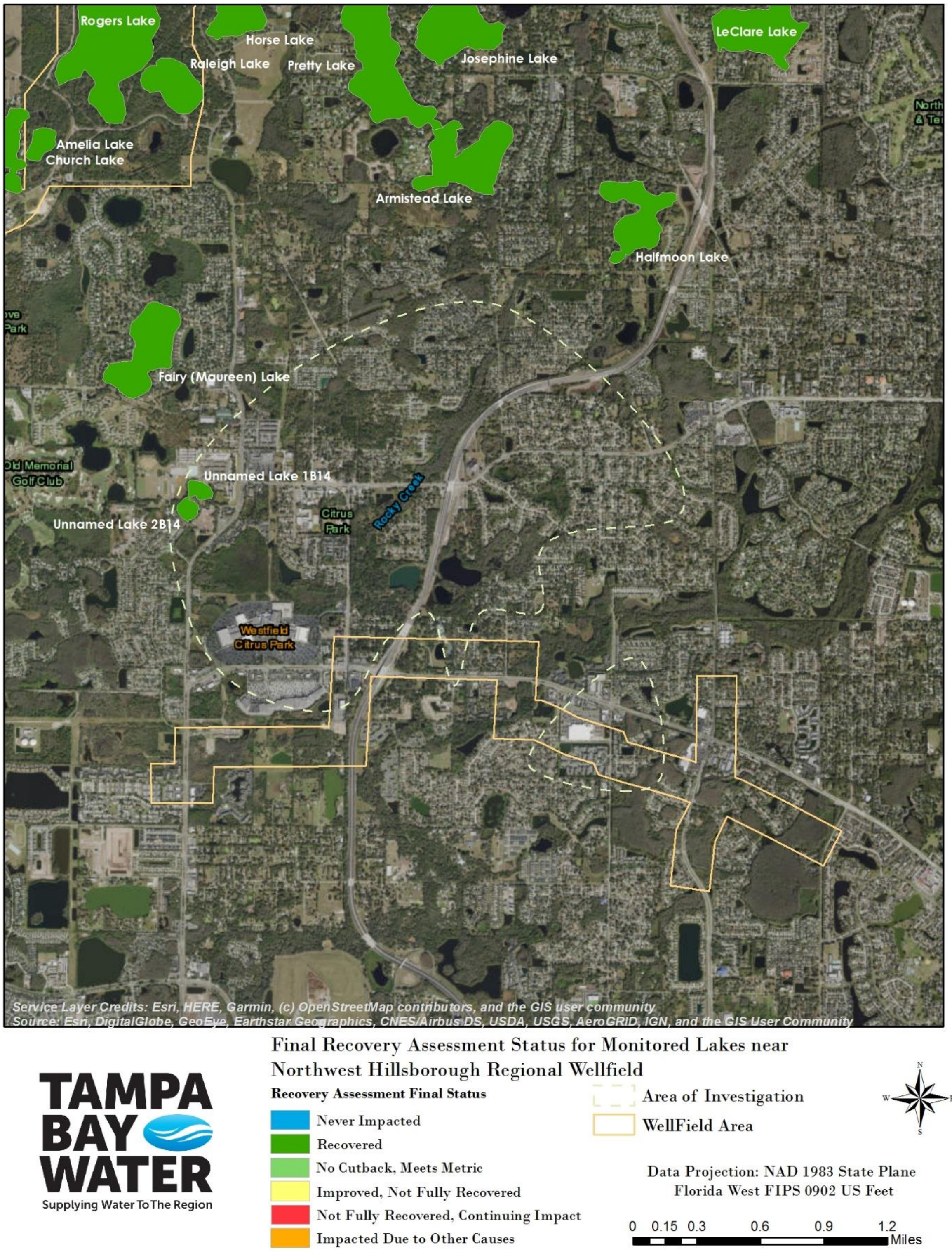

Figure 8.9: Map of Final Lake Assessment Results near the Northwest Hillsborough Regional Wellfield

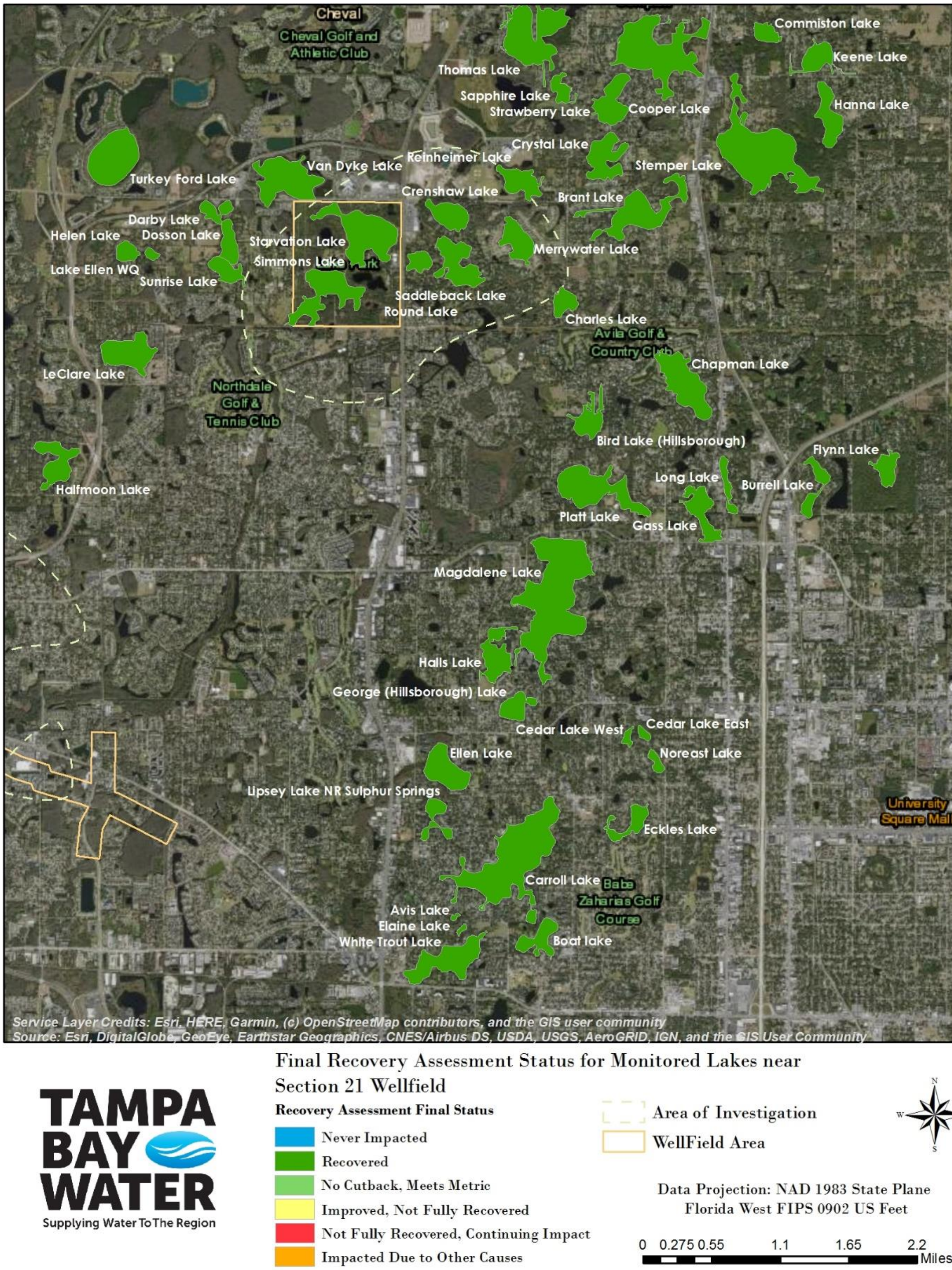

Figure 8.10: Map of Final Lake Assessment Results near the Section 21 Wellfield

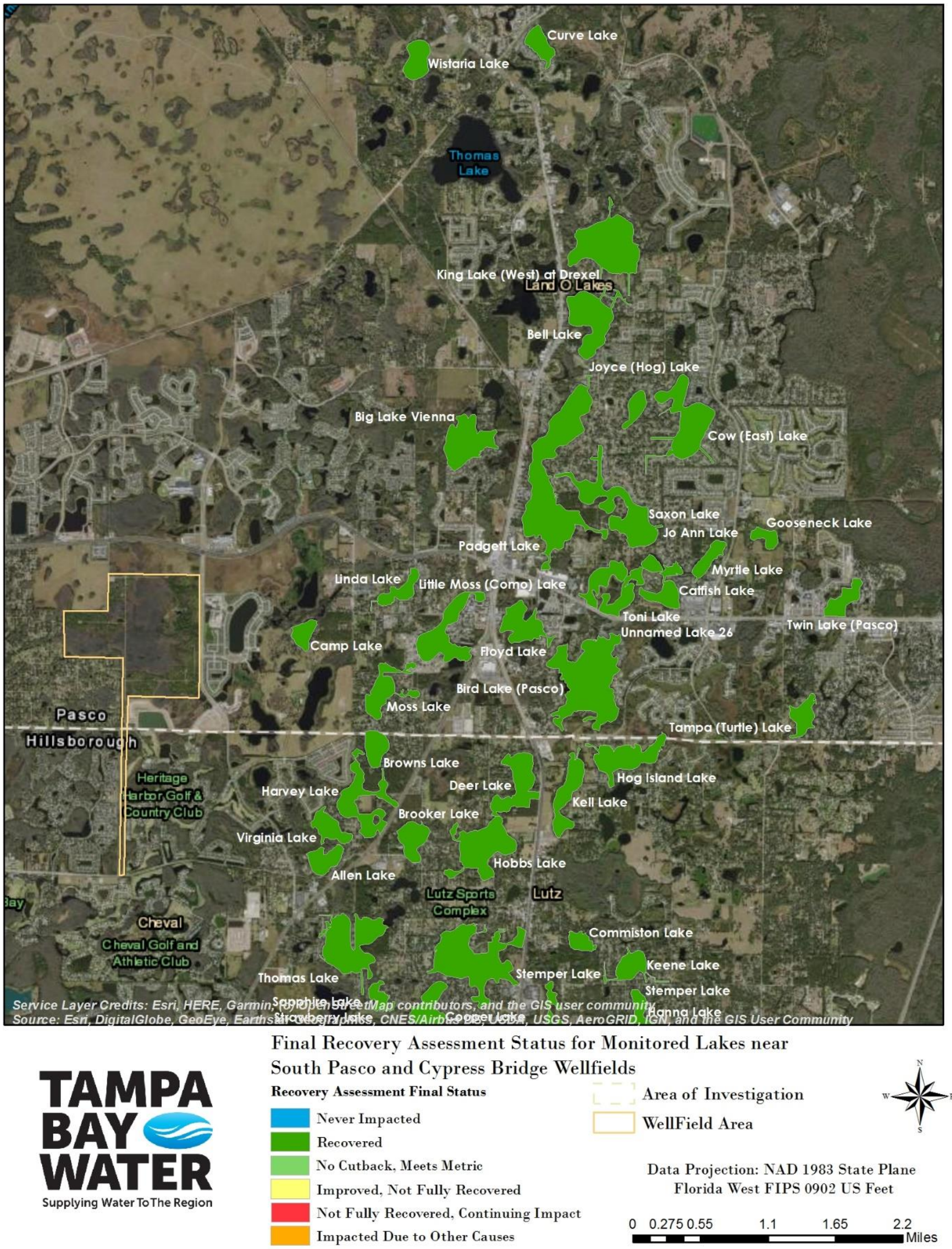

Figure 8.11: Map of Final Lake Assessment Results near the South Pasco and Cypress Bridge Wellfields

9: Recovery Analysis of Monitored Wetlands

9. Recovery Analyses of Monitored Wetlands

Tampa Bay Water has assessed the recovery of each wetland that was included in the final list of monitored wetlands in the Recovery Assessment Plan (Section 5.4). The applicable recovery metric (Section 6.3) was applied to each wetland based on the wetland type identified in the final monitored wetland list (Table 5.2) and a weight-of-evidence approach was applied as previously described in Section 6.6 and Section 6.8. In each original and updated assessment, staff used the most current reference elevation in the evaluation, historic normal pool elevation, or a reference percentile based on the individual site data. As the Recovery Assessment Plan analyses progressed, the normal pool elevation for some isolated wetlands were updated based on a reassessment of applicable normal pool indicators and updated survey data. These updated normal pool elevations were incorporated into any subsequent analyses for those wetlands. The collection of water level data for several formerly-monitored wetlands ended for a variety of reasons and these sites often had insufficient data in the post-pumping reduction period to be assessed with the monitored wetlands. These sites with truncated data records were assessed with the unmonitored wetlands within the defined Area of Investigation as described in Chapter 10.

9.1 Starkey Wellfield – Development of the Assessment Process

Tampa Bay Water was unable to develop a recovery metric using a correlation between vegetation health and water level data within wetlands as previously described in the discussion of metric development (Section 6.3). Even though there were no statistically significant or meaningful correlations established, the historical vegetation data were qualitatively informative in the establishment of recovery metrics. There is a time delay between changes in wetland water levels (positive or negative) and subsequent changes in the vegetation within a wetland; therefore, the vegetation data has value in describing longer-term changes and the overall health of a wetland. The vigor and assemblage of vegetation within a wetland is important to its overall health and this data was incorporated into the recovery assessment approach as lines of evidence. The Wetland Assessment Procedure (WAP) provides scores that describe vegetation zonation, using a list of indicator species. The Wetland Health Assessment (WHA) also takes plant species composition and zonation into account in scoring. Both of these datasets have been useful in the recovery analyses for individual wetlands.

The Starkey Wellfield was selected as the starting point for the wetland recovery assessments since this wellfield had a significant and instantaneous reduction in pumping (reduction from an annual average of approximately 13 mgd to 5 mgd) and higher water levels and improved wetland vegetation across the wellfield have been observed since that reduction. The wellfield has operated at this lower level of pumping with little fluctuation since the reduction in December 2007. Using the weight-of-evidence approach, staff first analyzed the wetland water level data against the appropriate metric of health or recovery for each type of wetland. This analysis was performed for a post-pumping reduction period of average rainfall; at the Starkey Wellfield, this assessment was performed using Water Year 2008 – 2014 data. If the median wetland water level was above the metric, the wetland was classified as "Recovered" or "Meets Metric". In limited cases, wetlands that met their recovery metric were classified as "Never Impacted" if there was historic evidence to support this conclusion. If a wetland did not meet its recovery metric or there were questions about the condition of the wetland, other data were evaluated to make an assessment of the wetland condition and determined whether conditions in the wetland were improving post-cutback. The data evaluated included vegetation (WAP) data, review of period-of-record hydrographs, rainfall data from the nearest gage, water level data from the related surficial and Upper Floridan aquifers near the wetland, historical aerial photography, review of the normal pool elevation to determine if it was appropriate and correct, and a potential field inspection of the site. Based on these multiple factors, staff determined where the weight of the evidence fell and assigned a recovery assessment bin for the wetlands based on this reasoned evaluation.

This weight-of-evidence approach proved to be a successful method of evaluating the recovery of wetlands at the Starkey Wellfield and has been applied to the wetlands at the remaining wellfields. This concept was also applied to the assessment of recovery at lakes and unmonitored sites. The process that was followed in assessing the environmental recovery at the identified wetlands and lakes on and near the Consolidated Permit wellfields is presented in Section 6.8 of this report.

9.2 Individual Wellfield Preliminary Assessments of Wetland Recovery

Tampa Bay Water staff performed a preliminary assessment of recovery at all monitored wetlands by applying the weight-of-evidence approach described in Sections 6.6 and 6.7 of this report. Each of the 11 wellfields are unique having different assemblages of wetlands, differing hydrogeology, and data with different period-of-record lengths. Monitored wetlands were assessed on a wellfield-by-wellfield basis. Analyses and results were presented to District staff in technical meetings and then in technical reports. The wetland assessments started with isolated-mesic cypress systems as this was the only developed metric when the analyses began. As new metrics were developed and staff gained concurrence from the District on each method, wetlands of each type were analyzed either by wellfield or for the entire population of each type of wetland.

The wetland assessment process is summarized in the following sections for each individual wellfield with any special differences noted in the text. There are multiple assessment reports for each wellfield due to the overlapping nature of the development of metrics and recovery assessments. All analytical reports submitted to the District are referenced and included as appendices to this report and each wellfield section references all the submitted reports that make up the body of monitored wetland assessments for that wellfield. These wellfield-specific assessments were assembled into the Recovery Assessment Plan Preliminary Report of Findings that was submitted to the District in December 2018 (Tampa Bay Water, 2018b). The preliminary assessment results for all the wellfields using data through Water Year 2018 are presented in Section 9.3. The assessments of isolated xeric wetlands in the preliminary report of findings were performed using the initial xeric wetland metric (Section 6.3.4.1). This metric was subsequently revised and the final assessment of isolated xeric wetlands was performed using the revised xeric wetland metric (Section 6.3.4.2). Subsequent analyses of wetlands using data collected through Water Year 2019 and the final assessment results for all monitored wetlands are presented in Sections 9.4 through 9.7.

9.2.1 Starkey Wellfield

Tampa Bay Water staff began by assessing the mesic-associated isolated cypress wetlands at the Starkey Wellfield against the standard for these wetlands as established by the District. As the approach was developed and preliminary assessments performed, Tampa Bay Water and District staff reviewed the condition of many of these wetlands in the field on October 8, 2015. The applied methodology and discussion of those sites that did not meet their recovery metric were documented in a technical report that was discussed with the District on December 17, 2015 and submitted on February 16, 2016 (Appendix 9.1). This initial assessment used the post-cutback period of 2008 – 2014 to assess recovery of these wetlands. A report by Wise Consulting Group titled "*Assessment of Recovery in Groundwater Levels; J.B. Starkey Wellfield, Pasco County, Florida*" was used to support the assessment of wetlands at the Starkey Wellfield and is included with the February 16, 2016 technical report (as Appendix A of that submittal). The District reviewed this submittal and concurred with the recommended preliminary assessments in a letter dated December 9, 2016 (included in Appendix 9.1).

Following District concurrence that the initial recovery metric for isolated xeric wetlands was appropriate for recovery assessment analyses, isolated xeric wetlands at the Starkey Wellfield were assessed against this initial metric. Tampa Bay Water and District staff reviewed the condition of many of these xeric wetlands at the Starkey Wellfield on May 26, 2016. The assessment of the isolated xeric wetlands was discussed with the District at the April, May, and June 2016 technical coordination meetings and these assessments are documented in a technical report submitted to the District on September 1, 2016 (Appendix 9.2). The District concurred with the recommended preliminary assessment bins in a letter dated November 21, 2016 (included in Appendix 9.2).

A number of wetlands monitored within the Starkey Wellfield were classified as "Other" or were not assessed with the isolated mesic or xeric wetlands. This collection of wetlands was assessed together using the recovery metric most applicable to each wetland and these assessments were presented to the District on March 9 and April 13, 2017. The technical report for these wetlands was submitted to the District on September 14, 2017 (Appendix 9.3). The District concurred with the preliminary assessments of these wetlands in a letter dated October 12, 2017 (included in Appendix 9.3) and District staff asked questions related to the normal pool elevation of several of these wetlands. These questions were resolved to the best of staff's ability through investigations by Tampa Bay Water and the District; revised normal pool elevations if available were used in the final recovery assessment determination for these wetlands.

The preliminary evaluations of five connected wetlands at the Starkey Wellfield are included in an assessment report analyzing the recovery of 76 connected wetlands in multiple wellfields. These preliminary assessment results are presented in Section 9.5 and were submitted to the District on May 23, 2018 (Appendix 9.22). Two additional submittals completed the preliminary assessment of recovery for the remaining wetlands on the Starkey Wellfield. The first submittal is an assessment of wetlands in multiple wellfields that either had not been assessed or had a preliminary bin of "More Detailed Assessment Needed" (MDAN). This report contains the assessment of three Starkey Wellfield wetlands and was submitted to the District on December 19, 2018 (Appendix 9.4). The second submittal addresses ten wetlands at this wellfield that were assessed with unmonitored sites due to a lack of current water level data. The preliminary assessment for these wetlands included a description of the initial method used to determine the preliminary recovery bins for all unmonitored sites, including formerly monitored sites with truncated period of record data. This report was submitted to the District on December 21, 2018 and is discussed in Section 6.5 and Chapter 10. The preliminary assessment report for the unmonitored sites, including the ten wetlands with truncated data records at the Starkey Wellfield, is attached as Appendix 6.14.

9.2.2 North Pasco Wellfield

Tampa Bay Water staff performed the preliminary assessment of recovery for wetlands on the North Pasco Wellfield after both the mesic and the initial xeric recovery metrics had been established. Both types of wetlands were assessed in one report that was discussed with the District on July 21, 2016 and a joint field assessment of their condition was performed on August 2, 2016. The assessment report was completed and submitted to the District on January 23, 2017 and is included as Appendix 9.5. The District concurred with the preliminary recommendations and asked questions about two of the wetlands in a letter dated March 31, 2017 (included in Appendix 9.5). These questions are addressed in the final assessments of these two wetlands. Three additional wetlands at the North Pasco Wellfield were assessed with the other connected wetlands in the connected wetland assessment report that will be discussed in Section 9.5. One additional wetland was assessed with the connected wetland metric and the assessment summary for this site is included in the report on unassessed and MDAN wetlands (Appendix 9.4). Six final wetlands were assessed with unmonitored sites due to a lack of current water level data. The preliminary assessment for these wetlands was included with a report describing the initial method used to determine the preliminary recovery bins for all unmonitored sites, including formerly monitored sites with truncated period of record data. This report was submitted to the District on December 21, 2018 and is discussed in Section 6.5 and Chapter 10. The preliminary assessment report for the unmonitored sites, including the six wetlands with truncated data records at the Starkey Wellfield, is attached as Appendix 6.14.

9.2.3 Cross Bar Ranch Wellfield

Tampa Bay Water staff performed the preliminary assessment of recovery for mesic and xeric wetlands at the Cross Bar Ranch Wellfield following the establishment of the mesic and initial xeric wetland recovery metrics. These assessments and recommendations were discussed with the District in the July 21, 2016 and October 13, 2016 technical coordination meetings and the condition of many of the wetlands was reviewed in the field on August 4, 2016. The preliminary assessment report for the mesic and xeric isolated wetlands was submitted to the District on October 27, 2016 (Appendix 9.6). The District concurred with the preliminary recommendations in a letter dated November 21, 2016 (included in Appendix 9.6). Five additional wetlands (mesic marshes and other/undetermined wetlands) were assessed in a technical assessment report submitted to the District on April 3, 2018 (Appendix 9.7). A report by Wise Consulting Group titled "*Assessment of Groundwater Level Recoveries for the Cross Bar Ranch Wellfield*" was used to support the assessment of wetlands at this wellfield; this groundwater recovery report is included with the April 3, 2018 technical report. These assessments were discussed with the District staff on November 9, 2017 and the District concurred with the recommended initial bins in a letter dated July 2, 2018 (included in Appendix 9.7) and asked questions about five sites. These questions are addressed in the final assessments of these five wetlands.

The preliminary assessments for five additional wetlands at the Cross Bar Ranch Wellfield are included in the report on unassessed and MDAN wetlands (Appendix 9.4). Three final wetlands at this wellfield were assessed with unmonitored sites due to a lack of current water level data. The preliminary assessment for these wetlands was included with a report describing the initial method used to determine the preliminary recovery bins for all unmonitored sites, including formerly monitored sites with truncated period of record data. This report was submitted to the District on December 21, 2018 and is discussed in Section

6.5 and Chapter 10. The preliminary assessment report for the unmonitored sites, including the three wetlands with truncated data records at the Cross Bar Ranch Wellfield, is attached as Appendix 6.14. One of the formerly-monitored wetlands (CBR-Q-23) that was assessed with the unmonitored wetlands was assigned a preliminary bin of "More Detailed Assessment Needed" since the results of the analyses were unclear. Tampa Bay Water and the District agreed that this preliminary bin was acceptable for this site for the preliminary report of findings. The final assessment for this wetland was made with the unmonitored sites (Chapter 10) due to the lack of current data. The final assessment bin is reported in Tables 9.7 and 9.8.

9.2.4 Cypress Creek Wellfield

Staff performed the preliminary assessment of recovery for isolated mesic and xeric wetlands at the Cypress Creek Wellfield following the establishment of the mesic and initial xeric wetland recovery metrics. These assessments and recommendations were discussed with the District at the August 25, 2016 technical coordination meeting and staff inspected several of these wetlands in a field visit on October 31, 2016. Tampa Bay Water submitted the preliminary assessment report for the mesic and xeric isolated wetlands at the Cypress Creek Wellfield on January 26, 2017 (Appendix 9.8). A report by Wise Consulting Group titled "*Assessment of Groundwater Level Recovery at the Cypress Creek Wellfield*" was used to support the assessment of wetlands at this wellfield; this groundwater recovery report is included with the January 26, 2017 technical report. The District concurred with the preliminary recommendations in a letter dated March 13, 2017 (included in Appendix 9.8) and provided review comments on the normal pool elevations for several wetlands and offered alternative preliminary recovery bins for a few of the assessed wetlands. Tampa Bay Water staff reviewed the District recommendations and revised the preliminary bin for three wetlands as detailed in a letter dated April 4, 2018 (included in Appendix 9.8). The District questions about normal pool elevation were resolved through investigations by Tampa Bay Water and the District and any revised normal pool elevations have been used in the final assessment of recovery for these wetlands.

Tampa Bay Water staff performed the assessment of 26 connected wetlands at the Cypress Creek Wellfield using the recovery metric for this wetland type. These preliminary assessment results are presented in Section 9.5 and were submitted to the District on May 23, 2018 (Appendix 9.22). The preliminary assessments for thirteen additional wetlands at the Cypress Creek Wellfield are included in the report on unassessed and MDAN wetlands (Appendix 9.4). Four final wetlands at this wellfield were assessed with unmonitored sites due to a lack of current water level data. The preliminary assessment for these wetlands was included with a report describing the initial method used to determine the preliminary recovery bins for all unmonitored sites, including formerly monitored sites with truncated period of record data. This report was submitted to the District on December 21, 2018 and is discussed in Section 6.5 and Chapter 10. The preliminary assessment report for the unmonitored sites, including the four wetlands with truncated data records at the Cypress Creek Wellfield, is attached as Appendix 6.14.

9.2.5 Cypress Bridge Wellfield

The preliminary assessment of wetland recovery at the Cypress Bridge Wellfield is different from the other wellfields. This was the last of the 11 Consolidated Permit wellfields to be fully developed and interconnected to the regional supply system and the wellfield pumping rate has not been reduced over time as is the case for the older wellfields. Since there has been no period of higher pumping followed by reduced pumping from the wellfield, an assessment of recovery for the wetlands in the vicinity of the Cypress Bridge Wellfield cannot be performed. Instead, staff have performed an assessment of the health of the monitored wetlands at this wellfield with respect to District permitting criteria. Tampa Bay Water and the District staff agreed that the recovery metrics for the different wetland types are applicable to the Cypress Bridge wetlands since all metrics were established based on maintaining the ecological health of a wetland. If the water levels in a wetland are above the appropriate metric for that wetland for an appropriate period of time, it is assumed that there is no significant harm occurring in the wetland for that period. The wetlands at the Cypress Bridge Wellfield have been assessed against the established metrics on a pass/fail basis. The wetlands either meet their metric of health or they do not; the Recovery Assessment bin "Improved, Not Fully Recovered" is not applicable to wetlands associated with this wellfield (see Section 6.2 for a discussion of the development of assessment classification bins).

The monitored isolated wetlands at the Cypress Bridge Wellfield were assessed in this manner and the analyses and recommended bins were discussed with the District at the September 22, 2017 technical coordination meeting. Staff assessments of the isolated mesic and xeric wetlands, the wetlands classified as "Other", and the preliminary Recovery Assessment status bins for these wetlands are included in a technical report submitted to the District on December 22, 2017 (Appendix 9.9). A report titled "*Period of Record Wetland Ecosite History Documentation for Cypress Bridge Wellfield*" was prepared in December 2012 by Dr. Patricia Dooris for Tampa Bay Water (Dooris and Associates, 2012). This report was used in the preliminary assessment of wetlands at the Cypress Bridge Wellfield and it is included in the December 22, 2017 report. The District concurred with the preliminary recommendations in a letter dated March 6, 2018 (included in Appendix 9.9) with the exception of the proposed bins for wetlands CYB-1 and CYB-2 which have large sinkholes within the wetlands (the formation of the sinkholes predated the initiation of pumping from the wellfield). The District staff recommended further assessment for these two wetlands and provided review comments on the normal pool elevations for several wetlands. The District questions about normal pool elevation were investigated by Tampa Bay Water and the District and any revised normal pool elevations have been used in the final assessment of recovery for these wetlands. Additional District questions are addressed in the final assessments of the monitored wetlands at the Cypress Bridge Wellfield.

Tampa Bay Water staff performed the assessment of 11 connected wetlands at the Cypress Bridge Wellfield using the recovery metric for this wetland type. These preliminary assessment results are presented in Section 9.5 and were submitted to the District on May 23, 2018 (Appendix 9.22). The preliminary assessments for five additional wetlands at the Cypress Bridge Wellfield are included in the report on unassessed and MDAN wetlands (Appendix 9.4). Two final wetlands at this wellfield were assessed with unmonitored sites due to a lack of current water level data. The preliminary assessment for these wetlands was included with a report describing the initial method used to determine the preliminary recovery bins for all unmonitored sites, including formerly monitored sites with truncated period of record data. This report was submitted to the District on December 21, 2018 and is discussed in Section 6.5 and Chapter 10. The preliminary assessment report for the unmonitored sites, including the two wetlands with truncated data records at the Cypress Bridge Wellfield, is attached as Appendix 6.14. One of the formerly monitored wetlands (CYB-12) that was assessed with the unmonitored wetlands was assigned a preliminary bin of "More Detailed Assessment Needed" since the results of the analyses were unclear. Tampa Bay Water and the District staff agreed that this preliminary bin was acceptable for this site for the preliminary report of findings. The final assessment for this wetland was made with the unmonitored sites (Chapter 10) due to the lack of current data. The final assessment bin is reported in Tables 9.7 and 9.8.

9.2.6 Morris Bridge Wellfield

Tampa Bay Water staff performed the preliminary assessment of recovery for isolated mesic cypress and marsh wetlands and two wetlands classified as "Other" or "Undetermined" at the Morris Bridge Wellfield following the establishment of the mesic wetland recovery metric. These assessments and recommendations were discussed with the District at the February 9, 2017 technical coordination meeting and staff inspected several of these wetlands in a field visit on February 16, 2017. Tampa Bay Water submitted the preliminary assessment report for the isolated mesic wetlands at the Morris Bridge Wellfield on August 18, 2017 (Appendix 9.10). A report by Wise Consulting Group titled "*Assessment of Groundwater Level Recovery at the Morris Bridge Wellfield*" was used to support the assessment of wetlands at this wellfield; this groundwater recovery report is included with the August 18, 2017 technical report. The District concurred with the preliminary recommendations in a letter dated October 1, 2017 (included in Appendix 9.10) and provided review comments on the normal pool elevations for several wetlands at this wellfield. District staff questions about normal pool elevation were investigated by Tampa Bay Water and the District and any revised normal pool elevations have been included into the final recovery assessment for these wetlands.

Tampa Bay Water staff performed the assessment of 15 connected wetlands at the Morris Bridge Wellfield using the recovery metric for this wetland type. These preliminary assessment results are presented in Section 9.5 and were submitted to the District on May 23, 2018 (Appendix 9.22). The preliminary assessments for seven additional wetlands at the Morris Bridge Wellfield are included in the report on unassessed and MDAN wetlands (Appendix 9.4). Two final wetlands at this wellfield were assessed with unmonitored sites due to a lack of current water level data. The preliminary assessment for these wetlands was included with a report describing the initial method used to determine the preliminary recovery bins for all unmonitored sites, including formerly monitored sites with truncated period of record data. This report was submitted to the District on December 21, 2018 and is discussed in Section 6.5 and Chapter 10. The preliminary assessment report for the unmonitored sites, including the two wetlands with truncated data records at the Morris Bridge Wellfield, is attached as Appendix 6.14.

9.2.7 Cosme Odessa Wellfield

The preliminary assessment of recovery for isolated mesic and xeric wetlands at the Cosme-Odessa Wellfield was performed by Tampa Bay Water staff following the establishment of the mesic and initial xeric wetland recovery metrics. These assessments and recommendations were discussed with the District at the August 25, 2016 technical coordination meeting and staff inspected several of these wetlands in a field visit on October 10, 2016. Tampa Bay Water submitted the preliminary assessment report for the isolated mesic and xeric wetlands at the Cosme-Odessa Wellfield on November 28, 2016 (Appendix 9.11). The District concurred with the preliminary recommendations in a letter dated December 9, 2016 (included in Appendix 9.11).

Staff compiled and analyzed additional information and recommended a preliminary recovery bin for four additional wetlands at this wellfield in a technical report submitted to the District on April 26, 2018 (Appendix 9.12). The District concurred with the preliminary recommendations in a letter dated July 2, 2018 (included in Appendix 9.12) and provided review comments on the normal pool elevations for a few of the wetlands at this wellfield. District staff questions about normal pool elevation were investigated by Tampa Bay Water and the District staff and any revised normal pool elevations were factored into the final recovery assessment for these wetlands. Tampa Bay Water staff performed the assessment of four connected wetlands at the Cosme-Odessa Wellfield using the recovery metric for this wetland type. These preliminary assessment results are presented in Section 9.5 and were submitted to the District on May 23, 2018 (Appendix 9.22).

The water level recovery in the surficial and Upper Floridan aquifers was documented in a report titled "*Assessment of Groundwater Level Recoveries; Wellfield Facilities near Northwestern Hillsborough County*" by Wise Consulting Group in December 2016. Information and graphics from this report were used in the preliminary wetland assessment reports for the Cosme-Odessa, Eldridge-Wilde, South Pasco, Section 21, and Northwest Hillsborough Wellfields. This groundwater level recovery report was not included in any of the preliminary wetland assessment reports for any of these wellfields so it is included separately for reference as Appendix 9.13.

9.2.8 Eldridge Wilde Wellfield

The preliminary assessment of recovery for isolated wetlands at the Eldridge-Wilde Wellfield was performed by Tampa Bay Water staff following the establishment of the mesic and initial xeric wetland recovery metrics. The analyses and recommended preliminary bins for these wetlands were discussed with the District at the January 19, 2017 technical coordination meeting and Tampa Bay Water and District staff inspected many of these wetlands during a field visit on February 21, 2017. Tampa Bay Water submitted the preliminary assessment report for the isolated mesic and xeric wetlands at the Eldridge-Wilde Wellfield on April 28, 2017 (Appendix 9.14). The District concurred with the preliminary recommendations in a letter dated May 9, 2017 (included in Appendix 9.14) with the exception of one wetland. The District recommended a preliminary recovery bin of "Improved, Not Fully Recovered" for wetland ELW NW022716 and Tampa Bay Water staff accepted this alternative recovery bin for the preliminary assessment report of findings.

Tampa Bay Water staff performed the assessment of one connected wetland at the Eldridge-Wilde Wellfield using the recovery metric for this wetland type. These preliminary assessment results are presented in Section 9.5 and were submitted to the District on May 23, 2018 (Appendix 9.22). Staff completed the preliminary assessment for two additional wetlands at the Eldridge-Wilde Wellfield and these assessments are included in the report on unassessed and MDAN wetlands (Appendix 9.4).

9.2.9 South Pasco Wellfield

Tampa Bay Water staff performed the preliminary assessment of recovery for isolated mesic cypress wetlands at the South Pasco Wellfield following agreement with District staff on the use of this wetland recovery metric. These assessments and recommendations were discussed with the District at the March 1, 2016 technical coordination meeting and staff inspected most of these wetlands during a field visit on

April 4, 2016. Tampa Bay Water submitted the preliminary assessment report for the isolated mesic wetlands at the South Pasco Wellfield on August 8, 2016 (Appendix 9.15). The District concurred with the preliminary recovery assessment bin recommendations in a letter dated November 21, 2016 (included in Appendix 9.15). Tampa Bay Water staff performed the assessment of four connected wetlands at the South Pasco Wellfield using the recovery metric for this wetland type. The preliminary assessment results for these four wetlands are presented in Section 9.5 and were submitted to the District on May 23, 2018 (Appendix 9.22).

9.2.10 Section 21 Wellfield

The preliminary assessment of recovery for isolated mesic and xeric wetlands at the Section 21 Wellfield was performed by Tampa Bay Water staff following the establishment of the mesic and initial xeric wetland recovery metrics. These assessments and recommendations were discussed with District staff at the December 15, 2016 technical coordination meeting and staff inspected several of these wetlands in a field visit on March 2, 2017. Tampa Bay Water submitted the preliminary assessment report for the isolated mesic and xeric wetlands at the Section 21 Wellfield on September 6, 2017 (Appendix 9.16). The District concurred with the preliminary recommendations in a letter dated December 19, 2017 (included in Appendix 9.16) and provided review comments on the normal pool elevations for most of the wetlands at this wellfield. The District questions about normal pool elevation were investigated by Tampa Bay Water and the District and any revised normal pool elevations were factored into the final recovery assessment for these wetlands.

Tampa Bay Water staff performed the assessment of two connected wetlands at the Section 21 Wellfield using the recovery metric for this wetland type. The preliminary assessment results for these two wetlands are presented in Section 9.5 and were submitted to the District on May 23, 2018 (Appendix 9.22). Staff completed the preliminary assessment for one additional wetland at the Section 21 Wellfield and this assessment is included in the report on unassessed and MDAN wetlands (Appendix 9.4).

9.2.11 Northwest Hillsborough Wellfield

Tampa Bay Water staff performed the preliminary assessment of recovery for isolated mesic and xeric wetlands at the Northwest Hillsborough Wellfield following the establishment of the mesic and initial xeric wetland recovery metrics. These assessments and recommendations were discussed with the District at the October 20, 2016 technical coordination meeting and staff inspected some of these wetlands in a field visit on March 2, 2017. Tampa Bay Water submitted the preliminary assessment report for the isolated mesic and xeric cypress wetlands at the Northwest Hillsborough Wellfield on November 17, 2017 (Appendix 9.17). The District concurred with the preliminary recovery assessment bin recommendations in a letter dated January 12, 2018 (included in Appendix 9.17) and provided review comments on the normal pool elevations for most of the wetlands at this wellfield and questions on a few of the proposed recovery bins. The District questions about normal pool elevation were investigated by Tampa Bay Water and District staff and any revised normal pool elevations have been used in the final assessment of recovery for these wetlands. Additional District questions are addressed in the final assessments of the monitored wetlands at the Northwest Hillsborough Wellfield. Tampa Bay Water staff performed the assessment of four connected wetlands at the Northwest Hillsborough Wellfield using the recovery metric for this wetland type. The preliminary assessment results for these four wetlands are presented in Section 9.5 and were submitted to the District on May 23, 2018 (Appendix 9.22).

9.2.12 Wetlands with no Wellfield Affiliation

The final Recovery Assessment monitored wetland list contains three District-monitored wetlands that are not associated with any of the 11 Consolidated Permit wellfields. All three wetlands are located on the Cypress Creek Environmental Lands Acquisition and Protection Program (ELAPP) property in northern Hillsborough County. The preliminary assessment of the two Cypress Creek ELAPP cypress and marsh wetlands was performed using the applicable metrics for these wetlands and the assessment results are included in the report on unassessed and MDAN wetlands (Appendix 9.4). The preliminary assessment of the Cypress Creek ELAPP Riverine site was made using the connected wetland metric and the preliminary assessment results for this wetland is presented in Section 9.5 and was submitted to the District on May 23, 2018 (Appendix 9.22).

9.3 Preliminary Recovery Assessment Evaluation Results

Tampa Bay Water submitted the Recovery Assessment Plan Preliminary Report of Findings to the District on December 27, 2018 in accordance with Special Condition 11.C of the 2011 Consolidated Permit (Tampa Bay Water, 2018b). There were 378 individual monitored wetlands assessed in this preliminary report and 278 were reported as “Never Impacted” or “Recovered” (74% of the total) using the District-approved recovery bins (Section 6.2). Another 84 sites were categorized as “Improved, Not Fully Recovered” and only four wetlands were assigned to the bin of “Not Fully Recovered, Continuing Impact”. Eight wetlands were determined to have been “Impacted by Other Causes” (not related to wellfield pumping) and four sites did not have an assigned bin due to inconclusive results in their preliminary analyses. The preliminary results from the December 2018 report are summarized in Figure 9.1 in table and chart format. Table 9.1 presents the preliminary assessment bin for the 378 monitored wetlands as reported in the Preliminary Report of Findings. These preliminary recovery assessment bins form the starting point for the final assessment of recovery at all monitored wetlands.

Wetland/Lake Assessment Status
Preliminary Bin Designations

Recovery Classes/Bins	Number	Percent
Monitored Wetlands	**378**	
Never Impacted	54	14%
Recovered/Meets Metric	224	59%
Improved, Not Fully Recovered	84	22%
Not Fully Recovered, Continuing Impact	4	1%
More Detailed Analysis Needed	4	1%
Impacted, Other Causes	8	2%
Total	378	100%

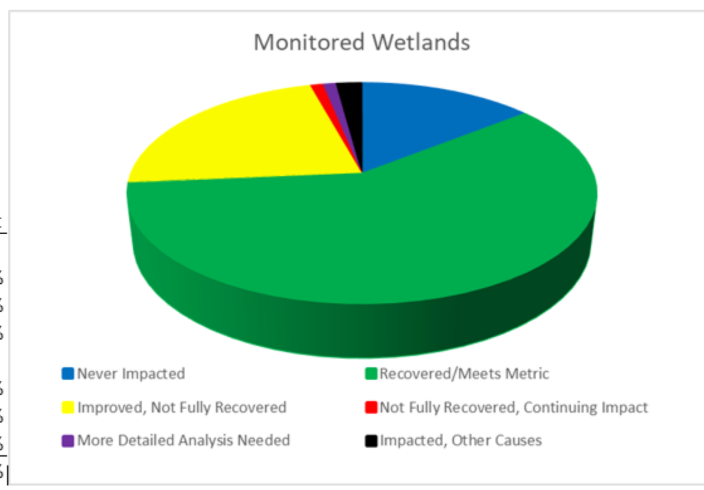

Figure 9.1: Preliminary Assessment Results for Monitored Wetlands (through Water Year 2018)

Table 9.1: Preliminary Recovery Assessment Findings for Monitored Wetlands

SWFWMD ID	TBW Site ID	Recovery Status	Site Name	Wellfield Code	Recovery Analysis
1	**4863**	**improved, not fully recovered**	**CBR-Q01**	**CBR**	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
2	4864	recovered	CBR-Q02	CBR	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
4	4866	recovered	CBR-Q04	CBR	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
5	4867	improved, not fully recovered	CBR-Q05	CBR	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
6	4868	improved, not fully recovered	CBR-Q06	CBR	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
7	4869	improved, not fully recovered	CBR-Q07	CBR	Previously Unbinned and MDAN Wetlands
8	4870	improved, not fully recovered	CBR-Q08	CBR	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
9	4871	improved, not fully recovered	CBR-Q10	CBR	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
10	4872	recovered	CBR-Q12	CBR	Cross Bar Mesic Marshes and Other Wetlands
11	4873	improved, not fully recovered	CBR-Q14	CBR	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
12	4874	improved, not fully recovered	CBR-Q15	CBR	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
13	4875	recovered	CBR-Q16	CBR	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
14	4876	improved, not fully recovered	CBR-Q17	CBR	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
17	4879	improved, not fully recovered	CBR-Q20	CBR	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
18	4880	improved, not fully recovered	CBR-Q21	CBR	Cross Bar Mesic Marshes and Other Wetlands
20	4882	more detailed analysis needed	CBR-Q23	CBR	Unmonitored Wetland Assessment - GIS Model Report
21	**4883**	**recovered**	**CBR-Q24**	**CBR**	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
22	**4884**	**improved, not fully recovered**	**CBR-Q25**	**CBR**	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
23	4885	improved, not fully recovered	CBR-Q26	CBR	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
31	6176	recovered	CBR Q34	CBR	Unmonitored Wetland Assessment - GIS Model Report

SWFWMD ID	TBW Site ID	Recovery Status	Site Name	Wellfield Code	Recovery Analysis
34	4894	improved, not fully recovered	CBR-T01	CBR	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
35	4895	improved, not fully recovered	CBR-T02A	CBR	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
36	**4896**	**recovered**	**CBR-T03**	**CBR**	Cross Bar Mesic Marshes and Other Wetlands
38	4898	recovered	CBR-T08A	CBR	Cross Bar Recovery Assessment: mesic and xeric-associated wetlands
39	4899	improved, not fully recovered	CBR-T10	CBR	Cross Bar Mesic Marshes and Other Wetlands
40	26218	recovered	CBR T11	CBR	Unmonitored Wetland Assessment - GIS Model Report
41		recovered	Ann Denker	CBR	Previously Unbinned and MDAN Wetlands
42		recovered	Pasco Trails	CBR	Previously Unbinned and MDAN Wetlands
542	50051	improved, not fully recovered	Lost Lake	CBR	Previously Unbinned and MDAN Wetlands
543	50052	recovered	Spring Lake	CBR	Cross Bar Mesic Marshes and Other Wetlands
544	50053	recovered	Cross Bar 6	CBR	Previously Unbinned and MDAN Wetlands
103	4955	recovered	COS-102717	COS	Cosme-Odessa Wellfield Recovery Assessment
104	4958	recovered	COS-162717	COS	Cosme-Odessa Wellfield Recovery Assessment
105	4967	recovered	COS-C042817	COS	Connected Wetlands Assessment
106	4956	recovered	COS-C142717	COS	Cosme-Odessa Wellfield Recovery Assessment
107	4959	recovered	COS-EC222717	COS	Cosme Additional Sites Assessment Memo
108	4964	recovered	COS-EC332717	COS	Connected Wetlands Assessment
109	4960	improved, not fully recovered	COS-NC242717	COS	Cosme-Odessa Wellfield Recovery Assessment
110	4961	recovered	COS-NC262717	COS	Cosme-Odessa Wellfield Recovery Assessment
111	4968	impacted due to other causes	NW042817	COS	Cosme Additional Sites Assessment Memo
112	4965	recovered	COS-NW332717	COS	Cosme Additional Sites Assessment Memo
113	**4963**	**improved, not fully recovered**	**COS-SC272717**	**COS**	Cosme-Odessa Wellfield Recovery Assessment
114	4966	recovered	COS-SC332717	COS	Connected Wetlands Assessment
115	4954	recovered	SE012717	COS	Cosme Additional Sites Assessment Memo
116	4957	recovered	COS-SE142717	COS	Connected Wetlands Assessment
121	3874	impacted due to other causes	CYB-01	CYB	Cypress Bridge Wellfield Wetland Assessment
122	3875	impacted due to other causes	CYB-02	CYB	Cypress Bridge Wellfield Wetland Assessment

SWFWMD ID	TBW Site ID	Recovery Status	Site Name	Wellfield Code	Recovery Analysis
123	3876	no cutback, meets metric	CYB-03	CYB	Cypress Bridge Wellfield Wetland Assessment
124	**3877**	**no cutback, meets metric**	**CYB-04**	**CYB**	Cypress Bridge Wellfield Wetland Assessment
125	9534	no cutback, meets metric	CYB-05	CYB	Cypress Bridge Wellfield Wetland Assessment
126	3878	no cutback, meets metric	CYB-06	CYB	Previously Unbinned and MDAN Wetlands
127	3879	no cutback, meets metric	CYB-09	CYB	Cypress Bridge Wellfield Wetland Assessment
128	9535	impacted due to other causes	CYB-11	CYB	Connected Wetlands Assessment
129	3880	more detailed analysis needed	CYB 12	CYB	Unmonitored Wetland Assessment - GIS Model Report
130	3881	no cutback, meets metric	CYB-13	CYB	Cypress Bridge Wellfield Wetland Assessment
131	3882	no cutback, meets metric	CYB-14	CYB	Cypress Bridge Wellfield Wetland Assessment
132	3883	more detailed analysis needed	CYB-15	CYB	Previously Unbinned and MDAN Wetlands
133	**3884**	**no cutback, meets metric**	**CYB-16**	**CYB**	Cypress Bridge Wellfield Wetland Assessment
134	3885	no cutback, meets metric	CYB-17	CYB	Previously Unbinned and MDAN Wetlands
135	9536	no cutback, meets metric	CYB-18	CYB	Connected Wetlands Assessment
138	3887	no cutback, meets metric	CYB-21	CYB	Cypress Bridge Wellfield Wetland Assessment
139	9537	no cutback, meets metric	CYB-22	CYB	Connected Wetlands Assessment
140	3888	no cutback, meets metric	CYB-23	CYB	Cypress Bridge Wellfield Wetland Assessment
141	3889	no cutback, meets metric	CYB 24	CYB	Unmonitored Wetland Assessment - GIS Model Report
142	**3890**	**no cutback, meets metric**	**CYB-25**	**CYB**	Cypress Bridge Wellfield Wetland Assessment
143	9538	no cutback, meets metric	CYB-26	CYB	Connected Wetlands Assessment
144	26220	no cutback, meets metric	CYB-27	CYB	Connected Wetlands Assessment
145	9539	no cutback, meets metric	CYB-28	CYB	Connected Wetlands Assessment
146	9540	no cutback, meets metric	CYB-29	CYB	Previously Unbinned and MDAN Wetlands
147	3891	no cutback, meets metric	CYB-30	CYB	Cypress Bridge Wellfield Wetland Assessment
148	9541	no cutback, meets metric	CYB-31	CYB	Connected Wetlands Assessment
149	**3892**	**no cutback, meets metric**	**CYB-32**	**CYB**	Cypress Bridge Wellfield Wetland Assessment
150	3893	no cutback, meets metric	CYB-33	CYB	Cypress Bridge Wellfield Wetland Assessment
151	3894	no cutback, meets metric	CYB-34	CYB	Cypress Bridge Wellfield Wetland Assessment
152	9542	no cutback, meets metric	CYB-37	CYB	Connected Wetlands Assessment

SWFWMD ID	TBW Site ID	Recovery Status	Site Name	Wellfield Code	Recovery Analysis
153	**3895**	**more detailed analysis needed**	**CYB-A**	**CYB**	Previously Unbinned and MDAN Wetlands
154	9543	no cutback, meets metric	CYB-C10	CYB	Connected Wetlands Assessment
155	9544	no cutback, meets metric	CYB-C12	CYB	Connected Wetlands Assessment
156	3896	no cutback, meets metric	CYB-C16	CYB	Cypress Bridge Wellfield Wetland Assessment
158	50001	no cutback, meets metric	New River Cypress	CYB	Cypress Bridge Wellfield Wetland Assessment
159	50009	no cutback, meets metric	New River Marsh	CYB	Cypress Bridge Wellfield Wetland Assessment
16	3777	improved, not fully recovered	CYC C25/ CBR Q19	CYC	Previously Unbinned and MDAN Wetlands
160	6096	recovered	C01	CYC	Previously Unbinned and MDAN Wetlands
162	3768	improved, not fully recovered	CYC-C06	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
163	6098	improved, not fully recovered	C08	CYC	Previously Unbinned and MDAN Wetlands
164	3773	recovered	CYC-C11	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
166	3774	recovered	CYC-C14	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
167	6100	recovered	C15	CYC	Unmonitored Wetland Assessment - GIS Model Report
168	6101	recovered	C16	CYC	Unmonitored Wetland Assessment - GIS Model Report
169	6103	recovered or never impacted	CYC-C19	CYC	Connected Wetlands Assessment
170	6104	recovered	CYC-C20	CYC	Previously Unbinned and MDAN Wetlands
172	6105	recovered	C22A	CYC	Unmonitored Wetland Assessment - GIS Model Report
173	3775	recovered	C23	CYC	Unmonitored Wetland Assessment - GIS Model Report
174	3776	recovered	CYC-C24	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
176	6106	recovered or never impacted	CYC-C33	CYC	Connected Wetlands Assessment
177	6107	recovered	CYC-C39	CYC	Connected Wetlands Assessment
178	6108	recovered	CYC-C40	CYC	Connected Wetlands Assessment
179	6109	recovered or never impacted	CYC-C100	CYC	Connected Wetlands Assessment
180	6124	recovered or never impacted	CYC-W25	CYC	Connected Wetlands Assessment

SWFWMD ID	TBW Site ID	Recovery Status	Site Name	Wellfield Code	Recovery Analysis
181	3769	recovered	CYC-C101	CYC	Previously Unbinned and MDAN Wetlands
182	3770	improved, not fully recovered	CYC-C102	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
183	6111	recovered or never impacted	CYC-C103	CYC	Connected Wetlands Assessment
184	3771	improved, not fully recovered	CYC-C104	CYC	Previously Unbinned and MDAN Wetlands
185	3772	recovered	CYC-C105	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
186	6112	recovered	C106	CYC	Connected Wetlands Assessment
187	6113	recovered	CYC-W01	CYC	Connected Wetlands Assessment
188	3778	improved, not fully recovered	W02A	CYC	Previously Unbinned and MDAN Wetlands
189	3779	improved, not fully recovered	CYC-W03	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
190	3780	improved, not fully recovered	CYC-W04	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands and Status Determination Letter
191	6115	recovered	CYC-W05	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
192	6118	recovered	W06/ W07/ W08	CYC	Connected Wetlands Assessment
193	6119	recovered	CYC-W09	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
194	3781	recovered	CYC-W10	CYC	Previously Unbinned and MDAN Wetlands
195	**3782**	**recovered**	**CYC-W11**	**CYC**	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
196	**3783**	**improved, not fully recovered**	**CYC-W12**	**CYC**	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
197	6121	recovered	CYC-W14	CYC	Connected Wetlands Assessment
198	3784	not fully recovered, continuing wellfield impact	CYC-W16	CYC	Previously Unbinned and MDAN Wetlands
199	**3785**	**improved, not fully recovered**	**CYC-W17**	**CYC**	Cypress Creek Recovery Assessment: Mesic-associated,

SWFWMD ID	TBW Site ID	Recovery Status	Site Name	Wellfield Code	Recovery Analysis
					xeric-associated and other wetlands
200	3786	recovered	CYC-W19	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
201	3787	recovered	CYC-W20	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
202	6122	recovered	CYC-W21N	CYC	Connected Wetlands Assessment
203	6122	recovered	CYC-W21S	CYC	Connected Wetlands Assessment
204	3788	improved, not fully recovered	CYC-W23	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
205	6125	improved, not fully recovered	CYC-W27	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
206	3789	recovered	CYC-W29	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
207	6126	recovered	CYC-W30N	CYC	Connected Wetlands Assessment
208	6126	recovered	W30S	CYC	Connected Wetlands Assessment
209	3790	recovered	CYC-W31	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
210	3791	improved, not fully recovered	CYC-W32	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
211	3792	recovered	CYC-W33	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
212	6127	recovered	W34	CYC	Connected Wetlands Assessment
213	6128	recovered	CYC-W36	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
214	6129	improved, not fully recovered	CYC-W37	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
215	3793	recovered	CYC-W39	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
216	3794	improved, not fully recovered	CYC-W40	CYC	Cypress Creek Recovery Assessment: Mesic-associated,

SWFWMD ID	TBW Site ID	Recovery Status	Site Name	Wellfield Code	Recovery Analysis
					xeric-associated and other wetlands
217	**3795**	**improved, not fully recovered**	**CYC-W41**	**CYC**	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
218	6130	recovered	W42	CYC	Connected Wetlands Assessment
220	6131	improved, not fully recovered	CYC-W43	CYC	Connected Wetlands Assessment
221	6132	improved, not fully recovered	CYC-W44	CYC	Connected Wetlands Assessment
222	3796	improved, not fully recovered	CYC-W45	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
223	3797	improved, not fully recovered	CYC-W46	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
225	6135	improved, not fully recovered	CYC-W49	CYC	Connected Wetlands Assessment
226	6136	improved, not fully recovered	CYC-W50	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
227	6137	improved, not fully recovered	CYC-W51	CYC	Connected Wetlands Assessment
228	3798	improved, not fully recovered	CYC-W52	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
229	3799	improved, not fully recovered	CYC-W55	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
230	**5491**	**improved, not fully recovered**	**CYC-W56**	**CYC**	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands and Status Determination Letter
231	6139	recovered	CYC-W57	CYC	Connected Wetlands Assessment
232	6140	recovered	CYC-W58	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
233	50035	recovered	CCS-5	CYC	Connected Wetlands Assessment
234	50030	not fully recovered, continuing wellfield impact	CCWF "F"	CYC	Previously Unbinned and MDAN Wetlands
235	50028	improved, not fully recovered	Conners Cypress Marsh	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands and Status Determination Letter

SWFWMD ID	TBW Site ID	Recovery Status	Site Name	Wellfield Code	Recovery Analysis
236	50014	never impacted	Conners Marsh 1	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
237	50015	never impacted	Conners Marsh 2	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
238	50036	never impacted	Conners Wet Prairie	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
239	50012	recovered	Correctional Facility Cypress	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands
240	50013	recovered	Correctional Facility Cypress marsh	CYC	Cypress Creek Recovery Assessment: Mesic-associated, xeric-associated and other wetlands and Status Determination Letter
241	50037	recovered or never impacted	Mertz Riverine	CYC	Connected Wetlands Assessment
242	50020	recovered	Pheasant Run (Quail Hollow) Cypress	CYC	Previously Unbinned and MDAN Wetlands
243	4974	recovered	ELW-C132716	ELW	Eldridge-Wilde Wellfield Recovery Assessment - monitored geographically-isolated wetlands in mesic and xeric landscapes
244	4971	recovered	ELW-EC112716	ELW	Eldridge-Wilde Wellfield Recovery Assessment - monitored geographically-isolated wetlands in mesic and xeric landscapes
245	4975	recovered	ELW-NC222716	ELW	Eldridge-Wilde Wellfield Recovery Assessment - monitored geographically-isolated wetlands in mesic and xeric landscapes
246	4972	recovered	ELW-NNW122716	ELW	Eldridge-Wilde Wellfield Recovery Assessment - monitored geographically-isolated wetlands in mesic and xeric landscapes
247	**4969**	**improved, not fully recovered**	**ELW-NW022716**	**ELW**	Eldridge-Wilde Wellfield Recovery Assessment - monitored geographically-isolated wetlands in mesic and xeric landscapes
248	**4978**	**recovered**	**ELW-NW052717**	**ELW**	Eldridge-Wilde Wellfield Recovery Assessment - monitored geographically-isolated wetlands in mesic and xeric landscapes
249	4979	improved, not fully recovered	ELW-NW062717	ELW	Eldridge-Wilde Wellfield Recovery Assessment -

SWFWMD ID	TBW Site ID	Recovery Status	Site Name	Wellfield Code	Recovery Analysis
					monitored geographically-isolated wetlands in mesic and xeric landscapes
250	4973	recovered	ELW-NW122716	ELW	Eldridge-Wilde Wellfield Recovery Assessment - monitored geographically-isolated wetlands in mesic and xeric landscapes
251	4976	recovered	ELW-SC272716	ELW	Eldridge-Wilde Wellfield Recovery Assessment - monitored geographically-isolated wetlands in mesic and xeric landscapes
252	4980	improved, not fully recovered	ELW-SW062717	ELW	Eldridge-Wilde Wellfield Recovery Assessment - monitored geographically-isolated wetlands in mesic and xeric landscapes
253	4981	recovered	SW082717	ELW	Previously Unbinned and MDAN Wetlands
254	4977	improved, not fully recovered	ELW-SW272716	ELW	Eldridge-Wilde Wellfield Recovery Assessment - monitored geographically-isolated wetlands in mesic and xeric landscapes
255	4970	recovered	ELW-WC102716	ELW	Connected Wetlands Assessment
256	50016	improved, not fully recovered	EWWF3	ELW	Previously Unbinned and MDAN Wetlands
257	6165	recovered	MBR-09	MBR	Connected Wetlands Assessment
258	6069	improved, not fully recovered	MBR-10	MBR	Morris Bridge - mesic-associated isolated wetlands
259	6070	recovered	MBR-11	MBR	Morris Bridge - mesic-associated isolated wetlands
260	6071	recovered	MBR-14	MBR	Morris Bridge - mesic-associated isolated wetlands
261	**6072**	**improved, not fully recovered**	**MBR-16**	**MBR**	Morris Bridge - mesic-associated isolated wetlands
262	6073	improved, not fully recovered	MBR-29	MBR	Morris Bridge - mesic-associated isolated wetlands
263	6074	improved, not fully recovered	MBR-30	MBR	Morris Bridge - mesic-associated isolated wetlands
264	**6075**	**improved, not fully recovered**	**MBR-35**	**MBR**	Morris Bridge - mesic-associated isolated wetlands
265	6170	recovered	MBR-36	MBR	Connected Wetlands Assessment
266	6076	improved, not fully recovered	MBR-37	MBR	Morris Bridge - mesic-associated isolated wetlands
267	6077	recovered	MBR-42	MBR	Morris Bridge - mesic-associated isolated wetlands
268	6171	recovered	MBR-60	MBR	Connected Wetlands Assessment
269	6172	recovered	MBR-79	MBR	Connected Wetlands Assessment
270	6173	recovered	MBR-80	MBR	Connected Wetlands Assessment

SWFWMD ID	TBW Site ID	Recovery Status	Site Name	Wellfield Code	Recovery Analysis
271	26224	recovered	MBR 81	MBR	Unmonitored Wetland Assessment - GIS Model Report
272	26225	recovered	MBR 86	MBR	Unmonitored Wetland Assessment - GIS Model Report
273	**6078**	**improved, not fully recovered**	**MBR-88**	**MBR**	Previously Unbinned and MDAN Wetlands
274	**6079**	**recovered**	**MBR-89**	**MBR**	Morris Bridge - mesic-associated isolated wetlands
275	6080	recovered	MBR-90	MBR	Morris Bridge - mesic-associated isolated wetlands
276	6081	improved, not fully recovered	MBR-91	MBR	Morris Bridge - mesic-associated isolated wetlands
277	6082	recovered	MBR-93	MBR	Morris Bridge - mesic-associated isolated wetlands
278	6083	recovered	MBR-94	MBR	Morris Bridge - mesic-associated isolated wetlands
279	6084	recovered	MBR-96	MBR	Morris Bridge - mesic-associated isolated wetlands
280	6085	improved, not fully recovered	MBR-97	MBR	Previously Unbinned and MDAN Wetlands
281	6086	recovered	MBR-98	MBR	Previously Unbinned and MDAN Wetlands
282	6166	recovered	MBR 100	MBR	Connected Wetlands Assessment
283	6174	improved, not fully recovered	MBR-102	MBR	Previously Unbinned and MDAN Wetlands
284	6167	recovered or never impacted	MBR-103	MBR	Connected Wetlands Assessment
285	6175	recovered or never impacted	MBR-104	MBR	Connected Wetlands Assessment
286	6168	improved, not fully recovered	MBR-105	MBR	Previously Unbinned and MDAN Wetlands
287	6169	recovered	MBR-106	MBR	Connected Wetlands Assessment
288	50038	recovered	MBWF Clay Gully Site	MBR	Connected Wetlands Assessment
289	50039	recovered	East Branch Clay S RD	MBR	Connected Wetlands Assessment
290	50040	improved, not fully recovered	East Branch Clay Gully	MBR	Previously Unbinned and MDAN Wetlands
291	50029	improved, not fully recovered	MBWF East Cypress Marsh	MBR	Previously Unbinned and MDAN Wetlands
292	50031	improved, not fully recovered	MBWF Trout Creek Marsh	MBR	Morris Bridge - mesic-associated isolated wetlands
293	50021	recovered	MBWF West Cypress	MBR	Morris Bridge - mesic-associated isolated wetlands
294	50041	recovered	MBWF Wild Hog Slough	MBR	Connected Wetlands Assessment
295	50022	improved, not fully recovered	MBWF X-1	MBR	Morris Bridge - mesic-associated isolated wetlands
296	50032	recovered	MBWF X-3	MBR	Morris Bridge - mesic-associated isolated wetlands
297	50023	recovered	MBWF X-6	MBR	Morris Bridge - mesic-associated isolated wetlands
312	50024	Never Impacted	Cypress Creek ELAPP Cypress	None	Previously Unbinned and MDAN Wetlands

SWFWMD ID	TBW Site ID	Recovery Status	Site Name	Wellfield Code	Recovery Analysis
313	50033	Never Impacted	Cypress Creek ELAPP Marsh	None	Previously Unbinned and MDAN Wetlands
314	50042	recovered or never impacted	Cypress Creek ELAPP Riverine	None	Connected Wetlands Assessment
336	5369	never impacted	NOP-01	NOP	North Pasco
337	5370	never impacted	NOP-02	NOP	North Pasco
338	**5371**	**never impacted**	**NOP-03**	**NOP**	North Pasco
339	5372	recovered	NOP-04	NOP	North Pasco
340	5373	recovered	NOP-05	NOP	North Pasco
341	5374	recovered	NP-06	NOP	Unmonitored Wetland Assessment - GIS Model Report
342	5375	improved, not fully recovered	NOP-07	NOP	North Pasco
343	5376	recovered	NP-08	NOP	Connected Wetlands Assessment
344	5377	never impacted	NOP-09	NOP	North Pasco
345	5378	improved, not fully recovered	NOP-10	NOP	North Pasco
346	5379	never impacted	NOP-11	NOP	North Pasco
347	5381	recovered	NP-13/CYB C17	NOP	Unmonitored Wetland Assessment - GIS Model Report
348	5383	recovered	NP-15	NOP	Unmonitored Wetland Assessment - GIS Model Report
349	5384	recovered	NP-16	NOP	Unmonitored Wetland Assessment - GIS Model Report
350	5385	recovered	NOP-17	NOP	North Pasco
351	5386	never impacted	NOP-18	NOP	North Pasco
352	**5389**	**recovered**	**NOP-21**	**NOP**	North Pasco
353	5390	never impacted	NOP-22	NOP	North Pasco
354	5393	recovered	NP-25	NOP	Unmonitored Wetland Assessment - GIS Model Report
355	5394	recovered	NP-26	NOP	Connected Wetlands Assessment
356	5395	recovered	NP-27	NOP	Connected Wetlands Assessment
357	5397	recovered	NP-29	NOP	Unmonitored Wetland Assessment - GIS Model Report
358	5398	never impacted	NOP-30	NOP	North Pasco
360	5400	never impacted	NP-32	NOP	Previously Unbinned and MDAN Wetlands
362	5402	never impacted	NOP-36	NOP	North Pasco
365	4987	recovered	112817	NWH	Northwest Hillsborough Regional Wellfield Recovery Assessment
366	4988	impacted due to other causes	NWH-132817	NWH	Northwest Hillsborough Regional Wellfield Recovery Assessment
367	4989	recovered	NWH-142817	NWH	Northwest Hillsborough Regional Wellfield Recovery Assessment
369	4999	impacted due to other causes	302818	NWH	Northwest Hillsborough Regional Wellfield Recovery Assessment
370	4997	recovered	C162818	NWH	Connected Wetlands Assessment
372	4994	recovered	NWH-EC072818	NWH	Northwest Hillsborough Regional Wellfield Recovery Assessment
373	4990	impacted due to other causes	NWH-EC232817	NWH	Northwest Hillsborough Regional Wellfield Recovery Assessment
374	4991	impacted due to other causes	NWH-NC042818	NWH	Northwest Hillsborough Regional Wellfield Recovery Assessment

SWFWMD ID	TBW Site ID	Recovery Status	Site Name	Wellfield Code	Recovery Analysis
375	4998	recovered	NC182818	NWH	Connected Wetlands Assessment
377	4985	recovered	NWH-NW012817	NWH	Connected Wetlands Assessment
378	4995	recovered	NWH-NW072818	NWH	Northwest Hillsborough Regional Wellfield Recovery Assessment
379	4992	recovered	NWH-SC042818	NWH	Northwest Hillsborough Regional Wellfield Recovery Assessment
380	4993	recovered	NWH-SC062818	NWH	Connected Wetlands Assessment
381	4996	recovered	NWH-SW082818	NWH	Northwest Hillsborough Regional Wellfield Recovery Assessment
382	4986	recovered	NWH-WC102817	NWH	Northwest Hillsborough Regional Wellfield Recovery Assessment
371	4983	recovered	NWH-E182718	S21	Section 21 Wellfield Recovery Assessment - monitored wetlands of various types in mesic and xeric landscapes
376	4982	recovered	NWH-NE132717	S21	Section 21 Wellfield Recovery Assessment - monitored wetlands of various types in mesic and xeric landscapes
383	5009	improved, not fully recovered	S21-272718	S21	Section 21 Wellfield Recovery Assessment - monitored wetlands of various types in mesic and xeric landscapes
384	5011	recovered	S21-322718	S21	Connected Wetlands Assessment
385	**5003**	**recovered**	**S21-CW212718**	**S21**	Section 21 Wellfield Recovery Assessment - monitored wetlands of various types in mesic and xeric landscapes
386	5002	Never impacted by wellfield production	S21-EC162718	S21	Previously Unbinned and MDAN Wetlands
387	5008	recovered	S21-EC222718	S21	Section 21 Wellfield Recovery Assessment - monitored wetlands of various types in mesic and xeric landscapes
388	5000	recovered	S21-NC092718	S21	Section 21 Wellfield Recovery Assessment - monitored wetlands of various types in mesic and xeric landscapes
389	7780	improved, not fully recovered	NE112718	S21	Section 21 Wellfield Recovery Assessment - monitored wetlands of various types in mesic and xeric landscapes
390	5004	recovered	S21-NE212718	S21	Section 21 Wellfield Recovery Assessment - monitored wetlands of various types in mesic and xeric landscapes
391	5001	improved, not fully recovered	NW112718	S21	Section 21 Wellfield Recovery Assessment - monitored wetlands of various types in mesic and xeric landscapes
393	5006	recovered	S21-SE212718	S21	Connected Wetlands Assessment

SWFWMD ID	TBW Site ID	Recovery Status	Site Name	Wellfield Code	Recovery Analysis
394	5010	recovered	S21-SW292718	S21	Section 21 Wellfield Recovery Assessment - monitored wetlands of various types in mesic and xeric landscapes
395	5007	recovered	S21-WC212718	S21	Section 21 Wellfield Recovery Assessment - monitored wetlands of various types in mesic and xeric landscapes
396	5012	recovered	S21-WC342718	S21	Section 21 Wellfield Recovery Assessment - monitored wetlands of various types in mesic and xeric landscapes
397	5013	never impacted	SOP-NE152618	SOP	South Pasco - mesic-associated isolated cypress
398	5015	recovered	SOP-PC282618	SOP	Connected Wetlands Assessment
399	5018	recovered	SOP-PT322618	SOP	Connected Wetlands Assessment
400	5021	recovered	SOP-PTC332618	SOP	Connected Wetlands Assessment
401	5017	recovered	SOP-PSW282618	SOP	South Pasco - mesic-associated isolated cypress
402	**5019**	**recovered**	**SOP-PC332618**	**SOP**	South Pasco - mesic-associated isolated cypress
403	**5016**	**recovered**	**SOP-PSE282618**	**SOP**	South Pasco - mesic-associated isolated cypress
404	5020	recovered	SOP-PSW332618	SOP	South Pasco - mesic-associated isolated cypress
405	**5022**	**recovered**	**SOP-PTE332618**	**SOP**	South Pasco - mesic-associated isolated cypress
406	5014	recovered	SOP-SC162618	SOP	Connected Wetlands Assessment
407	50010	recovered	Rt. 54 Aprile	SOP	South Pasco - mesic-associated isolated cypress
408	50011	recovered	Rt. 54 Nelson	SOP	South Pasco - mesic-associated isolated cypress
409	50026	recovered	J.B. Starkey 1	STK	Starkey - mesic-isolated cypress
410	5408	recovered	S-004	STK	Connected Wetlands Assessment
411	5409	not fully recovered, continuing wellfield impact	STK-S-005	STK	Starkey - xeric-associated
412	5410	improved, not fully recovered	STK-S-006	STK	Starkey - xeric-associated
415	5413	never impacted	STK-S-010	STK	Starkey - xeric-associated
417	5415	recovered	S-013	STK	Unmonitored Wetland Assessment - GIS Model Report
418	5417	recovered	STK-S-016	STK	Starkey - xeric-associated
419	5418	improved, not fully recovered	STK-S-018	STK	Starkey - xeric-associated
420	5419	improved, not fully recovered	STK-S-020	STK	Starkey - xeric-associated
421	5420	recovered	STK-S-023	STK	Starkey - xeric-associated
422	5421	recovered	STK-S-024	STK	Starkey - xeric-associated
423	5423	recovered	STK-S-030	STK	Starkey - xeric-associated
424	5424	recovered	STK-S-031	STK	Starkey - xeric-associated
425	5425	recovered	STK-S-035	STK	Starkey - xeric-associated

SWFWMD ID	TBW Site ID	Recovery Status	Site Name	Wellfield Code	Recovery Analysis
426	5426	recovered	S-036A	STK	Unmonitored Wetland Assessment - GIS Model Report
427	5427	recovered	STK-S-038	STK	Starkey - xeric-associated
428	5428	never impacted	STK-S-039	STK	Starkey - mesic-isolated cypress
429	5429	never impacted	STK-S-042	STK	Starkey - mesic-isolated cypress
430	5430	recovered	STK-S-044	STK	Starkey - xeric-associated
431	5431	improved, not fully recovered	STK-S-046	STK	Starkey - other wetlands
432	5432	recovered	S-051	STK	Connected Wetlands Assessment
433	5433	recovered	STK-S-052	STK	Starkey - mesic-isolated cypress
434	5434	improved, not fully recovered	STK-S-053	STK	Starkey - mesic-isolated cypress
435	5435	never impacted	STK-S-054	STK	Starkey - mesic-isolated cypress
436	5436	recovered	STK-S-055	STK	Starkey - other wetlands
437	5437	recovered	S-056	STK	Unmonitored Wetland Assessment - GIS Model Report
438	5439	recovered	STK-S-062	STK	Starkey - other wetlands
439	5440	not fully recovered, continuing wellfield impact	STK-S-063	STK	Starkey - mesic-isolated cypress
440	5441	never impacted	STK-S-064	STK	Starkey - mesic-isolated cypress
441	5442	never impacted	STK-S-065	STK	Starkey - mesic-isolated cypress
442	5443	recovered	STK-S-067	STK	Connected Wetlands Assessment
443	5444	never impacted	STK-S-068	STK	Starkey - mesic-isolated cypress
444	**5445**	**never impacted**	**STK-S-069**	**STK**	Starkey - mesic-isolated cypress
445	5446	never impacted	STK-S-070	STK	Starkey - mesic-isolated cypress
446	5447	recovered	STK-S-072	STK	Unmonitored Wetland Assessment - GIS Model Report
447	**5448**	**never impacted**	**STK-S-073**	**STK**	Starkey - mesic-isolated cypress
448	5449	never impacted	STK-S-074	STK	Starkey - mesic-isolated cypress
449	**5450**	**never impacted**	**STK-S-075**	**STK**	Starkey - mesic-isolated cypress
450	5451	never impacted	STK-S-076	STK	Starkey - mesic-isolated cypress
451	5452	improved, not fully recovered	STK-S-080	STK	Starkey - other wetlands
452	5453	recovered	S-082	STK	Unmonitored Wetland Assessment - GIS Model Report
453	5454	recovered	S-083	STK	Starkey - other wetlands
454	5455	improved, not fully recovered	STK-S-084	STK	Starkey - xeric-associated
455	5456	recovered	STK-S-085	STK	Starkey - xeric-associated
456	5457	never impacted	STK-S-089	STK	Starkey - mesic-isolated cypress
457	5458	recovered	STK-S-090	STK	Starkey - other wetlands
458	5459	recovered	S-094	STK	Starkey - other wetlands
459	5460	never impacted	STK-S-095	STK	Starkey - mesic-isolated cypress
460	5461	recovered	S-096	STK	Unmonitored Wetland Assessment - GIS Model Report
461	5462	never impacted	STK-S-097	STK	Starkey - mesic-isolated cypress
462	5463	recovered	STK-S-099	STK	Starkey - mesic-isolated cypress
463	5464	recovered	S-101	STK	Unmonitored Wetland Assessment - GIS Model Report
464	5465	never impacted	STK-S-108	STK	Starkey - mesic-isolated cypress
465	5466	never impacted	STK-S-109	STK	Starkey - mesic-isolated cypress
466	5467	recovered	S-111	STK	Connected Wetlands Assessment

SWFWMD ID	TBW Site ID	Recovery Status	Site Name	Wellfield Code	Recovery Analysis
467	5468	recovered	STK-S-112	STK	Starkey - other wetlands
468	5469	improved, not fully recovered	STK-S-113	STK	Starkey - mesic-isolated cypress
469	50043	recovered	SC-01	STK	Unmonitored Wetland Assessment - GIS Model Report
470	5473	never impacted	STK-SC-11	STK	Starkey - xeric-associated
471	5475	never impacted	STK-SC-30	STK	Starkey - xeric-associated
473	5477	recovered	SC-33	STK	Unmonitored Wetland Assessment - GIS Model Report
474	5478	recovered	SC-46	STK	Previously Unbinned and MDAN Wetlands
475	5480	recovered	STK-SC-58	STK	Starkey - xeric-associated
476	5481	never impacted	STK-SC-59	STK	Starkey - xeric-associated
477	5482	recovered	SC-62	STK	Starkey - other wetlands
478	5483	never impacted	STK-SC-67	STK	Starkey - mesic-isolated cypress
479	5484	never impacted	STK-SC-68	STK	Starkey - xeric-associated
480	5485	never impacted	SC-69	STK	Starkey - other wetlands
481	5486	recovered	SC-70	STK	Unmonitored Wetland Assessment - GIS Model Report
482	5487	never impacted	STK-SC-71	STK	Starkey - mesic-isolated cypress
483	5488	improved, not fully recovered	STK-SC-92	STK	Starkey - xeric-associated
484	**5404**	**never impacted**	**STK-Central-01**	**STK**	Starkey - mesic-isolated cypress
485	**5405**	**improved, not fully recovered**	**STK-D**	**STK**	Starkey - other wetlands
486	**5406**	**never impacted**	**STK-N**	**STK**	Starkey - mesic-isolated cypress
487	**5407**	**never impacted**	**STK-Z**	**STK**	Starkey - mesic-isolated cypress
488	5470	never impacted	STK-T-07	STK	Starkey - mesic-isolated cypress
489	5471	never impacted	STK-T-09	STK	Starkey - other wetlands
490	5472	recovered or never impacted	STK-T-10	STK	Connected Wetlands Assessment
491	50044	improved, not fully recovered	Anclote South Wet Prairie	STK	Starkey - other wetlands
492	50045	recovered	J.B. Starkey 2	STK	Starkey - other wetlands
493	50017	recovered	J.B. Starkey 3	STK	Previously Unbinned and MDAN Wetlands
494	50002	never impacted	J.B. Starkey 4	STK	Starkey - mesic-isolated cypress
495	50018	recovered	River Ridge High School	STK	Previously Unbinned and MDAN Wetlands
496	50046	improved, not fully recovered	Starkey Wet Prairie	STK	Starkey - other wetlands
497	50003	never impacted	STWF BB	STK	Starkey - mesic-isolated cypress
498	50004	never impacted	STWF C	STK	Starkey - mesic-isolated cypress
499	50005	never impacted	STWF EE	STK	Starkey - mesic-isolated cypress
500	50006	never impacted	STWF GG	STK	Starkey - mesic-isolated cypress
501	50007	never impacted	STWF K	STK	Starkey - mesic-isolated cypress
502	50047	recovered	STWF O	STK	Starkey - other wetlands
503	50008	never impacted	STWF T	STK	Starkey - mesic-isolated cypress
504	50048	recovered	STWF V	STK	Starkey - other wetlands
505	50027	improved, not fully recovered	STWF W	STK	Starkey - mesic-isolated cypress
506	50049	recovered	STWF X	STK	Starkey - other wetlands

This final assessment of environmental recovery was completed using data through 2019 (either Water Year 2019 or Calendar Year 2019 as described below for isolated and connected wetlands). This was the latest data that could be used in the final analyses due to the time needed to prepare the final report and include the results in the renewal application for the Consolidated Permit in 2020. The sections below describe the final assessment results for isolated and connected wetlands (comparison of the updated data sets to the respective wetland metrics) and any subsequent analyses and field reviews used to inform the final decision for the recovery of each monitored wetland. For any wetland whose recovery assessment status or bin changed from the preliminary assessment results (Table 9.1), the site-specific assessment or updated analysis and reason for the change in recovery status is presented in Section 9.6.

9.4 Isolated Wetland Hydrologic Screening – Original and Updates Through WY19

Tampa Bay Water compiled data for the monitored isolated mesic cypress wetlands at the beginning of the wetland assessment process and analyzed the water level data in the post-pumping reduction period of Water Years 2008 – 2014 against the metric for these wetlands. This wetland screening approach was discussed with the District at the February 26, 2015 technical coordination meeting as a way to quickly assess multiple monitored wetlands across all wellfields and determine which sites may be meeting their recovery metric. The intent was to screen through the wetlands and focus subsequent assessment efforts on the sites that were below their metric. This analysis was updated with water level data for marshes and District-monitored sites and any revised normal pool elevation data. Staff discussed this updated assessment with the District on July 30, 2015. At that meeting, staff agreed that this was an efficient way of assessing the status of multiple wetlands and that an annual update to this assessment would be beneficial. The results discussed with District staff in February and July 2015 were preliminary work products used in the development of this assessment method. The information is contained in the minutes and notes from these two meetings but results were not formally transmitted to the District for review.

Tampa Bay Water staff updated the analysis of isolated mesic cypress and marsh wetlands with data through Water Year 2015 and discussed the results with District staff on March 1, 2016. The assessment report on the normal pool offset analysis of mesic cypress and marsh wetlands for Water Years 2008 – 2015 was submitted to the District on April 28, 2016 (Appendix 9.18). District staff reviewed this information and concurred with the approach and assessments in a letter dated June 8, 2017 (included with Appendix 9.18).

Once the majority of wetlands were classified into preliminary Recovery Assessment bins through the wellfield-scale assessments presented in Section 9.2, staff began to assess new water level data on an annual basis and provided updated assessments to the District. The annual normal pool offset assessment updates incorporated any updated normal pool elevation data developed by Tampa Bay Water or the District at the time of the analysis. Tampa Bay Water performed the first annual update to the wetland normal pool offset assessment and discussed the update with District staff on January 18, 2018. The updated assessment report for mesic cypress and marsh wetlands for the period of Water Year 2008 – 2017 was submitted to the District on July 19, 2018 (Appendix 9.19). The second update report assessing the normal pool offset data for isolated cypress and marsh wetlands included data through Water Year 2018. This update also incorporated isolated wetlands in a xeric landscape into the analysis using the initial xeric wetland metric (Section 6.3.4.1). This update with data through Water Year 2018 assessed the current status of all isolated wetlands with respect to the applicable wetland metrics. The report was submitted to the District on December 19, 2018 and is contained in Appendix 9.20.

The final assessment of isolated wetlands was performed using water level data collected through the end of Water Year 2019. Water level data from Water Years 2008 – 2019 was assessed against the applicable mesic or xeric isolated wetland metric and the details of this final analysis are presented in Appendix 9.21. The results of this analysis are included as Table 9.2 and Table 9.3 for xeric and mesic isolated wetlands, respectively but the tables do not present the final Recovery Assessment bin for each site. The data in Tables 9.2 and 9.3 are simply long-term water level data compared to the applicable wetland metrics and each site is shown as above or below the metric comparison. The final recovery bin assignments are discussed in Sections 9.6 and 9.7. The final status for each wetland (Table 9.8) was assigned using the final Recovery Assessment bins for monitored lakes and wetlands as described in Table 6.1.

Table 9.2: Results for the analysis of xeric-associated isolated Recovery Assessment wetlands, including the selected P03, offset from P03, and whether or not the metric was met

Wetland ID	Associated Wellfield	TBW Name	SWFWMD Name	RA Wetland Type	Selected P03	WY 08-19 Offset from P03	Meet?
2	CBR	CBR Q02		Isolated Cypress	72.7	2.4	Yes
4	CBR	CBR Q04	Duck Pond	Isolated Marsh	72.6	2.9	Yes
5	CBR	CBR Q05		Isolated Marsh	67.7	4.2	No
6	CBR	CBR Q06		Isolated Marsh	68.1	10.0	No
7	CBR	CBR Q07		Other	66.5	13.5	No
8	CBR	CBR Q08		Isolated Marsh	67.6	6.8	No
9	CBR	CBR Q10		Isolated Cypress	70.0	1.9	Yes
10	CBR	CBR Q12		Other	74.0	1.2	Yes
12	CBR	CBR Q15		Isolated Marsh	75.8	4.7	No
13	CBR	CBR Q16		Isolated Marsh	73.1	1.3	Yes
14	CBR	CBR Q17		Isolated Marsh	74.4	2.3	Yes
17	CBR	CBR Q20		Isolated Marsh	68.8	2.1	Yes
21	CBR	CBR Q24	CBARWF TQ-1 West	Isolated Cypress	75.8	1.6	Yes
23	CBR	CBR Q26		Isolated Marsh	69.9	4.0	No
34	CBR	CBR T01		Isolated Marsh	70.6	11.1	No
35	CBR	CBR T02A		Isolated Marsh	75.6	3.9	No
38	CBR	CBR T08A		Isolated Cypress	67.7	1.5	Yes
103	COS	102717		Isolated Cypress	43.3	2.6	Yes
106	COS	C142717		Isolated Cypress	59.8	3.0	Yes
110	COS	NC262717		Isolated Cypress	47.6	0.9	Yes
113	COS	SC272717	Cosme WF Wetland	Isolated Cypress	41.5	4.0	No
170	CYC	C20		Isolated Marsh	73.6	2.2	Yes
181	CYC	C101		Isolated Cypress	84.7	2.0	Yes
236	CYC		Conners Marsh 1	Isolated Marsh	77.4	2.2	Yes
237	CYC		Conners Marsh 2	Isolated Marsh	78.3	2.3	Yes
256	ELW		EWWF 3	Isolated Cypress	27.3	2.4	Yes
336	NOP	NP-01		Isolated Marsh	52.1	0.9	Yes
337	NOP	NP-02		Isolated Cypress	48.5	1.4	Yes
338	NOP	NP-03	NPWF #3	Isolated Cypress	46.2	1.2	Yes
339	NOP	NP-04		Isolated Cypress	45.1	2.7	Yes
340	NOP	NP-05		Isolated Cypress	44.9	0.8	Yes
345	NOP	NP-10		Isolated Cypress	45.3	2.8	Yes
350	NOP	NP-17		Isolated Cypress	47.9	2.0	Yes
362	NOP	NP-36		Isolated Cypress	50.4	0.7	Yes
366	NWH	132817		Isolated Cypress	30.7	1.5	Yes
372	NWH	EC072818		Isolated Cypress	40.5	3.1	Yes

379	NWH	SC042818		Isolated Cypress	50.0	0.7	Yes
401	SOP	PSW282618		Isolated Cypress	59.2	1.4	Yes
411	STK	S-005	STWF A	Isolated Marsh	27.6	3.6	Yes
412	STK	S-006	STWF Q	Isolated Cypress	29.5	2.7	Yes
415	STK	S-010	STWF CC	Isolated Cypress	29.8	1.1	Yes
418	STK	S-016		Isolated Cypress	33.8	1.1	Yes
420	STK	S-020	STWF E	Isolated Marsh	35.5	3.3	Yes
421	STK	S-023	STWF H	Isolated Cypress	31.7	1.8	Yes
422	STK	S-024	S-024/STWF B (Grass Prairie West)	Isolated Marsh	32.138	2.768	Yes
423	STK	S-030	STWF U	Isolated Cypress	31.8	1.1	Yes
424	STK	S-031		Isolated Cypress	33.8	1.3	Yes
425	STK	S-035		Isolated Cypress	41.7	2.5	Yes
427	STK	S-038	STWF J	Isolated Cypress	37.2	2.1	Yes
430	STK	S-044	Starkey Western	Isolated Cypress	35.8	2.2	Yes
454	STK	S-084		Isolated Cypress	40.0	3.0	Yes
455	STK	S-085	STWF South Central	Isolated Cypress	36.7	2.1	Yes
	STK	SC-11		Isolated Cypress	36.7	1.9	Yes
471	STK	SC-30		Isolated Cypress	41.1	0.8	Yes
475	STK	SC-58		Isolated Cypress	40.7	2.1	Yes
	STK	SC-59		Isolated Cypress	19.9	1.1	Yes
479	STK	SC-68		Isolated Cypress	36.8	0.7	Yes
483	STK	SC-92		Isolated Cypress	41.0	2.7	Yes
493	STK		J.B. Starkey 3	Isolated Cypress	42.8	1.1	Yes
495	STK		River Ridge High School	Isolated Cypress	30.4	0.5	Yes

Table 9.3: Final Assessment Results for Isolated Mesic Wetlands (Data through WY 2019)

Wetland ID	Associated Wellfield	TBW Name	SWFWMD Name	RA Wetland type	NP	Offset	Mesic Status	Meet?
1	CBR	CBR Q01	CBARWF Q-1	Isolated Cypress	74.3	2.2	Mesic	No
11	CBR	CBR Q14		Isolated Cypress	76.7	2.8	Mesic	No
18	CBR	CBR Q21		Isolated Marsh	60.2	4.4	Mesic	No
22	CBR	CBR Q25	CBARWF Stop #7	Isolated Cypress	74.1	2.8	Mesic	No
36	CBR	CBR T03	CBARWF T-3	Undetermined	70.3	1.0	Undetermined	Yes
39	CBR	CBR T10		Isolated Marsh	76.9	5.4	Mesic	No
42	CBR	Pasco Trails		Isolated Marsh	76.2	1.5	Mesic	Yes
104	COS	162717		Isolated Cypress	38.4	0.7	Mesic	Yes
105	COS	C042817		Isolated Cypress	27.2	2.2	Mesic	No
107	COS	EC222717		Isolated Cypress	43.9	2.6	Mesic	No
108	COS	EC332717		Isolated Cypress	32.9	2.8	Mesic	No
109	COS	NC242717		Isolated Cypress	52.6	3.2	Mesic	No
112	COS	NW332717		Other	28.9	1.5	Undetermined	Yes
121	CYB	CYB 1		Isolated Cypress	66.3	4.3	Mesic	No
122	CYB	CYB 2		Isolated Cypress	66.3	2.4	Mesic	No
123	CYB	CYB 3		Other	68.9	2.2	Undetermined	No
124	CYB	CYB 4	CBRWF #4	Isolated Cypress	71.0	1.0	Mesic	Yes
125	CYB	CYB 5		Isolated Cypress	72.1	0.7	Mesic	Yes
126	CYB	CYB 6		Isolated Marsh	60.5	1.6	Mesic	Yes
127	CYB	CYB 9		Other	53.5	0.5	Undetermined	Yes
130	CYB	CYB 13		Isolated Marsh	58.3	0.7	Mesic	Yes
131	CYB	CYB 14		Isolated Cypress	60.9	1.3	Mesic	Yes
132	CYB	CYB 15		Other	57.8	2.8	Undetermined	No

Wetland ID	Associated Wellfield	TBW Name	SWFWMD Name	RA Wetland type	NP	Offset	Mesic Status	Meet?
133	CYB	CYB 16	CBRWF #16	Isolated Cypress	60.2	1.1	Mesic	Yes
134	CYB	CYB 17		Isolated Marsh	58.5	1.8	Mesic	Yes
138	CYB	CYB 21		Isolated Cypress	55.7	1.7	Mesic	Yes
140	CYB	CYB 23		Isolated Cypress	47.1	1.2	Mesic	Yes
142	CYB	CYB 25	CBRWF #25	Isolated Cypress	72.3	0.9	Mesic	Yes
147	CYB	CYB 30		Isolated Cypress	63.1	1.2	Mesic	Yes
149	CYB	CYB 32	CBRWF #32	Isolated Cypress	50.5	0.9	Mesic	Yes
150	CYB	CYB 33		Isolated Cypress	46.4	1.7	Mesic	Yes
151	CYB	CYB 34		Isolated Marsh	57.2	0.9	Mesic	Yes
153	CYB	CYB A	CBRWF A	Isolated Cypress	58.4	2.3	Mesic	No
156	CYB	CYB C16		Undetermined	66.3	0.5	Undetermined	Yes
158	CYB		New River Cypress	Isolated Cypress	47.9	0.9	Mesic	Yes
159	CYB		New River Marsh	Isolated Marsh	44.4	0.8	Mesic	Yes
162	CYC	C06		Isolated Marsh	73.5	0.7	Mesic	Yes
164	CYC	C11		Isolated Cypress	81.6	0.7	Mesic	Yes
166	CYC	C14		Other	81.1	1.4	Undetermined	Yes
174	CYC	C24		Isolated Cypress	72.6	0.4	Mesic	Yes
16	CYC	C25		Isolated Cypress	77.3	2.2	Mesic	No
182	CYC	C102	Quail Hollow Elementary	Isolated Cypress	75.4	2.9	Mesic	No
185	CYC	C105		Isolated Cypress	85.8	0.6	Mesic	Yes
189	CYC	W03	CCWF W-3 Marsh	Isolated Marsh	72.6	1.9	Mesic	No
190	CYC	W04	CCWF "E"	Isolated Marsh	70.7	1.2	Mesic	Yes
191	CYC	W05	CCWF "A"	Isolated Cypress	71.4	0.3	Mesic	Yes
193	CYC	W09		Isolated Marsh	68.6	0.2	Mesic	Yes
195	CYC	W11	CC W-11	Isolated Cypress	69.6	1.1	Mesic	Yes

Wetland ID	Associated Wellfield	TBW Name	SWFWMD Name	RA Wetland type	NP	Offset	Mesic Status	Meet?
196	CYC	W12	CC W-12 Sentry Wet'l.	Isolated Cypress	63.8	1.9	Mesic	No
198	CYC	W16	CCWF "D"	Isolated Marsh	68.9	11.0	Mesic	No
199	CYC	W17	CC W-17 Sentry Wet'l.	Isolated Cypress	64.6	1.5	Mesic	Yes
200	CYC	W19	W-19	Isolated Cypress	63.6	1.9	Mesic	No
201	CYC	W20		Isolated Marsh	65.7	1.0	Mesic	Yes
204	CYC	W23		Undetermined	60.4	2.5	Undetermined	No
205	CYC	W27		Isolated Cypress	70.5	7.1	Mesic	No
206	CYC	W29	W-29 (Rattlesnake	Isolated Marsh	70.0	1.6	Mesic	Yes
209	CYC	W31		Isolated Marsh	62.4	1.6	Mesic	Yes
210	CYC	W32		Isolated Marsh	70.2	3.6	Mesic	No
211	CYC	W33		Isolated Cypress	69.3	-0.9	Mesic	Yes
213	CYC	W36		Isolated Cypress	71.5	1.3	Mesic	Yes
214	CYC	W37	CCWF "C"	Isolated Cypress	72.1	2.2	Mesic	No
215	CYC	W39		Isolated Cypress	69.6	1.7	Mesic	Yes
216	CYC	W40	CCWF X-1	Isolated Cypress	64.3	3.1	Mesic	No
217	CYC	W41	CCWF W-41	Isolated Marsh	74.9	3.4	Mesic	No
222	CYC	W45	CCWF X-2	Isolated Cypress	71.5	3.7	Mesic	No
223	CYC	W46	CCWF "B"	Isolated Cypress	69.4	4.5	Mesic	No
226	CYC	W50	CCWF X-3	Isolated Cypress	67.8	1.7	Mesic	Yes
228	CYC	W52		Undetermined	73.9	1.9	Undetermined	No
229	CYC	W55		Isolated Cypress	69.2	8.6	Mesic	No
230	CYC	W56	CCWF "G'	Isolated Cypress	64.5	2.1	Mesic	No
234	CYC		CCWF "F"	Isolated Marsh	73.6	7.2	Mesic	No
238	CYC		Conners Wet Prairie	Other	77.2	4.2	Undetermined	No
239	CYC		Correctional Facility	Isolated Cypress	75.3	1.6	Mesic	Yes

Wetland ID	Associated Wellfield	TBW Name	SWFWMD Name	RA Wetland type	NP	Offset	Mesic Status	Meet?
240	CYC		Correctional Facility	Isolated Cypress	76.1	1.6	Mesic	Yes
242	CYC		Pheasant Run (Quail	Isolated Cypress	70.5	0.8	Undetermined	Yes
243	ELW	C132716		Isolated Cypress	24.1	1.0	Mesic	Yes
244	ELW	EC112716	EWWF 1	Isolated Cypress	24.0	0.5	Mesic	Yes
245	ELW	NC222716/C-15	Pine Ridge Cypress	Isolated Cypress	14.9	1.1	Mesic	Yes
246	ELW	NNW122716	EWWF 5	Isolated Cypress	28.9	1.7	Mesic	Yes
247	ELW	NW022716	EWWF Salls/10S/10	Isolated Cypress	21.6	1.3	Mesic	Yes
248	ELW	NW052717	EWWF 11/Wet	Isolated Cypress	38.2	1.5	Mesic	Yes
249	ELW	NW062717	EWWF East (Lk. Dan)	Other	33.5	4.0	Undetermined	No
250	ELW	NW122716	EWWF West Cypress	Isolated Cypress	28.7	1.2	Mesic	Yes
251	ELW	SC272716	Lansbrook East	Isolated Cypress	15.1	0.7	Mesic	Yes
252	ELW	SW062717		Other	32.7	2.2	Undetermined	No
254	ELW	SW272716	Lansbrook West	Isolated Cypress	13.2	2.3	Mesic	No
255	ELW	WC102716		Other	17.9	2.2	Undetermined	No
258	MBR	MBR 10		Isolated Marsh	42.1	5.4	Mesic	No
259	MBR	MBR 11		Isolated Marsh	41.7	1.6	Mesic	Yes
260	MBR	MBR 14	MBWF X-2	Isolated Cypress	35.1	1.4	Mesic	Yes
261	MBR	MBR 16	MBWF "Unnamed"	Isolated Cypress	33.9	1.3	Mesic	Yes
262	MBR	MBR 29	MBWF South	Undetermined	34.0	2.4	Undetermined	No
263	MBR	MBR 30		Isolated Cypress	34.4	3.8	Mesic	No
264	MBR	MBR 35	MBWF Entry Dome	Isolated Cypress	35.6	1.7	Mesic	Yes
266	MBR	MBR 37		Isolated Marsh	33.8	2.3	Mesic	No
267	MBR	MBR 42	MBWF Well Marsh	Isolated Marsh	42.3	1.6	Mesic	Yes
273	MBR	MBR 88	MBWF Clay Gully	Isolated Cypress	41.4	3.4	Mesic	No
274	MBR	MBR 89	MBWF X-4	Isolated Cypress	42.2	1.0	Mesic	Yes

Wetland ID	Associated Wellfield	TBW Name	SWFWMD Name	RA Wetland type	NP	Offset	Mesic Status	Meet?
275	MBR	MBR 90		Isolated Cypress	36.4	1.4	Mesic	Yes
276	MBR	MBR 91		Isolated Cypress	35.2	3.1	Mesic	No
277	MBR	MBR 93		Isolated Cypress	34.5	1.1	Mesic	Yes
278	MBR	MBR 94		Isolated Cypress	30.4	1.6	Mesic	Yes
279	MBR	MBR 96		Other	35.8	1.0	Undetermined	Yes
280	MBR	MBR 97		Isolated Cypress	40.3	3.3	Mesic	No
281	MBR	MBR 98		Isolated Marsh	41.8	2.4	Mesic	No
291	MBR		MBWF East Cypress	Isolated Marsh	42.8	2.3	Mesic	No
292	MBR		MBWF Trout Creek Marsh	Isolated Marsh	35.9	2.4	Mesic	No
293	MBR		MBWF West Cypress	Isolated Cypress	38.2	1.0	Mesic	Yes
295	MBR		MBWF X-1	Isolated Cypress	39.3	3.0	Mesic	No
296	MBR		MBWF X-3	Isolated Marsh	36.9	1.8	Mesic	Yes
297	MBR		MBWF X-6	Isolated Cypress	40.0	0.9	Mesic	Yes
312	None		Cypress Creek ELAPP	Isolated Cypress	42.0	1.7	Mesic	Yes
313	None		Cypress Creek ELAPP	Isolated Marsh	39.7	0.6	Mesic	Yes
342	NOP	NP-07		Isolated Cypress	43.9	2.1	Mesic	No
344	NOP	NP-09		Isolated Cypress	50.9	0.5	Mesic	Yes
346	NOP	NP-11		Isolated Cypress	43.8	1.3	Mesic	Yes
351	NOP	NP-18		Isolated Cypress	48.2	1.0	Mesic	Yes
352	NOP	NP-21	NPWF #21	Isolated Cypress	46.3	1.3	Mesic	Yes
353	NOP	NP-22		Isolated Cypress	46.7	0.8	Mesic	Yes
358	NOP	NP-30		Other	51.2	0.7	Undetermined	Yes
367	NWH	142817		Isolated Cypress	15.1	0.8	Mesic	Yes
371	S21	E182718		Other	54.9	2.4	Undetermined	No
373	NWH	EC232817	Bellamy School	Isolated Cypress	22.5	2.4	Mesic	No

Wetland ID	Associated Wellfield	TBW Name	SWFWMD Name	RA Wetland type	NP	Offset	Mesic Status	Meet?
374	NWH	NC042818		Isolated Cypress	54.1	3.3	Mesic	No
376	S21	NE132717	Brooker Creek	Undetermined	55.2	1.1	Undetermined	Yes
378	NWH	NW072818		Isolated Cypress	36.2	1.0	Mesic	Yes
381	NWH	SW082818		Isolated Cypress	36.7	1.1	Mesic	Yes
382	NWH	WC102817		Isolated Cypress	23.7	1.4	Mesic	Yes
383	S21	272718		Isolated Cypress	52.8	3.7	Mesic	No
385	S21	CW212718	S21 WF NW-53 East	Isolated Cypress	53.3	0.9	Mesic	Yes
387	S21	EC222718		Other	55.0	1.5	Undetermined	Yes
390	S21	NE212718		Isolated Cypress	57.3	1.9	Mesic	No
394	S21	SW292718		Isolated Cypress	52.9	1.2	Mesic	Yes
395	S21	WC212718		Other	53.3	0.9	Undetermined	Yes
396	S21	WC342718		Isolated Cypress	53.9	1.2	Mesic	Yes
397	SOP	NE152618		Isolated Cypress	66.2	1.4	Mesic	Yes
398	SOP	PC282618	SPWF - 1	Other	59.1	1.3	Undetermined	Yes
399	SOP	PT322618	SPWF - 3	Other	60.2	2.1	Mesic	No
400	SOP	PTC332618		Other	58.8	1.0	Undetermined	Yes
402	SOP	PC332618	SPWF South Cypress	Isolated Cypress	58.7	0.7	Mesic	Yes
403	SOP	PSE282618	SPWF - 6	Isolated Cypress	59.2	1.1	Mesic	Yes
404	SOP	PSW332618		Isolated Cypress	58.2	0.8	Mesic	Yes
405	SOP	PTE332618	SPWF - 2	Isolated Cypress	59.0	1.1	Mesic	Yes
406	SOP	SC162618		Other	62.5	1.3	Undetermined	Yes
408	SOP		Rt. 54 Nelson	Isolated Cypress	64.9	0.7	Mesic	Yes
409	STK	CYB C14	J.B. Starkey 1	Isolated Cypress	47.0	1.0	Mesic	Yes
428	STK	S-039		Isolated Cypress	37.4	1.7	Mesic	Yes
429	STK	S-042		Isolated Cypress	31.7	0.2	Mesic	Yes

Wetland ID	Associated Wellfield	TBW Name	SWFWMD Name	RA Wetland type	NP	Offset	Mesic Status	Meet?
431	STK	S-046		Other	38.6	2.3	Undetermined	No
433	STK	S-052		Isolated Cypress	39.7	0.9	Mesic	Yes
434	STK	S-053		Isolated Cypress	41.0	2.6	Mesic	No
435	STK	S-054	STWF L	Isolated Cypress	42.3	1.2	Mesic	Yes
436	STK	S-055		Other	41.6	0.6	Undetermined	Yes
438	STK	S-062		Other	43.4	1.3	Undetermined	Yes
439	STK	S-063		Isolated Cypress	42.3	2.3	Mesic	No
440	STK	S-064		Isolated Cypress	44.0	1.3	Mesic	Yes
441	STK	S-065	STWF S	Isolated Cypress	42.7	0.9	Mesic	Yes
442	STK	S-067	STWF P	Isolated Marsh	40.8	2.4	Mesic	No
443	STK	S-068	STWF DD	Isolated Cypress	43.9	0.7	Mesic	Yes
444	STK	S-069	STWF M	Isolated Cypress	44.9	0.7	Mesic	Yes
445	STK	S-070		Isolated Cypress	44.7	0.7	Mesic	Yes
447	STK	S-073	STWF Eastern	Isolated Cypress	46.4	0.9	Mesic	Yes
448	STK	S-074		Isolated Cypress	46.7	0.7	Mesic	Yes
449	STK	S-075	STWF S-75	Isolated Cypress	47.2	0.6	Mesic	Yes
450	STK	S-076	STWF R	Isolated Cypress	46.9	0.4	Mesic	Yes
451	STK	S-080		Other	44.1	1.9	Undetermined	No
456	STK	S-089		Isolated Cypress	44.7	0.0	Mesic	Yes
457	STK	S-090	Starkey Bay	Other	33.0	1.6	Undetermined	Yes
459	STK	S-095		Isolated Cypress	38.6	0.6	Mesic	Yes
461	STK	S-097		Isolated Cypress	44.2	1.1	Mesic	Yes
462	STK	S-099		Isolated Cypress	31.4	1.1	Mesic	Yes
464	STK	S-108		Isolated Cypress	45.8	1.3	Mesic	Yes
465	STK	S-109	STWF FF	Isolated Cypress	46.3	0.9	Mesic	Yes

Wetland ID	Associated Wellfield	TBW Name	SWFWMD Name	RA Wetland type	NP	Offset	Mesic Status	Meet?
467	STK	S-112	Starkey Wetland	Other	33.2	1.6	Undetermined	Yes
468	STK	S-113		Isolated Cypress	39.4	2.4	Mesic	No
478	STK	SC-67		Isolated Cypress	34.2	1.0	Mesic	Yes
482	STK	SC-71		Isolated Cypress	39.1	0.8	Mesic	Yes
484	STK	STWF-Central-01	STWF Central	Isolated Cypress	45.1	1.1	Mesic	Yes
485	STK	STWF-D	STWF D	Other	30.9	3.1	Undetermined	No
486	STK	STWF-N	STWF N	Isolated Cypress	47.0	0.4	Mesic	Yes
487	STK	STWF-Z	STWF Z	Isolated Cypress	41.5	1.2	Mesic	Yes
488	STK	T-07		Isolated Cypress	42.3	0.7	Mesic	Yes
489	STK	T-09		Other	46.8	0.3	Undetermined	Yes
491	STK		Anclote South Wet	Other	46.4	3.6	Undetermined	No
492	STK		J.B. Starkey 2	Other	45.6	0.4	Undetermined	Yes
494	STK		J.B. Starkey 4	Isolated Cypress	44.9	1.4	Mesic	Yes
496	STK		Starkey Wet Prairie	Other	47.5	2.0	Undetermined	No
497	STK		STWF BB	Isolated Cypress	41.7	1.3	Mesic	Yes
498	STK		STWF C	Isolated Cypress	38.2	1.6	Mesic	Yes
499	STK		STWF EE	Isolated Cypress	47.0	0.5	Mesic	Yes
500	STK		STWF GG	Isolated Cypress	48.7	0.9	Mesic	Yes
501	STK		STWF K	Isolated Cypress	41.4	1.0	Mesic	Yes
503	STK		STWF T	Isolated Cypress	42.4	0.6	Mesic	Yes
505	STK		STWF W	Isolated Cypress	34.6	1.6	Mesic	Yes

9.5 Connected Wetland Evaluation – Original and Update Through Calendar Year 2019

The metric and method of assessing the health/recovery of connected or flow-through wetlands was developed by Dr. Brian Ormiston and Flatwoods Consulting Group during 2017 (Section 6.3.5). This recovery metric is based on long-term median offset from the period of record 90th percentile water level at each site. The numerical metric is a long-term wetland water level that is within 2.5 feet of the wetland's period of record 90th percentile value; if the offset from the 90th percentile is less than 2.5 feet, the wetland is considered "Recovered" or "Meets Metric" for the connected wetlands at the Cypress Bridge Wellfield. Tampa Bay Water began applying this new metric to the wetlands designated as connected in the final Recovery Assessment Monitored Wetland List (Table 5.2) and discussed the results of these analyses with District staff at the technical coordination meetings in July, August, September, and December of 2017 and in April 2018.

A report containing the initial assessment of 76 connected wetlands for all of the wellfields with wetlands of this type was submitted to the District on May 23, 2018 (Appendix 9.22). District staff reviewed this submittal and concurred with the preliminary assessments in a letter dated July 2, 2018 (included in Appendix 9.22). In this letter, the District provided review comments related to the assessment of some wetlands, which have been addressed in Section 6.3.5. This initial assessment report included available wetland water level data through Calendar Year 2016. The analysis was performed on a calendar year basis since the pumping reduction at the Starkey Wellfield began in late December 2007. The use of a calendar year basis is different from the assessment of other monitored wetlands and lakes. Given the long-term assessment periods for all analyses, the results of the different wetland types can be reviewed as a whole; the three-month difference in time has a negligible effect on the results. The assessment results in the May 23, 2018 submittal were used in the Recovery Assessment Plan Preliminary Report of Findings (Tampa Bay Water, 2018b) for connected wetlands and are referenced in the sections above for the applicable wellfields.

The final assessment of connected wetlands was performed using water level data collected through the end of Calendar Year 2019. Water level data from Calendar Years 2008 – 2019 was assessed against the connected wetland metric (Section 6.3.5) and the results of this final analysis are presented in Table 9.4. Hydrographs of the connected wetlands are included as Appendix 9.23. Table 9.5 presents the final assessment results for the 20 inactive connected wetlands based on the best available data.

Table 9.4: Final Assessment Results for Connected Wetlands (data through Calendar Year 2019)

TBW Wetland Site ID	Wetland ID	TBW Name	SWFWMD Name	River/Creek system	meets metric?	P90PCO	comparison to metric	period screened	active?	Final RA bin	comment
	41		Ann Denker	unnnamed	yes	-0.6	1.9	2003-2019	yes	recovered	
4957	116	SE142717		Brooker Creek	yes	-0.8	1.7	2003-2019	yes	recovered	
4967	105	C042817		Memorial Channel	yes	-0.6	1.9	2003-2019	yes	recovered	
4964	108	EC332717		Memorial Channel	yes	-0.3	2.2	2003-2019	yes	recovered	
4966	114	SC332717		Memorial Channel	yes	-0.7	1.8	2003-2019	yes	recovered	
9535	128	CYB 11		Trout Creek	no	-2.9	-0.4	1996-2019	yes	impacted due to other causes	Atkins 2015 drainage study documents ditching effects
9536	135	CYB 18		Trout Creek	yes	-1.4	1.1	1996-2019	yes	no cutback, meets metric	
9537	139	CYB 22		Trout Creek	yes	-2.0	0.5	1996-2016	yes	no cutback, meets metric	
9538	143	CYB 26		Trout Creek	yes	-0.8	1.7	1996-2019	yes	no cutback, meets metric	
9539	145	CYB 28		Trout Creek	yes	-1.1	1.4	1996-2019	yes	no cutback, meets metric	
9541	148	CYB 31		Trout Creek	yes	-1.7	0.8	1996-2019	yes	no cutback, meets metric	
9542	152	CYB 37		Clay Gully	yes	-0.5	2.0	1998-2019	yes	no cutback, meets metric	headwater
9543	154	CYB C10		Cypress Creek	yes	-0.8	1.7	1998-2019	yes	no cutback, meets metric	
9544	155	CYB C12		Cypress Creek	yes	-1.2	1.3	1998-2019	yes	no cutback, meets metric	
6103	169	C18/C19		Cypress Creek	yes	-1.0	1.5	2003-2019	yes	recovered	
6106	176	C33		Cypress Creek	yes	-1.9	0.6	2003-2016	yes	recovered	headwaters of Cypress Creek
6107	177	C39		Trout Creek	yes	-1.1	1.4	2003-2019	yes	recovered	
6108	178	C40		Dye's Crossing	yes	-2.0	0.5	2003-2019	yes	recovered	
6109	179	C100		Cypress Creek	yes	-1.0	1.5	2003-2019	yes	recovered	
6124	180	W25		Cypress Creek	yes	-0.8	1.7	2003-2019	yes	recovered	
6111	183	C103	Cypress Creek Floodplain	Dye's Crossing	yes	-1.4	1.2	2003-2019	yes	recovered	
6113	187	W01		Cypress Creek	yes	-2.5	0.0	2003-2019	yes	recovered	
3781	194	W10		Dye's Crossing	yes	-1.2	1.3	2003-2019	yes	recovered	
6121	197	W14	CCS-2	Cypress Creek	yes	-1.1	1.4	2003-2019	yes	recovered	
6122	202	W21N	Cypress Creek North of Structure	Cypress Creek	yes	-2.1	0.4	2003-2019	yes	recovered	same CTS - 3619

TBW Wetland Site ID	Wetland ID	TBW Name	SWFWMD Name	River/Creek system	meets metric?	P90PCO	comparison to metric	period screened	active?	Final RA bin	comment
6122	203	W21S	Cypress Creek South of Structure	Cypress Creek	yes	-2.1	0.4	2003-2019	yes	recovered	same CTS - 3619
6126	207	W30N		Dye's Crossing	yes	-1.4	1.1	2003-2019	yes	recovered	same CTS - 3596
6126	208	W30S		Dye's Crossing	yes	-1.4	1.1	2003-2019	yes	recovered	same CTS - 3596
6127	212	W34		Dye's Crossing	yes	-1.9	0.6	2003-2019	no	recovered	POR extended by regression with SAS well CYC-WE-PF2sar
6131	220	W43	East Tributary	Dye's Crossing	no	-4.6	-2.1	2003-2019	yes	improved	
6132	221	W44	CCS-3 Snake Crossing	Cypress Creek	no	-2.8	-0.3	2003-2019	yes	improved	
6139	231	W57		Dye's Crossing	yes	-1.4	1.1	2003-2019	yes	recovered	
50035	233		CCS-5	Cypress Creek	yes	-0.8	1.7	2003-2019	yes	recovered	
50037	241		Mertz Riverine	Cypress Creek	yes	-0.9	1.6	2003-2019	yes	recovered	
4970	255	WC102716		Hollin Creek	yes	-0.3	2.3	2003-2019	yes	recovered	
6165	257	MBR 09		Clay Gully	yes	-0.8	1.7	2003-2019	yes	recovered	
6170	265	MBR 36		Wild Hog Slough	yes	-0.9	1.6	2003-2019	yes	recovered	
6171	268	MBR 60	MBWF X-5	Clay Gully	yes	-1.4	1.1	2003-2019	yes	recovered	
6172	269	MBR 79	MBWF Sawgrass Marsh	Hillsborough	yes	-0.9	1.6	2003-2019	yes	recovered	
6173	270	MBR 80		Wild Hog Slough	yes	-1.6	0.9	2003-2019	yes	recovered	
6174	283	MBR 102		Clay Gully	no	-3.0	-0.5	2003-2019	yes	improved	
6167	284	MBR 103		Trout Creek	yes	-1.8	0.7	2003-2019	yes	recovered	
6175	285	MBR 104		Trout Creek	yes	-1.7	0.8	2003-2019	yes	recovered	
6168	286	MBR 105		Clay Gully	no	-2.7	-0.2	2003-2019	yes	improved	
6169	287	MBR 106		Hillsborough	yes	-0.7	1.8	2003-2019	yes	recovered	
50038	288		MBWF Clay Gully Site	Clay Gully	yes	-1.2	1.3	2003-2019	yes	recovered	
50039	289		East Branch Clay S RD	Clay Gully	yes	-1.8	0.7	2003-2019	yes	recovered	
50040	290		East Branch Clay Gully	Clay Gully	no	-3.4	-0.9	2003-2019	yes	improved	
5014	406	SC162618		Anclote River	yes	-0.5	2.1	2003-2019	yes	recovered	
50041	294		MBWF Wild Hog Slough	Wild Hog Slough	yes	-2.0	0.5	2003-2019	yes	recovered	

TBW Wetland Site ID	Wetland ID	TBW Name	SWFWMD Name	River/Creek system	meets metric?	P90PCO	comparison to metric	period screened	active?	Final RA bin	comment
50042	314		Cypress Creek ELAPP Riverine	Cypress Creek	yes	-1.2	1.3	2003-2019	yes	recovered	
4985	377	NW012817		Rocky Creek	yes	-2.0	0.5	2003-2019	yes	recovered	
5000	388	NC092718		Rocky Creek	yes	-1.0	1.5	2003-2019	yes	recovered	
4993	380	SC062818		Brushy Creek	yes	-0.9	1.6	2003-2019	yes	recovered	
5011	384	322718		Brushy Creek	yes	-1.3	1.2	2003-2019	yes	recovered	
5006	393	SE212718		unnnamed	yes	-2.4	0.1	2003-2019	yes	recovered	30% of the readings are "inundated" remarks. These readings set to the HNP for analysis.
5015	398	PC282618	SPWF - 1	South Branch Anclote River	yes	-0.9	1.6	2003-2019	yes	recovered	
5018	399	PT322618	SPWF - 3	South Branch Anclote River	yes	-0.9	1.6	2003-2019	yes	recovered	
5021	400	PTC332618		South Branch Anclote River	yes	-0.9	1.6	2003-2019	yes	recovered	
5443	442	S-067	STWF P	Cross Cypress Branch	yes	-0.9	1.6	2008-2019	yes	recovered	
5405	485		STWF D	unnamed system that flows toward Pithlachascotee	yes	-2.5	0.0	2008-2019	yes	recovered	Listed as improved in preliminary report; 2008-2016 median was below metric
5472	490	T-10		Anclote	yes	-0.8	1.7	2003-2019	yes	never impacted	located on eatern Starkey; center well destroyed in 2011 and not replaced (dropped from permit)
50047	502		STWF O	Cross Cypress Branch	yes	-0.6	1.9	2008-2019		recovered	
50048	504		STWF V	unnamed system that flows toward Pithlachascotee	yes	-0.7	1.9	2008-2019	yes	recovered	
50049	506		STWF X	unnamed system that flows toward Anclote	yes	-1.6	0.9	2008-2019	yes	recovered	In the revised two foot SAS drawdown for the 2017 update
				passed screening	59				never impacted	1	
				failed screening	6			no cutback, meets metric		8	
									recovered	50	
									improved	5	
									impacted due to other causes	1	
									total	65	

Notes:

1) All years listed are calendar years unless otherwise noted.

Table 9.5: Inactive Connected Wetlands – Final Site Analysis and Bins

TBW Wetland Site ID	Wetland ID	TBW Name	SWFWMD Name	River/Creek system	meets metric?	P90PCO	comparison to metric	period screened	active?	Final RA bin	comment
26220	144	CYB 27		Trout Creek	yes	-1.5	1.0	1996-2002	no	no cutback, meets metric	Inactive - not currently monitored
9540	146	CYB 29		Trout Creek	yes	-2.4	0.1	1996-2016	no	no cutback, meets metric	Inactive - not currently monitored; POR extended through 2016 by correlation with upstream site CYB 18
6096	160	C01		Cypress Creek	no	-2.7	-0.2	2003-2010	no	recovered	Upstream Cypress Creek wetland CYC C19 is recovered; missing the metric is likely an artifact of the POR of available data
6098	163	C08		Cypress Creek	no	-2.8	-0.3	2003-2016	no	improved	Inactive; POR extended by correlation with downstream W01; showed improvement in hydroperiod and higher dry season levels
6112	186	C106		Dye's Crossing	insufficient data	NA	NA	2004-2010	no	recovered	Nearby upstream wetland C40 meets metric
6118	192	W06/ W07/ W08		Cypress Creek	yes	-2.5	0.0	2003-2010	no	recovered	data was from W-08 CTS 3606
6130	218	W42		Cypress Creek	yes	-0.4	2.1	2003-2005	no	recovered	
6135	225	W48/W49		Cypress Creek	no	-4.4	-1.9	2003-2012	no	improved	Post-cutback PE curve shows improvement (data was from W-49 CTS 3614)
6137	227	W51		Cypress Creek	no	-3.3	-0.8	2003-2010	no	improved	Post-cutback PE curve shows improvement
4981	253	SW082717		Brooker Creek	NA	NA	NA	1999-2002	no	recovered	Insufficient data to assess; lakes and wetlands both upstream and downstream meet metric
6166	282	MBR 100		unnnamed	yes	-2.5	0.0	2003-2010	no	recovered	
5376	343	NP-08		Pithlachascotee	yes	-0.7	1.8	2003-2010	no	recovered	
5394	355	NP-26		Cross Cypress Branch	yes	-1.0	1.5	2003-2010	no	recovered	
5395	356	NP-27		Cross Cypress Branch	yes	-0.8	1.7	1989-2006	no	recovered	
4997	370	C162818		Sweetwater Creek	yes	-1.7	0.8	2003-2010	no	recovered	urban, probably ditched
4998	375	NC182818		Rocky Creek	yes	-0.5	2.0	2003-2010	no	recovered	
5408	410	S-004		Pithlachascotee	yes	-0.7	1.8	2008-2010	no	recovered	
5432	432	S-051	STWF AA	unnamed system that flows toward Anclote	yes	-1.0	1.5	2008-2010	no	recovered	STWF AA staff is located on a seasonal flow-way to the west of S 51
50043	469	SC-01		Pithlachascotee	NA	NA	NA	1994-2003	no	High Degree of Certainty of Wetland Health	data not corrected to NGVD, assessed with unmonitored wetlands
5467	466	S-111		Anclote	yes	-1.4	1.1	2008-2010	no	recovered	

never impacted	0
no cutback, meets metric	2
recovered	14
improved	3
high degree of certainty of wetland health	1
total	20

9.6 Subsequent Assessments and Updates

The preceding sections of this chapter summarized the assessment work completed for the monitored wetlands through Water Year 2018, a summary of the preliminary results for monitored wetlands, and the updated assessment of each monitored wetland against their applicable metrics. Additional work has been completed by Tampa Bay Water and District staffs that inform the final assignment of each monitored wetland to its final Recovery Assessment classification bin and those assessments and field reviews are presented in the following sections.

9.6.1 Reevaluation of MFL Wetlands

The District maintains a Priority List and Schedule that is updated on an annual basis for the reevaluation of Minimum Flows and Levels waterbodies. District staff reevaluated each of the 41 Minimum Level wetlands in late 2019 according to this priority list and schedule; this was the first reevaluation of wetland Minimum Levels since they were adopted in August 2000. This reassessment did not include an evaluation of the underlying methodology for establishing Minimum Levels in wetlands but did include a site-specific review of each of the 41 MFL wetlands. This reassessment incorporated data from new survey benchmarks, a review of the biological indicators of normal pool elevation at each wetland, an assessment of wetland soils, the overall health of each wetland, and an assessment of structural alterations to the wetlands, including outlets from each wetland that could control the site water levels.

The District reassessment concluded that the Minimum Level for 19 of the wetlands should be revised with the levels changing between -0.6 foot and +0.5 foot (12 wetlands have a decreased Minimum Level and seven have an increased Minimum Level; the average change is -0.1 foot and the median change is -0.2 foot). The District found that seven wetlands were not appropriate for use as Minimum Level wetlands for various reasons and these sites were removed from the District's Minimum Level Wetland list. Minimum levels were adopted for two new wetlands as replacement sites for two of the wetlands removed from the Minimum Level Wetland list. The District assessment is contained in the report "Revised Minimum Levels Based on Reevaluation of Levels Adopted for 41 Southwest Florida Water Management District Wetlands" which is attached as Appendix 9.24. The revised Minimum Levels and changes to the Minimum Level Wetland list were approved by the District Governing Board in November 2019 and the current list of wetlands and the applicable revised Minimum Levels are found in Chapter 40D-8, F.A.C. (https://swfwmd.state.fl.us/business/epermitting/rules-and-references).

The updated normal pool elevations and revised Minimum Levels for the applicable wetlands have been incorporated into the final assessment of recovery for these wetlands. Six of the seven wetlands for which adopted Minimum Levels were rescinded have been assessed in this final Recovery Assessment Plan report and assigned a final assessment bin consistent with the methods described for those wetland types. The final wetland removed from the Wetland MFL list (Cypress Bridge 20) no longer exists due to an impact related to development and was not included in the final list of Recovery Assessment Wetlands addressed in this final report.

9.6.2 District Review of Improved and Other Wetlands

The District Regulatory staff performed a site review of many of the wetlands that were categorized as "Improved" in the Preliminary Report of Findings (Tampa Bay Water, 2018b). These site reviews were performed in late 2019 to evaluate the current ecological condition of these wetlands with respect to impact criteria found in Chapter 40D-2, F.A.C. These site reviews serve multiple purposes since the District's annual status assessments for MFL wetlands and Tampa Bay Water's assessment of empirical data in the Recovery Assessment Plan are both primarily focused on the hydrology of the monitored wetlands. Inherent in both the annual wetland status assessment for Minimum Level wetlands and staff analysis of empirical wetland data against recovery metrics or levels of wetland health is the assumption that a wetland is healthy if a certain water level is achieved on a long-term basis.

The District site reviews provided an ecological assessment of the reviewed wetlands to determine whether or not adverse impacts were present based on Water Use Permitting criteria. This objective review of wetland health provides a meaningful verification of the methodology used to assess the recovery or health status of monitored wetlands. Performing this assessment at sites previously categorized as "Improved" allows staff to determine if this status is correct (some impact observed but does not rise to the level of adverse impact). The field assessment of ecological health can also be used to modify the final proposed recovery bin for a wetland. If an adverse impact is observed given the post-cutback wellfield pumping levels, a wetland status may be downgraded from "Improved" to "Continued Impact" and the need for mitigation assessed. If a wetland showed no sign of impact, the wetland status may be upgraded to "Recovered".

The Recovery Assessment Plan Preliminary Report of Findings (Tampa Bay Water, 2018b) reported 84 wetlands with the status bin of "Improved" (Section 9.3). District staff performed a field assessment of 38 of these wetlands (plus two wetlands that had been assigned a preliminary assessment bin of "Continued Impact") between August and December 2019 to examine the current environmental condition of the wetlands. District staff did not complete a field review of the remaining "Improved" sites due to lack of site access or flooded conditions prevented access during the time of the field reviews. Some sites had been visited previously by Tampa Bay Water and District staff during the review of wetlands for Recovery Assessment analyses. The District field review of Improved wetlands did not apply quantitative criteria to assign a numeric score to the wetlands but instead assessed the hydrology, community structure, location and landscape setting of each wetland to determine if an adverse impact was present at the time of the field assessment based on the impact criteria found in Chapter 40D-2, F.A.C.

District staff reviewed historical aerial photography of each wetland to understand the changes that have occurred in the surrounding landscape, including any evidence of ditching/drainage modifications or other changes to the surrounding location and landscape. Current and historic wetland water levels and rainfall data were evaluated to inform the hydrology portion of the site assessment. Finally, the vegetation present within the wetland was evaluated including plant species, the level of stress within the observed vegetation, and the appropriateness of plant species in relation to the multiple wetland zones. District Regulatory staff applied their professional judgement of these multiple factors to render an assessment of the 40 assessed wetlands. As part of the assessment, District staff looked for signs of impact and potential causes of any observed stress or impact. The wellfield pumping record was examined as well as drainage or land use changes surrounding the wetland that could cause or contribute to an observed impact. If District staff observed an impact in the wetland and no physical cause of that impact could be discerned from a review of the data, drainage features, or historical imagery, District staff would then attribute the impact to the influence of wellfield pumping.

These wetlands were assessed by District staff as having non-adverse impact, adverse impact, or were designated as “other”. An assessment of non-adverse impact does not mean that no change or stress was present but that any observed impact was judged as non-adverse according to permitting rule criteria; the vegetation community at the wetland was appropriate given the surrounding land use. Wetlands that were determined to have an adverse impact by District staff had inappropriate vegetation zonation (the wrong plant types growing in different wetland zones) and these impacts had been observed for many years. Those wetlands that received a designation of “other” were found to have impacts that District staff attributed to factors other than wellfield pumping, were impacted many years ago, exhibited clear evidence of significant subsidence or collapse, or the wetland type has changed over time due to historic impacts.

The data evaluated, photographs and field notes were assembled into individual wetland habitat assessment reports by the District staff for each wetland. The 40 wetlands for which the District staff completed site assessments are listed on Table 9.6 along with their summary findings of wetland impact. The individual site assessment reports for the District-evaluated wetlands are included in Appendix 9.25 along with tables and maps summarizing the available data, location, and review status; this information has been considered in the final assignment of Recovery Assessment category bins for the monitored wetlands. The application of the District field assessments to the final bins for monitored wetlands is summarized in Section 9.6.3.

Table 9.6: Wetlands with Completed Habitat Assessments by District Staff

TBW Site ID	Site Name	Wellfield	Assessment Date(s)	Impact Assessment by District Staff
4863	**CBR-Q01**	**CBR**	9/10/2019	Non-Adverse
4867	CBR-Q05	CBR	9/10/2019	Non-Adverse
4868	CBR-Q06	CBR	12/3/2019	Non-Adverse
4869	CBR-Q07	CBR	12/3/2019	Non-Adverse
4870	CBR-Q08	CBR	12/3/2019	Non-Adverse
4871	CBR-Q10	CBR	12/3/2019	Non-Adverse
4884	**CBR-Q25**	**CBR**	9/10/2019	Non-Adverse
4885	CBR-Q26	CBR	12/3/2019	Non-Adverse
4894	CBR-T01	CBR	9/10/2019	Non-Adverse
4963	**COS-SC272717**	**COS**	10/15/2019	Other
3779	CYC-W03	CYC	9/24/2019	Other
3780	CYC-W04	CYC	9/17/2019	Non-Adverse
3785	**CYC-W17**	**CYC**	9/24/2019	Non-Adverse
3788	CYC-W23	CYC	9/24/2019	Other
6125	CYC-W27	CYC	9/24/2019	Other
3791	CYC-W32	CYC	9/24/2019	Adverse
6129	CYC-W37	CYC	9/17/2019	Other
3796	CYC-W45	CYC	9/24/2019	Adverse

TBW Site ID	Site Name	Wellfield	Assessment Date(s)	Impact Assessment by District Staff
3798	CYC-W52	CYC	9/17/2019	Non-Adverse
4979	ELW-NW062717	ELW	8/20/2019	Other
4980	ELW-SW062717	ELW	8/20/2019	Non-Adverse
6069	MBR-10	MBR	8/27/2019	Adverse
6072	**MBR-16**	**MBR**	10/29/2019	Non-Adverse
6073	MBR-29	MBR	9/3/2019	Non-Adverse
6074	MBR-30	MBR	9/3/2019	Non-Adverse
6075	**MBR-35**	**MBR**	9/3/2019	Non-Adverse
6076	MBR-37	MBR	9/3/2019	Non-Adverse
6078	**MBR-88**	**MBR**	8/27/2019	Non-Adverse
6081	MBR-91	MBR	8/27/2019	Non-Adverse
6085	MBR-97	MBR	8/27/2019	Non-Adverse
50031	MBWF Trout Creek Marsh	MBR	10/29/2019	Non-Adverse
5410	STK-S-006	STK	10/8/2019	Non-Adverse
5418	STK-S-018	STK	10/8/2019	Other
5419	STK-S-020	STK	10/8/2019	Non-Adverse
5434	STK-S-053	STK	10/1/2019	Non-Adverse
5452	STK-S-080	STK	10/8/2019	Non-Adverse
5455	STK-S-084	STK	10/8/2019	Non-Adverse
5469	STK-S-113	STK	10/8/2019	Non-Adverse
5409	STK-S-005	STK	10/8/2019	Non-Adverse
5440	STK-S-063	STK	10/1/2019	Other

District field assessment forms are included in Appendix 9.25 of the Final Recovery Assessment Report
Bold - MFL Wetland
Red – Wetland with a preliminary assessment bin of "Continued Impact"

9.6.3 Site-Specific Evaluation/Analyses

The recovery classification bin for some wetlands changed following the preparation of the Preliminary Report of Findings (Tampa Bay Water, 2018b). These adjustments are due to multiple reasons including the evaluation of additional water level data through 2019 for isolated and connected wetlands, updated wetland normal pool elevations, the change in the xeric wetland metric, the change in assessment method and bins for unmonitored sites, and site specific investigations. There are 69 wetlands where the recovery classification bin changed for this final assessment report and these sites are listed in Table 9.7. This table shows the classification bin for each of these wetlands from the Preliminary Report of Findings, this final assessment report, and the reason for the change. Twenty-seven wetlands on this table were assigned final classification bins using the unmonitored site assessment methodology since water level data collection at these sites ended years ago. The final assessment bins for these formerly-monitored wetlands were assigned using the updated site bins as discussed and presented in Chapter 10.

Table 9.7: Improved Sites - no wetland habitat assessment

TBW Site ID	Site Name	Wellfield	RA Group Field Review Date
4873	CBR-Q14	CBR	8/4/2016
4874	CBR-Q15	CBR	8/4/2016
4876	CBR-Q17	CBR	8/4/2016
4879	CBR-Q20	CBR	7/19/2016
4880	CBR-Q21	CBR	8/4/2016
4895	CBR-T02A	CBR	8/4/2016
4899	CBR-T10	CBR	8/4/2016
50051	Lost Lake	CBR	
4960	COS-NC242717	COS	No site access per new land owner
6098	C08	CYC	
50028	Conners Cypress Marsh	CYC	10/31/2016
3777	CYC C25/ CBR Q19	CYC	
3768	CYC-C06	CYC	
3770	CYC-C102	CYC	
3771	CYC-C104	CYC	
3783	**CYC-W12**	**CYC**	9/6/2016, 7/16/2019
3794	CYC-W40	CYC	9/6/2016
3795	**CYC-W41**	**CYC**	10/31/2016
6131	CYC-W43	CYC	
6132	CYC-W44	CYC	
3797	CYC-W46	CYC	9/6/2016
6135	CYC-W49	CYC	
6136	CYC-W50	CYC	
6137	CYC-W51	CYC	
3799	CYC-W55	CYC	10/31/2016, 7/16/2019
5491	**CYC-W56**	**CYC**	10/31/2016, 7/16/2019
3778	W02A	CYC	
4969	**ELW-NW022716**	**ELW**	2/21/2017
4977	ELW-SW272716	ELW	2/21/2017
50016	EWWF3	ELW	8/15/2019
6174	MBR-102	MBR	
6168	MBR-105	MBR	
50040	East Branch Clay Gully	MBR	
50029	MBWF East Cypress Marsh	MBR	
50022	MBWF X-1	MBR	2/16/2017
5375	NOP-07	NOP	8/2/2016
5378	NOP-10	NOP	8/2/2016
5009	S21-272718	S21	3/2/2017
7780	NE112718	S21	
5001	NW112718	S21	
5431	STK-S-046	STK	
5488	STK-SC-92	STK	
5405	**STK-D**	**STK**	
50044	Anclote South Wet Prairie	STK	
50046	Starkey Wet Prairie	STK	
50027	STWF W	STK	

District field assessment forms are included in Appendix 9.25 of the Final Recovery Assessment Report
Bold - MFL Wetland
Red – Wetland with a preliminary assessment bin of "Continued Impact"

The explanations for the classification bin changes for most wetlands are simple and noted in Table 9.7. A more detailed explanation of the reasons for the change in recovery assessment bin for 13 of the wetlands included in this table is presented below:

CYB-3: This is an “Other” type wetland. It was assessed in the “Cypress Bridge Wellfield Wetland Assessment” report submitted to the District on December 22, 2017 (Appendix 9.9). At that time, the wetland 6- and 10-year median water level was less than or equal to 1.8 feet and was therefore meeting the mesic wetland metric. When the wetland was reassessed in 2020, the WY 08 – 19 median water level offset was 2.2 feet, thereby not meeting the established metric and was investigated further.

Dooris and Associates (2012) describes drainage alterations in the vicinity of wetlands CYB-3 and CYB-4 that occurred during the construction of the residential development (circa WYs 1988 and 1989) adjacent to the wetlands. The roadway and associated culvert between the wetlands cause backwater conditions in CYB-4, while starving CYB-3 of runoff. CYB-3 is unnaturally dry due to the constructed flow of runoff associated with the development and is therefore **impacted due to other causes.** Two sinkholes were also documented in this wetland as early as February 1990, before the wellfield was in full operation and before any nearby production wells began operation.

CYB-15: This is an “Undetermined” type wetland located directly adjacent to MFL wetland CYB-A. It was assessed in the “Previously Unbinned and More Detailed Analysis Needed (MDAN) Wetlands” assessment report (Appendix 9.4). At that time, the wetland water levels were compared to the wetland pop-off elevation of 57.2 feet NGVD instead of the normal pool elevation currently listed as 57.8 feet NGVD. The 6- and 10-year median offset values were 1.8 feet and 2.1 feet. When the wetland was reassessed for final binning with water level offsets WY 08-19, the offset from normal pool was 2.8 feet (1 foot below the metric elevation). The Recovery Assessment bin was changed from More Detailed Analysis Needed to Not Fully Recovered, Continuing Wellfield Impact.

CYB-A: This is a Minimum Flows and Levels cypress wetland located directly adjacent to wetland CYB-15. It was assessed in the Previously Unbinned and MDAN Wetlands assessment report (Appendix 9.4). At that time, the median 6- and 10-year offsets from the normal pool elevation were 1.9 feet and 2.6 feet, respectively. When the wetland was reassessed for final binning with mean water level offsets for WYs 08 – 19, the offset from normal pool was 2.3 feet. The Recovery Assessment bin was changed from More Detailed Analysis Needed to Not Fully Recovered, Continuing Wellfield Impact.

CYC W-04: This wetland was binned as Recovered in the Cypress Creek Wellfield Recovery Assessment report (Appendix 9.8), but was assigned to the recovery bin of Improved, Not Fully Recovered due to a clerical error in the Preliminary Recovery Assessment Report. The WY 08 – 19 median offset from normal pool is 1.2 feet. The wetland is binned as Recovered for this final assessment report.

CYC W-19: This wetland was binned as Recovered in the Cypress Creek Wellfield Recovery Assessment report (Appendix 9.8), with a WY 08 – 16 median water level offset of 1.8 feet. When the wetland was reassessed for WYs 08 – 19, the offset was 1.9 feet (the period-of-record hydrograph is shown in Figure 9.2). There is a significant positive trend in water level from WY 08 – 19 ($p < 0.001$) as shown in Figure 9.3. Therefore, the bin was changed to Improved, Not Fully Recovered.

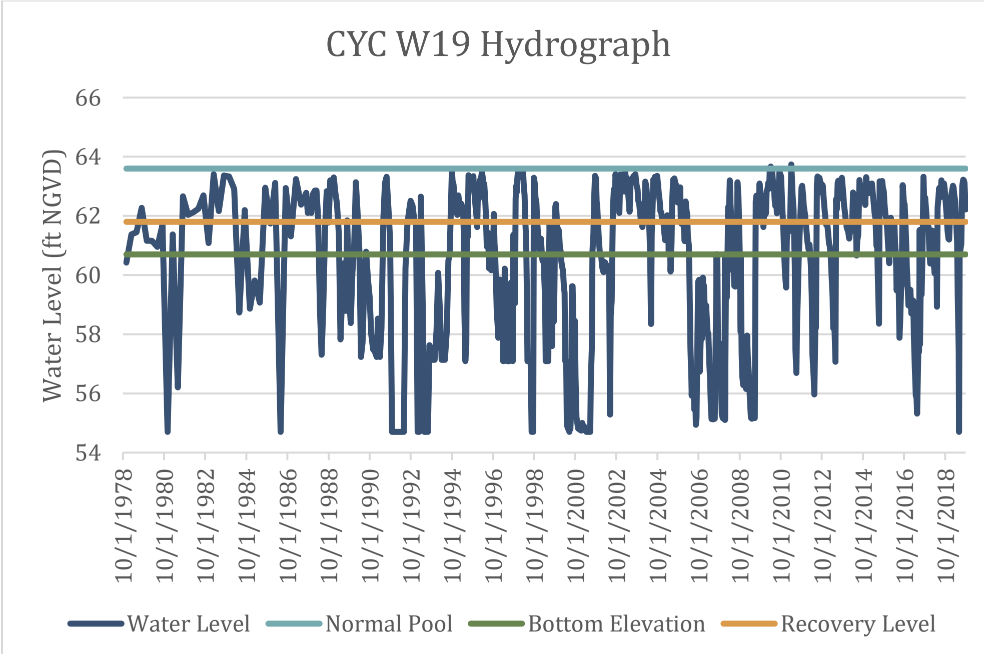

Figure 9.2: Period of Record Hydrograph for Wetland CYC W-19

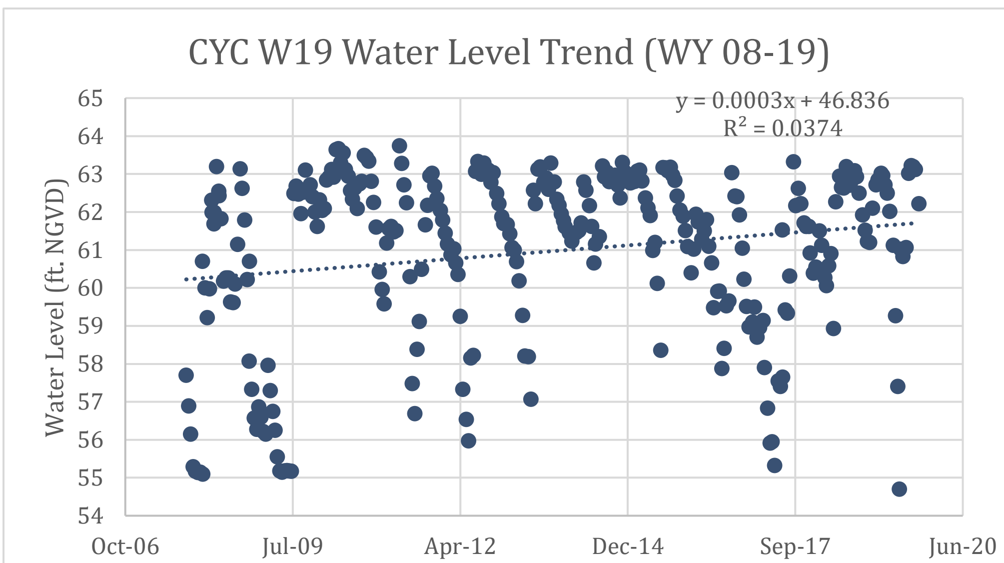

Figure 9.3: Wetland CYC W-19 Water Level Trend for Water Years 2008 – 2019

CYC W-32: This wetland was assessed in the "Recovery Assessment: Cypress Creek Wellfield Mesic, Xeric, Other, and Undetermined" report (Appendix 9.8). At that time, the median WY 08 – 16 water level offset from normal pool was 4.1 feet. When trends in the wetland and aquifer levels were assessed, there was a significant increase documented in water levels. This wetland was binned as Improved, Not Fully Recovered in the Preliminary Report of Findings.

When the wetland was reassessed for final binning, the WY 08 – 19 median water level offset from normal pool was 3.6 feet. Additionally, review of this site by the Southwest Florida Water Management District Regulatory staff indicated that adverse ecological impacts at the wetland were present. The observed adverse impacts included low/absent water levels and improper zonation of wetland vegetation with upland plant species recorded in all wetland zones. District staff also noted that these impacts occurred prior to 1989. This wetland is binned as Not Fully Recovered, Continuing Wellfield Impact for this final assessment report.

CYC W-45: This wetland was assessed in the "Recovery Assessment: Cypress Creek Wellfield Mesic, Xeric, Other, and Undetermined" report (Appendix 9.8). At that time, the median WY 08 – 16 water level offset from normal pool was 3.8 feet. When trends in the wetland and aquifer levels were assessed, there was a significant increase documented in water levels. This wetland was initially binned as Improved, Not Fully Recovered in the Preliminary Report of Findings.

When the wetland was reassessed for final binning, the WY 08 – 19 median water level offset from normal pool was 3.7 feet. Additionally, review of this site by the Southwest Florida Water Management District Regulatory staff indicated that adverse ecological impacts at the wetland were present. The observed adverse impacts included low/absent water levels and improper zonation of wetland vegetation with upland plant species recorded in all wetland zones. There has been substantial historic treefall in this wetland and the wetland type has changed from a cypress wetland to an open marsh. District staff noted that that these impacts occurred prior to 1989 and ditching into/out of the wetland occurred at some point after 1984. This wetland is binned as Not Fully Recovered, Continuing Wellfield Impact for this final assessment report.

CYC W-55: Wetland CYC W-55, also known as the Sims Property wetland, was established as a monitoring site in 1992. The wetland is a cypress dome and is bisected by the Cypress Creek Wellfield property line, with the majority of the wetland being located outside of the wellfield boundary. As documented in the Cypress Creek Wellfield Annual Report of WY 2015 (Tampa Bay Water, 2016b), the wetland experienced treefall before 1995 and stress of the remaining cypress trees was apparent through WY 1998 due to a water deficit.

In the January 26, 2017 report titled "Cypress Creek Wellfield Recovery Assessment" (Appendix 9.8) wetland W-55 was assessed and it was determined that this wetland needed a more detailed analysis to determine an appropriate Recovery Assessment bin. In the Recovery Assessment Plan Preliminary Report of Findings, the wetland was binned as Improved, Not Fully Recovered.

In a July 2019 field trip with Tampa Bay Water and District staff, the recovery status of the wetland was discussed, and a consensus was reached that the wetland is very likely impacted and continues to be impacted by wellfield pumping. Further analysis of wetland water levels performed in September 2019 showed that the median normal pool offset for this wetland was 9.0 feet for the period of WY 2008 – 2019, which is below the standard 1.8 foot median normal pool offset standard for isolated mesic wetlands (the period-of-record hydrograph is shown in Figure 9.4). The final classification bin for this wetland is Not Fully Recovered, Continued Wellfield Impact.

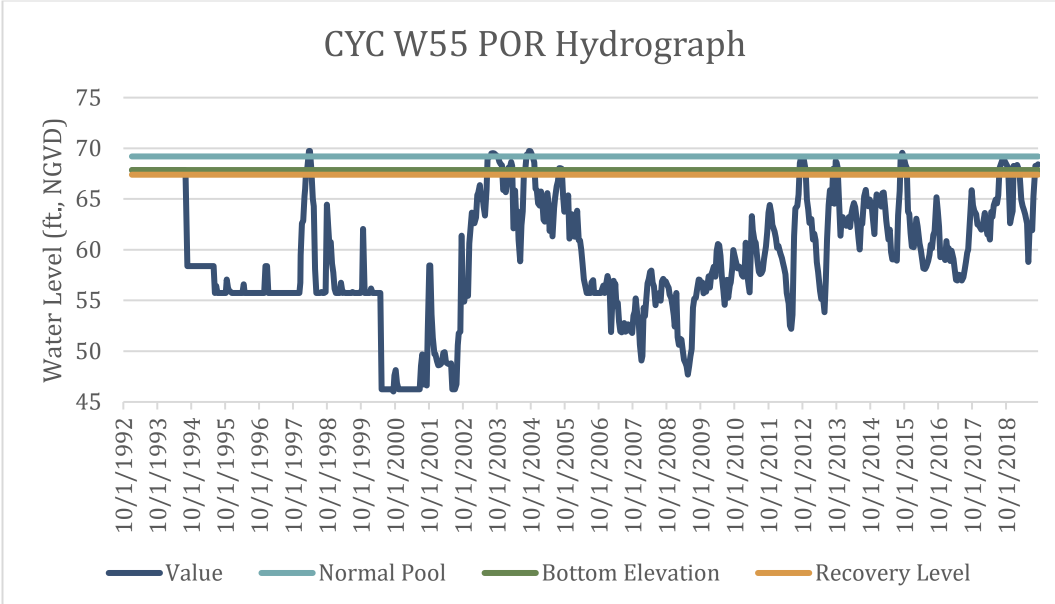

Figure 9.4: Period of Record Hydrograph for Wetland CYC W-55

ELW SW272716: Wetland ELW SW272716 is a shallow, isolated cypress wetland located at the Lansbrook Golf Course south of the Eldridge-Wilde Wellfield and occupies a location between the clubhouse parking lot and an excavated golf course pond (Figure 9.5). Prior to construction of the golf course, the area of the excavated pond was upland pasture, as shown in the 1970s-era aerial photograph (Figure 9.6). A field reconnaissance on February 21, 2017 found that the excavated pond adjacent to the wetland exists at a lower elevation such that water levels in the pond are lower than the wetland, and often below the wetland bottom, which promotes seepage out of the sides and bottom of the wetland. The wetland may receive some stormwater input from the adjacent parking lot, but the edge of the wetland has been excavated to promote surface flow out of the wetland and down toward the pond, preventing the site from staging up to its normal pool elevation during periods of high rainfall.

Figure 9.5: Location of Site ELW-SW272716 Adjacent to the Lansbrook Golf Course Parking Lot

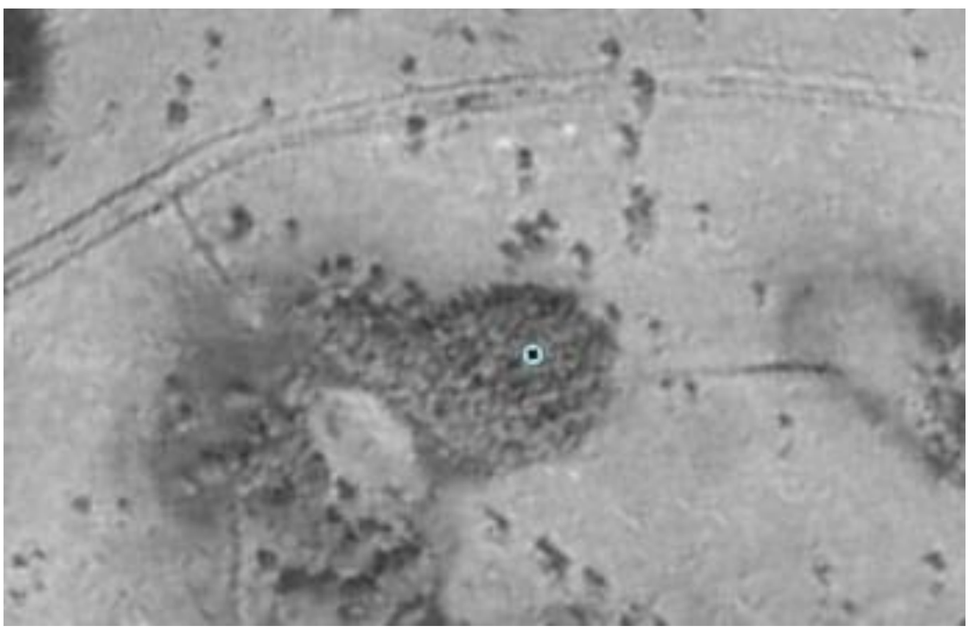

Figure 9.6: Aerial Photograph Circa 1972 Showing ELW-SW272716 and Adjacent Areas

The April 2017 wetland assessment report for the Eldridge-Wilde Wellfield (Appendix 9.14) evaluated the wetland post-cutback median water levels using the isolated mesic wetland recovery metric of normal pool elevation minus 1.8 feet and the wetland failed to meet that metric. The wetland was binned as Improved, Not Fully Recovered in that report based on a slightly increasing trend in the 6-year median water level. The report also noted the drainage and land use impacts to the wetland. When the wetland was reassessed for final binning, the WY 08 – 19 median water level offset from normal pool was 2.3 ft. (Appendix 9.21).

The wetland is considered to be largely unaffected by wellfield production. The nearest wellfields are the Eldridge-Wilde and Cosme-Odessa Wellfields at distances of approximately 3.5 and 6.5 miles, respectively. The period of record hydrograph for the Site (Figure 9.7) shows that the wetland was not noticeably affected by wellfield production (little sign of water level increase after cutbacks) as seasonal highs and average water levels remained very stable. Production at the Eldridge-Wilde and Cosme-Odessa Wellfields was reduced in the beginning of WY 2003. Annual median drawdown in the Upper Floridan Aquifer as modeled by Tampa Bay Water's Integrated Hydrologic Model at the location of the wetland averaged only 0.34 foot during the post-cutback years of 2003 to 2018. Drawdowns in the surficial aquifer at the wetland are even less. This amount of drawdown should not be a significant factor preventing the site from meeting its recovery metric. This wetland has continuing impacts due to man-enhanced drainage and seepage that prevent water from staging up or remaining within the wetland for more than a short period of time. The impacts at this wetland are not wellfield-related and the final assessment bin for wetland ELW SW272716 is Impacted Due to Other Causes.

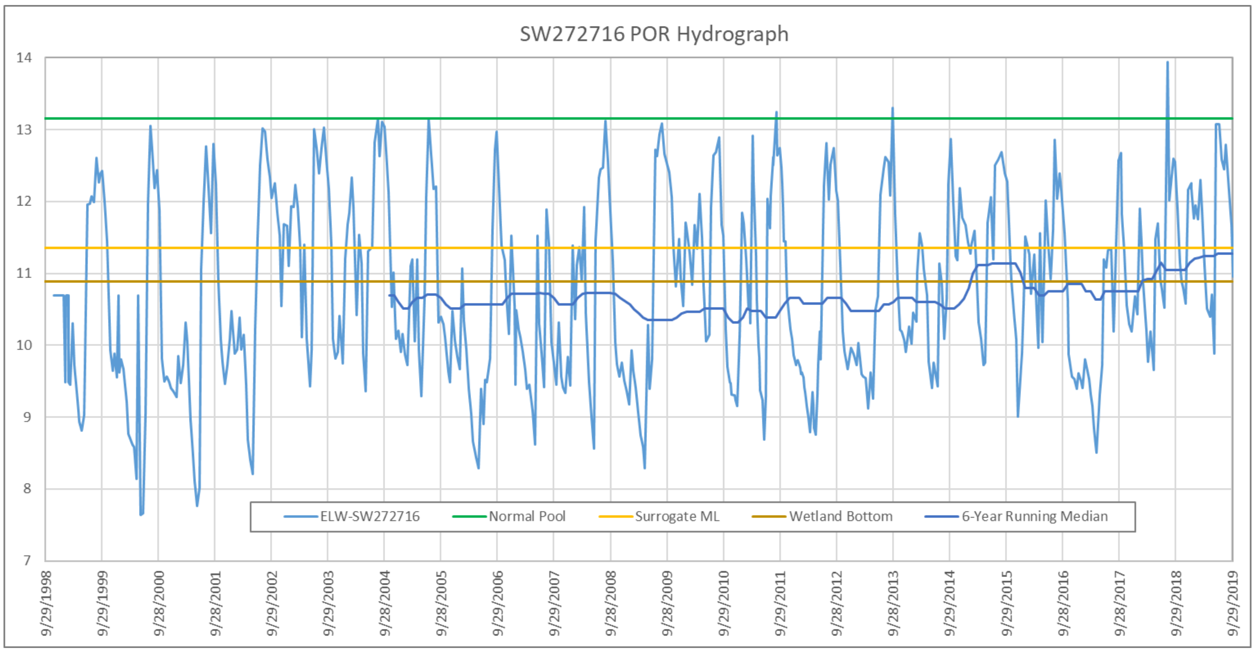

Figure 9.7: Period of Record Hydrograph of ELW-SW272716

MBR-10: This wetland is located in the north-central portion of the Morris Bridge Wellfield, north of the loop road and south of the northern wellfield property boundary. When assessed for preliminary binning, the wetland had a 5.6 foot offset from normal pool elevation for WYs 08 – 16, and significantly increasing wetland, surficial aquifer, Upper Floridan Aquifer level (Appendix 9.10). The wetland was binned as Improved, Not Fully Recovered in the Preliminary Report of Findings.

When this wetland was reassessed for final binning, the WY 08 – 19 median water level offset from normal pool elevation is 5.4 feet and could still be assessed as Improved, Not Fully Recovered due to water level improvement. However, the District Regulatory staff performed a field review of this wetland and noted adverse environmental impacts. The reported impacts were changes to wetland hydrology due to fissures in the central wetland soils when dry, reduced hydroperiod, and little to no zonation of wetland plant species within the wetland. The transition zone of the wetland was documented with upland vegetation species. This wetland has multiple documented sinkholes and has been the subject of investigation of sub-basin flow studies due to the development of the Hunter's Green sub-division, located north of the wetland. Based on the field observation of the District Regulatory staff, the final assessment bin for this wetland is Not Fully Recovered, Continued Wellfield Impact.

MBR-98: This wetland was binned as More Detailed Analysis Needed in the "Morris Bridge Wellfield Recovery Assessment" report (Appendix 9.10) because the normal pool elevation needed to be investigated. When the normal pool elevation was investigated by Flatwoods in November 2018, the elevation was changed from 42.8 feet to 41.7 feet NGVD. Using this updated normal pool elevation, the wetland was reassessed in the "MDAN and Previously Unbinned" Report (Appendix 9.4). A 1.7 foot median water level offset from normal pool was calculated for WYs 2003 – 2018 and the wetland was binned as Recovered in the Preliminary Report of Findings.

Following the Preliminary Report of Findings, the District staff updated the normal pool elevation slightly to 41.8 ft. NGVD. When the wetland was reassessed in March 2020 for final binning (the period-of-record hydrograph is shown in Figure 9.8), the WY 08 – 19 median water level offset from the revised normal pool elevation is 2.4 feet when the median was calculated using monthly average water levels, and 2.0 feet when bi-monthly data were used. The wetland water level increased significantly ($p < 0.001$) between WY 08 – 19 and this wetland is assigned a final assessment bin of Improved, Not Fully Recovered.

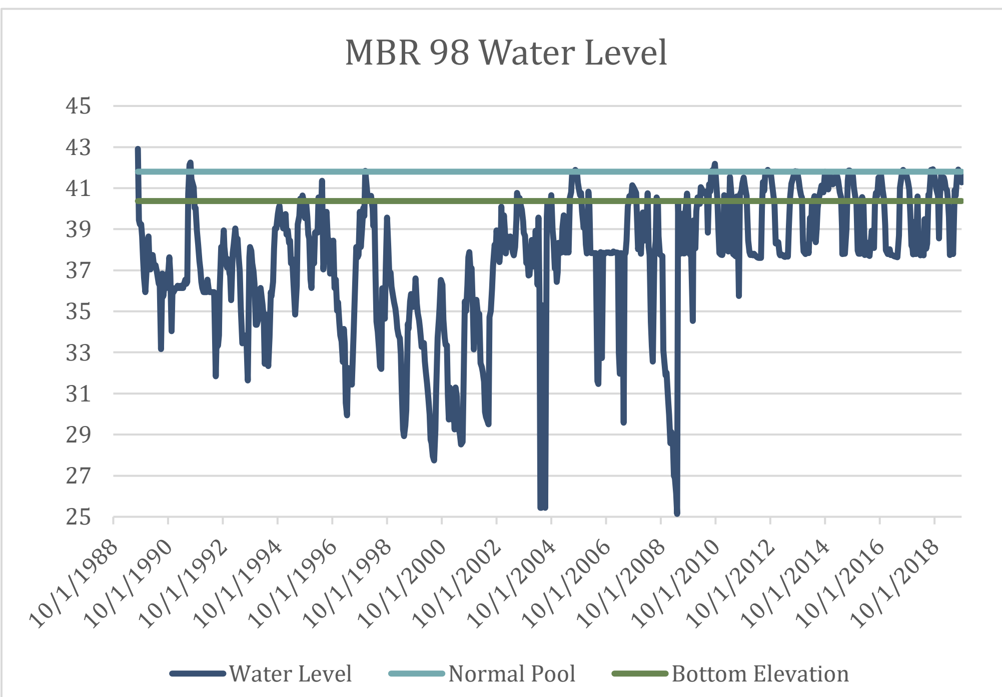

Figure 9.8: Period of Record Hydrograph for Wetland MBR-98

S21 NE112718: Wetland S21-NE112718 is associated with the Section 21 Wellfield and monitoring was discontinued in 2005. The wetland is located between two connected lakes, Lake Hobbs and Lake Cooper (Figure 9.9), that are part of a chain of lakes; this wetland receives some flow from Lake Hobbs and discharges to Lake Cooper. The wetland is much closer to Lake Cooper (500 feet) and is at approximately the same elevation. Water levels for this wetland and Lake Cooper track very closely, with the wetland water levels 0.3 foot less than Lake Cooper. Since the wetland monitoring was discontinued in 2005, about the same time as the pumping reduction at the Section 21 Wellfield, this water level relationship was used to calculate an extended water level record for the site in order to evaluate post-cutback recovery (Figure 9.10).

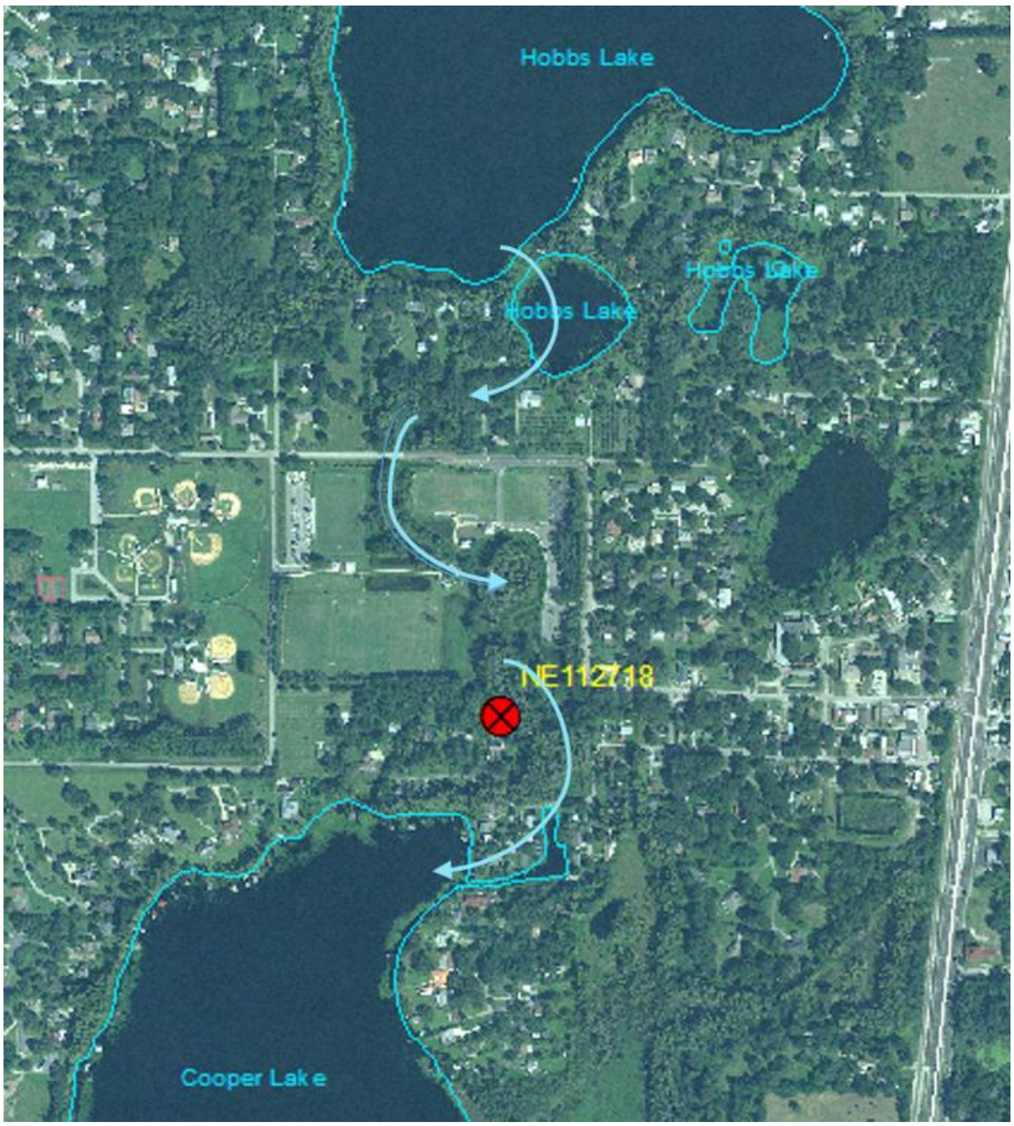

Figure 9.9: Location of Site S21-NE112718 between Lake Hobbs and Cooper Lake

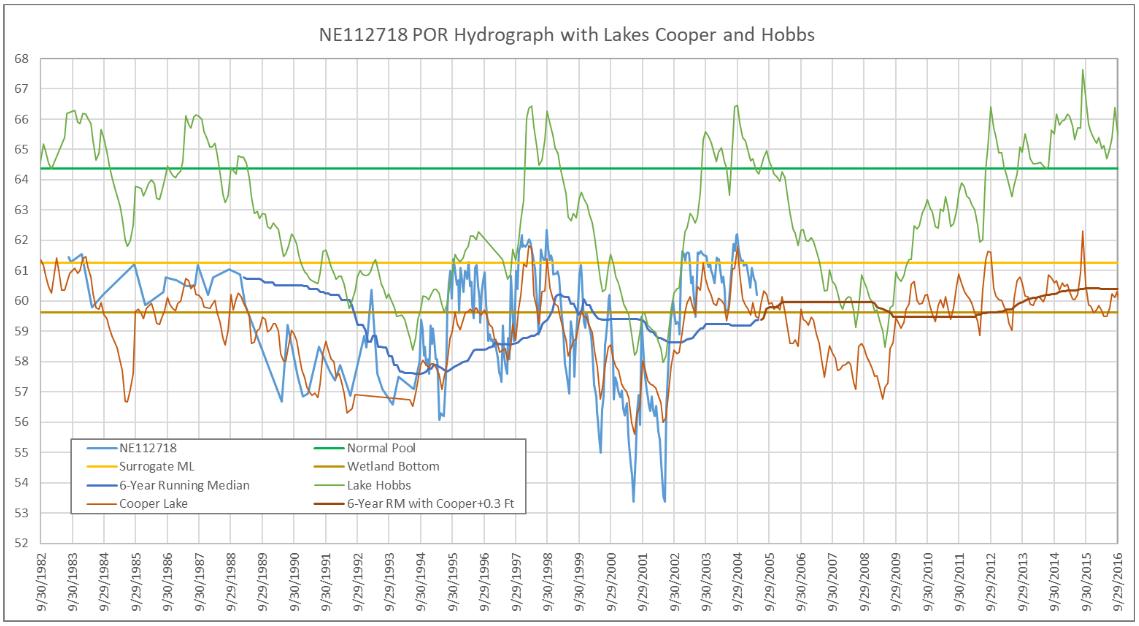

Figure 9.10: Period of Record Hydrograph of S21-NE112718 with Lakes Hobbs and Cooper

The report containing the preliminary Recovery Assessment evaluation of wetland sites associated with the Section 21 Wellfield was submitted to the District on September 6, 2017 (Appendix 9.16). This wetland is located in a xeric soil environment and the initial xeric wetland metric was used in the preliminary assessment of the wetland. Median wetland water levels following the wellfield pumping reduction did not meet the initial xeric metric; however, median water levels showed a slight increasing long-term trend in the post-cutback period. It is expected that post-cutback pumping levels have no notable effect on the wetland since it is approximately 2.7 miles north of the Section 21 Wellfield. Failure of the wetland to reach its recovery metric was determined to be due to the ditches and other drainage improvements that facilitate flow between Lakes Hobbs and Cooper. The initial report concluded that the appropriate bin for the Site was Improved, Not Fully Recovered based on the increasing water level trends. Since the date of that report, additional bins have been approved for lakes and wetlands in the Recovery Assessment Plan. The newly-added bin of Impacted Due to Other Causes would have been the most appropriate due to drainage-related issues at the wetland that prevent water levels from achieving the recovery metric.

The final recovery assessment for this wetland uses the revised xeric wetland metric, developed after the preliminary assessment was completed. Two analyses considered in this final assessment tested two time periods of lake water levels against the revised xeric wetland metric. The first, WY 2003 through May 2005, used the last available wetland data for a period that encompassed the more widespread pumping cutbacks at other area wellfields even though the Section 21 Wellfield pumping was not able to be reduced until Water Year 2005. The second time period was WY 2008 through 2019 using the expanded water level timeseries calculated from Lake Cooper water levels. The wetland met the revised metric in both tests.

This wetland has continuing impacts (low water levels) due to man-altered drainage that prevents water levels from staging up. The impacts are not wellfield-related, and the wetland has recovered to the greatest extent possible. The wetland lies in a flow path between Lakes Hobbs and Cooper. Both lakes have been binned as Recovered in this final assessment report, indicating a lack of significant wellfield-related drawdown and a generally recovered condition in the area. The wetland meets its recovery metric based on the most recent appropriate metric and analysis for this site. The final assessment bin for S21-NE112718 is Recovered.

STK S-063: Wetland S-063 is located in central Starkey Wellfield, in an area with greater than 3 feet of Upper Floridan Aquifer water level recovery (Appendix 9.1). Wetland S-063 is a shallow isolated cypress wetland and water levels in this wetland have been monitored since 1983. The median normal pool offset for WY 2008-2019 was 2.3 feet, below the recovery metric for isolated mesic cypress. Wetland S-063 was augmented from the early 1990s through 2007 and the effect of augmentation is apparent in the POR hydrograph (Figure 9.11). While six-year median water levels have declined since 2008, they are still above those from the 1980s before augmentation began. Water levels have been generally higher in the post-cutback period, as compared to the pre-augmentation period (1983-1990). Seasonal low water levels in the post-cutback period have been approximately 4 feet higher than the seasonal lows during the pre-augmentation era.

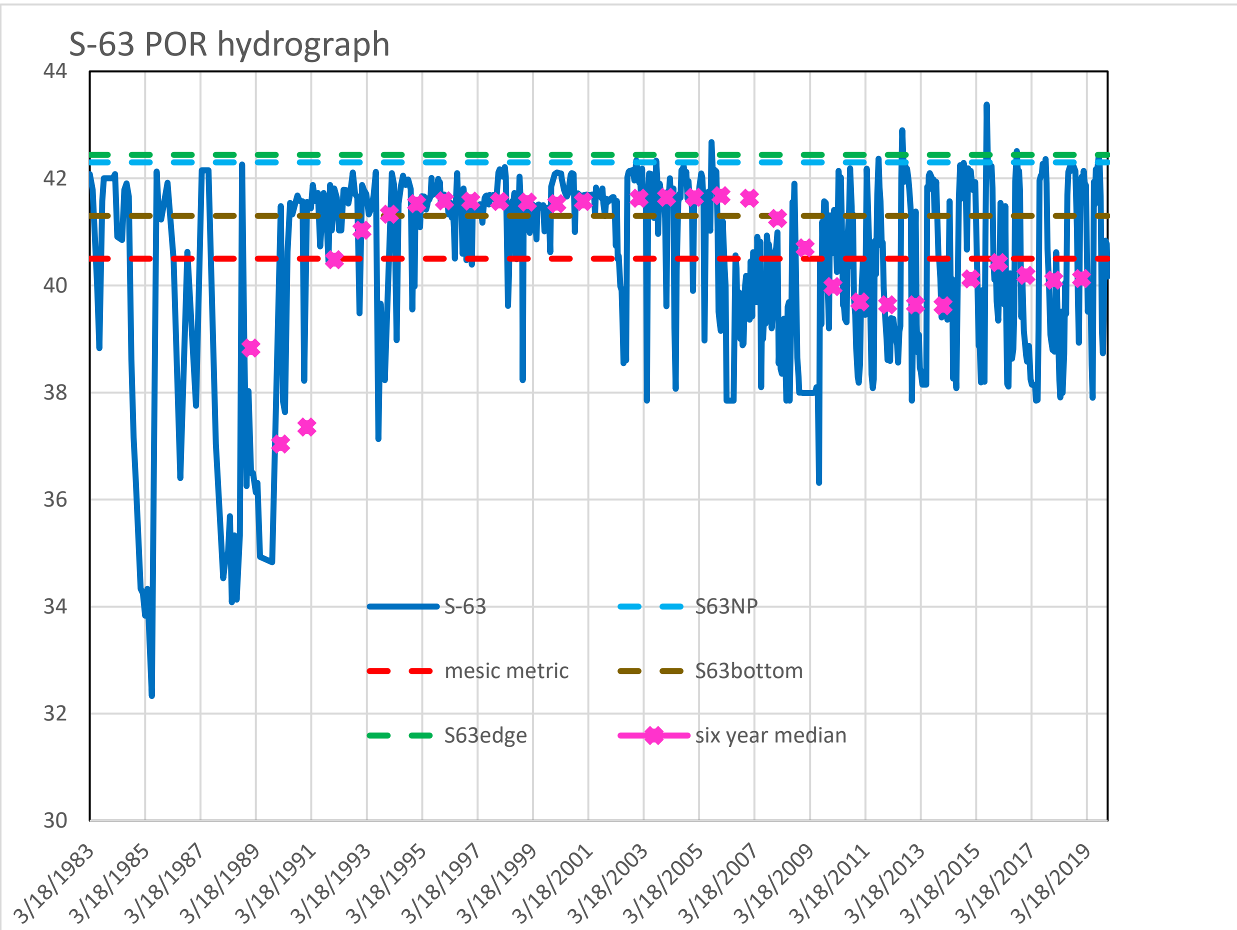

Figure 9.11: Period of Record Hydrograph for Wetland STK S-063.

The period of record Wetland Assessment Procedure (WAP) scores for S-063 (Figure 9.12) show relatively consistent, healthy scores, with the highest overall scores in the last three years (2017-2019). There was no decline in WAP scores after the cessation of augmentation, and vegetation in this wetland is generally appropriate in type and zonation. A field inspection conducted by Tampa Bay Water and District staff on October 8, 2015 revealed that the wetland was in healthy condition, with water levels appropriate to the season.

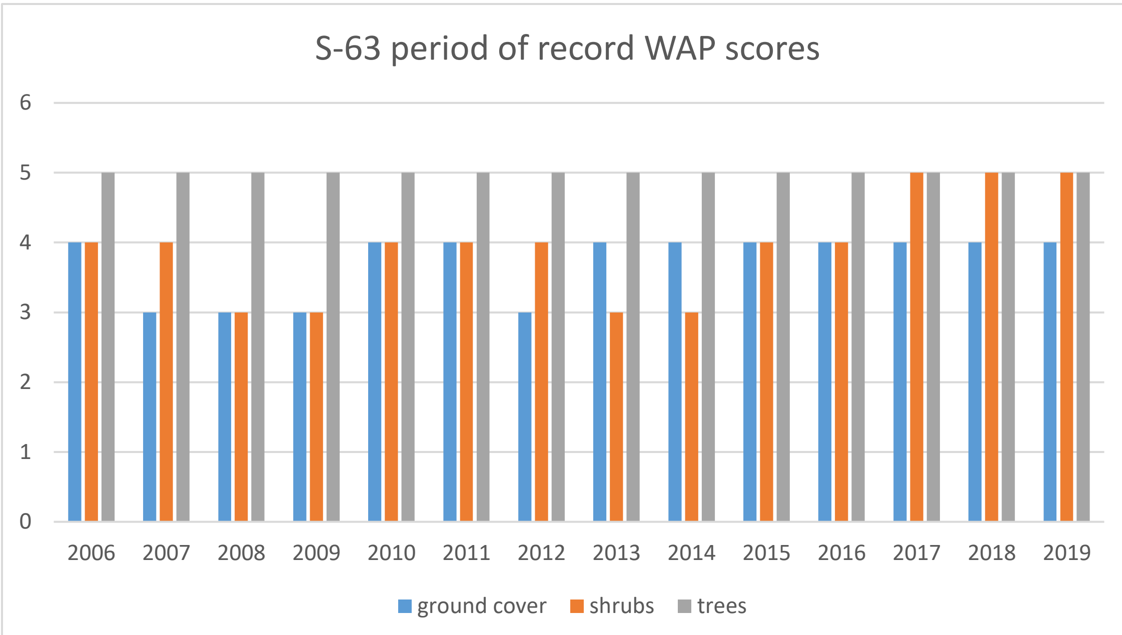

Figure 9.12: Period of Record Wetland Assessment Procedure Scores for Wetland STK S-063.

The percent exceedance curves for the pre and post-cutback periods for S-063 are presented in Figure 9.13. The period of 1983-1989 was chosen as the pre-cutback period, in order to avoid including data from the augmentation period. The post-cutback (2008-2014) and post-augmentation percent exceedance curve is higher than the pre-cutback period at the median and at the lower percentile values. The median post-cutback water level is approximately two feet higher than the pre-cutback, pre-augmentation water level. This evidence supports the classification of Improved, Not Fully Recovered for Starkey Wetland S-063.

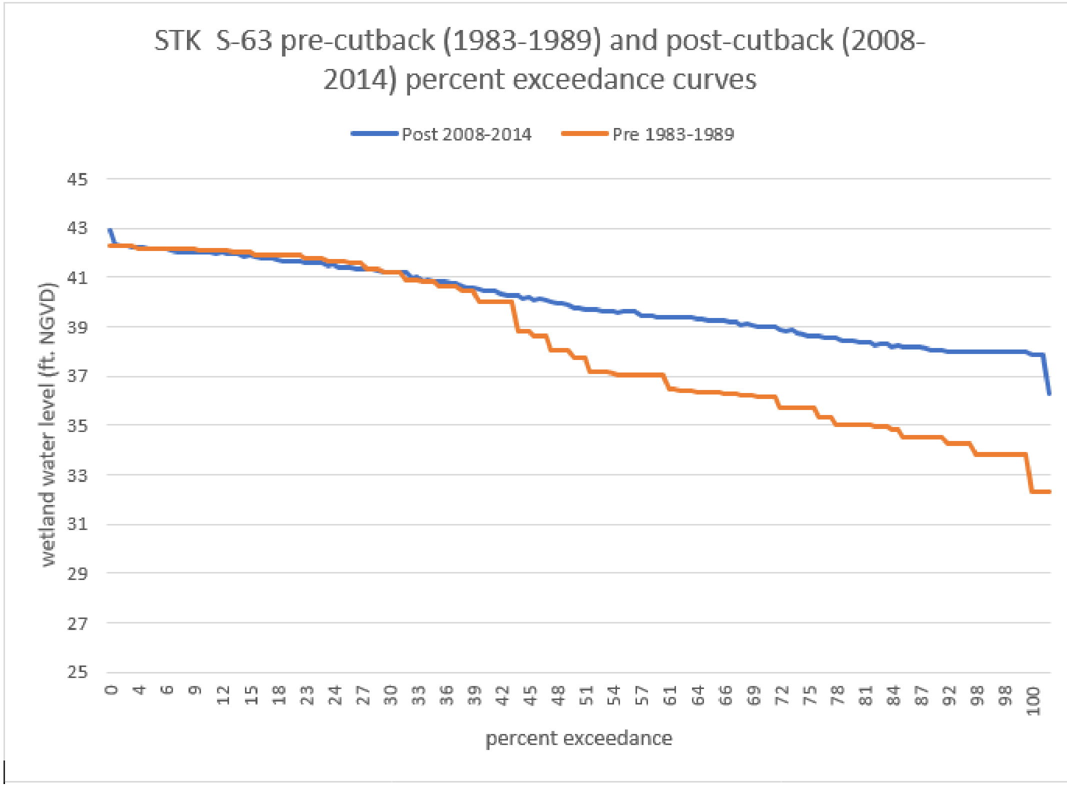

Figure 9.13: Pre-cutback and Post-cutback Percent Exceedance Curves for STK S-063.

Other wetlands (not listed on Table 9.7) did not have a change in classification bin between the preliminary and this final assessment report; however, there was either a change in wetland type, site-specific data issues, or a different assessment metric was used in their final assessments. A more detailed explanation of the reason for the change for five of the monitored wetlands is presented below:

CBR Pond 6: Pond 6 is an augmented wetland located in the west-central part of the Cross Bar Ranch Wellfield, near wetland Q07. The wetland was binned as Recovered in the Preliminary Report of Findings. Because of a large gap in wetland water level data between May 2006 and June 2012, a 10-year median normal pool offset was not previously calculated.

For the final assessment of recovery status, monthly average water levels between May 2012 and Sept. 2019 were compared to the normal pool elevation of 66.65 feet (hydrograph shown in Figure 9.14). The median offset from normal pool for this time was 0.54 foot. This wetland bin remains Recovered for this final assessment report.

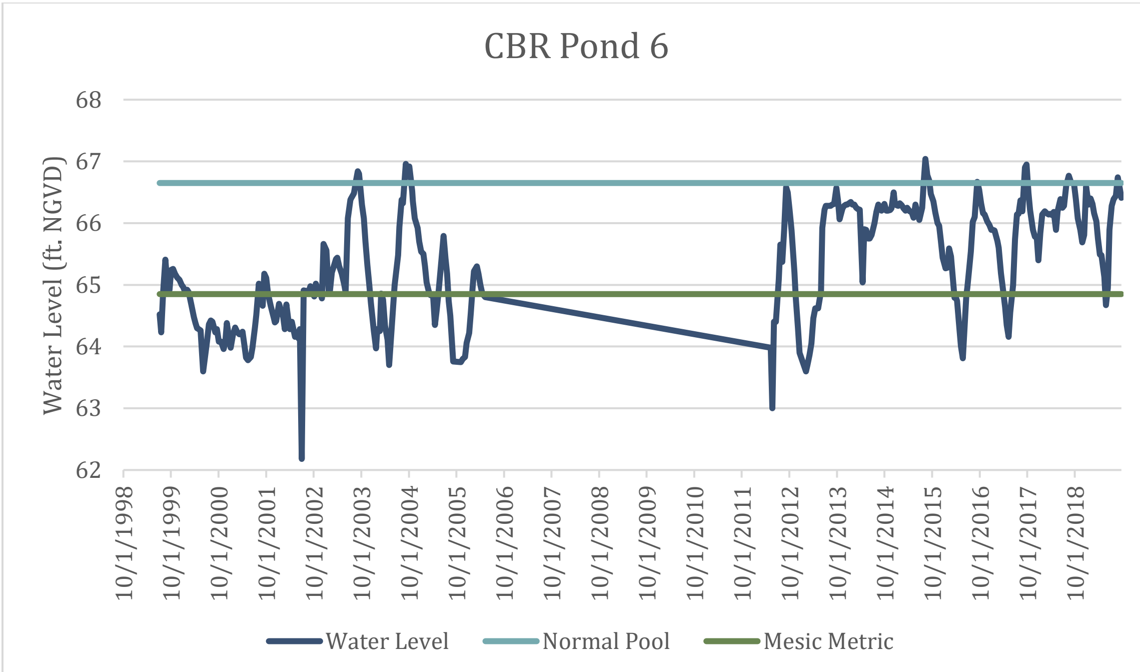

Figure 9.14: Period of Record Hydrograph for CBR Pond 6

CBR Lost Lake: Lost Lake is located in the central Cross Bar Ranch Wellfield. Water level records extend to WY1977 but do not appear to be continuous until WY1982. Between 1989 and 2018, water level monitoring has been discontinuous due to wetland water levels being below monitoring devices, access trails being flooded, and other site access issues. Lost Lake was binned as Improved, Not Fully Recovered in the Preliminary Report of Findings because there was no established normal pool elevation at the time, but the aquifer levels near the lake showed significant statistical improvement in the post-cutback period.

An updated analysis was attempted using the revised xeric metric and a calculated P03 elevation; however, the water level data record ends in June 2018 due to obstruction of water level measuring devices by vegetation. Therefore, the calculated offset from the P03 elevation of 1.33 feet for May 2014 – June 2018 is not necessarily characteristic of the entire post-cutback period (hydrograph shown in Figure 9.15). Because a substantial amount of water level data is missing from the period of record, even in recent years, a change to the recovery assessment bin is not recommended and the wetland should remain classified as Improved, Not Fully Recovered.

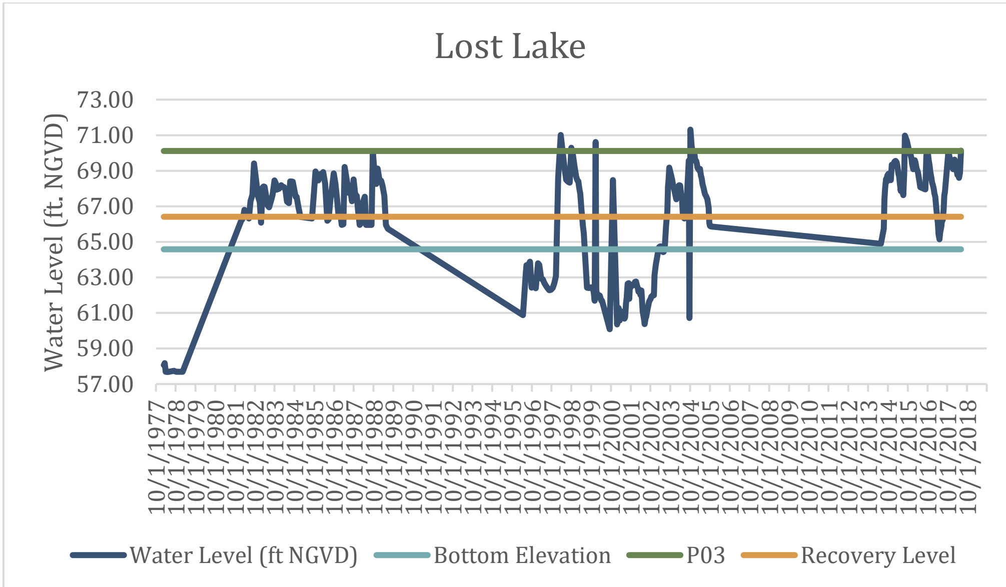

Figure 9.15: Period of Record Hydrograph for CBR Lost Lake

CBR Spring Lake: Spring Lake was binned in the Preliminary Report of Findings as Recovered because it met the previously-established xeric wetland metric in earlier analyses. It is a heavily ditched xeric lake that is connected to the Jumping Gully system and is in the south-central portion of the Cross Bar Ranch Wellfield. An updated analysis using the revised xeric wetland metric was used to assess the final bin status for Spring Lake. A select P03 value of 69.96 feet NGVD was calculated; this value is the Period of Record P03 elevation. The median water level offset from this P03 elevation for WY 08 – 19 is 2.07 feet (hydrograph shown in Figure 9.16) This wetland meets the revised xeric wetland metric and the final assessment bin is Recovered.

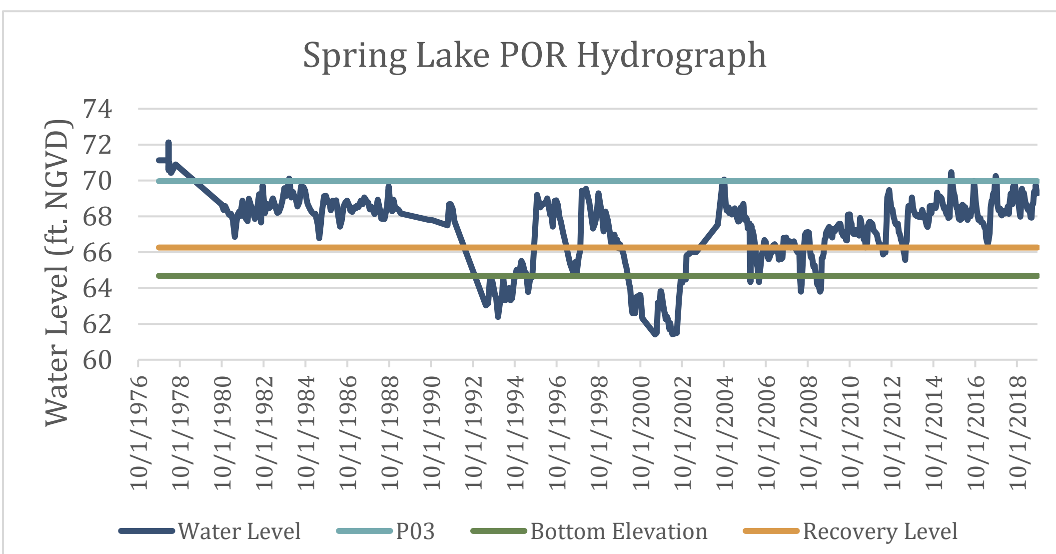

Figure 9.16: Period of Record Hydrograph for CBR Spring Lake

CYC C-14: This wetland was assessed in the Cypress Creek Recovery Assessment: Mesic-associated, Xeric-associated, and Other Wetlands report (Appendix 9.8). At that time, the WY 08 – 16 median offset was 1.2 feet and the wetland was binned as Recovered. However, between April 2013 and April 2019, access to the site was limited by fencing such that the center staff gage may be seen and a water level recorded if there was standing water in the wetland. The center well, however, could not be accessed or water levels recorded. Access to the property was reestablished in April 2019.

The updated WY 08 – 19 analysis using all available data resulted in a median offset of 1.4 feet; water level data between April and Sept. 2019 affected this slight shift. The final assessment bin is not changed due to the lack of sufficient data following the initial assessment. This wetland remains Recovered in this final assessment report.

S21 NC092718: Wetland S21-NC092718 is associated with the Section 21 Wellfield and is still actively monitored. The wetland lies adjacent to the south side of Lutz Lake Fern Road, with a large roadside ditch separating the road and the wetland (Figure 9.17). From the ground, this large wetland system appears similar to the many other roadside wetlands in the area, and was originally classified as Isolated Cypress; however, review of 1957 aerial photography (Figure 9.18) shows that the wetland is part of a flowing system that is a tributary to Turkey Ford Lake and Rocky Creek. The more recent imagery in Figure 9.17 shows that the stream channel conveying flow south from the wetland has been improved and is quite evident in aerial photography.

Figure 9.17: Location of Site S21-NC092718 and Improved Stream Channel

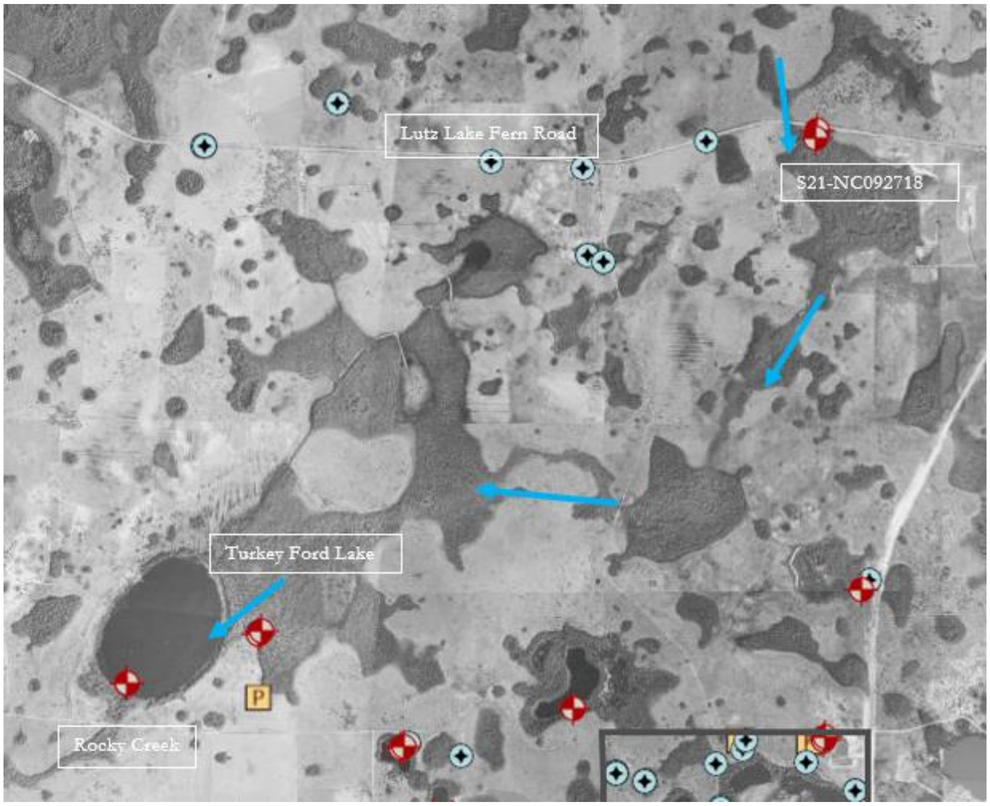

Figure 9.18: 1957 Aerial Photo of S21-NC092718 and Flow-Way to Rocky Creek

Surface water drainage and how it affects water levels in this wetland were discussed in the September 2017 wetland evaluation report for the Section 21 Wellfield (Appendix 9.16). The wetland classification type was not changed at that time and the report assessed the wetland using the isolated mesic wetland metric. The wetland was initially binned as Recovered in the Preliminary Report of Findings. The final assessment of isolated wetlands using water level data from WY 2008 through 2019 determined that this wetland did not meet the isolated mesic wetland metric. Further evaluation found that drainage improvements affecting the wetland prevent water levels from staging up, which depresses longer-term median water levels and the aerial photography clearly show this wetland is predominantly a flow-through wetland. For this final assessment report, the site was reclassified as a Connected Wetland. Assessment of wetland water levels using the Connected Wetland method resulted in a final assessment bin of Recovered for this wetland.

9.7 Final Recovery Assessment Evaluation

The final assessment of recovery for the 378 monitored wetlands incorporated all prior studies performed for individual wetlands and multiple types of data were considered in the final assessment classification of each site, including the results of District staff field assessments. By evaluating all available data, staff continued the weight-of-evidence approach for assessing environmental recovery and these analyses included data assessments that minimize the effects of rainfall variability. The analyses included wetland water level data from 2008 through 2019 to correspond to the post-reduction wellfield pumping period of time. With the exception of the Northwest Hillsborough Regional Wellfield, all of the Consolidated

Permit wellfields were fully interconnected to the regional system and the pumping rates were reduced by the beginning of 2008. Since staff have assessed the current health of many wetlands in the field to verify the assessment results, it was important to extend the assessment of wetland water level data through the end of calendar year or Water Year 2019. Due to the lag time between changes in hydrologic stresses and changes in wetland vegetation/health, staff analyzed a period (2008 – 2019) of recent, stable Consolidated Permit wellfield pumping (average annual rate at or below 90 mgd) with respect to wetland impacts/health and the presence or absence of wellfield pumping-related adverse impact.

There has been a significant recovery in wetland water levels during the years following the reduction in pumping from the Consolidated Permit wellfields. The past several years have been characterized as average to above-average annual rainfall with only seasonal rainfall deficits reported; however, the beginning of the wetland assessment time period included part of the extended drought period that occurred between 2005 – 2009. The residual low water-level effects of this drought were observed into 2010. The wetland evaluation period also includes very dry seasonal periods such as the dry season that stretched from October 2016 through the end of May 2017. As shown in Figure 3.48, the wellfields have experienced mostly normal rainfall with the exceptions of Water Years 2015 and 2018 which are characterized as above-average with respect to the long-term average for the wellfield areas. The final wetland assessment results are a continuation of the preliminary wellfield-scale assessments presented in Section 9.2 and all of these evaluations compared the current period of evaluation (current as of the time of the assessment) to a time period of similar rainfall before the wellfield pumping reductions. This analysis was performed to factor out the influence of rainfall to the greatest extent possible. Extending the preliminary assessment of wetland recovery through 2019 has allowed staff to extend the preliminary assessments to the present time and compare the individual wetland assessments to the current environmental condition of the wetlands.

The final Recovery Assessment designation or bin for each of the monitored wetlands is presented in Table 9.8. These results are compiled into a summary table and chart in Figure 9.19 which shows that 294 of the monitored wetlands (78% of the total) fall into one of the classification bins that consider a site to be Recovered (Never Impacted, Recovered/Meets Metric, or High Degree of Certainty of Wetland Health). Ten wetlands were determined to be impacted by causes other than wellfield pumping (3% of the total) and 66 wetlands (17% of the total) show improvement but do not yet meet their recovery target (sites binned as Improved, Not Fully Recovered [63 sites] or Low Degree of Certainty of Wetland Health [3 sites]). Only eight wetlands (2% of the total) are well below their recovery target and/or have been assessed as having adverse environmental impacts that are primarily due to the current level of wellfield pumping. The final assessment results for the monitored wetlands are also presented on Table 9.9 for each of the Consolidated Permit wellfields.

Table 9.8: Final Recovery Assessment Findings for Individual Monitored Wetlands

SWFWMD ID	Site Name	Wellfield Code	Preliminary Recovery Status	Final Assessment Method/Approach	Final Recovery Assessment Bin
1	**CBR-Q01**	**CBR**	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
2	CBR-Q02	CBR	Recovered	Isolated Wetlands - Xeric	Recovered
4	CBR-Q04	CBR	Recovered	Isolated Wetlands - Xeric	Recovered
5	CBR-Q05	CBR	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Improved, Not Fully Recovered
6	CBR-Q06	CBR	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Improved, Not Fully Recovered
7	CBR-Q07	CBR	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Improved, Not Fully Recovered
8	CBR-Q08	CBR	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Improved, Not Fully Recovered
9	CBR-Q10	CBR	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Recovered
10	CBR-Q12	CBR	Recovered	Isolated Wetlands - Xeric	Recovered
11	CBR-Q14	CBR	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
12	CBR-Q15	CBR	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Improved, Not Fully Recovered
13	CBR-Q16	CBR	Red	Isolated Wetlands - Xeric	Recovered
14	CBR-Q17	CBR	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Recovered
17	CBR-Q20	CBR	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Recovered
18	CBR-Q21	CBR	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
20	CBR-Q23	CBR	More Detailed Analysis Needed	Unmonitored Wetland Assessment	Low Degree of Certainty of Wetland Health
21	CBR-Q24	CBR	Recovered	Isolated Wetlands - Xeric	Recovered
22	CBR-Q25	CBR	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
23	CBR-Q26	CBR	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Improved, Not Fully Recovered
31	CBR Q34	CBR	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
34	CBR-T01	CBR	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Improved, Not Fully Recovered
35	CBR-T02A	CBR	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Improved, Not Fully Recovered
36	**CBR-T03**	**CBR**	**Recovered**	Isolated Wetlands - Mesic	Recovered
38	CBR-T08A	CBR	Recovered	Isolated Wetlands - Xeric	Recovered

SWFWMD ID	Site Name	Wellfield Code	Preliminary Recovery Status	Final Assessment Method/Approach	Final Recovery Assessment Bin
39	CBR-T10	CBR	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
40	CBR T11	CBR	Recovered	Unmonitored Wetland Assessment	Low Degree of Certainty of Wetland Health
41	Ann Denker	CBR	Recovered	Connected Wetlands	Recovered
42	Pasco Trails	CBR	Recovered	Isolated Wetlands - Mesic	Recovered
542	Lost Lake	CBR	Improved, Not Fully Recovered	Final Assessment Report/Xeric	Improved, Not Fully Recovered
543	Spring Lake	CBR	Recovered	Final Assessment Report/Xeric	Recovered
544	Cross Bar 6	CBR	Recovered	Final Assessment Report/Mesic	Recovered
103	COS-102717	COS	Recovered	Isolated Wetlands - Xeric	Recovered
104	COS-162717	COS	Recovered	Isolated Wetlands - Mesic	Recovered
105	COS-C042817	COS	Recovered	Connected Wetlands	Recovered
106	COS-C142717	COS	Recovered	Isolated Wetlands - Xeric	Recovered
107	COS-EC222717	COS	Recovered	Isolated Wetlands - Mesic	Recovered
108	COS-EC332717	COS	Recovered	Connected Wetlands	Recovered
109	COS-NC242717	COS	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
110	COS-NC262717	COS	Recovered	Isolated Wetlands - Xeric	Recovered
111	COS-NW042817	COS	Impacted Due to Other Causes	Inactive site - assessment not updated	Impacted Due to Other Causes
112	COS-NW332717	COS	Recovered	Isolated Wetlands - Mesic	Recovered
113	COS-SC272717	COS	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Improved, Not Fully Recovered
114	COS-SC332717	COS	Recovered	Connected Wetlands	Recovered
115	COS-SE012717	COS	Recovered	Inactive site - assessment not updated	Recovered
116	COS-SE142717	COS	Recovered	Connected Wetlands	Recovered
121	CYB-01	CYB	Impacted Due to Other Causes	Isolated Wetlands - Mesic	Impacted Due to Other Causes
122	CYB-02	CYB	Impacted Due to Other Causes	Isolated Wetlands - Mesic	Impacted Due to Other Causes
123	CYB-03	CYB	No Cutback, Meets Metric	Isolated Wetlands - Mesic	Impacted Due to Other Causes
124	**CYB-04**	**CYB**	**No Cutback, Meets Metric**	Isolated Wetlands - Mesic	No cutback, meets metric

SWFWMD ID	Site Name	Wellfield Code	Preliminary Recovery Status	Final Assessment Method/Approach	Final Recovery Assessment Bin
125	CYB-05	CYB	No Cutback, Meets Metric	Isolated Wetlands - Mesic	No cutback, meets metric
126	CYB-06	CYB	No Cutback, Meets Metric	Isolated Wetlands - Mesic	No cutback, meets metric
127	CYB-09	CYB	No Cutback, Meets Metric	Isolated Wetlands - Mesic	No cutback, meets metric
128	CYB-11	CYB	Impacted Due to Other Causes	Connected Wetlands	Impacted Due to Other Causes
129	CYB 12	CYB	More Detailed Analysis Needed	Unmonitored Wetland Assessment	Low Degree of Certainty of Wetland Health
130	CYB-13	CYB	No Cutback, Meets Metric	Isolated Wetlands - Mesic	No cutback, meets metric
131	CYB-14	CYB	No Cutback, Meets Metric	Isolated Wetlands - Mesic	No cutback, meets metric
132	CYB-15	CYB	More Detailed Analysis Needed	Isolated Wetlands - Mesic	Not Fully Recovered, Continuing Wellfield Impact
133	**CYB-16**	**CYB**	**No Cutback, Meets Metric**	Isolated Wetlands - Mesic	No cutback, meets metric
134	CYB-17	CYB	No Cutback, Meets Metric	Isolated Wetlands - Mesic	No cutback, meets metric
135	CYB-18	CYB	No Cutback, Meets Metric	Connected Wetlands	No cutback, meets metric
138	CYB-21	CYB	No Cutback, Meets Metric	Isolated Wetlands - Mesic	No cutback, meets metric
139	CYB-22	CYB	No Cutback, Meets Metric	Connected Wetlands	No cutback, meets metric
140	CYB-23	CYB	No Cutback, Meets Metric	Isolated Wetlands - Mesic	No cutback, meets metric
141	CYB 24	CYB	No Cutback, Meets Metric	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
142	**CYB-25**	**CYB**	**No Cutback, Meets Metric**	Isolated Wetlands - Mesic	No cutback, meets metric
143	CYB-26	CYB	No Cutback, Meets Metric	Connected Wetlands	No cutback, meets metric
144	CYB-27	CYB	No Cutback, Meets Metric	Inactive site - assessment not updated	No cutback, meets metric
145	CYB-28	CYB	No Cutback, Meets Metric	Connected Wetlands	No cutback, meets metric
146	CYB-29	CYB	No Cutback, Meets Metric	Inactive site - assessment not updated	No cutback, meets metric
147	CYB-30	CYB	No Cutback, Meets Metric	Isolated Wetlands - Mesic	No cutback, meets metric
148	CYB-31	CYB	No Cutback, Meets Metric	Connected Wetlands	No cutback, meets metric
149	**CYB-32**	**CYB**	**No Cutback, Meets Metric**	Isolated Wetlands - Mesic	No cutback, meets metric

SWFWMD ID	Site Name	Wellfield Code	Preliminary Recovery Status	Final Assessment Method/Approach	Final Recovery Assessment Bin
150	CYB-33	CYB	No Cutback, Meets Metric	Isolated Wetlands - Mesic	No cutback, meets metric
151	CYB-34	CYB	No Cutback, Meets Metric	Isolated Wetlands - Mesic	No cutback, meets metric
152	CYB-37	CYB	No Cutback, Meets Metric	Connected Wetlands	No cutback, meets metric
153	**CYB-A**	**CYB**	**More Detailed Analysis Needed**	Isolated Wetlands - Mesic	Not Fully Recovered, Continuing Wellfield Impact
154	CYB-C10	CYB	No Cutback, Meets Metric	Connected Wetlands	No cutback, meets metric
155	CYB-C12	CYB	No Cutback, Meets Metric	Connected Wetlands	No cutback, meets metric
156	CYB-C16	CYB	No Cutback, Meets Metric	Isolated Wetlands - Mesic	No cutback, meets metric
158	New River Cypress	CYB	No Cutback, Meets Metric	Isolated Wetlands - Mesic	No cutback, meets metric
159	New River Marsh	CYB	No Cutback, Meets Metric	Isolated Wetlands - Mesic	No cutback, meets metric
16	CYC C25/ CBR Q19	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
160	C01	CYC	Recovered	Inactive site - assessment not updated	Recovered
162	CYC-C06	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Recovered
163	C08	CYC	Improved, Not Fully Recovered	Inactive site - assessment not updated	Improved, Not Fully Recovered
164	CYC-C11	CYC	Recovered	Isolated Wetlands - Mesic	Recovered
166	CYC-C14	CYC	Recovered	Isolated Wetlands - Mesic	Recovered
167	C15	CYC	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
168	C16	CYC	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
169	CYC-C19	CYC	Recovered	Connected Wetlands	Recovered
170	CYC-C20	CYC	Recovered	Isolated Wetlands - Xeric	Recovered
172	C22A	CYC	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
173	C23	CYC	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
174	CYC-C24	CYC	Recovered	Isolated Wetlands - Mesic	Recovered

SWFWMD ID	Site Name	Wellfield Code	Preliminary Recovery Status	Final Assessment Method/Approach	Final Recovery Assessment Bin
176	CYC-C33	CYC	Recovered	Connected Wetlands	Recovered
177	CYC-C39	CYC	Recovered	Connected Wetlands	Recovered
178	CYC-C40	CYC	Recovered	Connected Wetlands	Recovered
179	CYC-C100	CYC	Recovered	Connected Wetlands	Recovered
180	CYC-W25	CYC	Recovered	Connected Wetlands	Recovered
181	CYC-C101	CYC	Recovered	Isolated Wetlands - Xeric	Recovered
182	CYC-C102	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
183	CYC-C103	CYC	Recovered	Connected Wetlands	Recovered
184	CYC-C104	CYC	Improved, Not Fully Recovered	Inactive site - assessment not updated	Improved, Not Fully Recovered
185	CYC-C105	CYC	Recovered	Isolated Wetlands - Mesic	Recovered
186	C106	CYC	Recovered	Inactive site - assessment not updated	Recovered
187	CYC-W01	CYC	Recovered	Connected Wetlands	Recovered
188	W02A	CYC	Improved, Not Fully Recovered	Inactive site - assessment not updated	Improved, Not Fully Recovered
189	CYC-W03	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
190	CYC-W04	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Recovered
191	CYC-W05	CYC	Recovered	Isolated Wetlands - Mesic	Recovered
192	W06/ W07/ W08	CYC	Recovered	Inactive site - assessment not updated	Recovered
193	CYC-W09	CYC	Recovered	Isolated Wetlands - Mesic	Recovered
194	CYC-W10	CYC	Recovered	Connected Wetlands	Recovered
195	**CYC-W11**	**CYC**	**Recovered**	Isolated Wetlands - Mesic	Recovered
196	**CYC-W12**	**CYC**	**Improved, Not Fully Recovered**	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
197	CYC-W14	CYC	Recovered	Connected Wetlands	Recovered
198	CYC-W16	CYC	Not Fully Recovered, Continuing Wellfield Impact	Isolated Wetlands - Mesic	Not Fully Recovered, Continuing Wellfield Impact

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199	**CYC-W17**	**CYC**	**Improved, Not Fully Recovered**	Isolated Wetlands - Mesic	Recovered
200	CYC-W19	CYC	Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
201	CYC-W20	CYC	Recovered	Isolated Wetlands - Mesic	Recovered
202	CYC-W21N	CYC	Recovered	Connected Wetlands	Recovered
203	CYC-W21S	CYC	Recovered	Connected Wetlands	Recovered
204	CYC-W23	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
205	CYC-W27	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
206	CYC-W29	CYC	Recovered	Isolated Wetlands - Mesic	Recovered
207	CYC-W30N	CYC	Recovered	Connected Wetlands	Recovered
208	W30S	CYC	Recovered	Connected Wetlands	Recovered
209	CYC-W31	CYC	Recovered	Isolated Wetlands - Mesic	Recovered
210	CYC-W32	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Not Fully Recovered, Continuing Wellfield Impact
211	CYC-W33	CYC	Recovered	Isolated Wetlands - Mesic	Recovered
212	W34	CYC	Recovered	Connected Wetlands	Recovered
213	CYC-W36	CYC	Recovered	Isolated Wetlands - Mesic	Recovered
214	CYC-W37	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
215	CYC-W39	CYC	Recovered	Isolated Wetlands - Mesic	Recovered
216	CYC-W40	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
217	CYC-W41	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
218	W42	CYC	Recovered	Inactive site - assessment not updated	Recovered
220	CYC-W43	CYC	Improved, Not Fully Recovered	Connected Wetlands	Improved, Not Fully Recovered
221	CYC-W44	CYC	Improved, Not Fully Recovered	Connected Wetlands	Improved, Not Fully Recovered
222	CYC-W45	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Not Fully Recovered, Continuing Wellfield Impact
223	CYC-W46	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered

SWFWMD ID	Site Name	Wellfield Code	Preliminary Recovery Status	Final Assessment Method/Approach	Final Recovery Assessment Bin
225	CYC-W49	CYC	Improved, Not Fully Recovered	Inactive site - assessment not updated	Improved, Not Fully Recovered
226	CYC-W50	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Recovered
227	CYC-W51	CYC	Improved, Not Fully Recovered	Inactive site - assessment not updated	Improved, Not Fully Recovered
228	CYC-W52	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
229	CYC-W55	CYC	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Not Fully Recovered, Continuing Wellfield Impact
230	**CYC-W56**	**CYC**	**Improved, Not Fully Recovered**	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
231	CYC-W57	CYC	Recovered	Connected Wetlands	Recovered
232	CYC-W58	CYC	Recovered	Inactive site - assessment not updated	Recovered
233	CCS-5	CYC	Recovered	Connected Wetlands	Recovered
234	CCWF "F"	CYC	Not Fully Recovered, Continuing Wellfield Impact	Isolated Wetlands - Mesic	Not Fully Recovered, Continuing Wellfield Impact
235	Conners Cypress Marsh	CYC	Improved, Not Fully Recovered	Inactive site - assessment not updated	Improved, Not Fully Recovered
236	Conners Marsh 1	CYC	Never Impacted	Isolated Wetlands - Xeric	Never Impacted
237	Conners Marsh 2	CYC	Never Impacted	Isolated Wetlands - Xeric	Never Impacted
238	Conners Wet Prairie	CYC	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
239	Correctional Facility Cypress	CYC	Recovered	Isolated Wetlands - Mesic	Recovered
240	Correctional Facility Cypress Marsh	CYC	Recovered	Isolated Wetlands - Mesic	Recovered
241	Mertz Riverine	CYC	Recovered	Connected Wetlands	Recovered

SWFWMD ID	Site Name	Wellfield Code	Preliminary Recovery Status	Final Assessment Method/Approach	Final Recovery Assessment Bin
242	Pheasant Run (Quail Hollow) Cypress	CYC	Recovered	Isolated Wetlands - Mesic	Recovered
243	ELW-C132716	ELW	Recovered	Isolated Wetlands - Mesic	Recovered
244	ELW-EC112716	ELW	Recovered	Isolated Wetlands - Mesic	Recovered
245	ELW-NC222716	ELW	Recovered	Isolated Wetlands - Mesic	Recovered
246	**ELW-NNW122716**	**ELW**	Recovered	Isolated Wetlands - Mesic	Recovered
247	ELW-NW022716	ELW	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Recovered
248	**ELW-NW052717**	**ELW**	Recovered	Isolated Wetlands - Mesic	Recovered
249	ELW-NW062717	ELW	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
250	ELW-NW122716	ELW	Recovered	Isolated Wetlands - Mesic	Recovered
251	ELW-SC272716	ELW	Recovered	Isolated Wetlands - Mesic	Recovered
252	ELW-SW062717	ELW	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
253	SW082717	ELW	Recovered	Inactive site - assessment not updated	Recovered
254	ELW-SW272716	ELW	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Impacted Due to Other Causes
255	ELW-WC102716	ELW	Recovered	Connected Wetlands	Recovered
256	EWWF3	ELW	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Recovered
257	MBR-09	MBR	Recovered	Connected Wetlands	Recovered
258	MBR-10	MBR	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Not Fully Recovered, Continuing Wellfield Impact
259	MBR-11	MBR	Recovered	Isolated Wetlands - Mesic	Recovered
260	MBR-14	MBR	Recovered	Isolated Wetlands - Mesic	Recovered
261	**MBR-16**	**MBR**	**Improved, Not Fully Recovered**	Isolated Wetlands - Mesic	Recovered
262	MBR-29	MBR	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
263	MBR-30	MBR	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
264	**MBR-35**	**MBR**	**Improved, Not Fully Recovered**	Isolated Wetlands - Mesic	Recovered
265	MBR-36	MBR	Recovered	Connected Wetlands	Recovered

SWFWMD ID	Site Name	Wellfield Code	Preliminary Recovery Status	Final Assessment Method/Approach	Final Recovery Assessment Bin
266	MBR-37	MBR	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
267	MBR-42	MBR	Recovered	Isolated Wetlands - Mesic	Recovered
268	MBR-60	MBR	Recovered	Connected Wetlands	Recovered
269	MBR-79	MBR	Recovered	Connected Wetlands	Recovered
270	MBR-80	MBR	Recovered	Connected Wetlands	Recovered
271	MBR 81	MBR	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
272	MBR 86	MBR	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
273	**MBR-88**	**MBR**	**Improved, Not Fully Recovered**	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
274	**MBR-89**	**MBR**	**Recovered**	Isolated Wetlands - Mesic	Recovered
275	MBR-90	MBR	Recovered	Isolated Wetlands - Mesic	Recovered
276	MBR-91	MBR	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
277	MBR-93	MBR	Recovered	Isolated Wetlands - Mesic	Recovered
278	MBR-94	MBR	Recovered	Isolated Wetlands - Mesic	Recovered
279	MBR-96	MBR	Recovered	Isolated Wetlands - Mesic	Recovered
280	MBR-97	MBR	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
281	MBR-98	MBR	Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
282	MBR 100	MBR	Recovered	Inactive site - assessment not updated	Recovered
283	MBR-102	MBR	Improved, Not Fully Recovered	Connected Wetlands	Improved, Not Fully Recovered
284	MBR-103	MBR	Recovered	Connected Wetlands	Recovered
285	MBR-104	MBR	Recovered	Connected Wetlands	Recovered
286	MBR-105	MBR	Improved, Not Fully Recovered	Connected Wetlands	Improved, Not Fully Recovered
287	MBR-106	MBR	Recovered	Connected Wetlands	Recovered
288	MBWF Clay Gully Site	MBR	Recovered	Connected Wetlands	Recovered
289	East Branch Clay S RD	MBR	Recovered	Connected Wetlands	Recovered

SWFWMD ID	Site Name	Wellfield Code	Preliminary Recovery Status	Final Assessment Method/Approach	Final Recovery Assessment Bin
290	East Branch Clay Gully	MBR	Improved, Not Fully Recovered	Connected Wetlands	Improved, Not Fully Recovered
291	MBWF East Cypress Marsh	MBR	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
292	MBWF Trout Creek Marsh	MBR	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
293	MBWF West Cypress	MBR	Recovered	Isolated Wetlands - Mesic	Recovered
294	MBWF Wild Hog Slough	MBR	Recovered	Connected Wetlands	Recovered
295	MBWF X-1	MBR	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
296	MBWF X-3	MBR	Recovered	Isolated Wetlands - Mesic	Recovered
297	MBWF X-6	MBR	Recovered	Isolated Wetlands - Mesic	Recovered
312	Cypress Creek ELAPP Cypress	None	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
313	Cypress Creek ELAPP Marsh	None	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
314	Cypress Creek ELAPP Riverine	None	Recovered	Connected Wetlands	Recovered
336	NOP-01	NOP	Never Impacted	Isolated Wetlands - Xeric	Never Impacted
337	NOP-02	NOP	Never Impacted	Isolated Wetlands - Xeric	Never Impacted
338	**NOP-03**	**NOP**	**Never Impacted**	Isolated Wetlands - Xeric	**Never Impacted**
339	NOP-04	NOP	Recovered	Isolated Wetlands - Xeric	Recovered
340	NOP-05	NOP	Recovered	Isolated Wetlands - Xeric	Recovered
341	NP-06	NOP	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
342	NOP-07	NOP	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
343	NP-08	NOP	Recovered	Inactive site - assessment not updated	Recovered
344	NOP-09	NOP	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
345	NOP-10	NOP	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Recovered

SWFWMD ID	Site Name	Wellfield Code	Preliminary Recovery Status	Final Assessment Method/Approach	Final Recovery Assessment Bin
346	NOP-11	NOP	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
347	NP-13/CYB C17	NOP	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
348	NP-15	NOP	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
349	NP-16	NOP	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
350	NOP-17	NOP	Recovered	Isolated Wetlands - Xeric	Recovered
351	NOP-18	NOP	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
352	**NOP-21**	**NOP**	**Recovered**	Isolated Wetlands - Mesic	**Recovered**
353	NOP-22	NOP	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
354	NP-25	NOP	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
355	NP-26	NOP	Recovered	Inactive site - assessment not updated	Recovered
356	NP-27	NOP	Recovered	Inactive site - assessment not updated	Recovered
357	NP-29	NOP	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
358	NOP-30	NOP	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
360	NP-32	NOP	Never Impacted	Inactive site - assessment not updated	Never Impacted
362	NOP-36	NOP	Never Impacted	Isolated Wetlands - Xeric	Never Impacted
365	112817	NWH	Recovered	Inactive site - assessment not updated	Recovered
366	NWH-132817	NWH	Impacted Due to Other Causes	Isolated Wetlands - Xeric	Impacted Due to Other Causes
367	NWH-142817	NWH	Recovered	Isolated Wetlands - Mesic	Recovered
369	302818	NWH	Impacted Due to Other Causes	Inactive site - assessment not updated	Impacted Due to Other Causes

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370	C162818	NWH	Recovered	Inactive site - assessment not updated	Recovered
372	NWH-EC072818	NWH	Recovered	Isolated Wetlands - Xeric	Recovered
373	NWH-EC232817	NWH	Impacted Due to Other Causes	Isolated Wetlands - Mesic	Impacted Due to Other Causes
374	NWH-NC042818	NWH	Impacted Due to Other Causes	Isolated Wetlands - Mesic	Impacted Due to Other Causes
375	NC182818	NWH	Recovered	Inactive site - assessment not updated	Recovered
377	NWH-NW012817	NWH	Recovered	Connected Wetlands	Recovered
378	NWH-NW072818	NWH	Recovered	Isolated Wetlands - Mesic	Recovered
379	NWH-SC042818	NWH	Recovered	Isolated Wetlands - Xeric	Recovered
380	NWH-SC062818	NWH	Recovered	Connected Wetlands	Recovered
381	NWH-SW082818	NWH	Recovered	Isolated Wetlands - Xeric	Recovered
382	NWH-WC102817	NWH	Recovered	Isolated Wetlands - Xeric	Recovered
371	NWH-E182718	S21	Recovered	Isolated Wetlands - Mesic	Recovered
376	NWH-NE132717	S21	Recovered	Isolated Wetlands - Mesic	Recovered
383	S21-272718	S21	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
384	S21-322718	S21	Recovered	Connected Wetlands	Recovered
385	S21-CW212718	S21	Recovered	Isolated Wetlands - Mesic	Recovered
386	S21-EC162718	S21	Never Impacted	Inactive site - assessment not updated	Never Impacted
387	S21-EC222718	S21	Recovered	Isolated Wetlands - Mesic	Recovered
388	S21-NC092718	S21	Recovered	Connected Wetlands	Recovered
389	NE112718	S21	Improved, Not Fully Recovered	Final Assessment Memo - xeric site	Recovered
390	S21-NE212718	S21	Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
391	NW112718	S21	Improved, Not Fully Recovered	Inactive site - assessment not updated	Improved, Not Fully Recovered
393	S21-SE212718	S21	Recovered	Connected Wetlands	Recovered

SWFWMD ID	Site Name	Wellfield Code	Preliminary Recovery Status	Final Assessment Method/Approach	Final Recovery Assessment Bin
394	S21-SW292718	S21	Recovered	Isolated Wetlands - Mesic	Recovered
395	S21-WC212718	S21	Recovered	Isolated Wetlands - Mesic	Recovered
396	S21-WC342718	S21	Recovered	Isolated Wetlands - Mesic	Recovered
397	SOP-NE152618	SOP	Never Impacted	Isolated Wetlands - Mesic	Recovered
398	SOP-PC282618	SOP	Recovered	Connected Wetlands	Recovered
399	SOP-PT322618	SOP	Recovered	Connected Wetlands	Recovered
400	SOP-PTC332618	SOP	Recovered	Connected Wetlands	Recovered
401	SOP-PSW282618	SOP	Recovered	Isolated Wetlands - Xeric	Recovered
402	**SOP-PC332618**	**SOP**	Recovered	Isolated Wetlands - Mesic	Recovered
403	**SOP-PSE282618**	**SOP**	Recovered	Isolated Wetlands - Mesic	Recovered
404	SOP-PSW332618	SOP	Recovered	Isolated Wetlands - Mesic	Recovered
405	**SOP-PTE332618**	**SOP**	Recovered	Isolated Wetlands - Mesic	Recovered
406	SOP-SC162618	SOP	Recovered	Connected Wetlands	Recovered
407	Rt. 54 Aprile	SOP	Recovered	Inactive site - assessment not updated	Recovered
408	Rt. 54 Nelson	SOP	Recovered	Isolated Wetlands - Mesic	Recovered
409	J.B. Starkey 1	STK	Recovered	Isolated Wetlands - Mesic	Recovered
410	S-004	STK	Recovered	Inactive site - assessment not updated	Recovered
411	STK-S-005	STK	Not Fully Recovered, Continuing Wellfield Impact	Isolated Wetlands - Xeric	Recovered
412	STK-S-006	STK	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Recovered
415	STK-S-010	STK	Never Impacted	Isolated Wetlands - Xeric	Never Impacted
417	S-013	STK	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
418	STK-S-016	STK	Recovered	Isolated Wetlands - Xeric	Recovered
419	STK-S-018	STK	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Recovered
420	STK-S-020	STK	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Recovered

SWFWMD ID	Site Name	Wellfield Code	Preliminary Recovery Status	Final Assessment Method/Approach	Final Recovery Assessment Bin
421	STK-S-023	STK	Recovered	Isolated Wetlands - Xeric	Recovered
422	STK-S-024	STK	Recovered	Isolated Wetlands - Xeric	Recovered
423	STK-S-030	STK	Recovered	Isolated Wetlands - Xeric	Recovered
424	STK-S-031	STK	Recovered	Isolated Wetlands - Xeric	Recovered
425	STK-S-035	STK	Recovered	Isolated Wetlands - Xeric	Recovered
426	S-036A	STK	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
427	STK-S-038	STK	Recovered	Isolated Wetlands - Xeric	Recovered
428	STK-S-039	STK	Never Impacted	Isolated Wetlands - Mesic	Recovered
429	STK-S-042	STK	Never Impacted	Isolated Wetlands - Mesic	Recovered
430	STK-S-044	STK	Recovered	Isolated Wetlands - Xeric	Recovered
431	STK-S-046	STK	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
432	S-051	STK	Recovered	Inactive site - assessment not updated	Recovered
433	STK-S-052	STK	Recovered	Isolated Wetlands - Mesic	Recovered
434	STK-S-053	STK	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
435	STK-S-054	STK	Never Impacted	Isolated Wetlands - Mesic	Recovered
436	STK-S-055	STK	Recovered	Isolated Wetlands - Mesic	Recovered
437	S-056	STK	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
438	STK-S-062	STK	Recovered	Isolated Wetlands - Mesic	Recovered
439	STK-S-063	STK	Not Fully Recovered, Continuing Wellfield Impact	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
440	STK-S-064	STK	Never Impacted	Isolated Wetlands - Mesic	Recovered
441	STK-S-065	STK	Never Impacted	Isolated Wetlands - Mesic	Recovered
442	STK-S-067	STK	Recovered	Connected Wetlands	Recovered
443	STK-S-068	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
444	**STK-S-069**	**STK**	**Never Impacted**	Isolated Wetlands - Mesic	**Never Impacted**

SWFWMD ID	Site Name	Wellfield Code	Preliminary Recovery Status	Final Assessment Method/Approach	Final Recovery Assessment Bin
445	STK-S-070	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
446	STK-S-072	STK	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
447	**STK-S-073**	**STK**	**Never Impacted**	Isolated Wetlands - Mesic	**Never Impacted**
448	STK-S-074	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
449	**STK-S-075**	**STK**	**Never Impacted**	Isolated Wetlands - Mesic	**Never Impacted**
450	STK-S-076	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
451	STK-S-080	STK	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
452	S-082	STK	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
453	S-083	STK	Recovered	Inactive site - assessment not updated	Recovered
454	STK-S-084	STK	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Recovered
455	STK-S-085	STK	Recovered	Isolated Wetlands - Xeric	Recovered
456	STK-S-089	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
457	STK-S-090	STK	Recovered	Isolated Wetlands - Mesic	Recovered
458	S-094	STK	Recovered	Inactive site - assessment not updated	Recovered
459	STK-S-095	STK	Never Impacted	Isolated Wetlands - Mesic	Recovered
460	S-096	STK	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
461	STK-S-097	STK	Never Impacted	Isolated Wetlands - Mesic	Recovered
462	**STK-S-099**	**STK**	Recovered	Isolated Wetlands - Mesic	Recovered
463	S-101	STK	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
464	STK-S-108	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
465	STK-S-109	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
466	S-111	STK	Recovered	Inactive site - assessment not updated	Recovered

SWFWMD ID	Site Name	Wellfield Code	Preliminary Recovery Status	Final Assessment Method/Approach	Final Recovery Assessment Bin
467	STK-S-112	STK	Recovered	Isolated Wetlands - Mesic	Recovered
468	STK-S-113	STK	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
469	SC-01	STK	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
470	STK-SC-11	STK	Never Impacted	Isolated Wetlands - Xeric	Never Impacted
471	STK-SC-30	STK	Never Impacted	Isolated Wetlands - Xeric	Never Impacted
473	SC-33	STK	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
474	SC-46	STK	Recovered	Inactive site - assessment not updated	Recovered
475	STK-SC-58	STK	Recovered	Isolated Wetlands - Xeric	Recovered
476	STK-SC-59	STK	Never Impacted	Isolated Wetlands - Xeric	Never Impacted
477	SC-62	STK	Recovered	Inactive site - assessment not updated	Recovered
478	STK-SC-67	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
479	STK-SC-68	STK	Never Impacted	Isolated Wetlands - Xeric	Never Impacted
480	SC-69	STK	Never Impacted	Inactive site - assessment not updated	Never Impacted
481	SC-70	STK	Recovered	Unmonitored Wetland Assessment	High Degree of Certainty of Wetland Health
482	STK-SC-71	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
483	STK-SC-92	STK	Improved, Not Fully Recovered	Isolated Wetlands - Xeric	Recovered
484	**STK-Central-01**	**STK**	Never Impacted	Isolated Wetlands - Mesic	Recovered
485	STK-D	STK	Improved, Not Fully Recovered	Connected Wetlands	Recovered
486	**STK-N**	**STK**	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
487	**STK-Z**	**STK**	Never Impacted	Isolated Wetlands - Mesic	Recovered
488	STK-T-07	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
489	STK-T-09	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted

SWFWMD ID	Site Name	Wellfield Code	Preliminary Recovery Status	Final Assessment Method/Approach	Final Recovery Assessment Bin
490	STK-T-10	STK	Never Impacted	Connected Wetlands	Never Impacted
491	Anclote South Wet Prairie	STK	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
492	J.B. Starkey 2	STK	Recovered	Isolated Wetlands - Mesic	Recovered
493	J.B. Starkey 3	STK	Recovered	Isolated Wetlands - Xeric	Recovered
494	J.B. Starkey 4	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
495	River Ridge High School	STK	Recovered	Isolated Wetlands - Xeric	Recovered
496	Starkey Wet Prairie	STK	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Improved, Not Fully Recovered
497	STWF BB	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
498	STWF C	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
499	STWF EE	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
500	STWF GG	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
501	STWF K	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
502	STWF O	STK	Recovered	Connected Wetlands	Recovered
503	STWF T	STK	Never Impacted	Isolated Wetlands - Mesic	Never Impacted
504	STWF V	STK	Recovered	Connected Wetlands	Recovered
505	STWF W	STK	Improved, Not Fully Recovered	Isolated Wetlands - Mesic	Recovered
506	STWF X	STK	Recovered	Connected Wetlands	Recovered

Table 9.9: Final Recovery Assessment Findings for Monitored Wetlands by Wellfield

Wellfield	Never Impacted	Recovered / Meets Metric	Improved	Continued Impact	Impacted due to other causes	High Degree of Certainty of Health	Low Degree of Certainty of Health	Total Assessed
Cross Bar Ranch	0	14	14	0	0	1	2	31
Cypress Creek	3	45	21	5	0	4	0	78
Cypress Bridge	0	28	0	2	4	1	1	36
Morris Bridge	0	25	13	1	0	2	0	41
Starkey	29	48	7	0	0	10	0	94
North Pasco	10	8	1	0	0	6	0	25
South Pasco	0	12	0	0	0	0	0	12
Eldridge-Wilde	0	11	2	0	1	0	0	14
Section 21	1	11	3	0	0	0	0	15
Cosme-Odessa	0	11	2	0	1	0	0	14
Northwest Hillsborough	0	11	0	0	4	0	0	15
None	2	1	0	0	0	0	0	3
	45	225	63	8	10	24	3	378

Wetland Assessment Status		
Final Bin Designations		
Recovery Classes/Bins	Number	Percent
Monitored Wetlands	**378**	
Never Impacted	45	12%
Recovered/Meets Metric	225	60%
Improved, Not Fully Recovered	63	17%
Not Fully Recovered, Continuing Impact	8	2%
Impacted, Other Causes	10	3%
High Degree of Certainty of Health	24	6%
Low Degree of Certainty of Health	3	1%
Total	378	100%

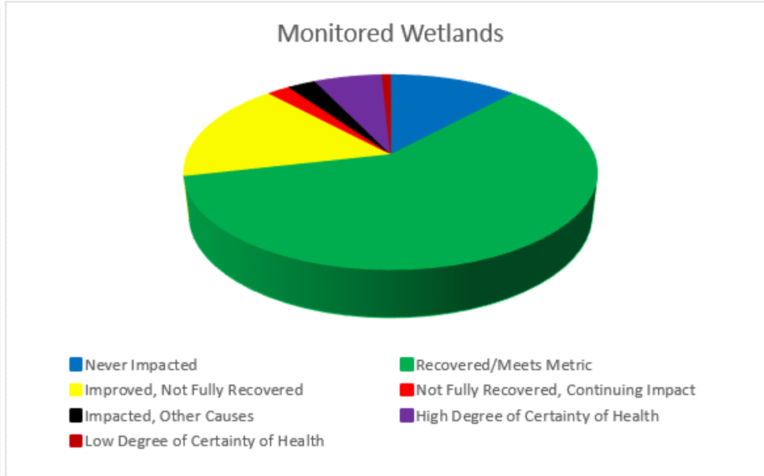


Figure 9.19: Final Assessment Results for Monitored Wetlands Through Water Year 2019 (Through Calendar Year 2019 for Connected Wetlands)

The final assessment results for monitored wetlands are not dramatically different than the preliminary assessment results reported in December 2018 (Tampa Bay Water, 2018b). The percentage of monitored wetlands considered as Recovered increased from 74% in the preliminary assessment to 78% in this final assessment. The percentage of Improved sites decreased (22% to 17%) with the application of the revised xeric wetland metric for appropriate wetlands and the incorporation of an additional year of water level data into the analyses. The number of wetlands determined to be Not Fully Recovered, Continuing Wellfield Impact increased from four to eight sites based on updated data analyses or the field assessment of adverse ecological condition by District Regulatory staff. The most significant difference is how the sites with no current or recent water level data were assessed. In the preliminary assessment, these sites were assigned to the most applicable assessment bin; however, in this final report, these inactive sites were assessed with the unmonitored wetlands and assigned to a bin with either a high or low degree of certainty of wetland health.

It is important to understand what the assessment category of Improved, Not Fully Recovered means and the degree of improvement documented for sites assigned to this assessment bin. In the context of the Recovery Assessment Plan, a wetland is classified as Improved if there is demonstrated improvement in wetland water levels since the reduction in pumping at that wellfield and the median water level during 2008 – 2019 was below the applicable metric for that wetland. It does not necessarily mean that signs of adverse impact exist at these wetlands; a field review of current wetland condition is necessary to make that determination. In this final assessment, there are 63 monitored wetlands that have been assigned to this classification bin. Monitoring at ten of these 63 wetlands was discontinued between 2010 and 2014 and the assessment bin of Improved for these sites is based on the available data used in the preliminary assessments. For these ten sites, the Improved bin became the default classification since there is no current or recent data to determine their actual hydrologic or ecologic condition; these sites remained in the recovery bin of improved for this final assessment report. The current water level condition for the remaining 53 Improved wetlands is summarized below for three different types of wetlands (isolated mesic, isolated xeric, and connected).

The water level deviation below the applicable target elevation or "miss by" value was calculated for all wetlands in the Improved, Not Fully Recovered bin by calculating the difference between the metric value (1.8 feet below HNP for mesic sites; 3.7 feet below the P03 for xeric sites) and the WY 08 – 19 monthly average water level value (Calendar Years 2008 – 2019 was used for the connected wetlands). The "miss by" value refers to how far the median water level "missed" the applicable metric. Figure 9.20 presents the summary of the "missed by" values for the 53 remaining monitored wetlands. As shown in this box-and-whisker diagram, more than half of these wetlands (32 wetlands) were less than one foot below their respective metrics for the 12-year time period analyzed (the median values for all three wetland types shown by the horizontal lines on the three boxes in the figure are less than 1.0 foot). This data is further summarized below:

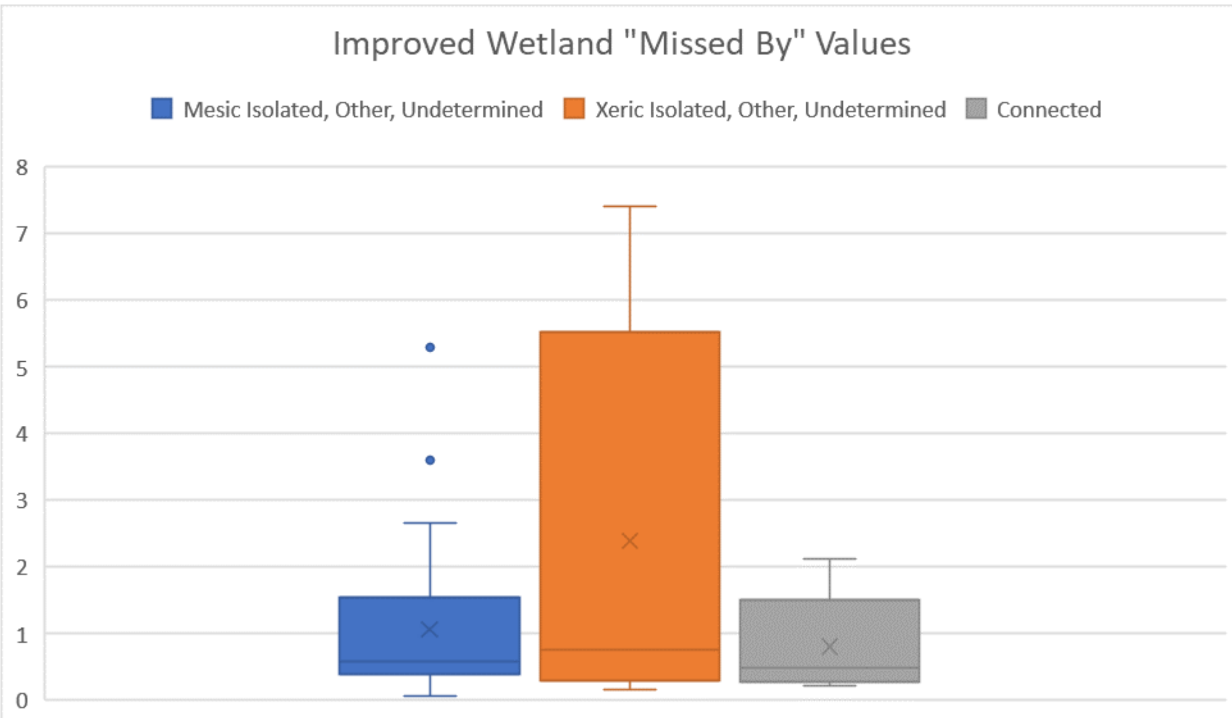


Figure 9.20: Box-and-Whisker Plot of the "Missed By" Values for Improved Wetlands

9.7.1 Isolated Mesic Wetlands

There are 40 isolated mesic wetlands in the final recovery assessment bin of Improved, Not Fully Recovered with sufficient recent data to complete this analysis. The average difference between the mesic metric and the median WY 08 – 19 water level for these sites is 1.1 feet, with a median difference of 0.6 foot. Two wetlands are outliers, with large "miss by" values. CYC-W27 had a median WY 08 – 19 monthly mean water level that is 5.3 feet below the mesic metric for isolated wetlands. CBR-T10 has a median WY 08 – 19 monthly mean water level that is 3.6 feet below the mesic metric for isolated wetlands.

Table 9.10: Improved Isolated Mesic Wetlands – Deviation of Long-Term Median Water Levels Below the Recovery Metric (in feet)

n	average	median	stdev	max	min
40	1.1	0.6	1.1	5.3	0.1

9.7.2 Isolated Xeric Wetlands

There are eight isolated xeric wetlands in the final recovery assessment bin of Improved, Not Fully Recovered with sufficient recent data to complete this analysis. The average difference between the xeric metric and the median WY 08 – 19 water level for these sites is 2.4 feet, with a median difference of 0.8 foot.

Table 9.11: Improved Isolated Xeric Wetlands – Deviation of Long-Term Median Water Levels Below the Recovery Metric (in feet)

n	average	median	stdev	max	min
8	2.4	0.8	2.9	7.4	0.2

9.7.3 Connected Wetlands

Five actively monitored connected wetlands are in the final Improved, Not Fully Recovered bin. The average difference between the connected metric and the Calendar Years 08 – 19 water level for these sites is 0.8 foot, with a median difference of 0.5 foot. The maximum "miss by" value is 2.1 feet. The minimum "miss by" value is 0.2 foot.

Table 9.12: Improved Isolated Connected Wetlands – Deviation of Long-Term Median Water Levels Below the Recovery Metric (in feet)

n	average	median	stdev	max	min
5	0.8	0.5	0.8	2.1	0.2

There are six MFL wetlands that the District has assessed as not meeting their established Minimum Levels using the most recent assessment (data through 2018). The final Recovery Assessment classification bin for each of these sites are presented on Table 9.8 and these sites are summarized below:

- CBR Q-01 (**CBARWF Q-1**). This site has been classified as Improved in this final Recovery Assessment Report. The median wetland water level was 0.43 foot below its metric for the WY 08 – 19 time period. This wetland was reviewed by District Regulatory staff and they concluded that there was no adverse impact at this site. Their site review (Appendix 9.25) indicates that normal zonation of wetland vegetation has returned, and that habitat does not appear to be impacted.

- CBR Q-25 (**CBR Stop #7**). This site has been classified as Improved in this final Recovery Assessment Report. The median wetland water level was 1.0 foot below its metric for the WY 08 – 19 time period. This wetland was reviewed by District Regulatory staff and they concluded that there was no current adverse impact at this site. They reported some dead or stressed cypress in the wetland but this appeared to be related to past impacts (Appendix 9.25). Based on other recent site investigations, District staff have concluded that there is substantial subsidence in this wetland that is greater in the north part of the wetland than in the south. This historic subsidence of the wetland bottom makes it difficult to obtain a reliable normal pool elevation and this wetland was deleted from the MFL wetland list (Chapter 40D-8, F.A.C.) in June 2020.

- CYB-A. This site has been classified as Not Fully Recovered, Continued Wellfield Impact in this final Recovery Assessment Report. The median wetland water level was 0.47 foot below its metric for the WY 08 – 19 time period. Since this wetland is in the Cypress Bridge Wellfield, it cannot be classified as Improved since there has been no reduction in pumping from this wellfield. Wetlands whose median water levels are below the applicable metric at the Cypress Bridge Wellfield are by definition classified as Not Fully Recovered, Continued Wellfield Impact. The ecological condition of this wetland was not reviewed by District Regulatory staff.

- CYC W-12 (**CC W-12 Sentry Wetland**). This site has been classified as Improved in this final Recovery Assessment Report. The median wetland water level was 0.08 foot below its metric for the WY 08 – 19 time period. The ecological condition of this wetland was not reviewed by District Regulatory staff.

- CYC W-56 (**CCWF "G"**). This site has been classified as Improved in this final Recovery Assessment Report. The median wetland water level was 0.26 foot below its metric for the WY 08 – 19 time period. The ecological condition of this wetland was not reviewed by District Regulatory staff.

- MBR-88 (**MBWF Clay Gully Cypress**). This site has been classified as Improved in this final Recovery Assessment Report. The median wetland water level was 1.55 feet below its metric for the WY 08 – 19 time period. This wetland was reviewed by District Regulatory staff and they concluded that there was no adverse impact at this site. Their site review (Appendix 9.25) indicates the presence of distinct wetland vegetation zonation and that habitat appears to show no signs of adverse impact. They further stated in their field review notes that a review of aerial photography shows little change in this wetland since the 1980s.

The individual assessment results are presented in map form in Figures 9.21 – 9.31 for the entire study area and each wellfield. These final recovery bin designations are largely based on hydrologic data compared to a numeric metric or threshold of individual wetland health. These results do not necessarily correspond to the presence or absence of adverse impact; however, District Regulatory staff reviewed the current ecological condition of most of the wetlands that were binned as Improved in the Preliminary Report of Findings. These field review observations have been considered as part of the weight-of-evidence as the wetlands were assigned to a final recovery assessment bin.

This chapter focused only on the assessment of the monitored wetlands. These final assessment results will be combined with the results of the monitored lakes and unmonitored sites in Chapter 12 to describe environmental recovery on a wellfield-scale. The final results for all monitored and unmonitored sites will also be discussed on a regional scale in Chapter 13 and summarized with all assessed sites in Chapter 14.

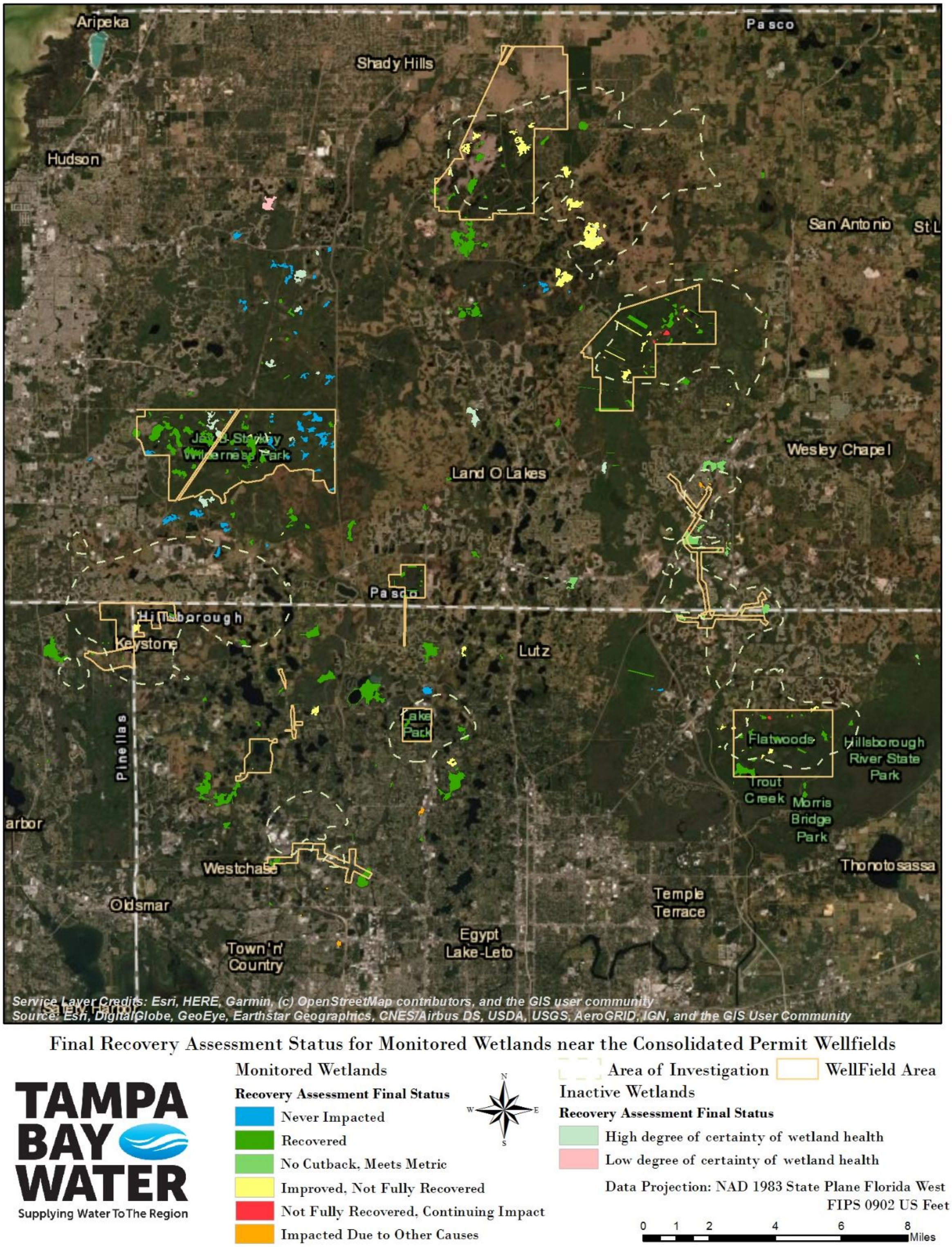


Figure 9.21: Map of Final Monitored Wetland Assessment Results – All Wellfield Areas

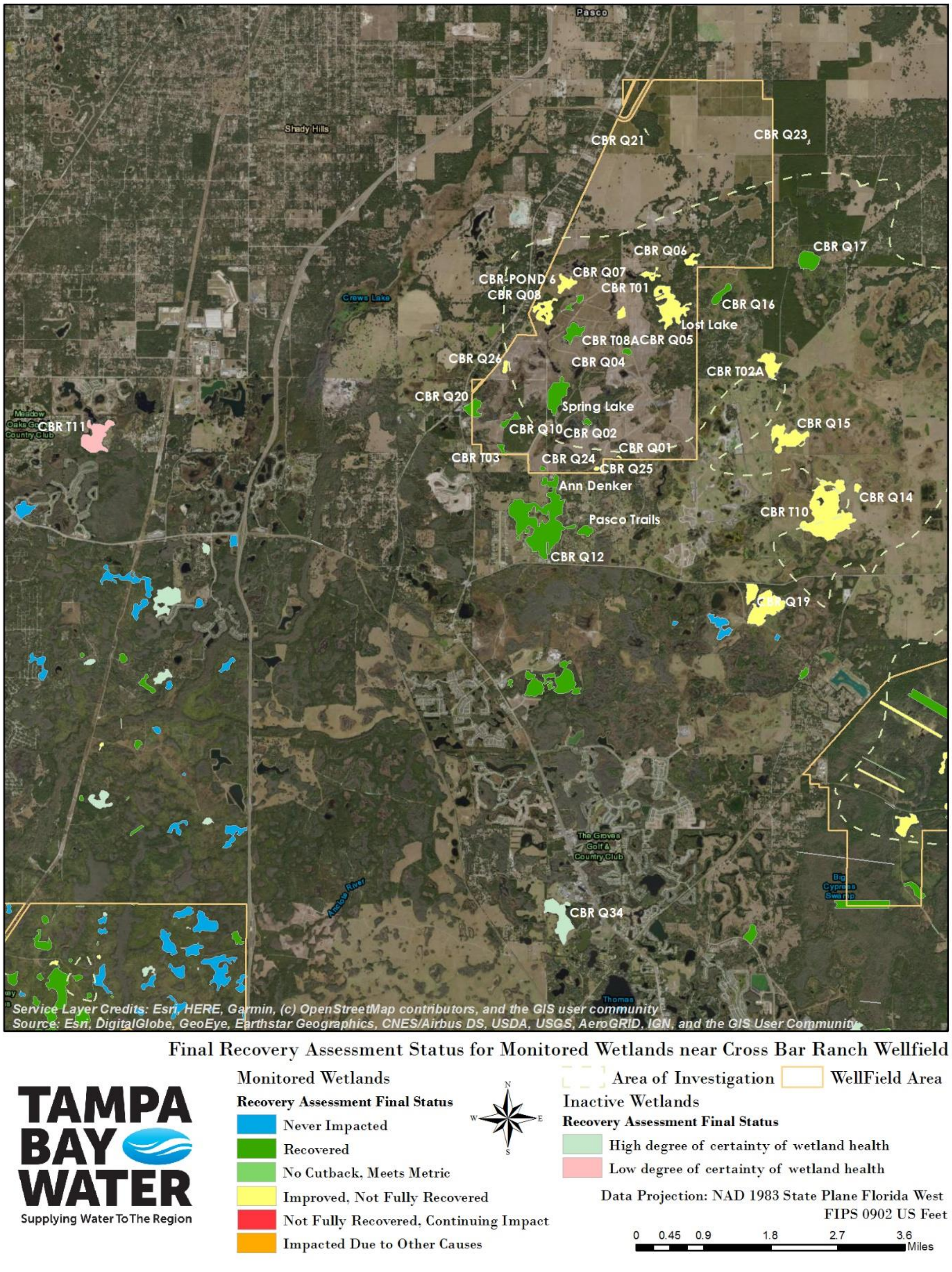


Figure 9.22: Map of Final Monitored Wetland Assessment Results near the Cross Bar Ranch Wellfield

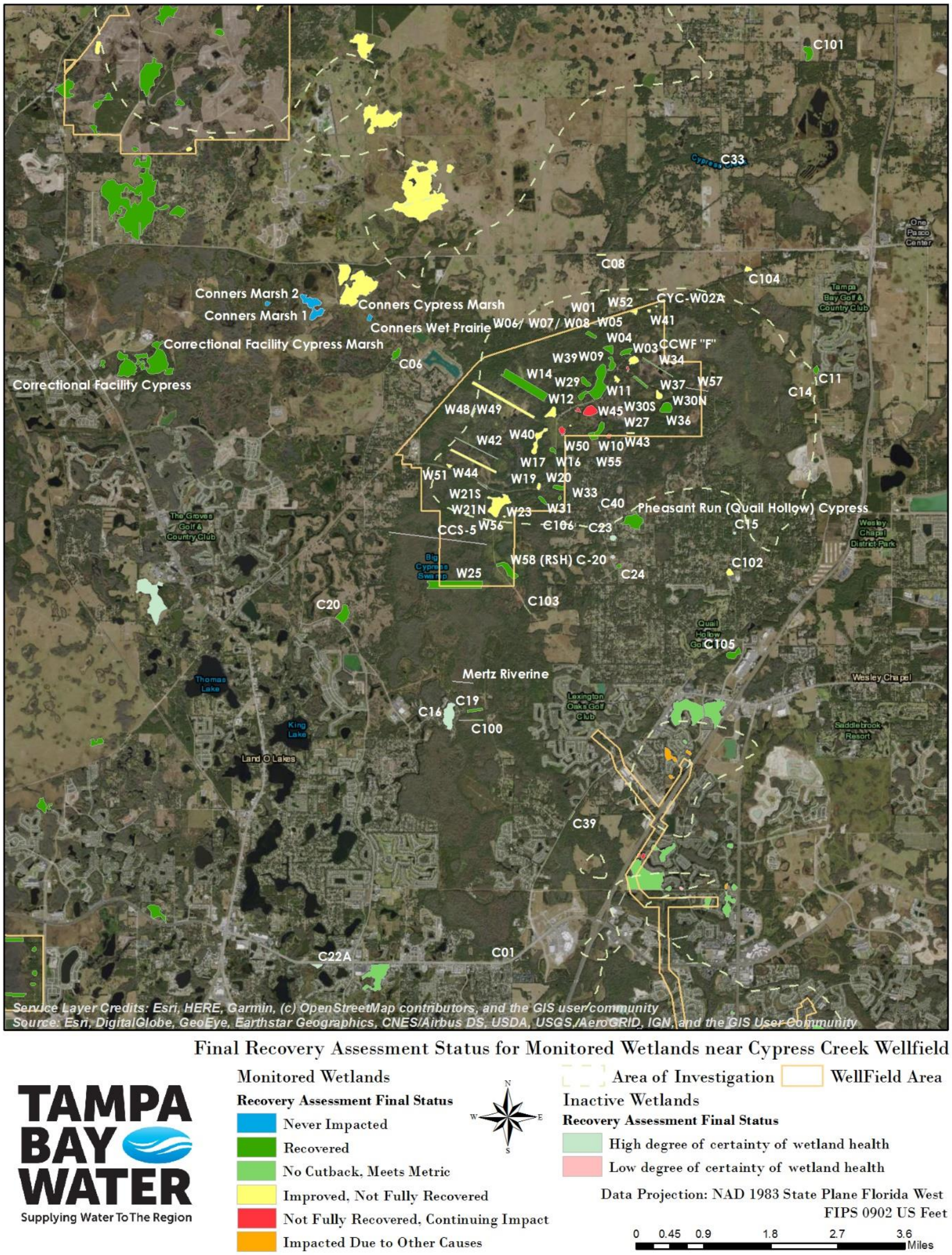


Figure 9.23: Map of Final Monitored Wetland Assessment Results near the Cypress Creek Wellfield

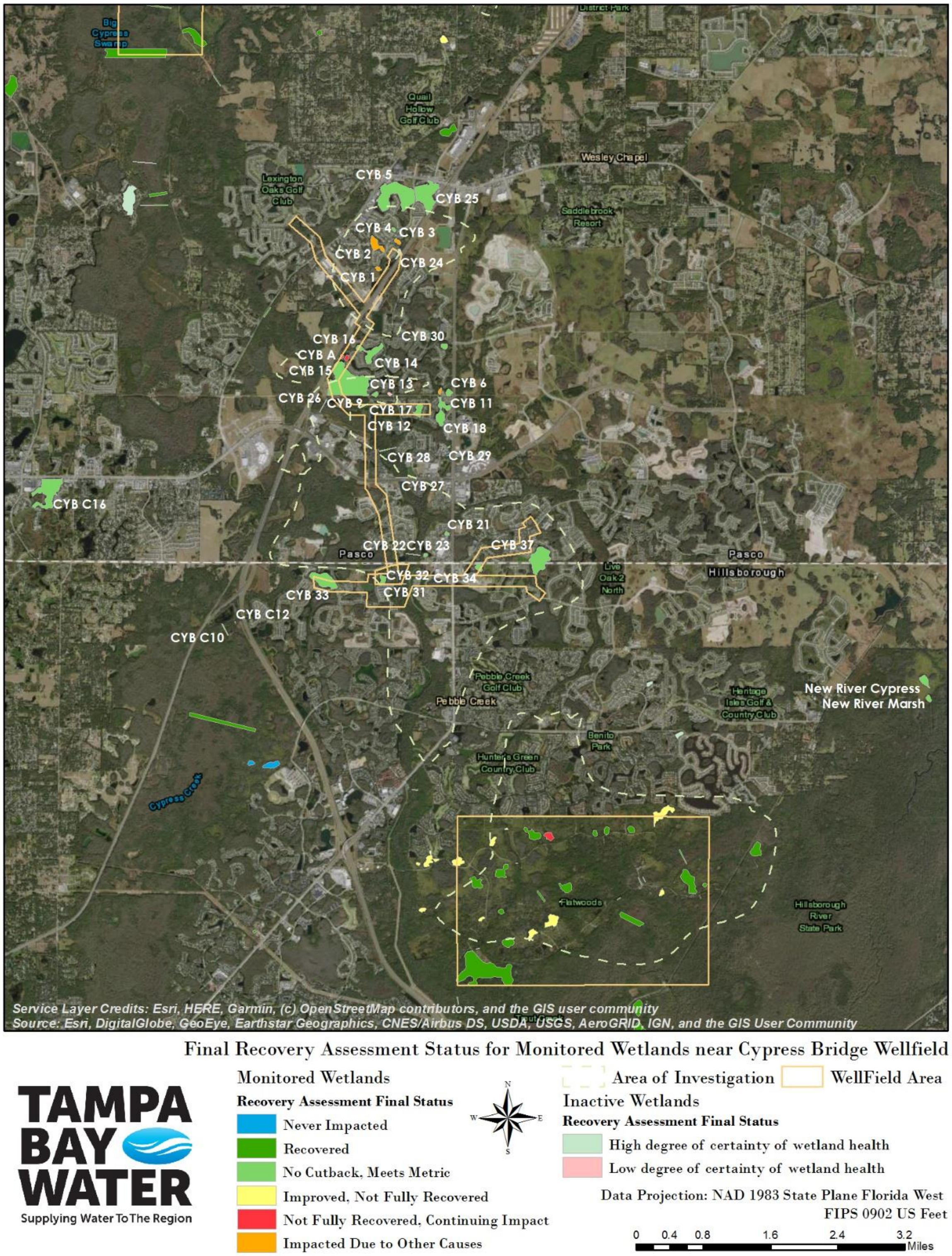


Figure 9.24: Map of Final Monitored Wetland Assessment Results near the Cypress Bridge Wellfield

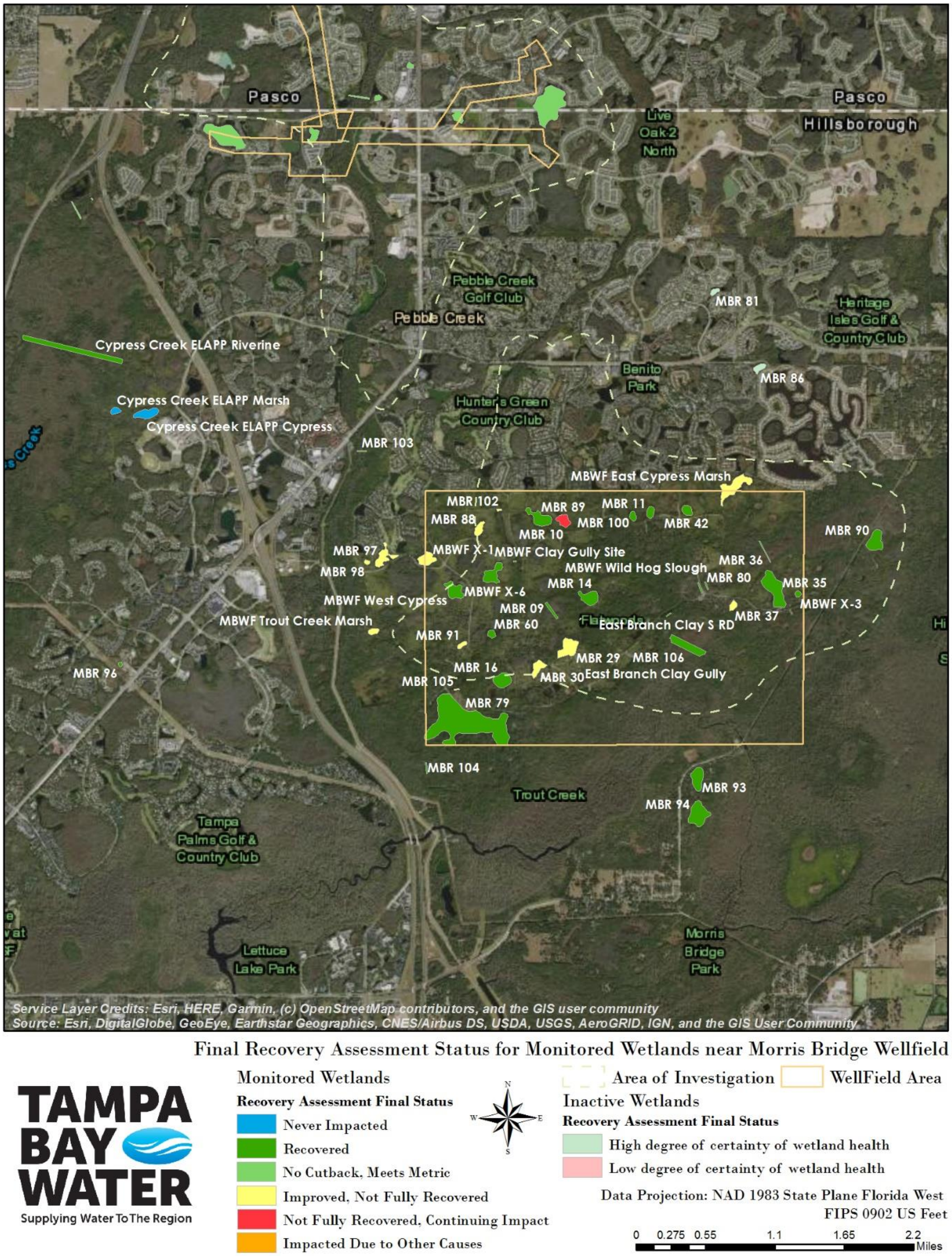


Figure 9.25: Map of Final Monitored Wetland Assessment Results near the Morris Bridge Wellfield

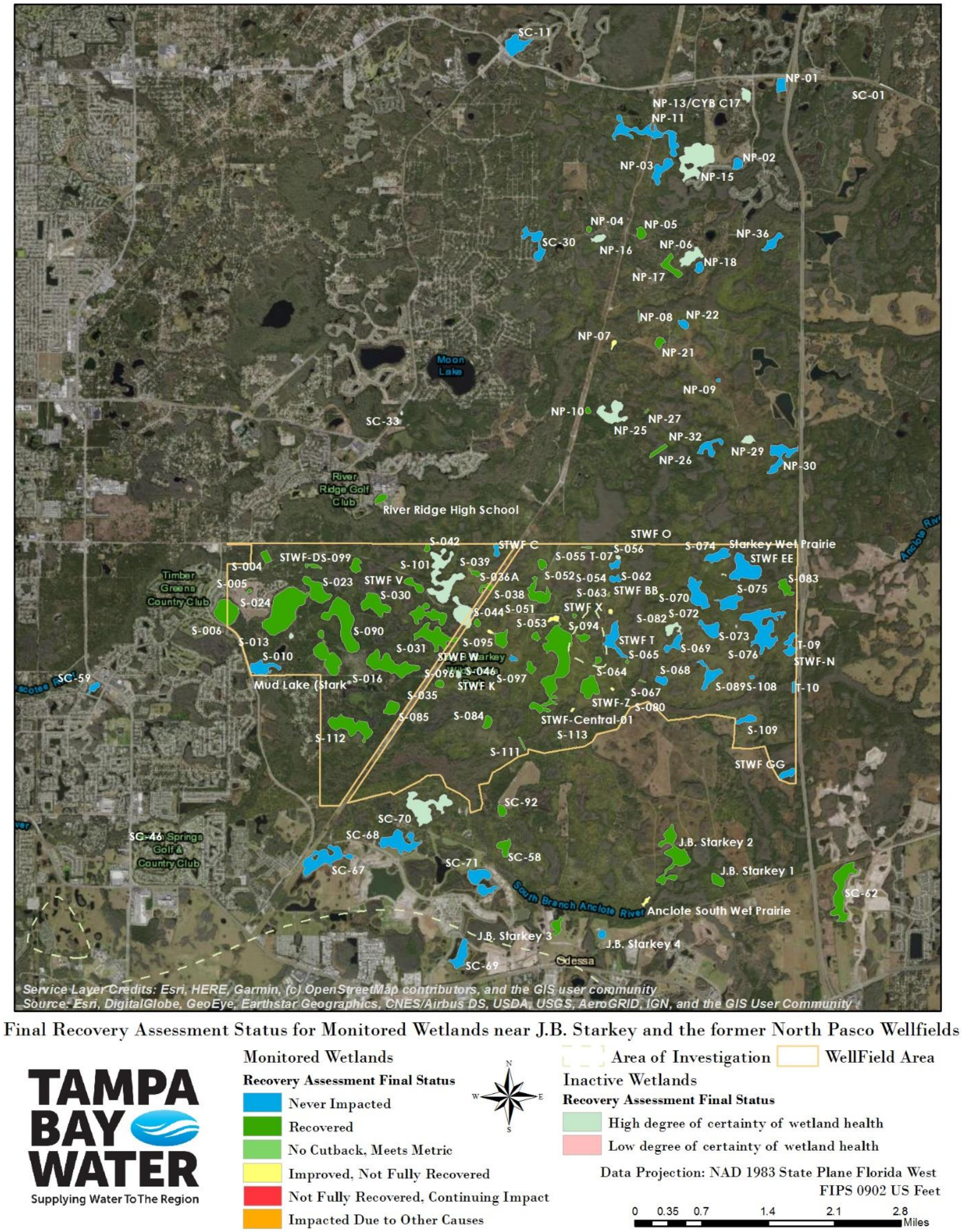


Figure 9.26: Map of Final Monitored Wetland Assessment Results near the Starkey and North Pasco Wellfields

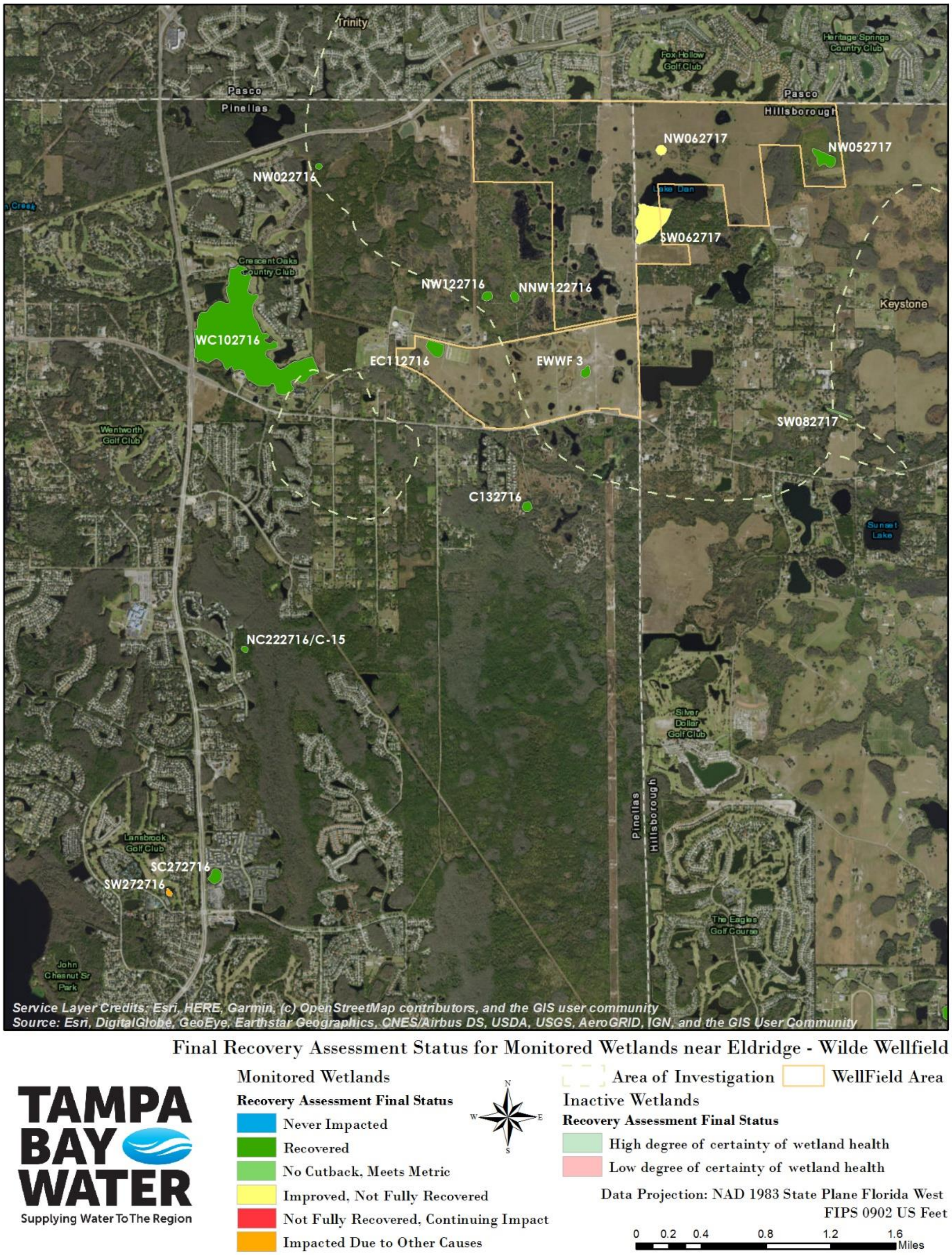


Figure 9.27: Map of Final Monitored Wetland Assessment Results near the Eldridge-Wilde Wellfield

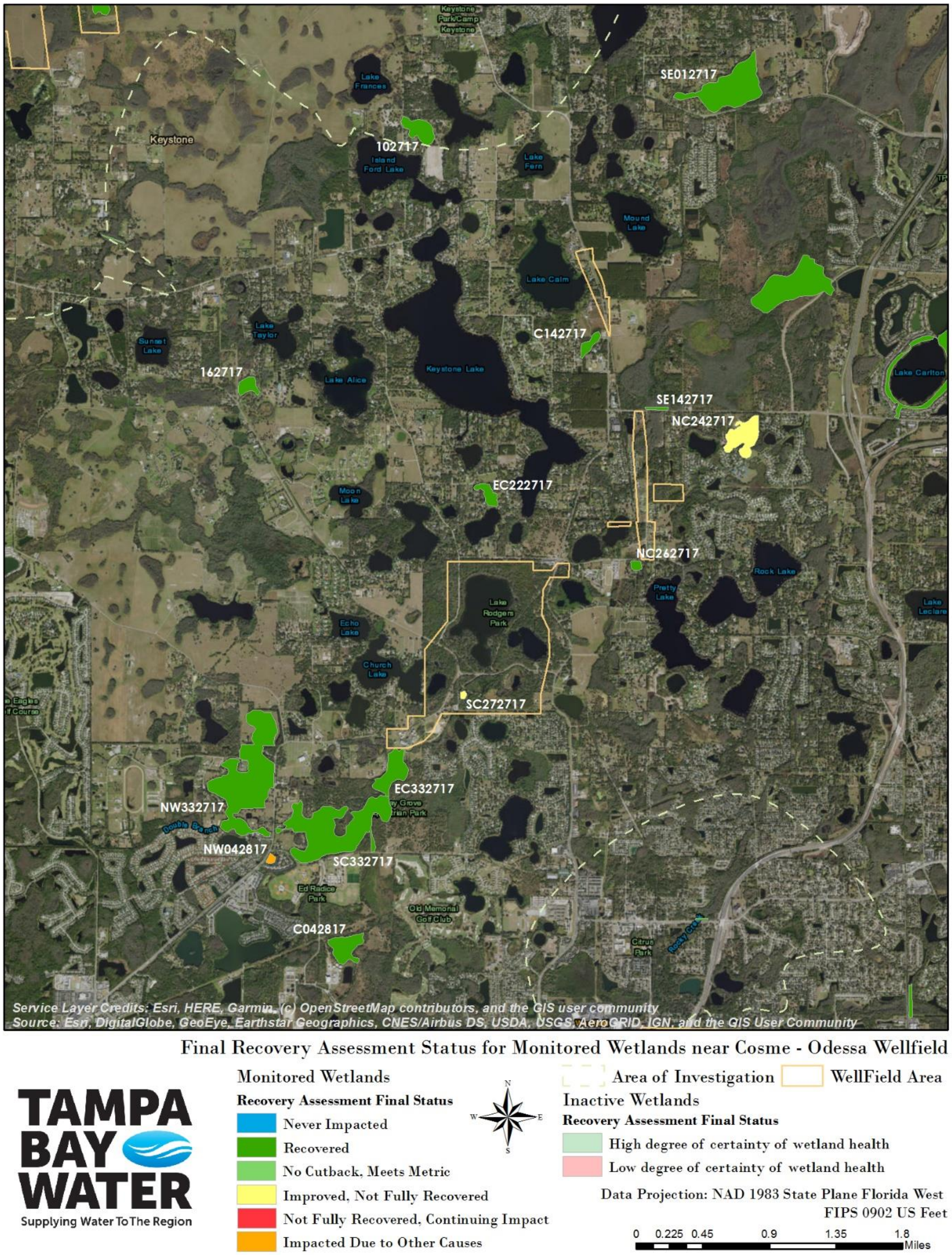


Figure 9.28: Map of Final Monitored Wetland Assessment Results near the Cosme-Odessa Wellfield

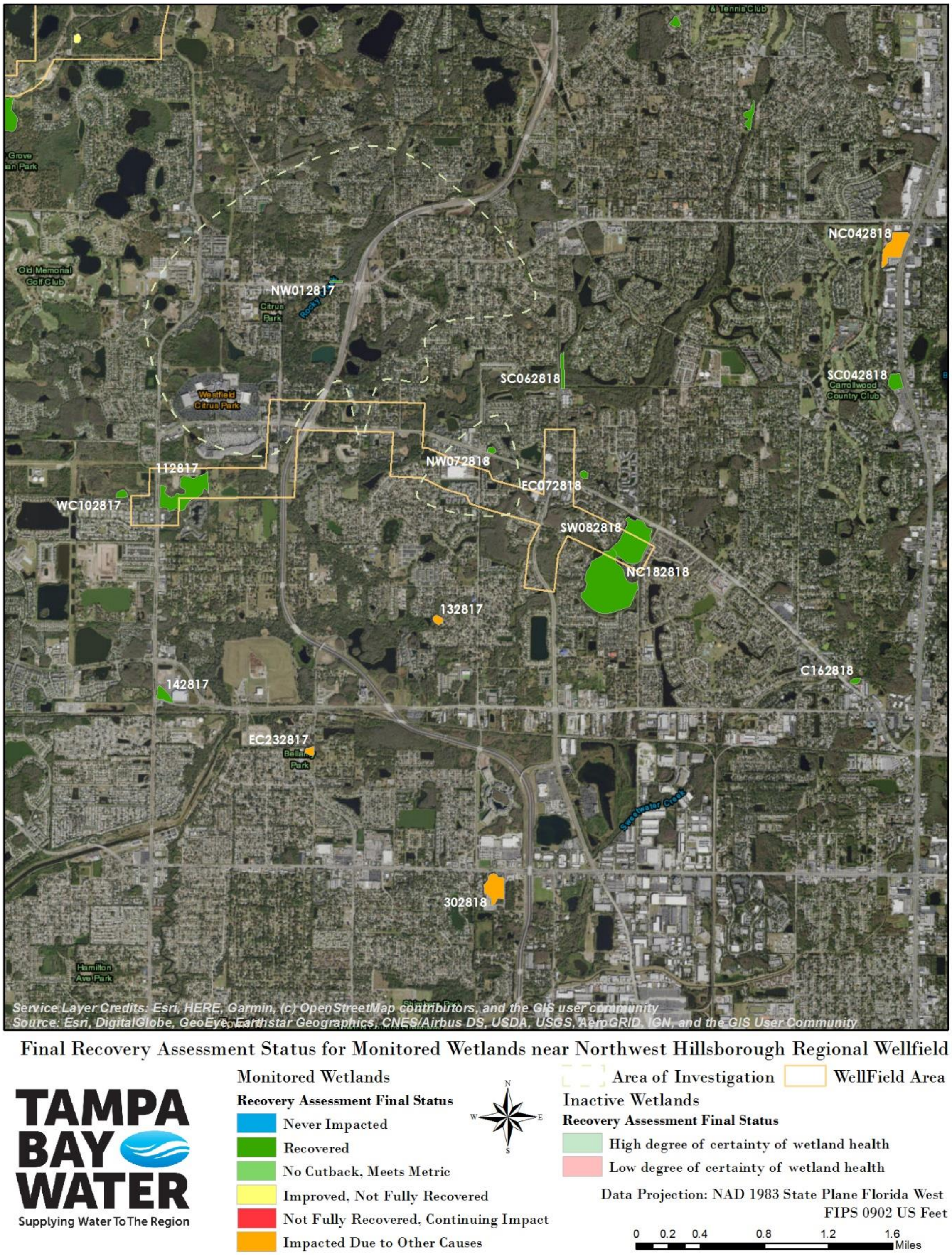


Figure 9.29: Map of Final Monitored Wetland Assessment Results near the Northwest Hillsborough Regional Wellfield

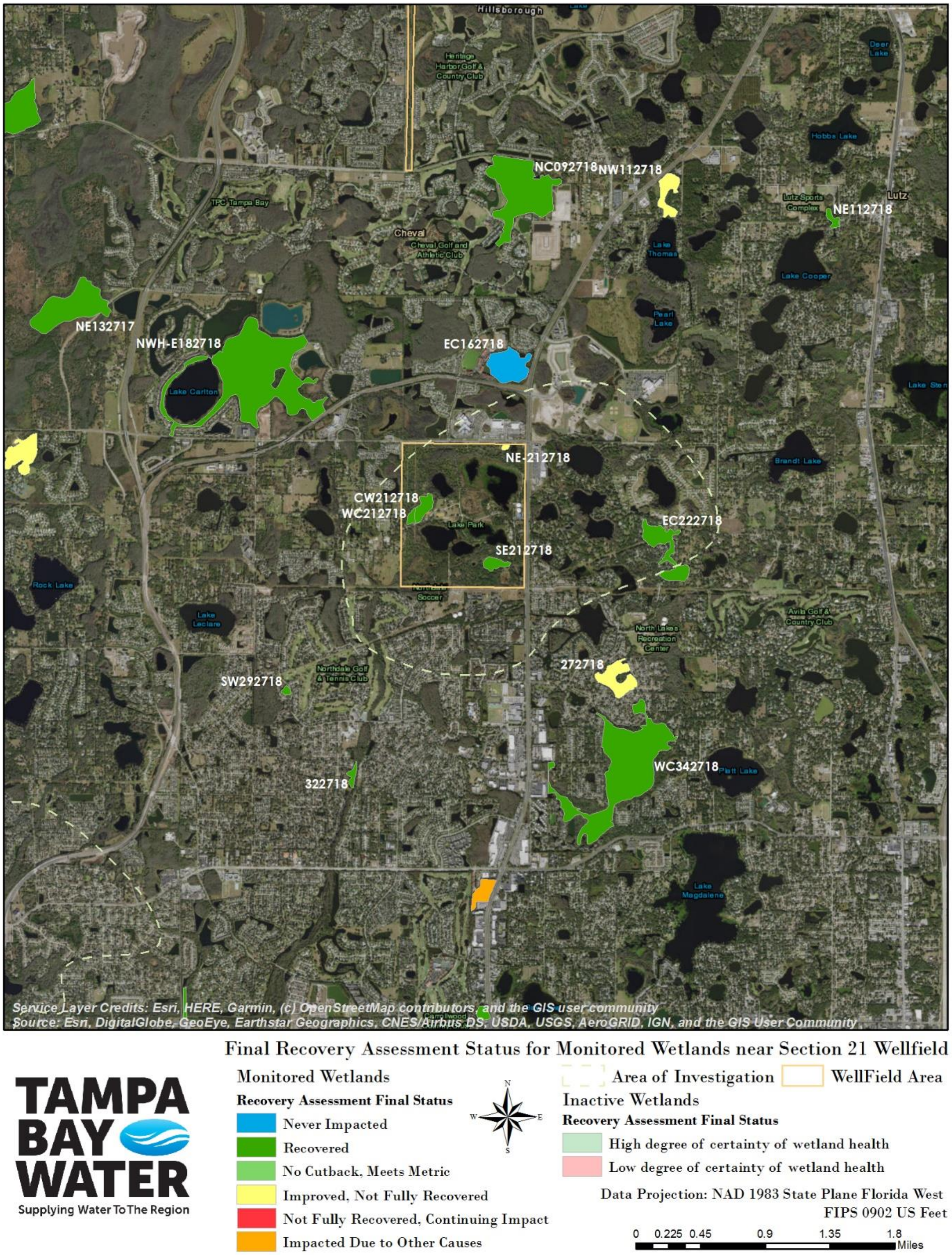


Figure 9.30: Map of Final Monitored Wetland Assessment Results near the Section 21 Wellfield

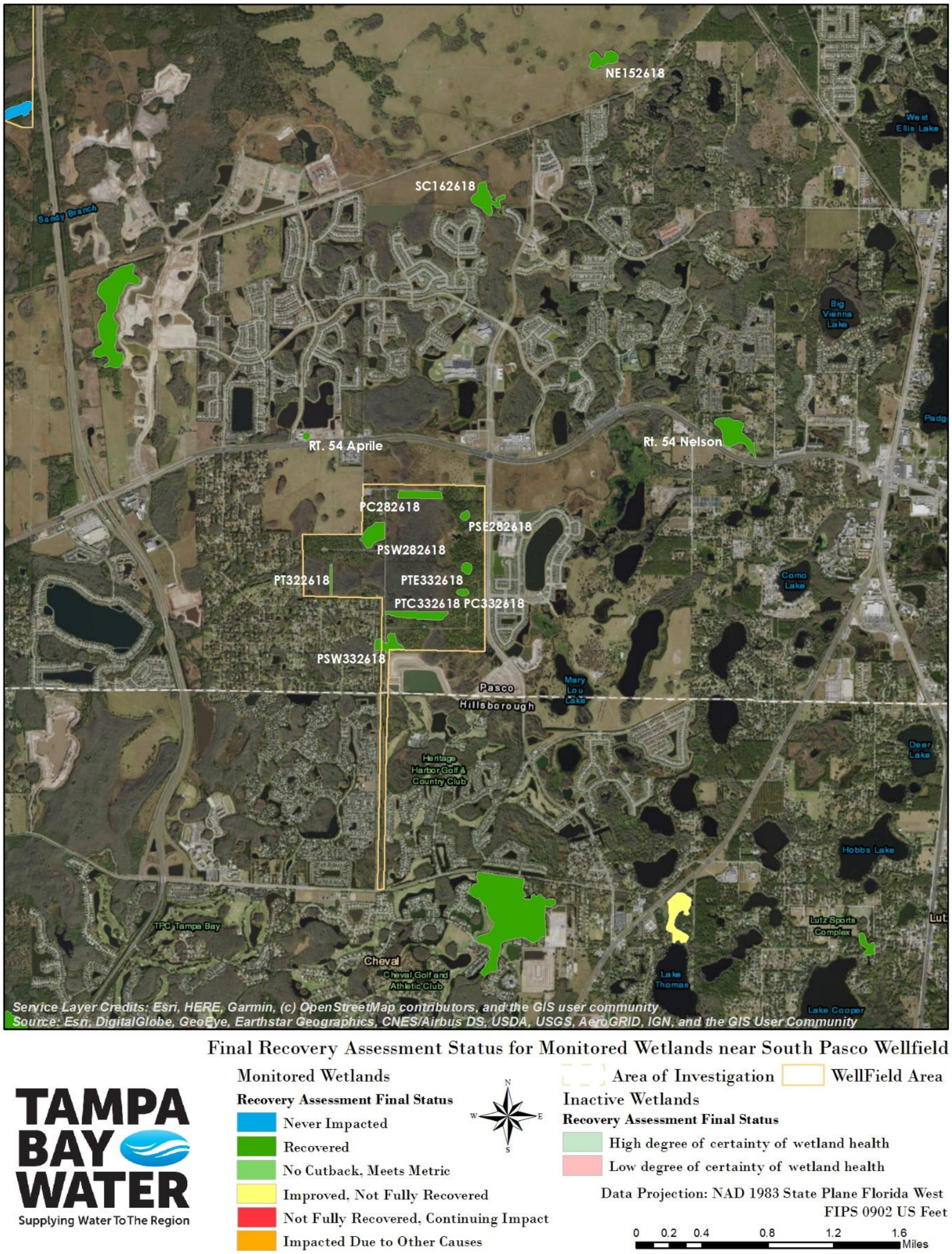


Figure 9.31: Map of Final Monitored Wetland Assessment Results near the South Pasco Wellfield

10: Recovery Analyses of Unmonitored Wetlands and Lakes

10. Recovery Analyses of Unmonitored Wetlands and Lakes

This chapter summarizes the process used to describe the environmental condition of unmonitored wetlands and lakes within the defined Area of Investigation. The original Area of Investigation was updated twice during this assessment and additional unmonitored sites were added to the unmonitored wetland and lake list when they fell within the new, expanded Area of Investigation. The assessment methodology used for the Preliminary Report of Findings in 2018 was subsequently modified as was the recovery assessment classifications or bins for the unmonitored sites. The assessment methodology to predict the health of unmonitored sites was developed and refined in a collaborative, iterative manner with District staff. Some of the information contained in this chapter duplicates information found in Chapters 5 and 6 in order to present a full and complete description of the methods and assessment results for the unmonitored sites in a single report chapter.

10.1 Application of Initial Screening Analyses

Tampa Bay Water and the District staff began discussing an approach to assess the recovery of the unmonitored wetlands at the September 15, 2016 technical coordination meeting. The assessment of sites with no monitoring data poses a significant technical challenge and requires other types of data or information and multiple approaches. Tampa Bay Water and the District collect hydrological and ecological data from wetlands, lakes, and aquifers in the area of all of the unmonitored wetlands to be assessed. Staff began discussing how to extrapolate the data from monitored sites to nearby unmonitored sites with no data. Given that any approach would contain uncertainty in the data used and the spatial nature of any assessment, staff from both agencies agreed to utilize a weight-of-evidence approach to evaluate the unmonitored wetlands and lakes. Tampa Bay Water retained Greenman-Pedersen, Inc. (GPI) to assist in developing methods for estimating ecological and hydrological conditions at unmonitored sites and a general approach for applying these methods to assign a level of recovery to each of the unmonitored sites.

The staff of GPI used statistical interpolation to develop methods for applying data from monitored sites to nearby sites with no data. The development of such statistical models that allow inference of recovery at unmonitored wetlands requires the development of large datasets from the nearby monitored sites during appropriate time periods (after pumping reduction). After a review of rainfall data from the 11 wellfields, GPI selected 2008-2014 as a period of time characterized by a range of rainfall conditions with an annual average that matched the long-term annual rainfall average for the Tampa Bay area. This time period was characterized by reduced wellfield pumping with the exceptions of the Northwest Hillsborough Wellfield (reduced pumping began at this wellfield in 2011) and the Cypress Bridge Wellfield (no reduction in pumping over the period of record). The data from the Five-Year Wetland Health Assessment program was also assembled into datasets based on the years when data were collected under this program and the change in ecological condition at assessed wetlands between the initial assessment period of 1997/1998 and the assessment completed in 2009.

The statistical method of regression-kriging was used to interpolate wetland water levels at the unmonitored sites. This predictive approach was first tested against sites with water level data to see how well the method would predict the water levels in the monitored sites. The model testing found that surficial aquifer drawdown and the ratio of mesic to xeric soils surrounding a wetland were the two most useful variables in predicting the water level in a wetland. GPI recommended that predicted water level data in the form of an offset from the normal pool elevation of a wetland should be produced from the developed model as a primary dataset for assessing recovery at unmonitored wetlands. GPI also recommended that the interpolated Wetland Health Assessment datasets developed for this investigation should be used as a further assessment tool. GPI recommended that historical and recent aerial photography be used only in a verification step in the process to provide additional information where needed. The technical investigations performed by GPI, recommendations for further study, and their recommended approach to the assessment of unmonitored wetlands and lakes was presented in a 2017 technical report which is contained in Appendix 6.12. The District provided review comments and recommendations to be considered in the development and refinement of this assessment method and datasets in a letter dated June 5, 2017 (included in Appendix 6.12). This report by GPI generated data for the original list of 684 unmonitored wetlands located in the original Area of Investigation (Appendix 5.3).

Tampa Bay Water retained the services of GPI staff to refine their prior assessment methods using additional data and incorporate the comments and recommendations made by Tampa Bay Water and District staff. GPI staff tested and refined their methods and datasets to provide predictions of ecological and hydrological conditions as well as changes in conditions at unmonitored sites between the pre- and post-pumping cutback periods. The Random Forest machine learning algorithm was investigated and determined to be useful in predicting both the hydrological and ecological conditions of wetlands in the time periods before and after pumping reduction; this algorithm performed these analyses better than the regression-kriging method used in the prior study. The Random Forest algorithm is a multiple tree-based decision method that can be used for regression or classification, is robust to outliers and data noise, handles datasets for a large number of variables and provides a conservative error estimate within its predictions.

The Random Forest algorithm provides an estimate of the importance of variables to the prediction outcome. A large number of variables were investigated for their value in predicting ecological conditions and normal pool offsets in wetlands. The most important variables to these predictions were surficial aquifer drawdown, Upper Floridan Aquifer drawdown, the head difference between the wetland or lake historical normal pool elevation and the underlying Upper Floridan Aquifer potentiometric surface, the xeric ratio of soils surrounding the study wetlands, the wetland/lake depth, and the predevelopment potentiometric surface of the Upper Floridan Aquifer (prior to wellfield development). ESRI shapefiles of these and other parameters were provided as work products from this study. The results of the 2016 Wetland Health Assessment survey were included in this study and incorporated into the spatial datasets. Maps of the predicted normal pool offset (NPO) elevations, the NPO changes between the pre-and post-pumping reduction periods, and wetland health predictions (based on predicted WHA scores) were also produced as GIS data products. These GIS data of predicted ecological and hydrological data were produced for use in subsequent analyses as part of the weight-of-evidence analysis of the recovery of unmonitored sites.

The additional work performed by GPI, including development of the Random Forest machine learning algorithm, is presented in a technical report included as Appendix 6.13. Prior to the completion of this report, the Recovery Assessment Area of Investigation was modified to account for slight changes in pumping at some wellfields during the years 2013 – 2016. The updated Area of Investigation is discussed and presented in Appendix 5.4 and the updated area included a total of 749 unmonitored sites. Within the

GPI technical study, the consultant used the developed algorithm to make predictions of recovery for the 749 unmonitored wetlands and lakes within the Recovery Assessment Plan. The predictions of recovery at the unmonitored wetlands may have conservative bias as the percentage of unmonitored sites that were predicted to be recovered due to the reduction in wellfield pumping was much lower than the percentage of monitored sites that were assessed as recovered in the preliminary report of findings (Tampa Bay Water, 2018b). While the results of this investigation are informative and useful, the results do not accurately represent the condition of recovery that has been observed in monitored wetlands and lakes in the Recovery Assessment Plan. The GIS layers of multiple parameters produced by the model are valuable datasets as they provide interpolated data for the unmonitored wetlands and lakes. These layers were carried forward into a weight-of-evidence assessment approach to make preliminary predictions of recovery for the unmonitored sites. The data published in the GPI report was used as the starting point for subsequent analysis of unmonitored site status.

Tampa Bay Water staff began the subsequent evaluation of the unmonitored wetlands by classifying each site as isolated or connected and calculating the mesic/xeric soil ratios. The unmonitored wetlands were assessed using the interpolated data sets and the metrics developed for isolated mesic cypress/marsh wetlands (1.8 feet below normal pool elevation), isolated xeric cypress/marsh wetlands (3.1 feet below normal pool elevation), and connected wetlands (2.5 feet below a connected wetland's period of record 90th percentile value). Staff applied a weight-of-evidence approach to screening unmonitored wetlands on a wellfield-scale. The interpolated datasets available for the unmonitored wetlands included: predicted normal pool offset elevation, potentiometric surface of the Upper Floridan Aquifer including depth below land surface, surficial aquifer recovery data (water level improvement following pumping reduction), surficial aquifer drawdown based on actual wellfield pumping rates and wellfield pumping rates scaled up to 90 mgd, proximity to Five-Year Wetland Health Assessment (WHA) wetlands, recovery assessment results from monitored lakes/wetlands, and water table elevations from nearby monitor wells. This qualitative assessment was performed for all but two of the wellfields which had unmonitored wetlands to be evaluated and the results were discussed with the District staff at meetings between May 10 and October 24, 2018. Each unmonitored wetland and lake was assigned to a recovery assessment bin, similar to the process for the monitored sites.

Tampa Bay Water staff developed a GIS model in late 2018 to assess the unmonitored wetlands using a logic tree or stepwise statements approach and multiple data sets previously described in this report. This model was created to provide a consistent and reproducible method of assigning the unmonitored sites to preliminary recovery bins. The interpolated data was already available in shapefiles, facilitating the unmonitored site assessment using a GIS approach. The model was based on the Select tool within the GIS application where all sites are assessed against a criterion and all sites passing that criterion were classified as Recovered. The sites that did not pass a criterion continued in the model and were assessed against subsequent hydrologic criteria. Each site continued through the model until either removed from the model as Recovered or assigned a recovery bin of Improved or More Detailed Assessment Needed in the final model step. The selection steps in the model included: the connected wetland metric, the xeric/mesic isolated wetland metrics, the depth of the Upper Floridan Aquifer potentiometric surface below land surface, the predicted median drawdown in the surficial aquifer beneath each wetland, a comparison of the median Upper Floridan Aquifer potentiometric surface in the post-cutback period to the predevelopment potentiometric surface, and the improvement in normal pool offset for each wetland in the post-cutback period.

At the completion of the preliminary GIS model analysis, a number of sites were classified as More Detailed Analysis Needed as they did not meet any of the criteria in the model. The individual wetland assessments performed for most wellfields, where available, were considered the “more detailed assessments” and the results of these individual evaluations were substituted for the GIS model results for the sites with a classification of More Detailed Analysis Needed. This blended approach for the preliminary assessment of unmonitored sites was discussed with District staff at the October 24 and November 8, 2018 technical coordination meetings. The GIS model was also used to assess the recovery status of 27 wetlands that were formerly monitored but had insufficient data to analyze with any of the monitored wetland analyses. The details of the GIS model development and implementation are presented in a technical report submitted to the District on December 21, 2018 (Appendix 6.14).

10.2 Preliminary Recovery Assessment Evaluation Results

Application of the GIS model analysis and site-specific wetland analysis provided a preliminary classification for 92% of the unmonitored wetlands. These sites were assigned a preliminary recovery bin similar to the bins used for monitored wetlands and lakes. As presented in the Recovery Assessment Preliminary Report of Findings (Tampa Bay Water, 2018b), 59 unmonitored sites did not meet any of the criteria in the model or wellfield screening analysis and were assigned a classification bin of More Detailed Assessment Needed. Fifty of these 59 sites were located at the Cypress Bridge Wellfield, the only wellfield that has not experienced a reduction in pumping. Since assessments of recovery for sites with no site-specific water level data were being made, Tampa Bay Water and District staff agreed to continue the evaluation and not assign a recovery category to these sites until the evaluations could be completed. These remaining sites were to be assigned to a recovery category bin in the final assessment report. The GIS model was also used to assess the recovery status of 27 wetlands that were formerly monitored and had insufficient data to analyze with any of the monitored wetland analyses. The results of these 27 wetlands were reported with the results of the monitored wetland assessments in the Preliminary Report of Findings.

The preliminary assessment results for the 749 unmonitored sites are presented in table and map format in Tampa Bay Water, 2018b but are not reproduced in this report for reasons explained in the following section. The preliminary assessment results for the unmonitored sites are presented in summary table and chart format in Figure 10.1.

Unmonitored Wetland/Lake Assessment Status		
Preliminary Bin Designations		
Recovery Classes/Bins	Number	Percent
Unmonitored Wetlands/Lakes	**749**	
Never Impacted	0	0%
Recovered/Meets Metric	457	61%
Improved, Not Fully Recovered	233	31%
Not Fully Recovered, Continuing Impact	0	0%
More Detailed Analysis Needed	59	8%
Total	749	100%

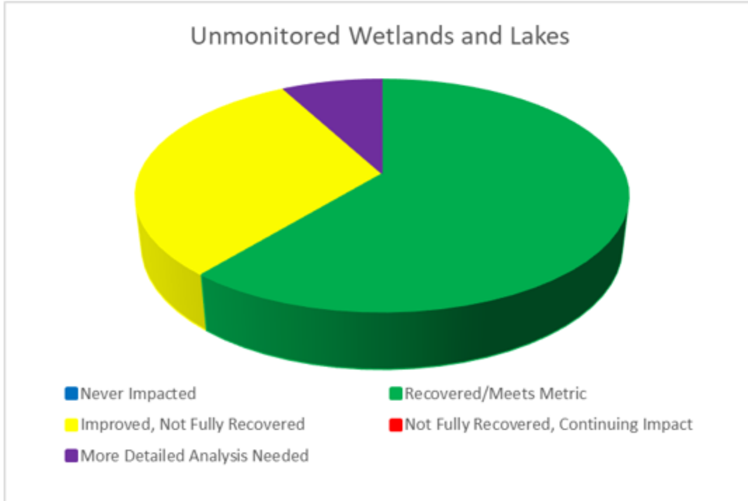


Figure 10.1 – Preliminary Assessment Results for Monitored Wetlands (2018)

10.3 Revision of Assessment Method

10.3.1 Final Area of Investigation and Inventory of Unmonitored Sites

Tampa Bay Water reviewed updated wellfield pumping data from the 11 wellfields to determine if actual pumping levels from 2017 and 2018 caused any increases to the defined Area of Investigation. This step was completed to ensure that all appropriate unmonitored sites were incorporated into the final Recovery Assessment analyses. The process used to assess and update the final Area of Investigation is presented in Section 5.3.3.

The final (2019) Area of Investigation boundary was used to identify additional unmonitored sites which fell within this new area for inclusion in the final analysis. Using this process, an additional 96 unmonitored sites were identified in the expanded boundary, increasing the total number of unmonitored sites from 749 to 845 sites for this final analysis. Section 5.4.4 also describes the final list of unmonitored sites in the Recovery Assessment Plan and the individual sites are listed in Table 5.3. The unmonitored sites which have been added to this analysis are presented in Figures 10.2 through 10.8 and the 749 sites based on the original and 2017 analysis are distinguished from the 2019 additional sites by color in these figures. The Random-Forest analysis that created spatial datasets for the assessment of recovery of unmonitored sites used the original normal pool offset values from monitored mesic and xeric wetlands sites to determine relationships between important variables and interpolate normal pool offset values for the unmonitored sites (2017 list of unmonitored sites). The Random Forest analysis was not updated but since the base relationships in the analysis remained the same, additional interpolated data was expanded to cover the 96 additional unmonitored sites.

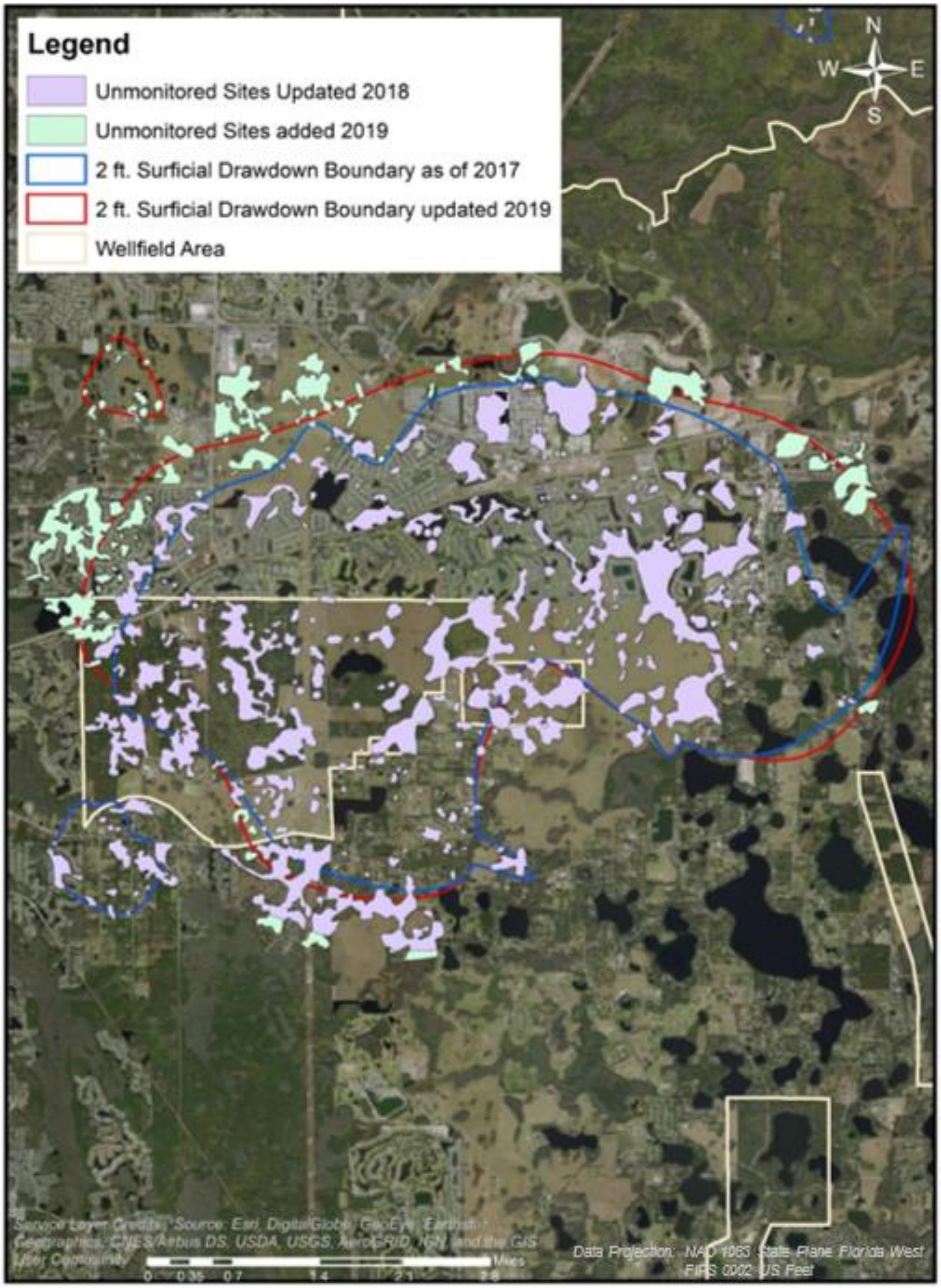


Figure 10.2: Map comparing the 749 wetland sites updated in the 2017 analysis to the 845 finalized from the 2019 pumping analysis, along with the 2017 updated AOI compared with the area developed from 2017 and 2018 pumping for the Eldridge-Wilde Wellfield. The new AOI is represented by the outermost extent of both the red and blue contours.

Figure 10.2: Map Comparing the 749 Wetland Sites

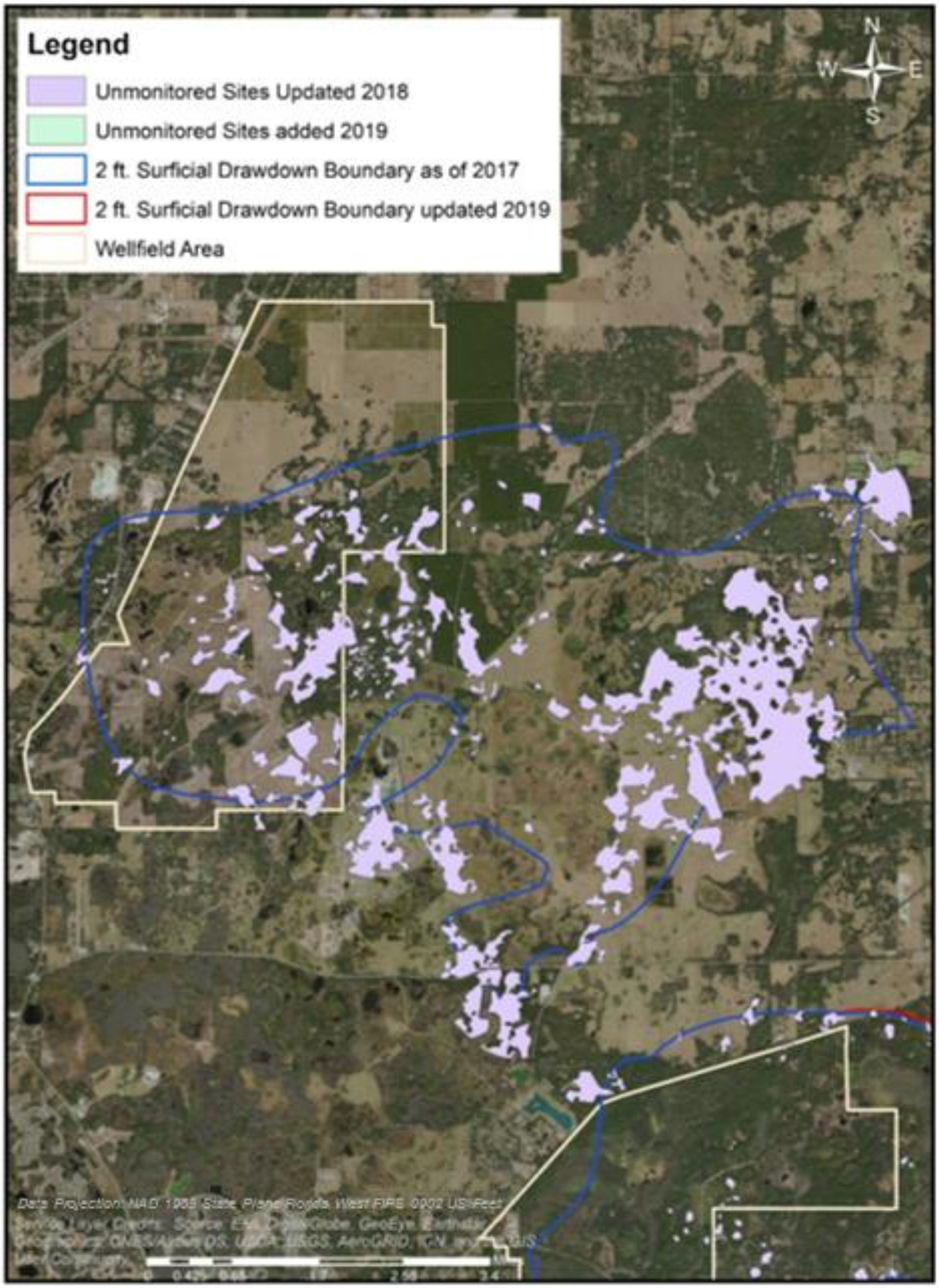


Figure 10.3: Map comparing the 749 wetland sites updated in the 2017 analysis to the 845 finalized from the 2019 pumping analysis, along with the 2017 updated AOI compared with the area developed from 2017 and 2018 pumping for the Cross Bar Ranch Wellfield. The new AOI is represented by the outermost extent of both the red and blue

Figure 10.3: Map Comparing the 749 Wetland Sites

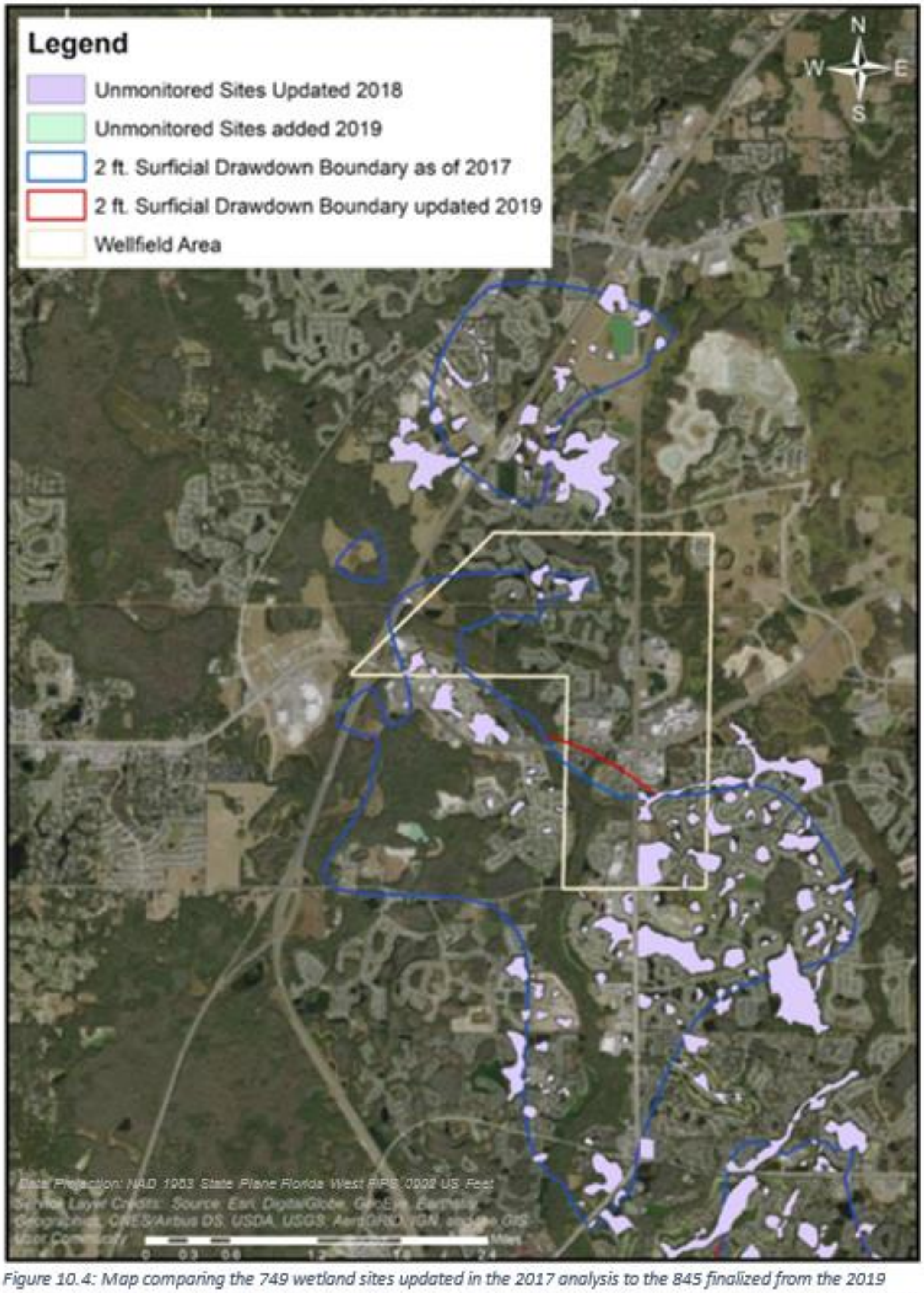


Figure 10.4: Map comparing the 749 wetland sites updated in the 2017 analysis to the 845 finalized from the 2019 pumping analysis, along with the 2017 updated AOI compared with the area developed from 2017 and 2018 pumping for the Cypress Bridge Wellfield. The new AOI is represented by the outermost extent of both the red and blue contours.

Figure 10.4: Map Comparing the 749 Wetland Sites

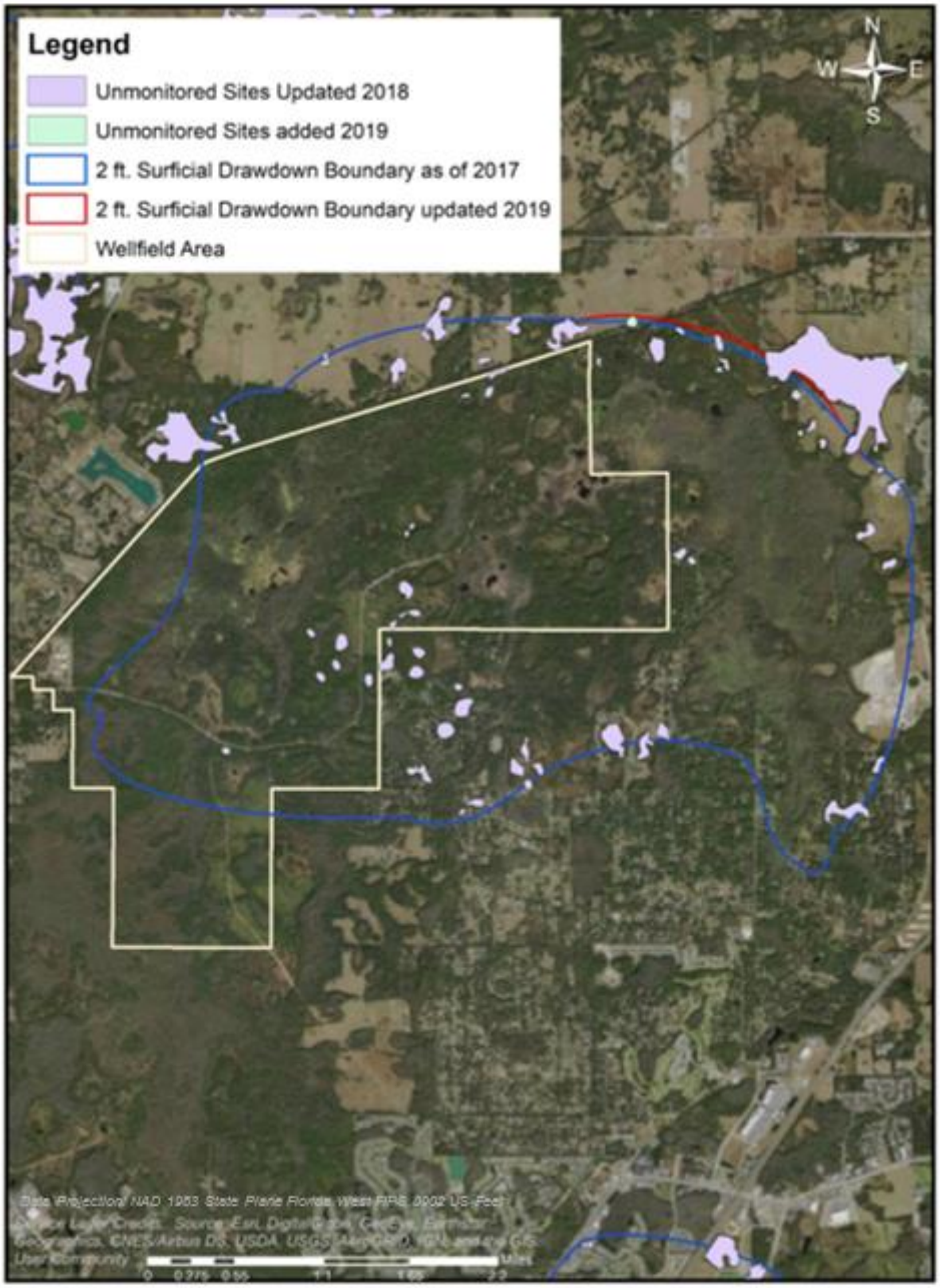


Figure 10.5: Map comparing the 749 wetland sites updated in the 2017 analysis to the 845 finalized from the 2019 pumping analysis, along with the 2017 updated AOI compared with the area developed from 2017 and 2018 pumping for the Cypress Creek Wellfield. The new AOI is represented by the outermost extent of both the red and blue contours.

Figure 10.5: Map Comparing the 749 Wetland Sites

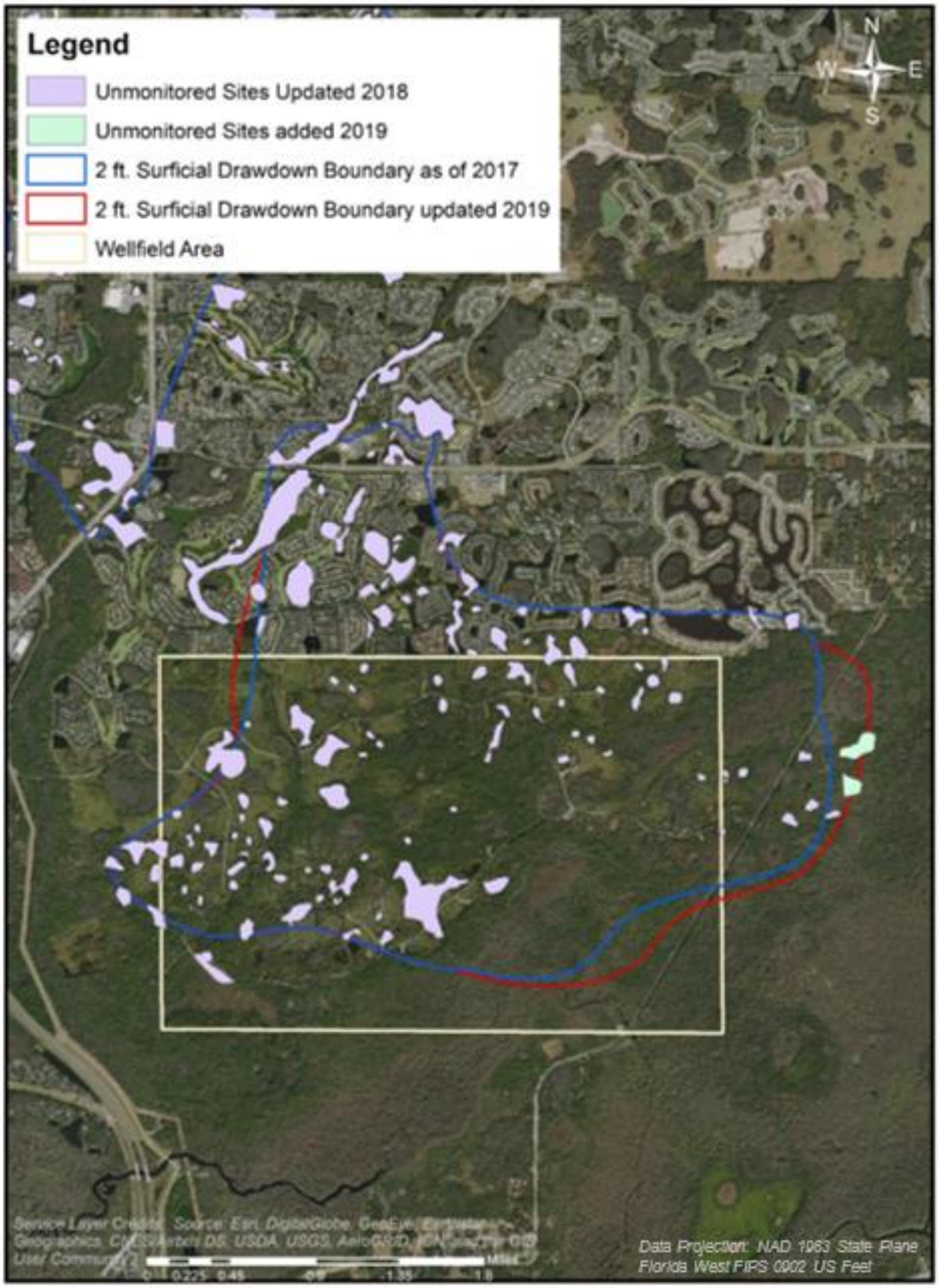


Figure 10.6: Map comparing the 749 wetland sites updated in the 2017 analysis to the 845 finalized from the 2019 pumping analysis, along with the 2017 updated AOI compared with the area developed from 2017 and 2018 pumping for the Morris Bridge Wellfield. The new AOI is represented by the outermost extent of both the red and blue contours.

Figure 10.6: Map Comparing the 749 Wetland Sites

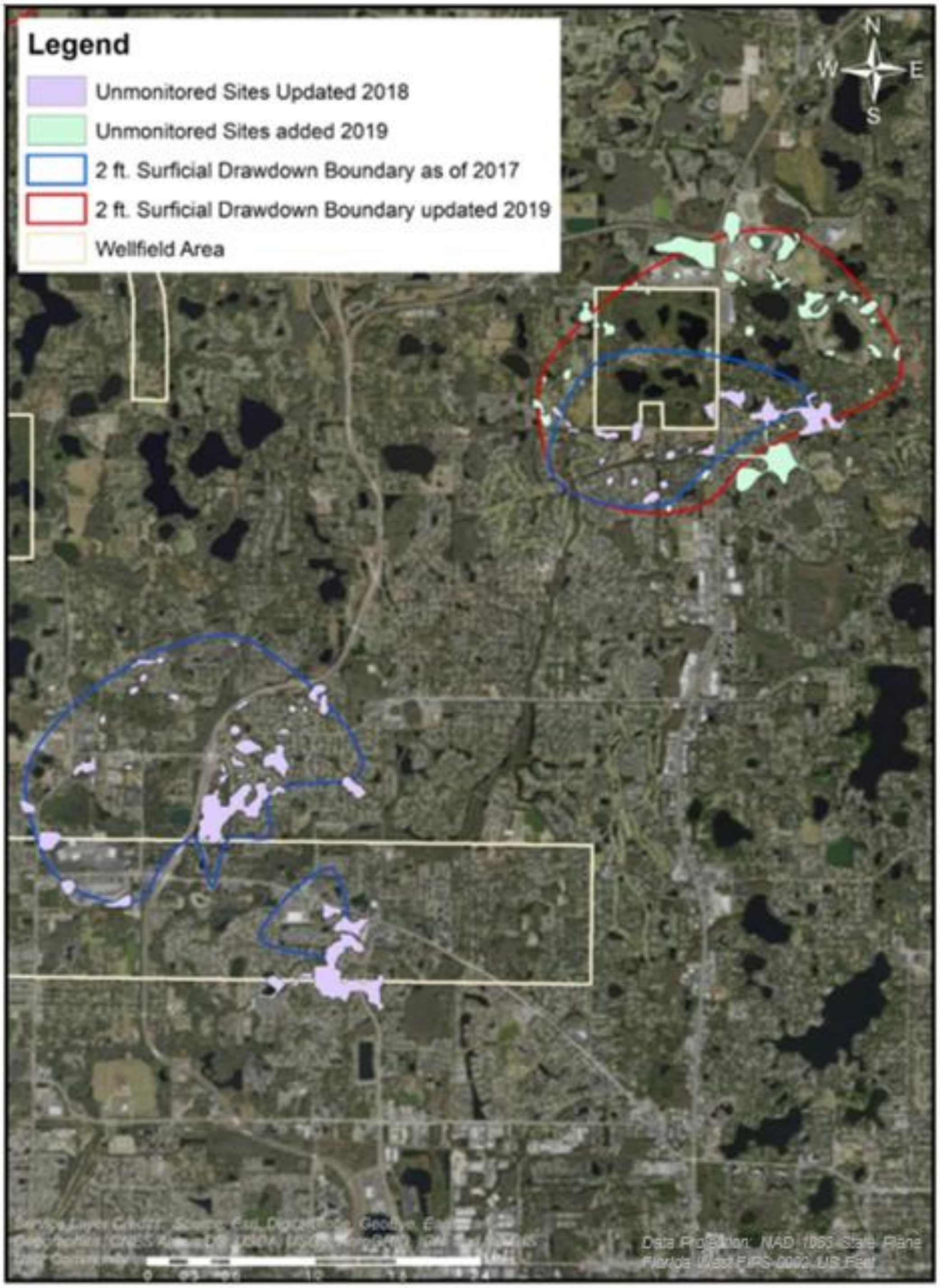


Figure 10.7: Map comparing the 749 wetland sites updated in the 2017 analysis to the 845 finalized from the 2019 pumping analysis, along with the 2017 updated AOI compared with the area developed from 2017 and 2018 pumping for the Section 21 and Northwest Hillsborough Regional Wellfields. The new AOI is represented by the outermost extent of both the red and blue contours.

Figure 10.7: Map Comparing the 749 Wetland Sites

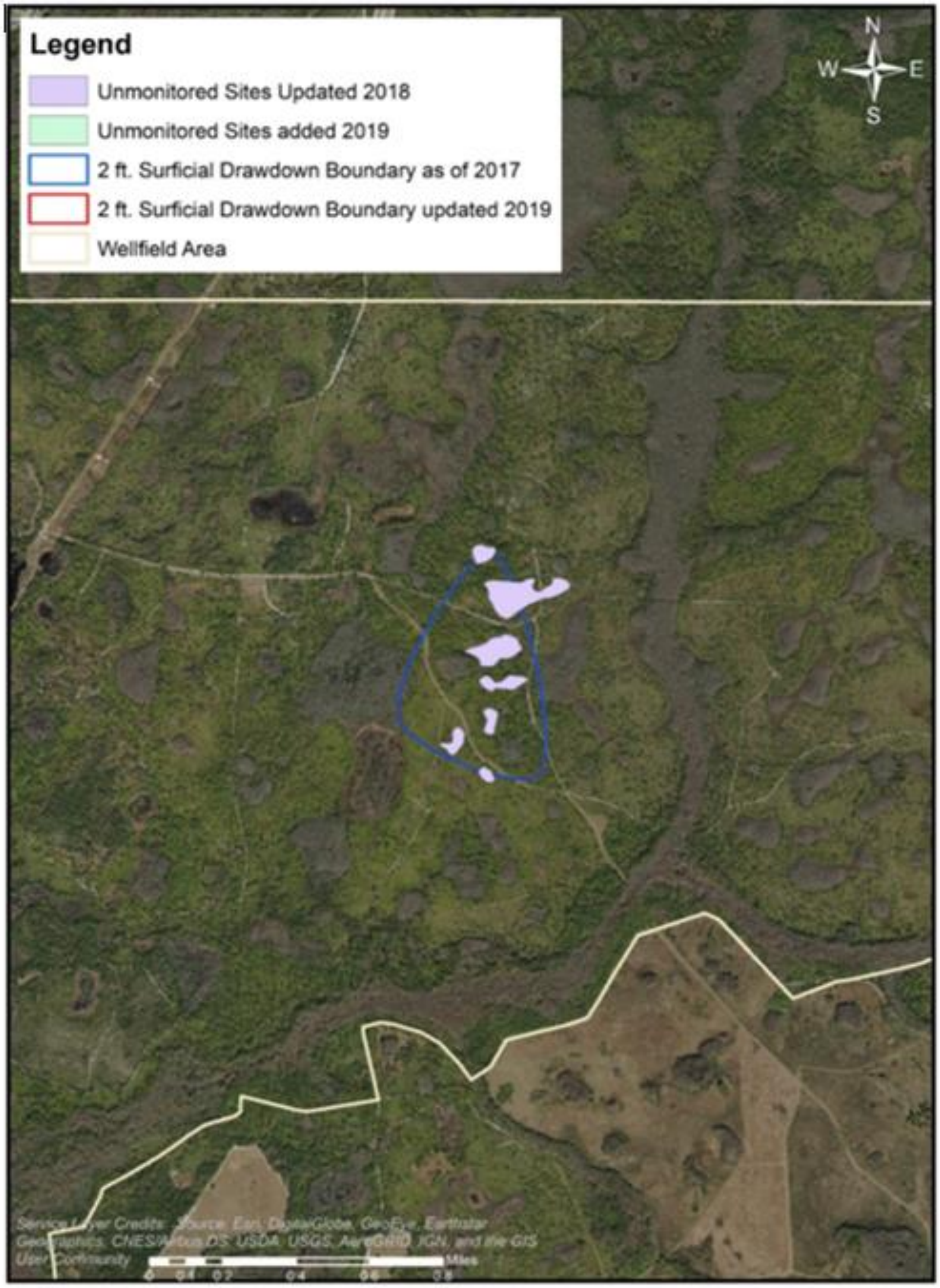


Figure 10.8: Map comparing the 749 wetland sites updated in the 2017 analysis to the 845 finalized from the 2019 pumping analysis, along with the 2017 updated AOI compared with the area developed from 2017 and 2018 pumping for the J.B. Starkey Wellfield. The new AOI is represented by the outermost extent of both the red and blue contours.

Figure 10.8: Map Comparing the 749 Wetland Sites

10.3.2 Discussion of Unmonitored Site Preliminary Assessment and Methods

Tampa Bay Water and District staff continued discussions of the assessment of unmonitored sites in technical coordination meetings in April, May, and June 2019. Staff reviewed the preliminary assessment results for these sites and further examined the methods used to assign the unmonitored sites to preliminary recovery bins. During these discussions with District staff, several important topics were discussed and decisions made that altered Tampa Bay Water's approach to the assessment of unmonitored sites on and near the wellfields.

The available Wetland Health Assessment (WHA) data was discussed at the April and May 2019 technical coordination meetings and staff determined that this is an important dataset that should be incorporated into the analysis of unmonitored sites. Staff agreed to use either the 2016 actual WHA score, where available, or those scores interpolated by GPI in their unmonitored site analysis (Appendix 6.13). Approximately 10% of the unmonitored sites have WHA scores collected in 2016, which was a direct assessment of their "current" health at that recent point in time. The actual scores and the interpolated values created by GPI for the other unmonitored sites are presented as a whole-number score on a five-point scale, and do not rely on interpolating to fractional decimal points like the Normal Pool Offset (NPO) values in order to apply this metric. Since actual WHA data exists for a number of the unmonitored sites and application of this metric is computationally simple, Tampa Bay Water and the District staff agreed that adding this data to the assessment of unmonitored sites would add weight to the assessment results and potentially reduce uncertainty in the results.

The initial GIS analysis of unmonitored sites was developed as a logic tree or stepwise statements model. The steps in the model were sequenced so that the decision criteria considered to be the most important (or highest confidence in the associated data) were used first, followed by those whose relationship to wetland recovery are not as well-defined (less certainty in the individual result). In the preliminary assessment results, some unmonitored wetlands were classified as Recovered even though they did not meet one of the two main criteria used in the GIS analysis (normal pool offset metric or having less than 2 ft. of surficial aquifer drawdown) and met only one of the additional criteria farther down the decision tree. Tampa Bay Water and District staff agreed that instead of assigning a priority ranking to the decision variables, Tampa Bay Water would redesign the analysis and assess the number of criteria met for each site with a pass/fail threshold number of criteria. This revised process follows the weight-of-evidence approach used for the Recovery Assessment monitored wetlands and lakes.

Tampa Bay Water completed an analysis to characterize the error associated with each of the datasets used in the preliminary GIS analysis for unmonitored sites (Appendix 6.14) and estimate the uncertainty in the model results. Staff presented this information to the District at the May 9, 2019 technical coordination meeting and estimated the error for each of the criteria. Staff concluded that the type and amount of error is different for each model criteria and the error estimates across data types could not always be directly compared. Error bounds were applied to each of the datasets in the unmonitored sites model and the most conservative and least conservative model scenarios were completed to assess the potential effect of these data error estimates. Sites were analyzed to determine the number of candidates in each recovery assessment bin for each of these two model scenarios. This analysis highlighted several areas of the unmonitored site analysis where data error could not be effectively resolved and that large shifts in the recovery assessment status could occur as a result of the data error. The error and uncertainty analyses are described in additional detail in the report "Expansion and Completion of Binning Process for Recovery Assessment of Unmonitored Lakes and Wetlands in the Northern Tampa Bay Area" (Appendix 10.1). This assessment led to several important modifications to the methodology of the unmonitored sites and substantial changes in the final results for these sites.

Tampa Bay Water and District staff discussed the need to revise the recovery assessment bins for the unmonitored sites at the May 9, 2019 technical coordination meeting. Staff concluded that since there is little or no empirical data available for these sites and the data used to assess their condition are statistically-derived and interpolated data sets based on data from nearby monitored sites, qualitative assessment bins would be more appropriate for the final assessment report. At the June 13, 2019 meeting, Tampa Bay Water proposed a new set of recovery assessment bins for the unmonitored sites. Based on the level of error and uncertainty in the data sets and analyses, the most appropriate designations for these sites are either a high degree or a low degree of certainty of wetland health. This is a qualitative assessment which is appropriate given that these are unmonitored sites with no available monitoring data. The new recovery assessment bins for the unmonitored sites are discussed in Section 6.2.2. and presented in Table 6.2. The most direct effect of this change is that the final results for the unmonitored sites are very different from the preliminary assessment results since a completely new assessment approach has been developed and new qualitative assessment bins replaced the original quantitative assessment bins.

It is important to note that while the isolated xeric wetland metric and the method of assessing recovery at xeric wetlands have changed, those changes were not carried forward into the final datasets used in the unmonitored site analysis. That would have required a significant update to the Random Forest analysis since there would be new relationships between each of the potential variables and the modified offset metric values for the xeric wetlands. Based on staff's decision to alter the unmonitored assessment methodology and use qualitative classification bins for these sites, Tampa Bay Water and District staff determined that an update to the Random Forest model would not be an effective use of time or resources. The Random Forest analysis for xeric and mesic monitored sites was created using site normal pool elevations as the reference datum. The resulting data interpolation for nearby unmonitored areas represents a consistent approach across the entire analysis area and this data layer was used in the final unmonitored site analysis.

10.3.3 Final Unmonitored Site Assessment Methodology

Based on the error in the interpolated datasets used in analyzing unmonitored sites and the uncertainty contained in the assessment process, Tampa Bay Water staff developed a revised approach to assess the unmonitored sites for this final report based on discussions with District staff. Tampa Bay Water and the District staff agreed that the stepwise method used in the preliminary unmonitored sites assessment was not the best method of assessing these sites given the types of data used and the uncertainty in each of those datasets. Tampa Bay Water modified the method of analysis to a weight-of evidence approach which is consistent with the overall method of Recovery Assessment analysis for the monitored lakes and wetlands. A sixth criteria and dataset (the 2016 actual or interpolated WHA score) were also introduced to the assessment approach as described above. The six criteria used in this final assessment of unmonitored sites are:

- Normal Pool Offset (2008-2014)
- Median Depth to Upper Floridan Aquifer potentiometric surface (2008-2014)

- Median of the median Surficial Aquifer Drawdown (2008-2014)
- Upper Floridan Aquifer Potentiometric Surface (2008-2014) compared to Predevelopment Potentiometric Surface
- Normal Pool Offset Change (2008-2014 minus 1996-2002)
- Wetland Health Assessment score (actual or interpolated for 2016) – added for this final assessment method

The first five of these criteria were used to assign a preliminary assessment bin for each of the 749 unmonitored wetlands in the Recovery Assessment Preliminary Report of Findings (Tampa Bay Water, 2018b). The data used in the preliminary assessment were carried forward to this final assessment without updates since Tampa Bay Water and the District staff agreed that the evaluation of the unmonitored sites would change to a qualitative assessment of health and not an explicit prediction of recovery status. Staff determined that updates to the datasets used in the final assessment of these sites would not provide appreciable benefit for the time needed to update the interpolated datasets. Therefore, for this final assessment, the differences in unmonitored site final assessment (as compared to the preliminary assessment) are limited to the addition of Wetland Health Assessment score, the change to qualitative categorization bins (Table 6.2), and the application of a weight-of-evidence approach as described at the end of this section. The six criteria, the datasets for each, and their application in the weight-of-evidence assessment approach are presented in the following paragraphs.

The Normal Pool Offset value is the median water level offset elevation for 2008-2014 because it was interpolated from the median 2008-2014 deviation from normal pool elevation for each of the monitored sites used to develop this dataset. Based on the mesic or xeric classification of each site, the Normal Pool Offset value for each unmonitored site was compared to the respective offset recovery metric established for appropriate wetland type. As discussed in Section 10.2, the isolated xeric wetland metric and the method of assessing recovery at xeric wetlands have changed for the final assessment of recovery but those changes were not carried forward into the final datasets used in the unmonitored site analysis. Unmonitored sites whose Normal Pool Offset values were above their metric passed this particular criterion (Appendix 10.1), similar to the assessment for monitored wetlands. For mesic sites, the recovery threshold is 1.8 feet below Normal Pool elevation; however, the threshold value in this unmonitored site assessment was increased to 1.805 feet to account for the decimal point precision in the Random Forest model results used to create this interpolated dataset. For xeric sites, the recovery threshold was maintained at the original metric value of 3.1 feet below Normal Pool elevation (threshold value increased to 3.105 feet in this analysis). For the Connected sites, the recovery threshold was established at 2.5 feet (threshold value increased to 2.505 feet in this analysis (the connected wetland metric is described in more detail in Section 6.3.5).

The median depth to the Upper Floridan Aquifer potentiometric surface was calculated for each unmonitored site from the monthly values for calendar years 2008-2014 as developed by Lee and Fouad (HSW Engineering, 2018 – Appendix 5.18). Sites whose median values were less than 2.5 feet below land surface (<-2.505 feet) were considered to have passed this criterion in the weight-of-evidence assessment (Appendix 10.1). Some of the unmonitored sites did not have a monthly value for this criterion as reported in Lee and Fouad's analysis. Data for these additional sites were obtained in one of three ways. The final unmonitored site layer (845 unmonitored site polygons) was compared to the

National Wetlands Inventory (NWI) data layer developed by Lee and Fouad. Most of the additional isolated sites were present in the NWI data layer which included monthly depth to the Upper Floridan Aquifer potentiometric surface; the median of these monthly values was calculated for these additional unmonitored sites. Some of the additional unmonitored sites were present in the NWI data layer but encompassed multiple NWI wetland polygons. For these sites, all encompassed NWI polygons were included in a weighted average of depth to Upper Floridan Aquifer potentiometric surface values, using the acreage of each NWI polygon versus the total acreage for the unmonitored site. When a single NWI site was larger than the unmonitored site, the NWI median value was used without modification. The last set of sites were those which were not included in the NWI data analysis. These were either sites which were delineated after the development of the 2016 NWI data layer or were a different type of site than those which were included in the Lee and Fouad analysis whose focus was palustrine wetlands. These sites were noted as N/A for the median depth to Upper Floridan Aquifer potentiometric surface in Appendix 10.1 and were deemed to not have passed this criterion.

The median of the median surficial aquifer drawdown dataset was developed by GPI as part of the Random-Forest Analysis (Appendix 6.13) for the assessment of the unmonitored sites. Similar to the interpolation process used to generate updates to the Area of Investigation, the median surficial aquifer drawdown value at each Unit Response Matrix grid cell for each of the years 2008 – 2014 was selected and used to interpolate a single surface. A median value was then determined for each of the unmonitored sites within that surface. Sites with less than 2 feet of surficial aquifer drawdown were considered to have passed this criterion (Appendix 6.14), as they are presumed to not be substantially affected by drawdown following the reduction in wellfield pumping.

The median Upper Floridan Aquifer Potentiometric Surface (Lee and Fouad, 2018) and the Predevelopment Upper Floridan Aquifer Potentiometric Surface (Bellino, 2011) layers were used to calculate the difference in these elevations beneath each unmonitored site by Lee and Fouad in their 2018 analysis (Appendix 5.18). Similar values were added to this analysis for the additional unmonitored sites by GPI as part of the Random Forest Analysis (Appendix 6.13). Sites where the (recent) Upper Floridan Aquifer Potentiometric Surface value was higher than that of the predevelopment potentiometric surface value were considered to have passed this criterion. The use of the predevelopment potentiometric surface (pre-wellfield development) acknowledges the error present in the data layer, including the models from which it was derived. While it is not expected that the recent potentiometric surface elevation at a site would actually be higher than the predevelopment surface elevation (prior to groundwater pumping in the area), the 2008-2014 potentiometric surface levels could be at or somewhat above the predicted predevelopment surface given the reduction in wellfield pumping and the error within the predevelopment surface (Appendix 10.1).

Based on availability of Normal Pool Offset data for monitored wetlands in the Consolidated Water Use Permit area, offsets were interpolated for unmonitored sites as a median value for 2008-2014 and 1996-2002. These 2008 – 2014 offset values were subtracted from the 1996 – 2002 offset values to determine the change over time with a positive number indicating improvement. According to a statistical analysis presented at the September 26, 2018 technical coordination meeting, the median increase in the Normal Pool Offset between these two time periods for control sites (sites not believed to be impacted by groundwater pumping) was 1.05 feet (the upper interquartile threshold based on the median Normal Pool Offset improvement). Unmonitored sites with a Normal Pool Offset improvement of greater than 1.05 were considered to be in an improved condition and passed this criterion.

The one criterion added for this final assessment of unmonitored sites was the Wetland Health Assessment score. All sites analyzed in the 2016 Wetland Health Assessment survey were assigned a score of 1 to 3 points for overall wetland health. The 2016 scores were used to create an interpolated surface across the Consolidated Permit wellfield area showing a predicted average Wetland Health Assessment score for each unmonitored site across the area. The 3-point score was condensed to a binary metric, where sites with a score of 1 or 2 were considered stressed and received a zero value, while sites with a score of 3 (the highest rating) were given a value of 1, meaning the wetland was in a non-stressed condition. Sites with a value of 1 were considered to have passed this criterion.

Tampa Bay Water presented the final revised bin categories and thresholds for assessment of unmonitored sites at the June 13, 2019 technical coordination meeting with the District. Based on feedback from the District staff at the meeting, Tampa Bay Water staff finalized the revised assessment method for unmonitored sites. The unmonitored sites will be classified as having either a High Degree of Certainty of Wetland Health or a Low Degree of Certainty of Wetland Health (see discussed in Section 6.2.2. and Table 6.2). In the final assessment approach, each unmonitored site will be assessed according to the six criteria. Sites meeting two or more criteria are classified as having a high degree of certainty of wetland health. Those sites that meet less than two criteria are classified as having a low degree of certainty of wetland health. There is no preferential weighting to any of the six criteria; all are treated as equal weight with respect to the final assignment of site bins. These new classification bins provide a more accurate representation of the conclusions which can be made at a site with no physical data, whose data comes solely from the interpolation of monitored data.

10.4 Final Recovery Assessment Evaluation

Tampa Bay Water assessed 27 of the Recovery Assessment monitored wetlands with the unmonitored sites in the Preliminary Report of Findings (Tampa Bay Water, 2018b). Water level monitoring at these wetlands ceased for various reasons and insufficient water level data was available to assess these wetlands using the appropriate monitored wetland metric. These 27 formerly-monitored wetlands were assessed for this final report using the revised unmonitored site methodology. The datasets for the five original criteria did not change from the preliminary assessment and the actual or predicted Wetland Health Assessment dataset was applied to these sites for this final analysis using the new weight-of-evidence approach.

None of the xeric wetlands on this list could be assessed using the new isolated xeric wetland metric because they had very limited water level data records and the Random Forest assessment was not updated using this new xeric metric for reasons previously discussed. For this final assessment of the 27 formerly-monitored sites, the xeric sites on this list were assessed using the original xeric wetland metric based on the results of the Random Forest analysis. Two of the formerly-monitored wetlands were outside of the range of Lee and Fouad’s analyses (HSW Engineering, 2018); therefore, they have been given a designation of N/A for the median depth to Upper Floridan Aquifer criterion. The data at these 27 sites were assessed for each of the six criteria and the results for each criterion at each site is presented in Appendix 10.1 and in Table 10.1. These sites were assigned one of the two new bin names for unmonitored sites; 24 of the sites were assessed as having a “High Degree of Certainty of Wetland Health” and three of the sites were assessed as having a “Low Degree of Certainty of Wetland Health”. The final site assessment results for these formerly-monitored (inactive) sites are also presented in map form in Figures 10.9 through 10.14. and these assessment results are reported with the final bins for monitored wetlands in Table 9.3.

Figure 10.9: Map of the Inactive Sites near the Cross Bar Ranch Wellfield with Final Bin Designations

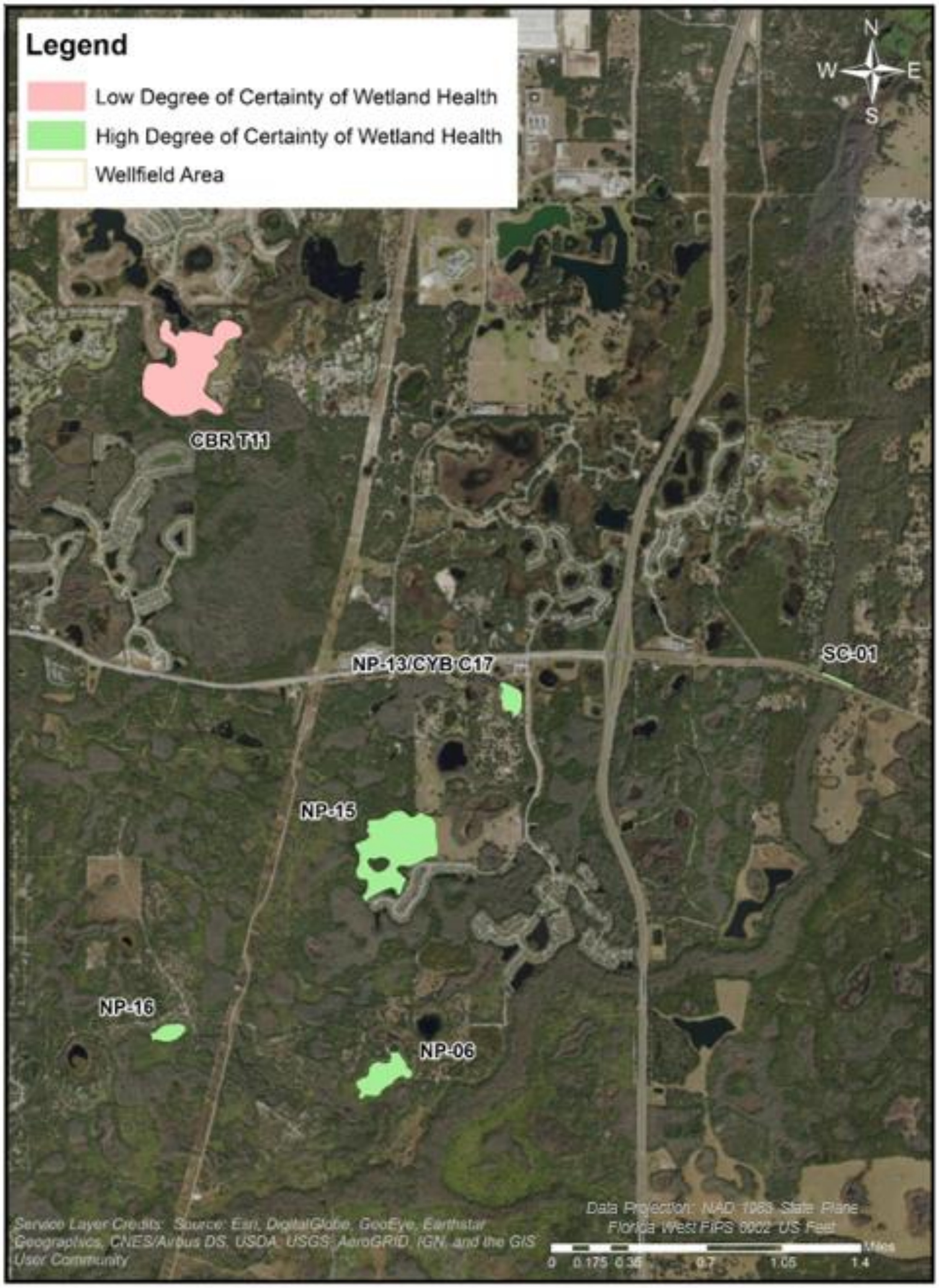


Figure 10.10: Map of the Inactive Sites near the Cross Bar Ranch and North Pasco Wellfield with Final Bin Designations

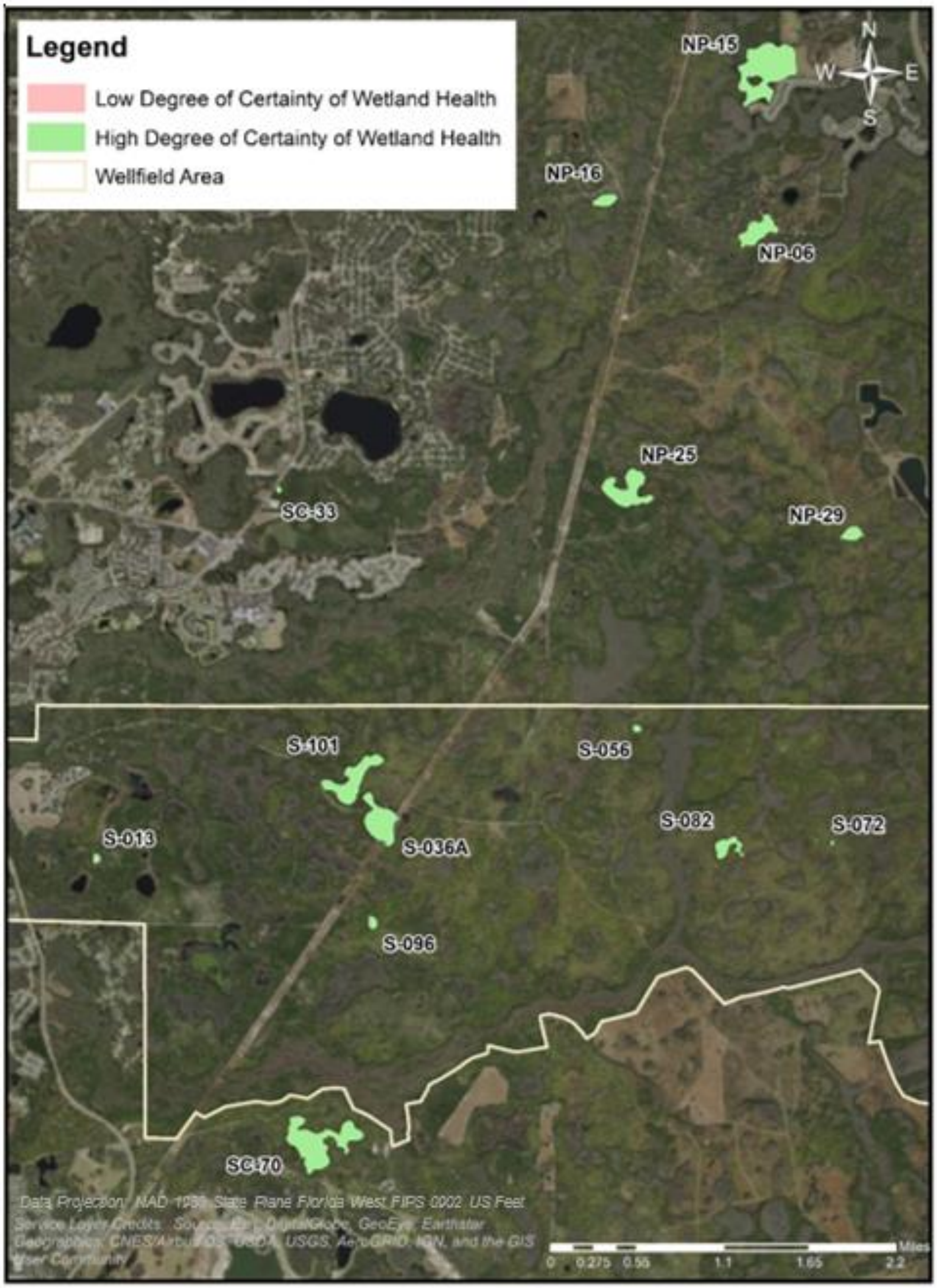


Figure 10.11: Map of the Inactive Sites near the J.B. Starkey and North Pasco Wellfields with Final Bin Designations

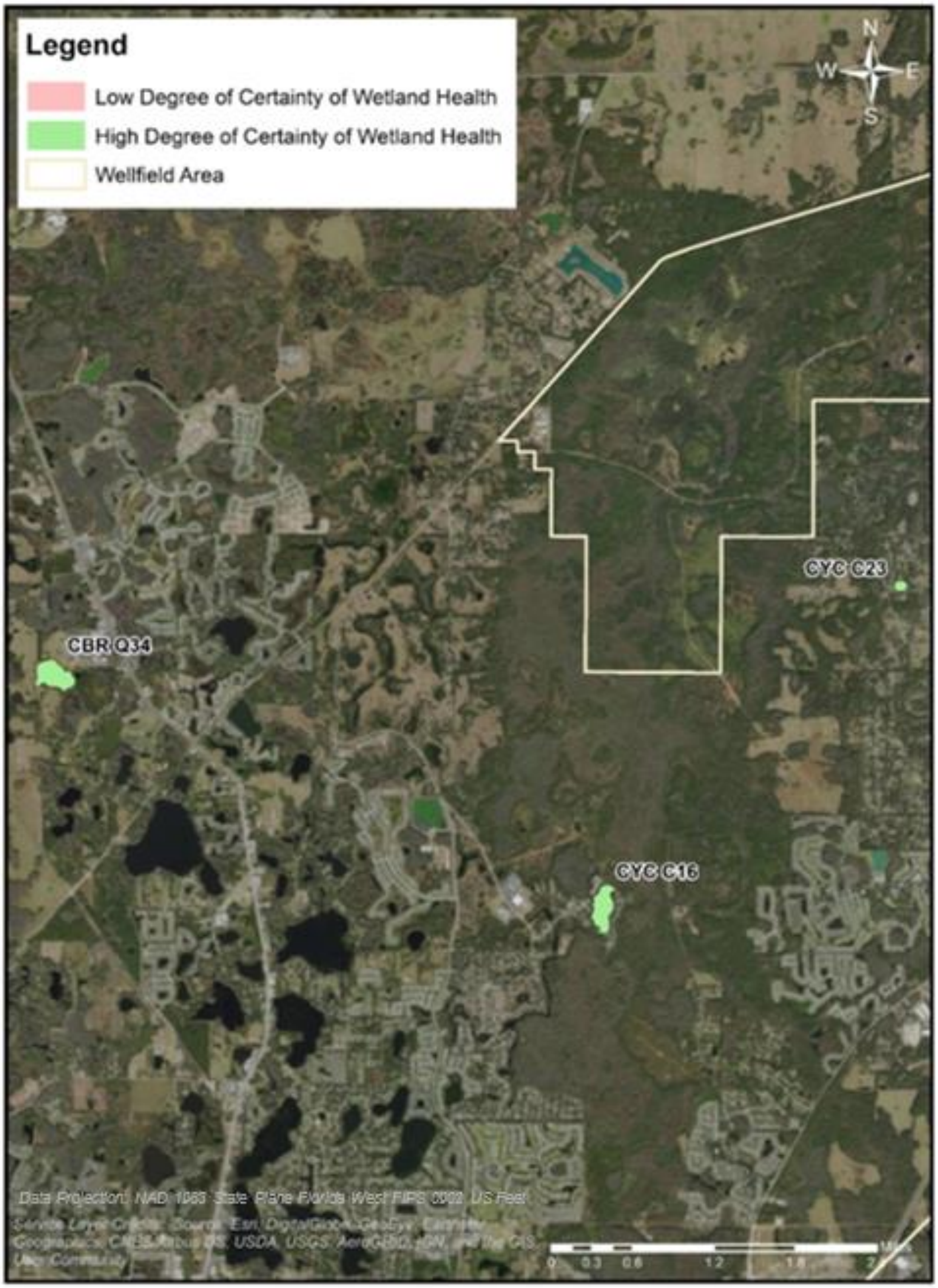


Figure 10.12: Map of the Inactive Sites near the Cypress Creek Wellfield with Final Bin Designations

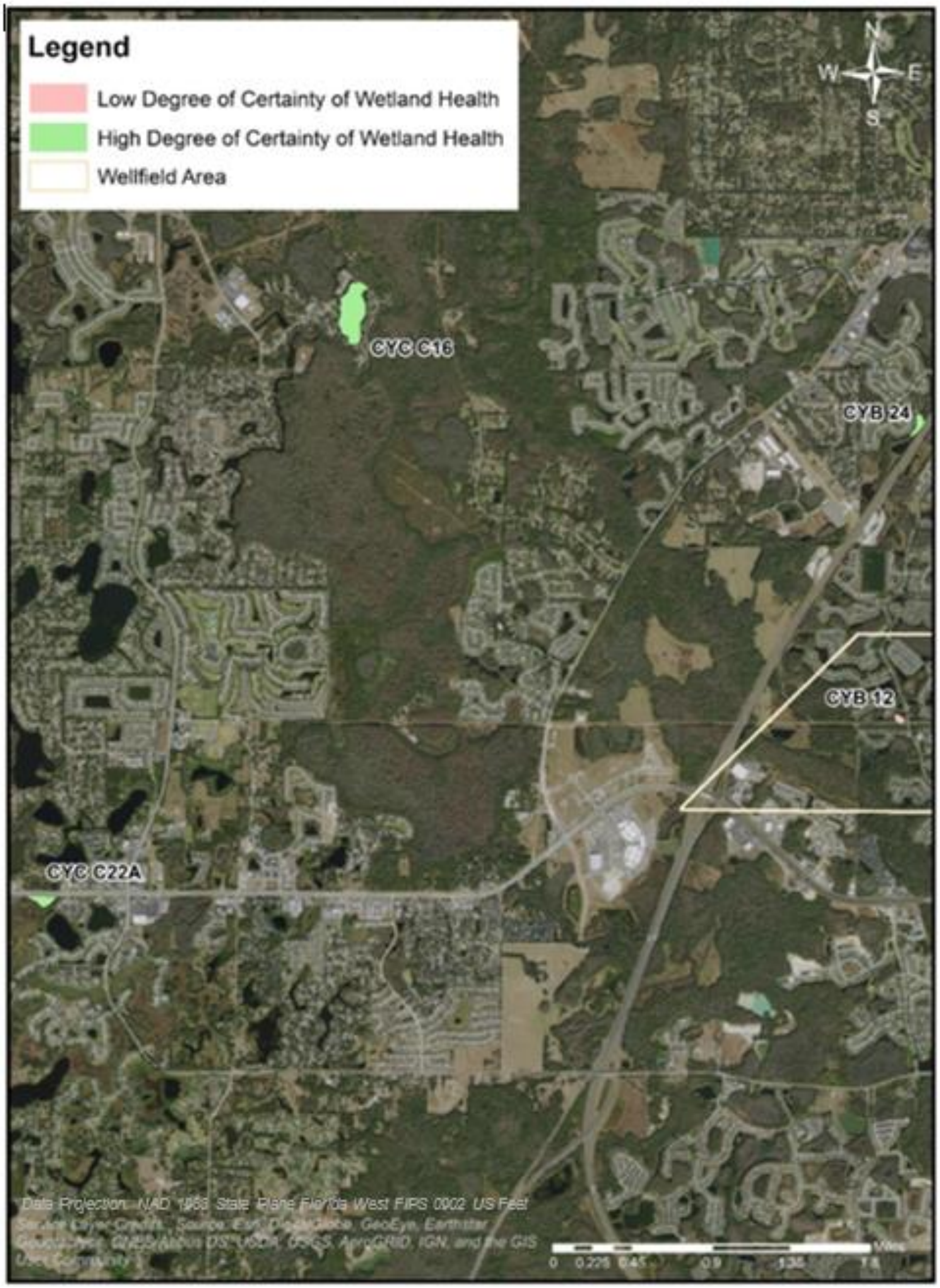


Figure 10.13: Map of the Inactive Sites near the Cypress Bridge Wellfield with Final Bin Designations

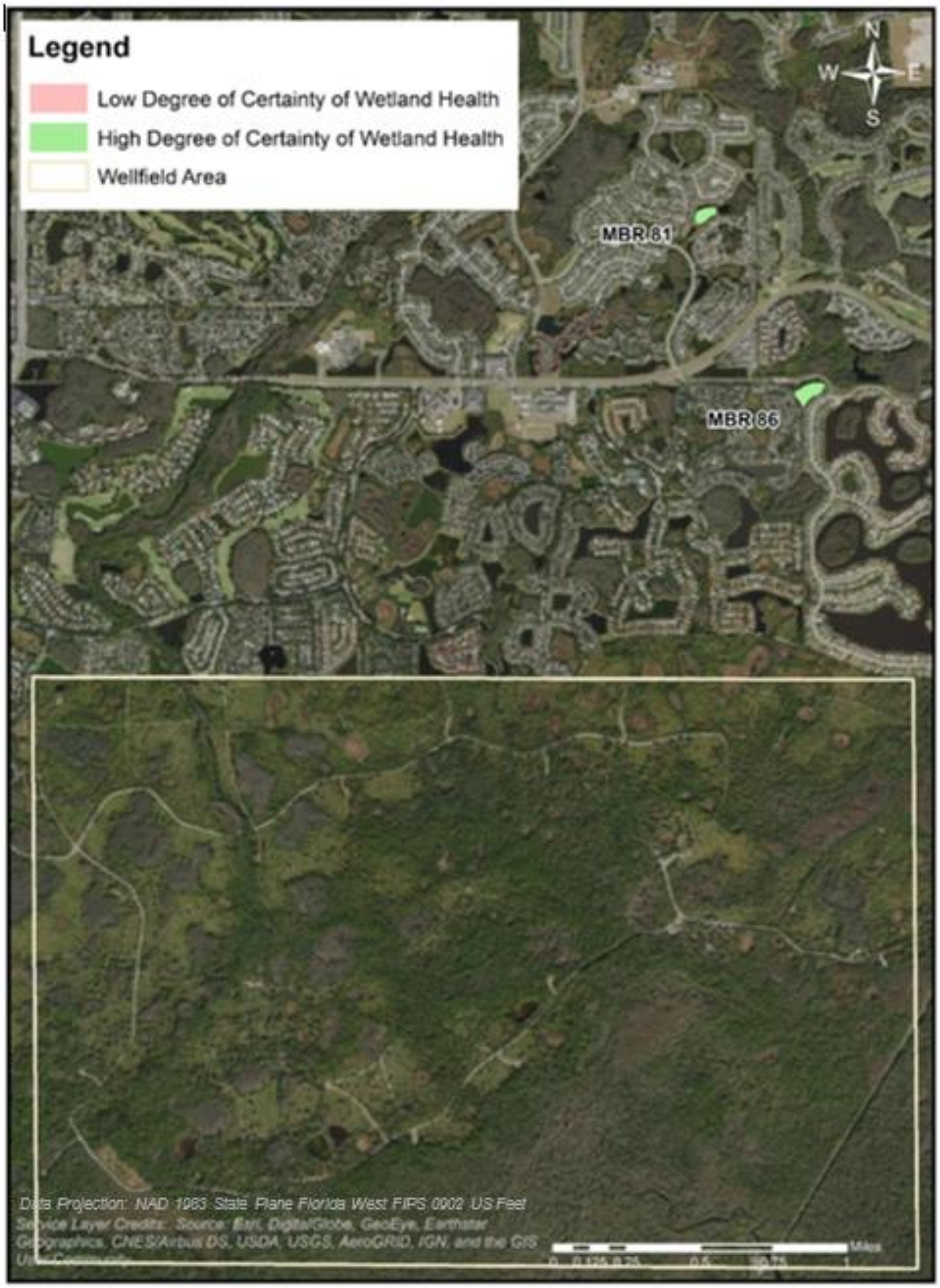


Figure 10.14: Map of the Inactive Sites near the Morris Bridge Wellfield with Final Bin Designations

Table 10.1: Results of Inactive Monitored Wetland Analysis

Results of Inactive Monitored Wetland Analysis using new methodology and new bin designations developed for the unmonitored sites. N/A listed under the NPO metrics signifies analyses that did not apply due to wetland type. N/A designation for all other criteria signifies that the site was not included in that analysis.

Wetland Name	Wetland ID	Predicted NPO Offset (2008-2014)			Median 08-14 Depth to UFAS	SAS DDN	Predevelopment Potentiometric Surface minus Median 08-14 Potentiometric Surface	NPO Change	WHA Score 2016	Status based on new Unmonitored Assessment
		Connected Offset	Xeric Offset	Mesic Offset						
CBR Q23		N/A	N/A	N/A	-28.770020	N/A	8.87854402	N/A	N/A	LOW DEGREE OF CERTAINTY OF WETLAND HEALTH
CBR Q34	31	N/A	N/A	-1.818437	3.440251	0.054638	-5.53491163	0.603326458	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
CBR T11	40	N/A	N/A	N/A	N/A	0.045102	N/A	N/A	N/A	LOW DEGREE OF CERTAINTY OF WETLAND HEALTH
CYB 12	129	N/A	N/A	-1.849688	-3.697571	2.7346318	5.59060637	0.22807095	1	LOW DEGREE OF CERTAINTY OF WETLAND HEALTH
CYB 24	141	N/A	N/A	-2.598564	-5.193911	2.465199	-1.32591218	1.518197341	0	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
CYC C15	167	-1.733975	N/A	N/A	-0.741095	1.066241	0.55689211	1.703671382	0	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
CYC C16	168	N/A	-1.824814	N/A	3.907312	0.212303	4.24607086	0.921486678	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
CYC C22A	172	-1.742154	N/A	N/A	-5.207642	0.612059	-4.59679772	0.673375316	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
CYC C23	173	N/A	N/A	-1.775884	-9.3816	1.382417	10.09043161	1.175774301	0	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
MBR 81	271	N/A	N/A	-1.928643	-16.742925	0.873646	1.60204348	0.888527207	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
MBR 86	272	N/A	N/A	-2.065995	-8.486826	0.333103	1.24932814	0.798088124	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
Wetland Name	Wetland ID	Connected Offset	Xeric Offset	Mesic Offset	Median 08-14 Depth to UFAS	SAS DDN	Predevelopment Potentiometric Surface minus Median 08-14 Potentiometric Surface	NPO Change	WHA Score 2016	Status based on new Unmonitored Assessment

Wetland Name	Wetland ID	Predicted NPO Offset (2008-2014) Connected Offset	Xeric Offset	Mesic Offset	Median 08-14 Depth to UFAS	SAS DDN	Predevelopment Potentiometric Surface minus Median 08-14 Potentiometric Surface	NPO Change	WHA Score 2016	Status based on new Unmonitored Assessment
NP-06	341	N/A	-1.814319	N/A	-1.767388	0.100039	1.10623891	1.411940228	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
NP-13/ CYB-C17	347	N/A	-1.378583	N/A	-1.893199	0.053641	-2.02264443	0.444388357	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
NP-15	348	N/A	-1.845540	N/A	-1.463764	0.044068	-0.55494702	1.061846319	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
NP-16	349	N/A	-1.730783	N/A	-0.47827	0.105080	-2.47670028	1.441598468	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
NP-25	354	N/A	-1.845606	N/A	-2.392029	0.222318	1.8899535	1.540918519	0	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
NP-29	357	N/A	N/A	-1.506463	-4.900759	0.349543	4.73228824	0.580174097	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
S-013	417	N/A	-3.079902	N/A	-3.982376	0.687506	0.1683888	1.528729022	0	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
S-036A	426	N/A	-1.933185	N/A	-0.093244	1.319283	4.36198376	3.910777309	0	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
S-056	437	N/A	N/A	-1.094444	-2.6994	0.106822	3.51777987	2.087732168	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
STK-S-072	446	N/A	-1.349168	N/A	-3.562907	0.355334	4.92167297	1.598940359	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
S-082	452	N/A	N/A	-1.071922	-3.570439	0.2729137	4.58712811	1.090233616	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
Wetland Name	Wetland ID	Connected Offset	Xeric Offset	Mesic Offset	Median 08-14 Depth to UFAS	SAS DDN	Predevelopment Potentiometric Surface minus Median 08-14 Potentiometric Surface	NPO Change	WHA Score 2016	Status based on new Unmonitored Assessment
S-096	460	N/A	N/A	-2.060941	-11.48348	1.4676567	3.57442446	0.261126276	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH

Wetland Name	Wetland ID	Predicted NPO Offset (2008-2014)			Median 08-14 Depth to UFAS	SAS DDN	Predevelopment Potentiometric Surface minus Median 08-14 Potentiometric Surface	NPO Change	WHA Score 2016	Status based on new Unmonitored Assessment
		Connected Offset	Xeric Offset	Mesic Offset						
S-101	463	N/A	-2.097111	N/A	-0.648761	1.427799	3.18161395	3.739688884	0	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
SC-01	469	-1.492028	N/A	N/A	3.471856	0.017658	-2.93221657	1.092610104	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
SC-33	473	N/A	-2.187142	N/A	-2.076172	0.430486	1.00864935	1.045334397	1	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH
SC-70	481	N/A	N/A	-1.592627	-0.266557	0.790694	-1.34964791	1.887901566	0	HIGH DEGREE OF CERTAINTY OF WETLAND HEALTH

Table 10.2: Results of Unmonitored Sites Weight of Evidence Analysis

Results of Unmonitored Sites Weight-of-evidence Analysis, including all criteria and final bins. Cells colored red have not met the metric, and those in green have.

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
1121			-2.994292604	-9.667542	1.696858048	2.92108059000	2.54219105721	1	High Degree of Certainty of Wetland Health
1133			-2.683704419	-9.231185	1.828132987	3.00623894000	1.75414728447	1	High Degree of Certainty of Wetland Health
1145			-2.652548557	-8.694242	2.256201983	2.49122047000	1.87610499212	1	High Degree of Certainty of Wetland Health
1166		□	-3.508343806	-7.620076	1.323843956	0.77984238000	2.41967865807	1	High Degree of Certainty of Wetland Health
1186		□	-3.598270444	-9.358416	1.866914034	0.61646366000	3.54600642874	1	High Degree of Certainty of Wetland Health
1201			-2.806986324	-7.05647	1.803943992	0.59079742000	3.13875706896	1	High Degree of Certainty of Wetland Health
1217		□	-3.56822018	-4.706413	1.859616041	1.47150803000	2.73311184417	0	High Degree of Certainty of Wetland Health
1218		□	-3.268761939	-9.846588	2.041996956	0.03456401000	3.61471412749	1	High Degree of Certainty of Wetland Health
1221		□	-3.330773582	-9.035009	2.035098076	0.00480080000	3.28943267838	0	High Degree of Certainty of Wetland Health
1222			-2.03429429	-3.613946	1.802288055	0.53141308000	1.11551391449	1	High Degree of Certainty of Wetland Health
1226		□	-4.928485382	-11.051918	2.191224098	0.82703018000	2.23821506410	1	High Degree of Certainty of Wetland Health
1228		□	-3.049735933	-3.294942	2.153878927	0.19902230000	2.19433466840	1	High Degree of Certainty of Wetland Health
1229		□	-4.232123949	-10.697869	1.791193008	0.66515541000	2.89333181903	1	High Degree of Certainty of Wetland Health
1235			-2.201265726	-6.292372	1.937855005	0.10658168000	1.85396834152	1	High Degree of Certainty of Wetland Health
1246		□	-3.849745736	-10.492625	2.217034101	1.31642151000	3.38892664577	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
				UFAS 2008-2014		2008-2014 median UFAS			
1248			-2.877678504	-7.704727	2.200385094	0.49323082000	3.47363277609	1	High Degree of Certainty of Wetland Health
1254		□	-2.46328115	-9.285432	1.672178984	-0.35061455000	1.89168365727	1	High Degree of Certainty of Wetland Health
1259		□	-4.904950775	-10.076	2.217034101	1.62271500000	2.38058011827	1	High Degree of Certainty of Wetland Health
1262		□	-4.168357647	-10.089052	2.200385094	1.08783436000	3.22580185431	1	High Degree of Certainty of Wetland Health
1264			-2.61503222	-6.180271	1.896242976	-0.52798843000	2.60349902099	1	High Degree of Certainty of Wetland Health
1270			-1.941103813	-7.510073	1.264299989	-0.72593116000	1.10580286600	1	High Degree of Certainty of Wetland Health
1274			-3.446100437	-12.117126	1.306471944	1.61965752000	2.75206841875	0	High Degree of Certainty of Wetland Health
1283			-2.534857328	-7.638884	1.264299989	-0.35356521000	1.82795695855	1	High Degree of Certainty of Wetland Health
1291			-2.29328732	-6.324413	1.017935038	-0.09477520000	2.11988828349	1	High Degree of Certainty of Wetland Health
1292			-2.31582374	-4.864376	1.384461045	0.10304070000	1.58316901831	1	High Degree of Certainty of Wetland Health
1304	□		-2.711746134	-5.007605	1.713886023	1.50784111000	2.33529900917	1	High Degree of Certainty of Wetland Health
1416			-1.757737841	-13.53809	1.038537502	-0.71850316010	1.20191124378	1	High Degree of Certainty of Wetland Health
1436			-3.226996938	-11.511206	2.956509113	-0.56810951000	4.38587798510	0	High Degree of Certainty of Wetland Health
1437	□		-3.43431609	-11.646596	3.021673918	0.54314804000	4.50214019850	1	High Degree of Certainty of Wetland Health
1438	□		-3.212065145	-11.257132	3.021673918	1.21307564000	4.58912744250	1	High Degree of Certainty of Wetland Health
1444			-1.756682804	-11.488744	0.85514003	-1.16514334900	0.47514803029	1	High Degree of Certainty of Wetland Health
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
1452			-2.543750841	-12.804923	2.879017115	1.18922806000	1.86600966200	1	High Degree of Certainty of Wetland Health
1455	□		-2.984460421	-10.584263	3.28335309	-0.27018929000	5.54167216933	1	High Degree of Certainty of Wetland Health
1459	□		-2.590208822	-10.66993	3.196141005	-0.67050743000	4.02393034347	1	High Degree of Certainty of Wetland Health
1474	□		-2.676254826	-9.172115	3.227741003	1.43722916000	6.52639573916	1	High Degree of Certainty of Wetland Health
1477	□		-2.081963139	-10.244775	3.037538052	2.71299171000	3.30501159819	1	High Degree of Certainty of Wetland Health
1481		□	-3.184603361	-8.84295	3.227741003	0.72554588000	7.23936993434	1	High Degree of Certainty of Wetland Health
1491			-2.139133628	-11.3330286	0.881697416	2.62928107140	2.73589006813	1	High Degree of Certainty of Wetland Health
1494	□		-1.99154539	-10.257692	0.921055973	2.77100754000	2.76778571924	1	High Degree of Certainty of Wetland Health
1498			-2.582137135	-4.720961	3.870471954	-0.36888695000	6.74428454182	0	High Degree of Certainty of Wetland Health
1506			-2.332776622	-2.185394	1.855726957	-1.52072335000	3.11303964183	1	High Degree of Certainty of Wetland Health
1512			-2.603203845	-4.267116	3.870471954	-0.73631859000	5.69079511157	0	High Degree of Certainty of Wetland Health
1513			-1.72684159	-0.48291	1.311662316	-3.27946501420	2.51718280600	1	High Degree of Certainty of Wetland Health
1523			-2.050581126	-14.049707	1.02207005	2.71510676960	2.81522072020	1	High Degree of Certainty of Wetland Health
1532			-2.135844729	-12.2105230	1.332674503	2.28999414330	1.71945465414	0	High Degree of Certainty of Wetland Health
1551			-2.161457129	-7.1957565	1.422161222	-2.42082456840	4.35508731082	1	High Degree of Certainty of Wetland Health
1556			-1.943234926	-4.824678	1.409292221	-3.35761114430	3.71146024186	0	High Degree of Certainty of Wetland Health
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
1574			-1.984008966	N/A	1.140086532	1.78067158330	2.76841499463	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
1575			-1.897761403	-9.415461	1.21934998	1.58159269070	3.29721467139	0	High Degree of Certainty of Wetland Health
1579			-1.503503699	-6.977574	1.139106154	-3.01621308300	3.53923040772	1	High Degree of Certainty of Wetland Health
1591			-1.754948484	-12.685246	1.04290998	1.86920596030	2.22045579447	1	High Degree of Certainty of Wetland Health
1593			-1.830676586	-6.058517	1.087030053	-2.87775808960	4.77627894072	0	High Degree of Certainty of Wetland Health
1605		□	-2.170552615	-5.27327861	1.184298396	-2.17737206200	4.58162855320	1	High Degree of Certainty of Wetland Health
1606		□	-1.734976774	-6.52821646	1.098057032	-2.67295581270	4.05190583274	1	High Degree of Certainty of Wetland Health
1607			-2.020527959	N/A	1.186627984	0.44167029550	2.90722731077	1	High Degree of Certainty of Wetland Health
1627			-2.04639268	-6.9901745	1.626349688	-0.94347837260	3.93700190305	1	High Degree of Certainty of Wetland Health
1640			-1.707263737	-6.909296	0.978461027	-0.83975569140	3.29742887287	1	High Degree of Certainty of Wetland Health
1642		□	-2.366941461	-6.2665945	1.292952061	-1.71645616580	4.47306994578	1	High Degree of Certainty of Wetland Health
1657			-1.686341543	-8.806887	1.503451943	-0.86561662940	1.51327449106	1	High Degree of Certainty of Wetland Health
1680			-1.750766035	-9.022344	0.824285984	-1.30400423250	2.13132254265	1	High Degree of Certainty of Wetland Health
1683			-2.404951492	-9.92379	1.087400556	-1.72846453660	3.67379177682	0	High Degree of Certainty of Wetland Health
1707			-2.092481442	-8.8670435	0.830955148	-0.79216937830	3.15948411485	1	High Degree of Certainty of Wetland Health
1738			-2.645628815	-5.284136	1.758754015	2.27128554000	1.34648434550	1	High Degree of Certainty of Wetland Health
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
1746			-2.251595547	-4.591817	2.382836103	3.51361370000	1.73126097507	1	High Degree of Certainty of Wetland Health
1749			-2.659427117	-5.355778	2.382836103	2.42863178000	1.71715353523	0	Low Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
1756			-2.309274568	-5.646202	1.660740972	3.09540844000	1.31757270302	1	High Degree of Certainty of Wetland Health
1767			-1.779251406	-3.885969	1.967519999	1.88845540000	0.84031105477	1	High Degree of Certainty of Wetland Health
1768	□	□	-3.222692982	-5.227121	0.898029029	0.07820797000	1.97752010672	1	High Degree of Certainty of Wetland Health
1775		□	-3.357832858	-5.470351	1.678279996	-0.02959728000	1.43845771822	1	High Degree of Certainty of Wetland Health
1776	□	□	-3.177718551	-3.933261	1.601253986	0.38669300000	1.39898902938	1	High Degree of Certainty of Wetland Health
1800		□	-3.60999689	-4.351598	3.140686035	-0.13361264000	2.69134317570	1	High Degree of Certainty of Wetland Health
1805		□	-3.599765115	-5.582111	3.56020999	0.47068119000	3.85312499165	0	Low Degree of Certainty of Wetland Health
1806			-2.289065308	-4.3244845	2.039895058	0.17574098680	1.51416768366	1	High Degree of Certainty of Wetland Health
1817		□	-2.933155907	-6.154614	3.140686035	0.14961625000	2.15770608196	0	High Degree of Certainty of Wetland Health
1821		□	-2.793810616	-6.693992	2.214834929	-0.26365852000	1.67912658761	1	High Degree of Certainty of Wetland Health
1822	□	□	-3.16997038	-5.998094	2.33967495	0.65404415000	1.67660180410	0	Low Degree of Certainty of Wetland Health
1825		□	-2.613383084	-7.333195	2.214834929	0.73954868000	1.50185702352	1	High Degree of Certainty of Wetland Health
1832		□	-2.61867723	-4.604304	2.33967495	0.35994053000	1.53449972593	1	High Degree of Certainty of Wetland Health
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
1838			-2.696544076	-3.770383	2.462501049	1.53201724000	1.70576277770	0	Low Degree of Certainty of Wetland Health
1841			-2.948239465	-1.691885	1.712641001	0.17123031000	2.01822001328	0	High Degree of Certainty of Wetland Health
1853	□	□	-3.48573638	-7.408729	1.49882102	0.21339703000	2.54260614820	1	High Degree of Certainty of Wetland Health
1859			-3.146689881	-3.421855	5.779153824	-0.17994881000	3.06235101130	0	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
1860		□	-2.817840287	-4.617974	3.408416033	-0.10706711000	2.59975361212	1	High Degree of Certainty of Wetland Health
1879			-2.712994929	-1.569594	5.779153824	-0.33820152000	2.54369530804	0	High Degree of Certainty of Wetland Health
1890			-1.837631153	-0.840677	1.696051955	-0.12414798010	1.45743736208	1	High Degree of Certainty of Wetland Health
1891			-2.732913962	-3.239843	1.696051955	-0.20181275000	1.54065006497	1	High Degree of Certainty of Wetland Health
1900		□	-3.839914042	-1.39284	7.215696812	-0.34475803000	3.85887631496	0	High Degree of Certainty of Wetland Health
1904			-2.851601906	-3.504644	1.777510047	-0.26894570000	1.96102482729	1	High Degree of Certainty of Wetland Health
1910		□	-3.498548862	0.556582	4.478209972	-0.37134265000	2.96316015103	0	High Degree of Certainty of Wetland Health
1923			-3.180028352	-4.31779	6.962423801	-0.26825142000	2.86866270642	0	High Degree of Certainty of Wetland Health
1925	□		-2.873826828	-0.972156	7.215816975	-0.00504970000	2.75167732734	0	High Degree of Certainty of Wetland Health
1927		□	-3.849471046	0.435201	7.215696812	-0.24918366000	3.28289768604	0	High Degree of Certainty of Wetland Health
1937			-2.82055738	-1.607916	1.777510047	-0.40120506000	2.14699749289	1	High Degree of Certainty of Wetland Health
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
1940		□	-2.864297848	-3.890452	1.777510047	-0.39617252000	2.39944023546	1	High Degree of Certainty of Wetland Health
1945			-2.72132345	-2.625871	1.777510047	-0.58923149000	1.76517517343	1	High Degree of Certainty of Wetland Health
1946			-2.171966379	-7.790266	1.632915974	-0.71342277000	1.95982338127	1	High Degree of Certainty of Wetland Health
1952		□	-3.569951152	-1.665817	6.962423801	-0.12741948000	4.25431894105	0	High Degree of Certainty of Wetland Health
1955		□	-2.839241425	-0.746202	4.478209972	-0.63176537000	3.43514278323	1	High Degree of Certainty of Wetland Health
1959		□	-3.893400815	-6.057155	4.289765835	-0.39508629000	5.45222353814	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
1962		☐	-2.342198283	-7.771682	1.603688002	-0.72048759000	2.00110078869	1	High Degree of Certainty of Wetland Health
1963		☐	-2.986215014	-1.492566	4.289765835	-0.73874188000	3.22778562517	0	High Degree of Certainty of Wetland Health
1965	☐	☐	-3.839287516	-5.309373	5.174123764	-0.48364448000	4.38721959642	0	High Degree of Certainty of Wetland Health
1966		☐	-4.178815598	-5.897113	6.493803024	-0.89797306000	5.88722573133	0	High Degree of Certainty of Wetland Health
1969			-2.586798521	-8.333339	1.603688002	-0.71357727000	3.88868468912	1	High Degree of Certainty of Wetland Health
1979	☐	☐	-3.581047679	-3.376768	5.174123764	-0.95113945000	3.31815289455	0	High Degree of Certainty of Wetland Health
1989		☐	-5.403414871	-11.556174	5.174123764	-0.60125828000	4.27138313438	0	High Degree of Certainty of Wetland Health
1993			-1.826292466	-7.922616	0.850247025	-1.00219726000	0.51426389125	1	High Degree of Certainty of Wetland Health
2003			-2.085153742	-8.117749	1.952100992	-0.53366566000	2.01440023120	1	High Degree of Certainty of Wetland Health
2008			-1.616429068	-3.382423	2.839644909	-3.66782570000	2.17089483238	0	High Degree of Certainty of Wetland Health
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2016			-1.689164102	-3.79866	2.964044094	-4.02251244000	2.32667448591	0	High Degree of Certainty of Wetland Health
2022			-1.827430135	-8.205647	1.411996961	-1.30915642000	1.19112687953	1	High Degree of Certainty of Wetland Health
2026			-1.659706344	-2.991922	3.081031084	-4.09201813000	2.40503596539	0	High Degree of Certainty of Wetland Health
2033			-2.086778772	-7.47091	2.985289097	-1.36781311000	2.30171213931	1	High Degree of Certainty of Wetland Health
2044			-2.258123703	-2.851282	1.07457602	-1.95033264000	1.61090313951	1	High Degree of Certainty of Wetland Health
2059			-1.622174802	-3.101639	3.081031084	-4.70316505000	2.27931701281	0	High Degree of Certainty of Wetland Health
2063		☐	-4.797571878	-10.214118	8.510779381	-0.56161308000	5.67656765341	0	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2064			-2.404789428	-8.09339	6.300582886	-1.71260071000	2.16767846351	1	High Degree of Certainty of Wetland Health
2069			-2.028038948	-2.617915	1.373070002	-2.30542660000	1.85371170357	0	High Degree of Certainty of Wetland Health
2070		□	-2.478813178	-7.98881	0.822965801	-1.35920592050	2.53711095242	1	High Degree of Certainty of Wetland Health
2072		□	-2.92492507	-7.928914	2.159935951	-1.81488800000	4.66433499083	1	High Degree of Certainty of Wetland Health
2073		□	-2.642431849	-7.688955	1.150334001	-2.25572967000	3.37107091586	1	High Degree of Certainty of Wetland Health
2074			-1.967315403	-2.647673	3.482259989	-1.75978279000	2.43103646463	1	High Degree of Certainty of Wetland Health
2075	□	□	-4.139958479	-4.600456	5.233377934	-0.48351956000	5.03081745683	1	High Degree of Certainty of Wetland Health
2077		□	-2.000782322	-7.433009	1.150334001	-2.16771698000	2.23937419065	1	High Degree of Certainty of Wetland Health
2080			-3.227016935	-6.993475	7.241100788	-0.88477325000	4.59493981139	1	High Degree of Certainty of Wetland Health
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2083			-1.641416259	-3.287681	3.297823906	-4.86620903000	2.31824000302	0	High Degree of Certainty of Wetland Health
2086		□	-3.857399439	-4.398136	9.078974724	-0.95328998000	5.86054962850	0	High Degree of Certainty of Wetland Health
2095		□	-3.96930836	-5.04246	9.078974724	-1.17059803000	5.74082413210	0	High Degree of Certainty of Wetland Health
2098			-1.566528556	-2.363443	3.297823906	-5.27790070000	2.17229475008	0	High Degree of Certainty of Wetland Health
2099		□	-3.80980276	-7.952277	8.554637909	-0.69536114000	5.13078148465	1	High Degree of Certainty of Wetland Health
2100		□	-4.273860152	-8.04502	8.554637909	-0.53188896000	5.64542086007	0	High Degree of Certainty of Wetland Health
2105		□	-3.61168887	-6.581784	6.214931965	-1.02243519000	6.38678634270	1	High Degree of Certainty of Wetland Health
2106			-3.702394697	-9.121309	8.554637909	-0.29790973000	4.96431824169	0	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2109		□	-3.263148994	-2.640983	9.325304985	-0.65757943000	2.73262180808	0	High Degree of Certainty of Wetland Health
2115			-1.853642751	-6.749397	2.532008886	-1.90396595000	1.47731412254	1	High Degree of Certainty of Wetland Health
2118			-1.972376399	-4.94909	2.4363451	-5.90831756000	0.97857064402	0	Low Degree of Certainty of Wetland Health
2126			-1.944212686	-4.87448	2.147182941	-5.12100029000	1.07616456231	0	High Degree of Certainty of Wetland Health
2130			-1.6875444	-4.181339	2.306334019	-2.18202019000	1.63970710083	0	High Degree of Certainty of Wetland Health
2133			-4.120698408	-6.182709	9.325304985	-0.51918221000	6.09314668982	0	High Degree of Certainty of Wetland Health
2135			-2.114536445	-4.253406	2.090652943	-4.88451958000	1.73605269412	0	High Degree of Certainty of Wetland Health
2136			-2.070953663	-3.630048	5.275607109	-2.02067757000	2.28615041808	1	High Degree of Certainty of Wetland Health
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2137			-1.971748084	-3.269485	1.709903955	-2.49862809770	1.70797568866	0	High Degree of Certainty of Wetland Health
2139			-1.708929896	-4.005066	3.757282019	-6.21032143000	2.15824806581	0	High Degree of Certainty of Wetland Health
2140			-1.636950968	-4.451831	2.147182941	-5.65301895000	1.50914434896	0	High Degree of Certainty of Wetland Health
2141			-1.649989595	-3.178685	3.757282019	-5.89652443000	2.15839298685	0	High Degree of Certainty of Wetland Health
2146			-1.713268074	-1.553445	3.06050396	-4.73078156000	2.77040072449	0	High Degree of Certainty of Wetland Health
2149			-1.717107665	-4.276448	2.4363451	-6.36956597000	1.47397515106	0	High Degree of Certainty of Wetland Health
2150			-1.750544567	-3.574778	1.959069967	-2.89964199000	1.45065091482	1	High Degree of Certainty of Wetland Health
2153			-1.835991975	-6.545691	2.46897006	-4.85120583000	1.42478359663	0	High Degree of Certainty of Wetland Health
2157		□	-4.163554814	-8.595671	9.292469025	-0.10853100000	6.15857587650	0	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2158			-1.801544554	-5.855943	2.448110104	-3.99871635000	1.32874906480	1	High Degree of Certainty of Wetland Health
2161			-2.386938918	-0.966893	2.765932083	-5.68820381000	2.67349479909	0	High Degree of Certainty of Wetland Health
2162			-1.615979021	-4.123453	2.178637981	-5.56143379000	1.35519710175	0	High Degree of Certainty of Wetland Health
2163			-1.645063562	-3.779721	2.178637981	-6.13661384000	1.41776130620	0	High Degree of Certainty of Wetland Health
2165			-4.297354144	-8.424273	9.555556297	-0.16495419000	5.82614166887	0	High Degree of Certainty of Wetland Health
2168			-3.680952015	-5.085646	9.632222176	-0.08272648000	4.78583292330	0	High Degree of Certainty of Wetland Health
2170			-2.441435905	-5.298515	5.217965126	-1.22877598000	3.18644276084	1	High Degree of Certainty of Wetland Health
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2172			-1.588928909	-3.522792	2.328965902	-7.02698136000	1.07072045692	0	High Degree of Certainty of Wetland Health
2174			-1.668035146	-2.255243	3.628290892	-7.01579285000	1.93043157230	0	High Degree of Certainty of Wetland Health
2176			-3.409751163	-3.291309	9.121117592	-0.44462776000	2.96008362597	0	High Degree of Certainty of Wetland Health
2177			-2.601782506	-6.996994	2.193331957	-3.55743790000	3.54874965071	0	High Degree of Certainty of Wetland Health
2182			-3.780018051	-7.417804	9.173851967	0.19976998000	6.10674655470	0	Low Degree of Certainty of Wetland Health
2185			-2.761337365	-7.166962	7.258506775	-0.41101456000	2.95605143720	0	High Degree of Certainty of Wetland Health
2186			-2.169781046	-3.232166	1.959069967	-2.53040791000	1.69301775260	1	High Degree of Certainty of Wetland Health
2190			-3.888938656	-3.277896	7.955591202	-0.00005722000	4.56903622364	0	High Degree of Certainty of Wetland Health
2191			-1.596592428	0.585997	2.78927207	-6.49498558000	1.40816428204	0	High Degree of Certainty of Wetland Health
2193			-1.697589881	-4.012771	2.34008503	-5.33216095000	1.28260261640	0	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2195		□	-4.873149763	-7.210426	8.322854042	0.10180473000	5.72621406788	0	Low Degree of Certainty of Wetland Health
2203			-2.563559158	-2.9582035	1.777552605	-2.65570147310	1.58980481734	1	High Degree of Certainty of Wetland Health
2210		□	-5.136648199	-11.870641	8.322854042	0.06151485000	5.35019141374	0	Low Degree of Certainty of Wetland Health
2216	□		-1.817715774	-4.523053	1.998293996	-5.01302910000	1.23097607508	0	High Degree of Certainty of Wetland Health
2218			-1.82711707	-1.925631	2.091886044	-5.78638840000	1.36893019451	0	High Degree of Certainty of Wetland Health
2221			-1.576170729	-1.846609	2.139081955	-6.55236626000	1.01828234017	0	High Degree of Certainty of Wetland Health
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2223			-3.355054366	-5.279161	8.670304298	-0.75409604000	3.75955508536	0	High Degree of Certainty of Wetland Health
2225			-2.129540751	-4.350374	3.327280998	-0.91777992000	2.15882657878	1	High Degree of Certainty of Wetland Health
2229			-2.811749195	-6.273354	4.554703236	-0.96382713000	5.35460647569	1	High Degree of Certainty of Wetland Health
2239			-2.923883598	-4.81506	5.653162003	-1.41610051000	3.08721685205	1	High Degree of Certainty of Wetland Health
2242			-2.223236254	-4.470572	3.327280998	-1.38981915000	2.88388732958	1	High Degree of Certainty of Wetland Health
2245			-2.413318032	-2.07174075	1.425685048	-2.85313900400	1.55130023336	1	High Degree of Certainty of Wetland Health
2249			-1.581343553	-1.776164	2.139081955	-6.80799103000	1.18954120920	0	High Degree of Certainty of Wetland Health
2254		□	-2.325151294	-3.078847	2.085817099	-2.16371631000	1.73107994443	1	High Degree of Certainty of Wetland Health
2255			-1.912313956	-2.749443	1.857302427	-2.68245533120	1.70716043276	1	High Degree of Certainty of Wetland Health
2256			-2.55075111	0.168705	3.029166937	-7.03525543000	3.80123662248	1	High Degree of Certainty of Wetland Health
2263		□	-2.695732836	-3.017314	1.917286992	-5.63939667000	2.94162935417	0	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2270			-2.050456567	-3.836234	1.860735059	-2.46600343460	1.63673150021	1	High Degree of Certainty of Wetland Health
2271			-2.058871553	-2.9526305	1.878825784	-2.64535396310	1.60988517809	1	High Degree of Certainty of Wetland Health
2277			-2.128445994	-6.215452	4.196103096	-1.02229499000	2.42905727655	1	High Degree of Certainty of Wetland Health
2278			-1.673356615	-3.4653215	1.860735059	-2.52172445660	1.56381144287	1	High Degree of Certainty of Wetland Health
2279	□		-1.840896987	-2.30036	2.286439896	-5.81385231000	1.32467632377	0	High Degree of Certainty of Wetland Health
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2285			-1.776145082	-0.626317	2.411324978	-6.46338463000	2.08707884504	0	High Degree of Certainty of Wetland Health
2312			-2.010133228	-4.008068	1.763574004	-2.31096979590	1.60911317904	1	High Degree of Certainty of Wetland Health
2315			-1.47714032	1.218761	2.494703054	-6.75367737000	1.17587180831	0	High Degree of Certainty of Wetland Health
2317			-1.685017062	-4.109461	1.763574004	-2.41859710060	1.77430944012	1	High Degree of Certainty of Wetland Health
2321			-2.753046473	-5.590382	6.159699917	-1.14853191000	2.97601336791	1	High Degree of Certainty of Wetland Health
2326		□	-2.071051506	-3.262695	1.908224106	-2.07705533290	2.03622947436	1	High Degree of Certainty of Wetland Health
2328			-1.656587725	-3.7424465	1.763574004	-2.35914289140	1.55646490201	1	High Degree of Certainty of Wetland Health
2330			-2.582581457	-5.183571	5.212591171	-3.15309906000	2.97943358412	1	High Degree of Certainty of Wetland Health
2332			-2.666646795	-5.48112	6.159699917	-0.43941212000	2.55301172352	1	High Degree of Certainty of Wetland Health
2334		□	-2.847288181	-5.649715	4.485706806	-0.84833813000	4.22170769157	1	High Degree of Certainty of Wetland Health
2336		□	-3.113474435	-6.353559	2.73417592	1.65080071000	3.34124185733	0	Low Degree of Certainty of Wetland Health
2341	□		-2.57120365	-2.576571	4.293550015	-4.24602699000	2.21906314664	0	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2351			-1.468277248	1.933631	2.753484011	-6.76072883000	1.44240697645	0	High Degree of Certainty of Wetland Health
2352	□		-3.082204647	-4.758871	4.485706806	0.53933143000	4.20763903690	1	High Degree of Certainty of Wetland Health
2356			-1.486951761	-0.359679	3.015779018	-6.88809776000	1.80723518917	0	High Degree of Certainty of Wetland Health
2357		□	-2.362379412	-1.645955	2.027331114	-5.94744301000	2.52767191519	1	High Degree of Certainty of Wetland Health
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2360	□		-2.363770144	-2.459048	4.293550015	-4.35597420000	2.32620468903	0	High Degree of Certainty of Wetland Health
2362			-1.461046923	0.993246	2.602762938	-6.52371407000	1.31233329270	0	High Degree of Certainty of Wetland Health
2365			-2.108216627	-4.188662	1.602669954	-2.08480377240	1.54827589800	1	High Degree of Certainty of Wetland Health
2367			-2.299182347	-3.736335	1.734239697	-1.50421487840	2.00930256534	1	High Degree of Certainty of Wetland Health
2369	□		-2.519727675	-3.402012	4.348517895	-3.23964882000	2.34847081279	1	High Degree of Certainty of Wetland Health
2373	□		-2.678264357	-4.296137	4.694629192	-1.48799229000	3.09378804309	0	High Degree of Certainty of Wetland Health
2374			-1.688591636	-1.840232	3.9377141	-4.62691498000	1.99950479230	0	High Degree of Certainty of Wetland Health
2375			-1.718884513	-1.547729	3.9377141	-5.03647614000	1.98040019144	0	High Degree of Certainty of Wetland Health
2377		□	-1.897678894	-3.8213585	2.040000439	-1.28829864430	2.28507384352	1	High Degree of Certainty of Wetland Health
2380			-1.700839692	-1.190932	3.75770402	-6.09419441000	2.13732302119	0	High Degree of Certainty of Wetland Health
2381		□	-3.064400448	-8.242695	2.923820972	1.94334888000	3.17649807399	0	High Degree of Certainty of Wetland Health
2382			-1.724051292	0.711832	2.955302	-6.98977852000	1.59788395371	0	High Degree of Certainty of Wetland Health
2386			-1.659856943	-0.199494	2.647315979	-6.64680291000	1.40801100745	0	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2391		□	-3.015788043	-3.451902	2.196680069	-6.43701171000	2.67486198327	1	High Degree of Certainty of Wetland Health
2395			-1.523447075	-0.749587	2.955302	-6.39801407000	1.41052661036	0	High Degree of Certainty of Wetland Health
2397		□	-3.801996152	-7.270847	2.196680069	-6.07298470000	3.51248237908	1	High Degree of Certainty of Wetland Health
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2399		□	-1.981909924	0.814222	2.520391941	-6.69112777000	2.26359355754	0	High Degree of Certainty of Wetland Health
2400			-1.70269752	-1.046467	3.75770402	-6.14640618000	1.88818525753	0	High Degree of Certainty of Wetland Health
2404	□		-1.428346369	-0.428328	2.955302	-6.41170693000	1.74071639487	0	High Degree of Certainty of Wetland Health
2418			-1.870908537	-0.378479	3.384701014	-6.04586029000	1.85699031356	0	High Degree of Certainty of Wetland Health
2425			-2.049350262	-7.026921	1.746335983	1.74528694000	0.58155175695	1	High Degree of Certainty of Wetland Health
2439		□	-2.657225985	-7.131519	2.125536919	1.37941771640	1.56133835165	0	High Degree of Certainty of Wetland Health
2440	□	□	-1.632201664	-1.546105	0.544364989	-4.90073696890	1.32923443382	1	High Degree of Certainty of Wetland Health
2448			-1.699035636	-2.225811	3.758533955	-4.88360786000	2.34126664498	0	High Degree of Certainty of Wetland Health
2457			-2.032168941	-8.564091	2.394845009	1.87674808000	1.02185798926	0	Low Degree of Certainty of Wetland Health
2458			-2.254563347	-10.2736945	2.125536919	1.36127797720	1.82408221861	0	Low Degree of Certainty of Wetland Health
2463			-2.817169532	-7.175522	1.72388804	1.09279632000	2.64300251532	0	High Degree of Certainty of Wetland Health
2473			-1.630142133	-1.339675	2.455322981	-5.38861846000	1.40518855497	0	High Degree of Certainty of Wetland Health
2488			-2.297045134	-6.898963	1.869001985	0.85369110000	1.51154582849	0	High Degree of Certainty of Wetland Health
2491			-1.61365183	0.272964	1.919576049	-5.55577087000	1.36881846507	0	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2492			-2.879566891	-10.931823	2.125536919	0.76128864000	2.71104368495	0	Low Degree of Certainty of Wetland Health
2505			-2.223119925	-3.164842	1.668034077	-1.93963344620	1.67120893759	1	High Degree of Certainty of Wetland Health
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2506			-1.433460856	-0.1355945	1.919576049	-5.49472618000	1.12923662687	0	High Degree of Certainty of Wetland Health
2510			-2.384097912	-3.17857370	1.458380342	-2.55786926560	1.65370055160	1	High Degree of Certainty of Wetland Health
2511			-2.35357863	-7.01441780	2.02630496	0.99854581120	1.80567989252	0	High Degree of Certainty of Wetland Health
2516			-1.409269002	-1.277851	2.455322981	-4.39842606000	1.32558370980	0	High Degree of Certainty of Wetland Health
2522			-2.132842582	-7.2979135	1.592792988	1.00852079950	0.59487907741	0	Low Degree of Certainty of Wetland Health
2523			-1.928520322	-3.17847630	1.767354131	-2.44637572030	1.63630566364	1	High Degree of Certainty of Wetland Health
2531			-2.05426396	-4.108866	1.814365029	-1.82254139890	1.76156335356	1	High Degree of Certainty of Wetland Health
2535			-1.465512783	-1.71979	2.070458889	-4.15803337000	1.17081079336	0	High Degree of Certainty of Wetland Health
2536			-1.594556483	-3.380437	1.351799965	-2.77242761710	1.51790729457	1	High Degree of Certainty of Wetland Health
2541			-1.883940594	-3.701776	1.814365029	-2.77799588660	2.24563821389	1	High Degree of Certainty of Wetland Health
2548			-2.283162791	-7.805375	1.942656517	-1.38327023280	2.14548962595	1	High Degree of Certainty of Wetland Health
2549			-2.065150244	-4.690723	2.748191118	-3.55273056000	2.07340737851	1	High Degree of Certainty of Wetland Health
2550			-1.932013214	-8.316853	1.775535941	0.83665044210	0.88990012638	0	Low Degree of Certainty of Wetland Health
2551			-1.797921558	-3.745779	2.178775072	-1.32192249090	1.67901447993	1	High Degree of Certainty of Wetland Health
2567			-1.722505587	-0.1355945	1.580060005	-4.08118521690	1.97943022456	0	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2569	□		-2.004958917	-5.695355	2.404413462	-2.35440436740	1.55405291985	1	High Degree of Certainty of Wetland Health
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
2570			-2.109092299	-3.363675	1.859429955	-3.73316574000	1.57801633438	0	High Degree of Certainty of Wetland Health
2571			-1.83220031	-5.038685	1.621313572	-2.73633049650	1.27264242172	0	High Degree of Certainty of Wetland Health
2578			-1.725870807	-3.3017235	1.440299034	-1.45380064620	1.62824290914	1	High Degree of Certainty of Wetland Health
2583			-2.373780044	-4.931141	1.736518979	-2.75864718220	2.20029660611	1	High Degree of Certainty of Wetland Health
2593			-1.735933405	-2.8969435	1.440299034	-1.20064459570	1.63764604092	1	High Degree of Certainty of Wetland Health
2604			-2.488386665	-3.25748	2.063336849	-2.91266025100	2.09671377161	1	High Degree of Certainty of Wetland Health
2636			-1.75463202	-4.901284	1.19307816	-2.22365184400	1.57603493818	1	High Degree of Certainty of Wetland Health
3039			-3.59488485	-4.602301	7.258506775	-0.47092438000	5.13945304328	1	High Degree of Certainty of Wetland Health
3044			-2.530916377	-2.779063	1.269394994	-1.33496952000	2.71988174825	1	High Degree of Certainty of Wetland Health
3046			-2.52985468	-3.144252	1.845075965	-2.22377396000	1.81887455832	1	High Degree of Certainty of Wetland Health
3047			-2.732963615	-3.690447	5.275607109	-1.54017353000	2.48373757686	1	High Degree of Certainty of Wetland Health
3048			-2.346544818	-2.910061	3.356343985	-2.14521218000	2.29242259243	1	High Degree of Certainty of Wetland Health
3049			-2.205680487	-4.757863	5.217965126	-1.89620400000	2.29758091312	0	High Degree of Certainty of Wetland Health
3050			-2.065870757	-5.013189	4.188845158	-1.75429535000	2.36742580105	1	High Degree of Certainty of Wetland Health
3051		□	-2.623121898	-3.778624	2.626981974	-1.90751648000	1.73108985903	1	High Degree of Certainty of Wetland Health
3052		□	-1.998366792	-2.866381	2.085817099	-1.86997700000	2.08735073832	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
3053			-2.522453095	-4.601165	4.554703236	-0.73529053000	3.79499956799	1	High Degree of Certainty of Wetland Health
3054			-2.77920797	-3.776962	5.275607109	-1.76371670000	3.25945283936	1	High Degree of Certainty of Wetland Health
3059			-2.072784546	-2.378893	1.959069967	-2.71140480000	1.62695059856	1	High Degree of Certainty of Wetland Health
3060			-2.405136923	-2.00184134	1.923702955	-2.58642006370	1.52474155367	1	High Degree of Certainty of Wetland Health
3061	□	□	-3.651333475	-1.247557	7.215816975	-0.04982758000	3.04782182345	0	High Degree of Certainty of Wetland Health
3065			-1.885623199	-1.176341	1.800460458	-0.06045859240	0.78306824303	1	High Degree of Certainty of Wetland Health
3066			-2.758449304	-1.395585	5.779153824	-0.17920494000	2.67234027961	1	High Degree of Certainty of Wetland Health
3067			-2.535104532	-3.90936	2.497750044	0.02911377000	2.20744118464	1	High Degree of Certainty of Wetland Health
3070			-2.257214308	-3.551029	2.200660944	-0.02916241000	1.72748343209	1	High Degree of Certainty of Wetland Health
3071			-2.507176002	-2.574031	1.275876045	-0.73031235000	1.52116010527	1	High Degree of Certainty of Wetland Health
3075		□	-3.907676227	-2.994421	8.157190323	-0.77573109000	5.11925007689	0	High Degree of Certainty of Wetland Health
3077			-2.571236036	-4.289307	1.889837027	1.99553299000	1.63458086582	0	High Degree of Certainty of Wetland Health
3080			-2.457312679	-3.65263	1.889837027	2.04434109000	1.61908391992	0	High Degree of Certainty of Wetland Health
3081			-2.893334032	-4.334272	1.967519999	1.02296830000	1.66193902106	1	High Degree of Certainty of Wetland Health
3082			-1.743303422	-4.289356	2.184298038	-0.16838312000	1.78273240510	1	High Degree of Certainty of Wetland Health
3085			-2.198983949	-5.100982	1.968032956	3.14198637000	1.27225869869	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
3087		□	-2.332673171	-6.239378	1.49882102	-0.16862965000	1.89805019453	1	High Degree of Certainty of Wetland Health
3088		□	-3.362004666	-7.145854	3.408416033	0.36134815000	4.26563036052	1	High Degree of Certainty of Wetland Health
3089			-2.837917937	N/A	1.49882102	-0.18928718000	2.31862630736	1	High Degree of Certainty of Wetland Health
3091			-1.993238459	-4.791663	1.973168969	-3.55333519000	1.75394736074	1	High Degree of Certainty of Wetland Health
3092			-1.69130496	-3.812012	3.081031084	-4.12758446000	2.37399624631	0	High Degree of Certainty of Wetland Health
3094			-1.431877642	-0.141208	2.722099066	-4.75031662000	2.72629912575	0	High Degree of Certainty of Wetland Health
3095			-1.383296554	-0.006498	2.587881088	-4.82570267000	1.68473576913	0	High Degree of Certainty of Wetland Health
3096		□	-2.007481649	1.758931	2.852308989	-6.99720955000	2.57270714244	0	High Degree of Certainty of Wetland Health
3100			-1.944690592	-0.328527	3.316128969	-6.94462204000	1.53769476216	0	High Degree of Certainty of Wetland Health
3101			-1.562517934	0.781034	2.78927207	-6.84654045000	1.40073661199	0	High Degree of Certainty of Wetland Health
3102			-2.141928144	-4.360291	1.998293996	-4.59270859000	1.75484490723	0	High Degree of Certainty of Wetland Health
3103			-2.148135354	-3.919916	2.337611914	-4.24861717000	1.82107945519	1	High Degree of Certainty of Wetland Health
3104		□	-2.375673032	1.739931	2.583229065	-7.34937477000	2.08898169979	0	High Degree of Certainty of Wetland Health
3105			-1.74675497	-0.532369	2.608690023	-6.31072044000	1.62430473903	1	High Degree of Certainty of Wetland Health
3106		□	-2.681254465	-0.551914	2.413249016	-6.15699005000	2.24574015224	0	High Degree of Certainty of Wetland Health
3107			-2.914955229	-5.225225	2.630794048	1.60889912000	3.01084943898	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
3108		□	-3.35000805	-5.1952875	2.127326012	1.11960972390	3.07781062593	0	Low Degree of Certainty of Wetland Health
3109		□	-3.05370402	-2.783467	1.808655977	-1.41975880000	2.71352766482	1	High Degree of Certainty of Wetland Health
3110			-2.466819195	-4.205374	2.694556952	1.80844403000	2.53890617130	1	High Degree of Certainty of Wetland Health
3111		□	-3.128883981	-3.435271	2.105020046	-1.45709896000	2.99727509825	1	High Degree of Certainty of Wetland Health
3112		□	-2.758143202	-5.358978	2.105020046	-0.96211242000	2.91319317972	1	High Degree of Certainty of Wetland Health
3113		□	-4.276399546	-2.985367	9.121117592	-0.51029587000	5.33026594670	0	High Degree of Certainty of Wetland Health
3114		□	-4.983324119	-3.956318	8.586923599	0.11428071000	5.12230144516	0	Low Degree of Certainty of Wetland Health
3115			-2.379057658	-8.988659	2.497637033	1.99861050000	2.69597535859	0	Low Degree of Certainty of Wetland Health
3116			-2.847543899	-9.567405	2.394845009	1.79674244000	2.49395128617	0	Low Degree of Certainty of Wetland Health
3117			-2.83279643	-7.01323	1.958920002	2.09016990000	3.20704243360	0	High Degree of Certainty of Wetland Health
3118			-2.56425405	-8.257473	2.488992929	2.18258286000	2.56050111500	0	Low Degree of Certainty of Wetland Health
3119		□	-3.230086535	-7.089895	2.338674068	2.17047691000	3.47574162850	0	Low Degree of Certainty of Wetland Health
3120		□	-3.692980871	-8.160659	2.125536919	0.99126815000	3.12664496726	0	Low Degree of Certainty of Wetland Health
3121			-2.538515299	-3.726231	1.93157196	-2.37177563000	2.33920170368	1	High Degree of Certainty of Wetland Health
3122			-2.4162184	-5.016661	2.082492113	-1.96920681000	2.53461737926	1	High Degree of Certainty of Wetland Health
3123			-2.522210523	-3.50819	3.758533955	-4.04651642000	2.91236061836	0	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
3124			-1.816548127	-0.32018	2.417783022	-6.26260948000	2.14674130658	0	High Degree of Certainty of Wetland Health
3125	□		-2.851986242	-7.178979	2.045655966	0.75076867000	3.13237481509	0	High Degree of Certainty of Wetland Health
3126			-2.207435381	-6.24797502	1.393481016	0.69950209060	1.47437006414	1	High Degree of Certainty of Wetland Health
3127			-1.869167342	-9.349576	2.321558952	2.38605594000	0.92134357196	0	Low Degree of Certainty of Wetland Health
3128			-1.953662492	-9.1589885	2.165381908	1.77547744860	1.00557986537	0	Low Degree of Certainty of Wetland Health
3130		□	-2.315205446	-3.442923	2.152942896	-3.82305146000	2.54382562645	0	High Degree of Certainty of Wetland Health
3131		□	-2.72578469	-2.311234	2.121014118	-5.64456939000	2.17837032065	0	High Degree of Certainty of Wetland Health
3133		□	-2.986442885	-1.276201	2.196680069	-5.79426003000	2.36405556857	1	High Degree of Certainty of Wetland Health
3134	□		-2.272221065	-2.21195427	1.326259971	-4.87931386170	2.80584377534	1	High Degree of Certainty of Wetland Health
3136			-2.294693174	-12.056879	1.06358695	-0.37570572000	2.63495729555	1	High Degree of Certainty of Wetland Health
3140		□	-3.563604919	-9.312242	2.102782965	2.16065312000	3.24349623720	1	High Degree of Certainty of Wetland Health
3143		□	-2.666223174	-5.963077	2.197653055	0.62031937000	1.43926149822	1	High Degree of Certainty of Wetland Health
3144			-2.39304074	-2.81601	1.927031994	0.11493969000	1.64988998805	1	High Degree of Certainty of Wetland Health
3145			-2.958848437	-5.732657	1.927031994	0.51314926000	3.04185978139	1	High Degree of Certainty of Wetland Health
3331			-1.397930521	-6.284237	1.748160958	3.87797737000	1.35123675993	1	High Degree of Certainty of Wetland Health
3361			-1.562962114	-5.911065	1.855429053	4.16614151000	2.18949370999	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
3390			-1.947229884	-5.040029	2.171097994	3.95365715000	2.93110278518	1	High Degree of Certainty of Wetland Health
3399			-1.927287056	-6.028942	2.171097994	3.95750427000	3.23470141511	1	High Degree of Certainty of Wetland Health
3420			-1.608457127	-4.149438	2.171097994	4.41596031000	2.12717734223	1	High Degree of Certainty of Wetland Health
3461			-2.282150446	-3.67036597	2.41656208	4.27919960000	2.70113855628	0	Low Degree of Certainty of Wetland Health
3489			-1.761539148	-6.403274	0.245189995	4.29858589000	1.37895678470	1	High Degree of Certainty of Wetland Health
3881			-2.209747911	-9.291733	1.573727965	11.49031449000	1.35929200507	0	High Degree of Certainty of Wetland Health
3898			-2.093640122	0.514929	0.656741023	-1.46020127000	1.23288644383	1	High Degree of Certainty of Wetland Health
3903			-2.177448571	-10.361708	1.523051977	11.30245590000	1.77655728211	0	High Degree of Certainty of Wetland Health
3939			-1.847542297	-10.930084	1.830875039	9.69156265000	1.67949251652	1	High Degree of Certainty of Wetland Health
3955			-2.379786082	-11.216618	1.830875039	9.49317551000	1.64971835661	0	High Degree of Certainty of Wetland Health
3961			-2.783022178	-10.757137	1.830875039	10.63509560000	2.30777980808	0	High Degree of Certainty of Wetland Health
3962			-1.922273488	0.637516	0.313998014	-0.38624191000	0.91648949761	1	High Degree of Certainty of Wetland Health
3975			-2.542434635	-4.256403	2.407974958	14.54389190000	1.68721025924	0	Low Degree of Certainty of Wetland Health
3991			-2.247026979	-9.42383	2.681710005	10.45817756000	2.27867350052	0	Low Degree of Certainty of Wetland Health
4008			-1.984350178	-10.785649	3.273441076	12.82798576000	2.01301109534	0	Low Degree of Certainty of Wetland Health
4009			-3.097695198	-6.57845	3.21863699	5.06054688000	1.86467016115	0	Low Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
4043			-2.893954631	-9.056499	3.651746988	12.39052582000	3.30299958491	0	Low Degree of Certainty of Wetland Health
4064			-2.375338908	-9.392923	3.651746988	12.52697563000	2.37013451318	0	Low Degree of Certainty of Wetland Health
4079			-2.878252122	-6.530855	3.818842888	14.78597832000	2.09919736345	0	Low Degree of Certainty of Wetland Health
4081			-3.04767102	-7.355233	3.433402061	15.10576439000	2.14371978609	0	Low Degree of Certainty of Wetland Health
4086		□	-1.90642689	N/A	0.395633996	0.28269577000	1.08122242994	1	High Degree of Certainty of Wetland Health
4087			-3.364065486	-11.595403	3.390420914	14.11479569000	1.91114601050	0	Low Degree of Certainty of Wetland Health
4097			-2.987424947	-8.924173	3.433402061	15.04209328000	1.77530517076	0	Low Degree of Certainty of Wetland Health
4102			-2.819423216	-9.023839	3.818842888	14.71583367000	3.03807446591	0	Low Degree of Certainty of Wetland Health
4112			-3.10688492	-11.120566	3.390420914	13.91906357000	2.07915745468	0	Low Degree of Certainty of Wetland Health
4123			-3.840456203	-10.876903	3.761333942	14.81087685000	1.05455395956	0	Low Degree of Certainty of Wetland Health
4128			-3.164269637	-9.418356	3.826256037	15.19097900000	2.75272211196	0	Low Degree of Certainty of Wetland Health
4148			-4.100886489	-11.353538	3.628252029	14.64861489000	0.90740999240	0	Low Degree of Certainty of Wetland Health
4236			-2.858151257	-0.907705	2.064795017	2.15096664000	3.08337645576	1	High Degree of Certainty of Wetland Health
4271			-4.079190297	-12.073051	3.908289909	13.02173042000	1.36257960532	0	Low Degree of Certainty of Wetland Health
4283			-1.52882717	2.126554	1.172631979	3.17689896000	2.66926982329	1	High Degree of Certainty of Wetland Health
4286			-4.271646023	-12.860859	3.908289909	13.01807976000	1.90942335334	0	Low Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
4336			-1.470718621	-4.361188	0.765326977	2.70956803000	0.77963936000	1	High Degree of Certainty of Wetland Health
4355			-1.597395606	-4.128015	0.664111972	3.30592346000	0.72701839958	1	High Degree of Certainty of Wetland Health
4392			-2.563054044	0.637533	2.461488962	5.32783509000	2.32036643408	0	High Degree of Certainty of Wetland Health
4405			-2.943189487	-4.290592	1.785573959	5.68519592000	2.28226603190	0	High Degree of Certainty of Wetland Health
4423			-2.936896929	-4.064928	1.785573959	5.23943329000	2.77618483002	0	High Degree of Certainty of Wetland Health
4439			-2.715986203	-12.355554	1.268345952	10.17488098000	1.98074782120	0	High Degree of Certainty of Wetland Health
4442			-2.938878618	-12.801733	1.325785041	10.57565690000	1.74760526038	0	High Degree of Certainty of Wetland Health
4465			-2.830162644	-11.393643	1.926903963	10.20818520000	1.26321691111	0	High Degree of Certainty of Wetland Health
4468			-3.966212469	-7.213439	1.785573959	5.46599961000	1.86351810760	0	High Degree of Certainty of Wetland Health
4474			-3.647114334	-10.723607	2.074316025	9.72808456000	2.25252261474	0	Low Degree of Certainty of Wetland Health
4489			-3.733022849	-10.756593	2.074316025	9.02172470000	2.34765986016	0	Low Degree of Certainty of Wetland Health
4491			-4.260372746	-6.658525	4.876490116	6.29693222000	3.02936892349	0	Low Degree of Certainty of Wetland Health
4501			-4.203441597	-6.81334	4.876490116	6.44347000000	2.97182676636	0	Low Degree of Certainty of Wetland Health
4503			-4.128370919	-10.725725	6.57758379	7.63417053000	3.57124793001	0	Low Degree of Certainty of Wetland Health
4504			-2.844996487	-8.864368	2.074316025	8.90025520000	1.52292092254	0	Low Degree of Certainty of Wetland Health
4512		□	-3.319035083	-13.057242	1.741423965	9.80918884000	1.89983840883	0	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
4514			-3.419240693	-11.513387	2.233151913	10.00796128000	2.30671716999	0	Low Degree of Certainty of Wetland Health
4538			-3.799042825	-6.718858	5.303737164	7.25951385000	3.28944303644	0	Low Degree of Certainty of Wetland Health
4543			-4.290777436	-9.129867	4.876490116	6.27648163000	3.92404532643	0	Low Degree of Certainty of Wetland Health
4558			-2.522807024	-7.956326	0.610548019	7.07655716000	0.13856926632	0	Low Degree of Certainty of Wetland Health
4562			-2.372068514	-1.313204	0.539153993	4.79581070000	0.95638302882	1	High Degree of Certainty of Wetland Health
4574			-2.531372022	-9.690393	1.054777026	7.89828873000	1.46926290234	0	High Degree of Certainty of Wetland Health
4578			-2.473962155	-7.921324	0.963105977	8.26902771000	0.05839100445	0	Low Degree of Certainty of Wetland Health
4613	□		-2.950880938	-9.569153	1.250023961	8.93903350000	1.97186470344	0	High Degree of Certainty of Wetland Health
4682	□		-2.944334827	-7.976857	0.484225005	6.21060944000	3.61367540350	1	High Degree of Certainty of Wetland Health
4802			-4.654239062	-6.010248	1.833686948	3.01239395000	2.52547014443	1	High Degree of Certainty of Wetland Health
4822	□		-4.671826295	-7.498521	2.524785042	5.16329575000	3.34640545459	0	Low Degree of Certainty of Wetland Health
4832			-4.818694688	-5.28993	1.752414942	2.16163636000	2.55268385760	0	High Degree of Certainty of Wetland Health
4848		□	-4.436983228	-6.818052	1.783077002	1.74572372000	2.33975285310	0	High Degree of Certainty of Wetland Health
4871			-3.582203238	-8.880404	2.610924006	4.87693405000	2.06671513024	0	Low Degree of Certainty of Wetland Health
4884			-3.53216977	-9.280739	2.610924006	5.33588409000	2.34484609710	0	Low Degree of Certainty of Wetland Health
4893			-3.962414521	-8.463714	2.610924006	4.67931366000	1.91491717127	0	Low Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
4924			-3.870573527	-7.371688	2.394674063	4.88962555000	2.11544474969	0	Low Degree of Certainty of Wetland Health
4959			-4.329335028	-7.382473	2.351739883	4.71844101000	2.23203298315	0	Low Degree of Certainty of Wetland Health
4963			-4.08095756	-7.418197	2.3748281	4.79693604000	2.10071221786	0	Low Degree of Certainty of Wetland Health
4977			-4.77356843	-8.013545	1.834082961	3.01751327000	1.88302227924	0	High Degree of Certainty of Wetland Health
4985			-3.603969403	-5.62617	1.666550994	1.45605469000	2.22951745641	0	High Degree of Certainty of Wetland Health
4990			-3.918506003	-7.674056	2.169307947	5.06811905000	1.97939199852	0	Low Degree of Certainty of Wetland Health
5003			-4.115623474	-6.452889	1.921591043	1.48755645000	3.06518980886	0	High Degree of Certainty of Wetland Health
5004			-5.018371073	-6.197138	1.834758997	1.90670014000	2.52100547502	0	High Degree of Certainty of Wetland Health
5006	□		-5.487256396	-5.497546	1.749218941	1.86173630000	2.18044262287	0	High Degree of Certainty of Wetland Health
5010			-3.462999057	-7.907485	1.880041957	0.89762497000	2.18115065729	0	High Degree of Certainty of Wetland Health
5011	□	□	-4.499487797	-5.183121	1.880041957	0.09580231000	2.83663070899	0	High Degree of Certainty of Wetland Health
5012	□		-5.150536103	-7.318818	1.939124942	4.99501419000	1.90450841198	0	High Degree of Certainty of Wetland Health
5019		□	-3.394087401	-6.643385	1.51868701	-2.90440368000	2.60790476749	1	High Degree of Certainty of Wetland Health
5021		□	-5.16325514	-7.245432	2.46254611	4.45443726000	2.76003705661	1	High Degree of Certainty of Wetland Health
5025		□	-3.551913669	-8.175899	1.214519978	-3.53413010000	3.61401132206	1	High Degree of Certainty of Wetland Health
5027		□	-3.464079288	-5.942397	2.399343967	8.32565613000	1.73064638176	0	Low Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5031		□	-3.672712631	-7.897481	2.156410933	1.37543488000	2.98318663187	0	Low Degree of Certainty of Wetland Health
5032		□	-5.244746396	-9.065093	1.998033047	3.38714600000	2.40274788933	0	High Degree of Certainty of Wetland Health
5036			-4.764402527	-6.013404	2.228439093	4.90345002000	1.95507601369	0	Low Degree of Certainty of Wetland Health
5038		□	-3.39627481	-11.354907	2.037127018	3.49079895000	2.74430717523	0	High Degree of Certainty of Wetland Health
5040		□	-4.794790499	-8.958557	2.007250071	3.35540390000	2.90772087496	0	High Degree of Certainty of Wetland Health
5041			-4.226525254	-7.986861	2.228439093	5.11875152000	2.39782495243	0	Low Degree of Certainty of Wetland Health
5043		□	-3.437436893	-10.522959	1.253231049	4.15297699000	3.03387684346	0	High Degree of Certainty of Wetland Health
5046	□	□	-4.542040559	-8.609723	2.347934008	1.54502868000	3.50059299583	0	Low Degree of Certainty of Wetland Health
5049	□	□	-4.397055007	-8.793312	2.153083086	2.96719742000	3.44506054780	0	Low Degree of Certainty of Wetland Health
5051		□	-2.914278938	-11.736097	1.354606986	-4.33051872000	2.38085108310	1	High Degree of Certainty of Wetland Health
5054			-4.03905506	-11.107903	2.207834005	5.36192704000	1.84330384749	0	Low Degree of Certainty of Wetland Health
5057			-4.662527405	-9.864326	2.10986805	6.08377838000	2.90491735692	0	Low Degree of Certainty of Wetland Health
5058			-3.242480424	-10.432463	2.337176085	3.88742637000	2.79864034083	0	Low Degree of Certainty of Wetland Health
5059			-3.216366382	-14.752166	2.261951923	4.07793426000	3.27287445943	0	Low Degree of Certainty of Wetland Health
5060		□	-3.028867508	-16.037722	2.261951923	4.19889641000	2.46130408507	0	High Degree of Certainty of Wetland Health
5061		□	-3.909142549	-10.105432	3.098515034	1.48464775000	2.82824738732	0	Low Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5063	□		-3.118418019	-9.527136	2.458462954	3.85408020000	1.99734057124	0	Low Degree of Certainty of Wetland Health
5064			-4.224230524	-9.839165	2.143134117	6.38666343000	3.16955026879	0	Low Degree of Certainty of Wetland Health
5065		□	-3.131337686	-12.678613	2.192013979	5.63930511000	3.04629860798	0	Low Degree of Certainty of Wetland Health
5066		□	-3.091895485	-13.480771	2.192013979	6.37059021000	3.07341683341	0	High Degree of Certainty of Wetland Health
5067		□	-3.396197852	-15.128281	2.261951923	4.53606224000	3.35165341561	0	Low Degree of Certainty of Wetland Health
5068	□	□	-3.776513744	-6.730081	2.442447901	-2.81367111000	3.28044017149	1	High Degree of Certainty of Wetland Health
5070			-4.101325985	-15.816291	2.367247105	3.81621361000	3.36039753923	0	Low Degree of Certainty of Wetland Health
5071		□	-4.237223492	-16.076359	2.367247105	4.89690209000	3.40754868765	0	Low Degree of Certainty of Wetland Health
5073	□	□	-5.342589157	-10.547048	3.516135931	1.00002289000	5.48276440218	0	Low Degree of Certainty of Wetland Health
5074			-3.658782163	-13.25891	2.312953949	4.12965966000	2.55362960614	1	High Degree of Certainty of Wetland Health
5075	□		-2.776065373	-12.76146	2.312953949	4.25771904000	1.28413304208	0	Low Degree of Certainty of Wetland Health
5076		□	-5.111649259	-11.344903	2.035075903	7.09456062000	2.33435991212	0	High Degree of Certainty of Wetland Health
5077			-3.367444716	-14.963397	2.367247105	5.05749512000	3.42847417403	0	Low Degree of Certainty of Wetland Health
5078			-3.810124328	-14.199344	2.312953949	3.67439842000	2.19101333267	0	Low Degree of Certainty of Wetland Health
5080	□	□	-5.102019149	-9.475316	2.490675926	-3.93479538000	2.76901444538	1	High Degree of Certainty of Wetland Health
5081			-3.609002347	-14.539087	2.312953949	3.85721588000	2.35203424057	0	Low Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5082		□	-4.262396369	-17.370947	2.367247105	4.27834320000	3.30533018629	0	Low Degree of Certainty of Wetland Health
5083			-2.734243797	-14.521916	2.312953949	4.23144722000	2.03554621406	0	Low Degree of Certainty of Wetland Health
5084		□	-6.652359374	-13.414671	3.099034071	-3.09534645000	4.02308661882	1	High Degree of Certainty of Wetland Health
5086		□	-3.828532737	-17.008259	2.457565069	6.11401367000	3.31889519719	0	Low Degree of Certainty of Wetland Health
5087		□	-5.539283426	-18.297065	2.427369118	5.48862648000	2.28513899604	0	Low Degree of Certainty of Wetland Health
5088			-3.952377246	-14.945563	2.525485039	4.67157173000	2.68906378168	0	Low Degree of Certainty of Wetland Health
5090		□	-3.919333572	-17.355748	2.280117035	4.99689865000	3.13908071647	0	Low Degree of Certainty of Wetland Health
5091		□	-4.05842456	-10.093023	1.262276053	-4.85940743000	3.36720376545	1	High Degree of Certainty of Wetland Health
5092		□	-3.616636875	-11.180483	1.177332044	8.12444115000	2.27021744267	0	High Degree of Certainty of Wetland Health
5093		□	-4.116817847	-19.104011	2.427369118	4.69634247000	2.83188950200	0	Low Degree of Certainty of Wetland Health
5094		□	-3.899659136	-17.576954	2.178100109	5.66116905000	3.00986962597	0	Low Degree of Certainty of Wetland Health
5095		□	-5.670652147	-14.133467	3.252616882	-0.97453689000	4.96878774959	0	High Degree of Certainty of Wetland Health
5099		□	-5.069075819	-18.488419	2.427369118	4.54866600000	1.81794145441	0	Low Degree of Certainty of Wetland Health
5100		□	-4.881564891	-17.523201	2.178100109	4.79177093000	3.02798945667	0	Low Degree of Certainty of Wetland Health
5101		□	-2.789267577	-8.158478	1.154031038	-5.15174484000	2.95932994676	1	High Degree of Certainty of Wetland Health
5102		□	-5.344991811	-17.436529	2.280117035	6.46257019000	2.92069562417	0	Low Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5103		□	-5.426177066	-19.271374	2.145464897	6.18042183000	2.24792635734	0	Low Degree of Certainty of Wetland Health
5104		□	-4.119586188	-18.378604	2.571881056	5.97799873000	3.51614415285	0	Low Degree of Certainty of Wetland Health
5105		□	-7.865353145	-17.31268	3.110393047	-1.31896973000	1.71072985257	0	High Degree of Certainty of Wetland Health
5106		□	-3.632095371	-18.478426	2.571881056	6.62945747000	2.54442619540	0	Low Degree of Certainty of Wetland Health
5107			-2.746729513	-19.954887	2.571881056	6.13156510000	0.64105763683	0	Low Degree of Certainty of Wetland Health
5108		□	-4.672918396	-16.301123	2.238800049	7.81088066000	3.56066347985	0	Low Degree of Certainty of Wetland Health
5109		□	-4.53760065	-19.702029	2.392834902	6.75306702000	3.11872686392	0	Low Degree of Certainty of Wetland Health
5110	□	□	-7.14536334	-16.19937	3.146768093	1.61891555000	3.61570629980	0	Low Degree of Certainty of Wetland Health
5111		□	-3.926549451	-20.035669	2.661708117	5.54998779000	2.14719500967	0	Low Degree of Certainty of Wetland Health
5114		□	-10.51438419	-17.934255	3.23061204	0.15475082000	2.08903304386	0	Low Degree of Certainty of Wetland Health
5115		□	-4.505707216	-20.916701	2.905035019	4.08782959000	1.33289331826	0	Low Degree of Certainty of Wetland Health
5116	□	□	-8.158825928	-18.375235	3.2622509	1.33611107000	1.65419635713	0	Low Degree of Certainty of Wetland Health
5117	□	□	-6.052544853	-20.172752	2.905035019	3.52862168000	0.98938577615	0	Low Degree of Certainty of Wetland Health
5118		□	-4.321028566	-19.515335	2.145464897	6.30346680000	1.63688355097	0	Low Degree of Certainty of Wetland Health
5119		□	-5.952839368	-14.390873	1.82416904	-4.87699318000	2.09158452279	1	High Degree of Certainty of Wetland Health
5120		□	-9.806509742	-20.341108	3.44068408	1.29041100000	1.32576867078	0	Low Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5123		□	-4.74636465	-16.17619	1.969208956	8.27712059000	3.37974311167	0	High Degree of Certainty of Wetland Health
5124	□	□	-6.318669666	-13.09122	3.718077898	-0.95040893000	4.92871970302	0	High Degree of Certainty of Wetland Health
5125	□	□	-7.686582632	-21.218676	3.566559076	1.53988456000	2.79785541369	0	Low Degree of Certainty of Wetland Health
5126			-3.367269747	-25.701551	2.13053298	5.92758484000	1.26865472444	0	Low Degree of Certainty of Wetland Health
5129	□	□	-11.02460591	-18.985898	3.478281975	1.88117409000	2.96803697750	0	Low Degree of Certainty of Wetland Health
5131		□	-8.419804799	-19.633276	3.196531057	-0.12384987000	2.52233447607	0	High Degree of Certainty of Wetland Health
5133			-2.998868698	-22.774535	1.830760956	7.17011261000	1.26501430644	0	High Degree of Certainty of Wetland Health
5134		□	-4.813823368	-26.66161	2.600389957	7.86209679000	2.34492149972	0	Low Degree of Certainty of Wetland Health
5136	□	□	-11.4285317	-21.361891	3.211632967	4.44387627000	1.98945092671	0	Low Degree of Certainty of Wetland Health
5137		□	-8.450382402	-24.526458	3.348937988	2.89563179000	3.54689285303	0	Low Degree of Certainty of Wetland Health
5138		□	-3.033195526	-29.52939	1.998986959	5.39007874000	2.04372635497	0	High Degree of Certainty of Wetland Health
5139		□	-2.478989503	-15.410225	1.955113053	4.80559845000	2.27520885142	0	High Degree of Certainty of Wetland Health
5140		□	-3.358253677	-18.082852	2.005597115	6.33908463000	2.70233766056	0	High Degree of Certainty of Wetland Health
5141		□	-4.496765882	-21.462194	1.830760956	8.00658226000	3.02245259481	0	High Degree of Certainty of Wetland Health
5143		□	-9.701411739	-24.202336	3.624289036	3.52581597000	5.38851733836	0	Low Degree of Certainty of Wetland Health
5144		□	-10.86095973	-24.710581	3.435765028	3.49390602000	4.22199187973	0	Low Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5148		□	-3.704334144	-17.063722	1.580332994	7.17736817000	2.35120979769	0	High Degree of Certainty of Wetland Health
5149		□	-3.563232619	-22.122951	1.793959975	4.37503357000	2.61423961394	0	High Degree of Certainty of Wetland Health
5150		□	-10.71780741	-25.85415	3.549504042	4.72421837000	4.28651106280	0	Low Degree of Certainty of Wetland Health
5151		□	-2.627076543	-18.63095	1.716405034	2.42468567000	2.26888466267	0	High Degree of Certainty of Wetland Health
5152		□	-9.715726244	-25.741733	3.435765028	5.41955375000	2.28556177933	0	Low Degree of Certainty of Wetland Health
5153	□	□	-3.821571518	-22.908455	1.849084973	5.70000000000	2.73280844053	0	High Degree of Certainty of Wetland Health
5155		□	-4.594212154	-22.537324	1.649379969	7.26417541000	1.77102125623	0	High Degree of Certainty of Wetland Health
5156		□	-6.946900271	-28.458806	3.085956097	5.51576042000	-0.3382222699	0	Low Degree of Certainty of Wetland Health
5157		□	-4.364804742	-28.462289	2.359270096	7.79269219000	1.48593054454	0	Low Degree of Certainty of Wetland Health
5158		□	-4.542608368	-28.651403	2.103239059	9.48785591000	1.49427168831	0	Low Degree of Certainty of Wetland Health
5159	□	□	-2.948858878	-19.712637	N/A	0.90275002000	2.51529110778	1	High Degree of Certainty of Wetland Health
5160		□	-8.483436268	-25.740138	3.711602926	6.86891937000	1.16563299984	0	Low Degree of Certainty of Wetland Health
5161		□	-3.940142091	-24.094469	1.742959976	9.25329399000	1.72597413930	0	High Degree of Certainty of Wetland Health
5162		□	-5.21791104	-29.758111	2.850492954	7.16473388000	0.48662314958	0	Low Degree of Certainty of Wetland Health
5163		□	-3.944910339	-22.178919	1.81378603	6.94779396000	1.80382130688	0	High Degree of Certainty of Wetland Health
5166		□	-8.946422903	-29.262874	3.740009069	6.43935966000	2.01381630985	0	Low Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5168		☐	-3.417118575	-21.794089	1.709696054	2.22857208000	2.89170686371	0	High Degree of Certainty of Wetland Health
5169		☐	-2.804433747	-21.807614	1.709696054	2.22857208000	2.24618410726	0	High Degree of Certainty of Wetland Health
5170		☐	-8.566249349	-27.712614	3.711602926	6.30375290000	1.61288738825	0	Low Degree of Certainty of Wetland Health
5171		☐	-3.330507015	-19.076124	N/A	3.01188469000	3.51754121866	1	High Degree of Certainty of Wetland Health
5172		☐	-4.139993637	-24.236275	1.742959976	8.97772408000	1.37406639384	0	High Degree of Certainty of Wetland Health
5174		☐	-8.682855396	-29.591094	3.085956097	7.41868972000	0.21490298035	0	Low Degree of Certainty of Wetland Health
5177		☐	-3.93787542	-24.979478	N/A	6.44147683000	6.45144054592	1	High Degree of Certainty of Wetland Health
5178		☐	-4.745956546	-30.986034	2.508764029	6.87916374000	0.98673555350	0	Low Degree of Certainty of Wetland Health
5179		☐	-3.060431795	N/A	N/A	5.18794060000	3.14334276999	1	High Degree of Certainty of Wetland Health
5182		☐	-5.950197039	-26.014427	2.008620977	7.75057220000	2.11331749606	0	High Degree of Certainty of Wetland Health
5194		☐	-4.768095139	-30.920143	2.319139957	8.71104812000	2.65850299742	0	Low Degree of Certainty of Wetland Health
5195		☐	-7.833997438	-23.372286	2.813175917	4.78060150000	1.47042070796	0	Low Degree of Certainty of Wetland Health
5196		☐	-3.372400181	-12.937658	2.015455961	5.70000000000	2.34698475153	0	High Degree of Certainty of Wetland Health
5198	☐	☐	-4.473316688	-11.383524	1.82416904	-3.81121063000	2.92440874849	1	High Degree of Certainty of Wetland Health
5203	☐	☐	-8.660185078	-16.241014	3.354309082	-0.93128967000	4.09494964352	0	High Degree of Certainty of Wetland Health
5208	☐	☐	-4.568150986	-7.59748	2.078752041	1.39741135000	3.52422710011	0	Low Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5210	□	□	-4.282638269	-7.458657	2.000252962	2.84351730000	2.71567457832	0	High Degree of Certainty of Wetland Health
5214	□	□	-4.75478498	-14.521096	2.234170914	5.55064965000	3.67776093985	0	Low Degree of Certainty of Wetland Health
5215	□	□	-4.44448039	-22.030034	N/A	2.27078057000	6.67836361749	1	High Degree of Certainty of Wetland Health
5217			-2.968691906	-14.448263	2.164346933	6.71705819000	2.54153343830	0	Low Degree of Certainty of Wetland Health
5218	□	□	-10.82807335	-21.156526	3.566559076	2.02840806000	4.35359068073	0	Low Degree of Certainty of Wetland Health
5221	□	□	-6.097532145	-22.141949	2.842955112	5.05109596000	2.62323312752	0	Low Degree of Certainty of Wetland Health
5222		□	-7.64871439	-25.617124	2.978344917	4.84135056000	1.22968826429	0	Low Degree of Certainty of Wetland Health
5236			-4.372153294	-9.4706	2.0401299	5.52927017000	2.23419430933	0	High Degree of Certainty of Wetland Health
5237			-3.081615955	-15.308665	2.174220085	5.97204400000	1.94431781978	0	Low Degree of Certainty of Wetland Health
5238			-3.555817349	-15.05482	2.136107922	6.88133240000	2.31048567962	0	Low Degree of Certainty of Wetland Health
5239		□	-4.107323763	-19.399478	1.803220987	6.68875122000	3.30520422625	0	High Degree of Certainty of Wetland Health
5245		□	-3.020768457	-12.301471	1.88933301	4.06431885000	2.23330923516	0	High Degree of Certainty of Wetland Health
5246		□	-3.704404398	-13.538819	2.200428009	7.25753326000	2.12746793237	0	Low Degree of Certainty of Wetland Health
5247		□	-3.095999807	-19.552428	1.642693043	0.98768158000	2.59974963468	0	High Degree of Certainty of Wetland Health
5248		□	-3.680052452	-28.582336	N/A	7.86387252000	5.20904675960	1	High Degree of Certainty of Wetland Health
5259		□	-3.502663537	-21.045866	1.762402058	5.10911102000	2.75005580427	0	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5270		□	-3.209418816	-17.459927	2.200428009	6.69366760000	1.85896618569	0	Low Degree of Certainty of Wetland Health
5271		□	-3.240607828	-12.351783	2.304868937	8.26099701000	1.80538563943	0	Low Degree of Certainty of Wetland Health
5279		□	-2.638347359	-33.478924	1.289952993	8.10980530000	2.96949276407	0	High Degree of Certainty of Wetland Health
5286		□	-4.444612904	-15.989257	2.492033005	5.41092300000	3.19599470176	0	Low Degree of Certainty of Wetland Health
5308		□	-3.851625709	-9.427546	2.295356035	-2.25470734000	2.14555592239	1	High Degree of Certainty of Wetland Health
5309		□	-2.878856569	-12.078383	2.295356035	-1.74186707000	2.25385106806	1	High Degree of Certainty of Wetland Health
5320			-3.332715275	-6.473979	3.21863699	5.75987625000	2.52103249214	0	Low Degree of Certainty of Wetland Health
5323			-2.857308712	-6.55529	3.972645998	7.25719643000	2.99433683208	0	Low Degree of Certainty of Wetland Health
5347			-4.099862425	-11.579076	3.628252029	14.36218453000	1.07749711027	0	Low Degree of Certainty of Wetland Health
5348			-3.639154915	-13.144505	3.109786987	14.06506729000	1.30905793916	0	Low Degree of Certainty of Wetland Health
5357			-2.940580316	-7.000485	2.743130922	15.11266899000	2.03036973199	0	Low Degree of Certainty of Wetland Health
5366	□		-3.754336687	-4.815264	4.764925003	6.87771988000	2.26747184676	0	Low Degree of Certainty of Wetland Health
5367	□		-3.715277999	-4.901998	4.764925003	7.62433242000	2.33246621064	0	Low Degree of Certainty of Wetland Health
5488			-2.238088152	-4.370178	2.459574938	3.44240856000	1.59136895697	1	High Degree of Certainty of Wetland Health
5493			-2.442349056	-5.761852	2.459574938	4.02742672000	1.74896801045	1	High Degree of Certainty of Wetland Health
5496			-2.696737214	-2.845795	1.500450969	2.94536400000	1.38757900685	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5497			-2.53114694	-5.042257	1.813442945	4.11519718000	1.57446555039	0	High Degree of Certainty of Wetland Health
5499			-2.842539116	-4.347784	3.221390963	3.20678997000	1.46028657683	1	High Degree of Certainty of Wetland Health
5501			-1.952548115	-3.597682	2.604373932	3.54541683000	1.38005591091	1	High Degree of Certainty of Wetland Health
5506			-1.926323904	-4.146998	1.871613026	4.11267376000	0.93610588737	1	High Degree of Certainty of Wetland Health
5508			-1.956966054	-3.764288	2.604373932	3.53774261000	1.25008032966	1	High Degree of Certainty of Wetland Health
5513			-2.029022516	-5.28892	2.542670965	4.15831185000	1.45203805565	1	High Degree of Certainty of Wetland Health
5515			-2.448670045	-3.089984	2.649771929	5.22037887000	0.96793626741	1	Low Degree of Certainty of Wetland Health
5516	□		-2.024528234	-5.62038	2.855443001	4.23475456000	0.98806760595	1	High Degree of Certainty of Wetland Health
5518			-2.082124141	-6.905254	2.556399107	3.96877194000	0.44942649033	1	Low Degree of Certainty of Wetland Health
5521			-2.205199548	-6.069681	2.556399107	4.02465725000	0.69414951654	1	Low Degree of Certainty of Wetland Health
5522			-2.152403698	-5.465043	1.871613026	4.46752262000	1.54334399685	1	High Degree of Certainty of Wetland Health
5523			-1.928410317	-4.917387	2.604373932	3.73851204000	1.26842857547	1	High Degree of Certainty of Wetland Health
5524			-2.047392691	-4.861996	2.542670965	3.63661003000	1.40047018949	1	High Degree of Certainty of Wetland Health
5527			-1.646447437	-4.780379	0.314741999	4.49343872000	0.66181814429	1	High Degree of Certainty of Wetland Health
5528			-2.15966908	-3.702542	3.324352026	3.98625756000	1.31991933005	0	Low Degree of Certainty of Wetland Health
5529			-2.1820565	-5.65173	3.612829924	4.51884269000	1.29874290289	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5530			-2.020520781	-5.675035	3.71488905	4.39712048000	0.95145424530	0	Low Degree of Certainty of Wetland Health
5531	☐		-2.276458115	-4.546184	2.855443001	4.11927509000	1.60866631902	1	High Degree of Certainty of Wetland Health
5535			-2.099399376	-4.772316	3.324352026	4.28081036000	1.18723851143	0	Low Degree of Certainty of Wetland Health
5536			-1.918596691	-4.124306	3.620435953	4.02198600000	1.41770899282	0	Low Degree of Certainty of Wetland Health
5538			-2.023299145	-6.851588	3.71488905	3.99248409000	0.43928218435	0	Low Degree of Certainty of Wetland Health
5539			-2.076742891	-6.103299	3.324352026	4.22252274000	0.78840292380	0	Low Degree of Certainty of Wetland Health
5540			-2.084186805	-6.430157	3.71488905	3.94057370000	0.89550400058	0	Low Degree of Certainty of Wetland Health
5543			-2.244232542	-1.671306	2.737013102	5.13770771000	0.40358628214	1	High Degree of Certainty of Wetland Health
5545			-1.942989326	-5.781697	3.324352026	5.02682304000	0.31397793640	0	Low Degree of Certainty of Wetland Health
5546			-1.995180225	-5.264699	3.872838974	4.87455464000	1.23320780396	0	Low Degree of Certainty of Wetland Health
5549			-2.113780825	-7.860316	3.71488905	4.73552704000	0.94218851021	0	Low Degree of Certainty of Wetland Health
5550			-2.318203449	-1.542833	2.236016989	5.49946975000	1.10892204986	1	High Degree of Certainty of Wetland Health
5551			-1.875517569	-2.252751	1.409212947	6.66308308000	0.70224628285	1	High Degree of Certainty of Wetland Health
5554			-2.295406088	-7.474556	0.923830986	5.05728340000	-0.0824702784	1	High Degree of Certainty of Wetland Health
5557			-1.92818453	-2.939783	3.952819109	3.95607567000	0.82963747231	0	Low Degree of Certainty of Wetland Health
5559			-2.313840309	-2.520001	2.557112932	6.46059990000	1.14096493956	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5560			-2.811580646	-6.755299	5.219267845	5.75855351000	0.57435882002	1	Low Degree of Certainty of Wetland Health
5563			-2.219643323	-4.62495	4.402757168	5.21784306000	1.54363053487	0	Low Degree of Certainty of Wetland Health
5567			-2.129019254	N/A	1.631611347	7.28305210520	1.18302397063	1	High Degree of Certainty of Wetland Health
5568			-1.971939616	-4.022833	3.113286018	5.12686920000	0.36346579366	1	Low Degree of Certainty of Wetland Health
5572			-2.375438965	-4.109583	3.125237942	5.30593109000	1.20359476649	1	High Degree of Certainty of Wetland Health
5573			-2.099973748	-2.78814	3.125237942	5.50144005000	0.53043820041	1	Low Degree of Certainty of Wetland Health
5578			-2.358143993	-4.091994	3.952954054	5.48421192000	1.14589486851	1	High Degree of Certainty of Wetland Health
5580			-2.155467823	-3.0505	2.642215967	5.78092003000	0.40074553762	1	Low Degree of Certainty of Wetland Health
5581			-2.022774189	-1.38154	3.667304039	4.39892578000	0.63505507565	1	High Degree of Certainty of Wetland Health
5583			-2.586206497	-4.913176	5.077103138	5.68306160000	0.62490550919	1	Low Degree of Certainty of Wetland Health
5584			-2.105950872	-3.917692	4.135146141	4.17248345000	1.05415753425	1	High Degree of Certainty of Wetland Health
5587			-2.252141735	-2.018236	3.667304039	5.31065750000	0.80830485066	1	High Degree of Certainty of Wetland Health
5589			-2.618132227	-6.57662	4.672357082	5.19879818000	1.68371091671	1	High Degree of Certainty of Wetland Health
5593			-1.896348481	N/A	0.828499973	6.84127415770	0.70231181953	1	High Degree of Certainty of Wetland Health
5594			-2.145726213	-2.371178	3.952954054	4.80150795000	0.29335689623	1	High Degree of Certainty of Wetland Health
5595			-2.412441041	-7.170514	1.731884956	5.97472954000	0.85078000741	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5599			-2.652642588	-7.915756	1.731884956	5.72517586000	0.33915357071	1	High Degree of Certainty of Wetland Health
5605			-1.989513255	-6.644416	4.271080971	4.84349823000	0.19655948551	1	Low Degree of Certainty of Wetland Health
5608			-2.764683313	-5.839369	4.926690102	4.94561958000	1.35181528349	1	High Degree of Certainty of Wetland Health
5610			-1.731648801	-3.904446	4.39036417	4.24909783000	0.57187125030	1	High Degree of Certainty of Wetland Health
5612			-1.858833554	-5.588743	4.271080971	4.25605583000	0.36445074867	1	Low Degree of Certainty of Wetland Health
5613			-2.732681969	-5.354476	4.949549198	4.27500153000	1.66268712726	1	High Degree of Certainty of Wetland Health
5614			-1.964843252	-3.11704	3.934202909	3.50913811000	1.02373118738	1	Low Degree of Certainty of Wetland Health
5617			-1.898386422	-3.638168	3.934202909	3.68244553000	0.91369759160	0	Low Degree of Certainty of Wetland Health
5618			-2.339342005	-6.080387	4.664969921	4.44552803000	0.32634812984	1	Low Degree of Certainty of Wetland Health
5619			-2.882327113	-6.639166	4.747662067	3.79460144000	1.04092171383	0	Low Degree of Certainty of Wetland Health
5623			-2.193532681	-7.077903	4.435726166	4.32892227000	1.00841745456	0	Low Degree of Certainty of Wetland Health
5624			-2.603062688	-5.599026	4.949549198	3.43818283000	1.43004023588	0	Low Degree of Certainty of Wetland Health
5626			-2.049488674	-3.425362	3.934202909	3.26981354000	0.88775393068	0	Low Degree of Certainty of Wetland Health
5629			-1.956915832	-6.10964	4.191854954	3.84832954000	1.09756587098	1	High Degree of Certainty of Wetland Health
5634			-1.901775382	-7.923603	3.624017	3.60036278000	1.29892743393	1	High Degree of Certainty of Wetland Health
5635			-1.835011359	-5.544652	4.064084053	4.16538810000	0.68311588592	1	Low Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5636			-2.147810019	-6.934839	4.333845139	3.08733368000	1.44347585593	1	High Degree of Certainty of Wetland Health
5640			-1.934098534	-4.672663	3.755040884	3.38508224000	0.86578808098	1	Low Degree of Certainty of Wetland Health
5643			-1.950512634	-6.303655	4.191854954	3.09407806000	0.70824719134	1	Low Degree of Certainty of Wetland Health
5646			-1.937615492	-5.773937	4.333845139	2.80568314000	0.73012093383	1	Low Degree of Certainty of Wetland Health
5648			-2.171699977	-4.703123	4.064084053	3.02090073000	0.95460790253	1	Low Degree of Certainty of Wetland Health
5649			-1.991636201	-5.185898	4.064084053	3.05504799000	1.24831029744	1	High Degree of Certainty of Wetland Health
5653			-1.830732562	-5.910343	3.755040884	3.29271126000	0.30760918673	1	Low Degree of Certainty of Wetland Health
5654			-2.004655581	-6.11986	4.333845139	3.03801727000	0.69286451057	1	Low Degree of Certainty of Wetland Health
5657			-2.480354047	-9.301002	3.624017	3.61460877000	1.92079884970	1	High Degree of Certainty of Wetland Health
5662			-2.368241168	-7.750813	2.709038019	4.55967331000	1.39719001531	1	High Degree of Certainty of Wetland Health
5664			-2.02611229	-2.517434	0.196641997	2.25603485000	0.53931962849	1	High Degree of Certainty of Wetland Health
5667			-2.057526601	-4.265583	0.521408021	2.37964821000	0.63683019752	1	High Degree of Certainty of Wetland Health
5669			-2.060533169	-6.562334	0.723897994	1.98124504000	0.74944581666	1	High Degree of Certainty of Wetland Health
5670			-1.985662941	-5.597225	0.576304019	2.98011398000	0.73707671746	1	High Degree of Certainty of Wetland Health
5671			-1.94835849	-5.826727	0.591140985	2.09004974000	0.78437716069	1	High Degree of Certainty of Wetland Health
5672	□		-2.265079623	-2.723348	0.531629026	1.85962105000	0.69866550733	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5673			-2.346484915	-8.239522	2.913325071	2.79361535000	1.59671334372	1	High Degree of Certainty of Wetland Health
5674			-1.616978183	-8.261887	2.439496994	2.49229812000	1.24500327862	1	High Degree of Certainty of Wetland Health
5683			-1.886541267	-6.988535	2.439496994	2.40516853000	1.43866248161	1	High Degree of Certainty of Wetland Health
5684			-1.993672357	-9.018685	2.913325071	2.49095345000	1.71173056039	1	High Degree of Certainty of Wetland Health
5685			-2.085913044	-9.559641	2.709038019	3.81899833000	1.55965271271	1	High Degree of Certainty of Wetland Health
5692			-1.924937437	-8.646085	2.913325071	2.31039429000	1.41941294680	1	High Degree of Certainty of Wetland Health
5701			-2.003349911	-5.777495	0.591140985	1.88626289000	0.89653668780	1	High Degree of Certainty of Wetland Health
5710			-2.345172036	-10.076827	2.709038019	3.41755677000	1.84318559153	1	High Degree of Certainty of Wetland Health
5713			-2.383838104	-8.177029	2.536736012	2.48791314000	2.21082914155	1	High Degree of Certainty of Wetland Health
5720			-1.8063513	-6.665807	2.897109032	1.86126900000	1.05989952946	1	High Degree of Certainty of Wetland Health
5728			-1.675574635	-7.694593	2.536736012	2.18191910000	1.21406858891	1	High Degree of Certainty of Wetland Health
5731			-1.991920257	-7.540054	0.468867004	1.87128067000	0.82113030879	1	High Degree of Certainty of Wetland Health
5733			-1.97897353	-7.56725	2.897109032	2.00041771000	1.81825619690	1	High Degree of Certainty of Wetland Health
5739			-2.220877237	-6.266829	0.977387011	5.58133888000	0.56507674160	1	High Degree of Certainty of Wetland Health
5744			-2.639699244	-9.668238	3.007134914	2.83756447000	2.38709698510	0	Low Degree of Certainty of Wetland Health
5749			-2.169142424	-6.277528	0.348679006	4.97846794000	0.26986264448	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5757			-1.833105289	-5.253671	3.161257982	5.65464020000	0.48828208164	1	Low Degree of Certainty of Wetland Health
5768			-2.018756138	-6.164924	0.463512003	4.93462753000	0.69477923405	1	High Degree of Certainty of Wetland Health
5771			-3.176094067	-8.758225	3.168798923	2.31325150000	2.25948800451	1	High Degree of Certainty of Wetland Health
5772			-2.305975	-9.803932	2.888561964	2.81469917000	1.84069808665	0	Low Degree of Certainty of Wetland Health
5813			-1.986682516	-11.104359	2.799309969	2.44223213000	1.31122775225	1	High Degree of Certainty of Wetland Health
5819			-2.490716071	-12.091892	2.799309969	2.34125900000	2.13453261225	1	High Degree of Certainty of Wetland Health
5826			-2.302747531	-5.427301	0.878953993	5.36715889000	1.21966468490	1	High Degree of Certainty of Wetland Health
5827			-2.367238639	-6.799652	2.045519114	7.06565857000	1.03741737523	1	High Degree of Certainty of Wetland Health
5833			-2.265060432	-11.69804	2.799309969	2.58644676000	0.94501067310	1	Low Degree of Certainty of Wetland Health
5844			-2.076537328	-13.507149	1.019227028	3.08359528000	0.86328446595	1	High Degree of Certainty of Wetland Health
5850			-1.874068759	-4.589212	2.830267906	5.89981842000	0.34299258656	1	Low Degree of Certainty of Wetland Health
5865	□		-2.428381846	-8.255311	2.507224083	2.77676773000	1.69124237530	1	High Degree of Certainty of Wetland Health
5866			-2.565340596	-13.812262	1.353770971	2.39011193000	0.10318030342	1	High Degree of Certainty of Wetland Health
5890			-1.876129001	-10.010874	0.801072001	8.32826996000	0.87132384186	1	High Degree of Certainty of Wetland Health
5908			-1.872001095	-9.538422	3.556233883	7.80410766000	0.39994961447	1	Low Degree of Certainty of Wetland Health
5909			-1.890721234	-9.369651	3.556233883	7.35994912000	0.62316437552	1	Low Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
5918			-1.842937238	-9.340143	3.556233883	7.93134880000	0.40528563071	1	Low Degree of Certainty of Wetland Health
5958			-1.935352699	-6.537623	0.717211008	4.41637612000	0.76386214751	1	High Degree of Certainty of Wetland Health
6000			-1.755213333	-9.160702	4.231823921	8.76461983000	0.52186003743	1	High Degree of Certainty of Wetland Health
6010			-2.503785076	-6.862467	5.835727215	6.50347519000	0.39119835660	1	Low Degree of Certainty of Wetland Health
6014			-2.094998867	-9.169294	0.780547023	5.28297806000	0.40543165536	1	High Degree of Certainty of Wetland Health
6033			-2.45756687	-9.81015	5.18207407	8.40125847000	1.08208986700	1	High Degree of Certainty of Wetland Health
6036			-2.776549118	-10.487127	5.18207407	9.19004249000	1.06579704863	1	High Degree of Certainty of Wetland Health
6037			-2.03542063	-10.068395	1.144325972	9.65294075000	0.94569784417	1	High Degree of Certainty of Wetland Health
6041			-2.428579865	-9.472902	5.818572044	5.84679794000	0.16923616020	1	Low Degree of Certainty of Wetland Health
6043			-2.782692071	-10.8716	6.73336792	6.72585869000	1.26990914596	1	High Degree of Certainty of Wetland Health
6046			-2.558963958	-9.189643	6.546723843	6.76842118000	1.11027852589	1	High Degree of Certainty of Wetland Health
6047			-2.481797609	-9.130357	6.546723843	7.14476013000	1.42041186744	1	High Degree of Certainty of Wetland Health
6048			-2.946351697	-10.032711	5.455301762	8.96757507000	0.69395747530	1	Low Degree of Certainty of Wetland Health
6049			-1.220494046	-3.203048	1.446473002	6.07946206000	0.28189064937	1	High Degree of Certainty of Wetland Health
6050			-1.712998328	-14.75796	2.484787941	5.59856987000	0.96137402400	1	High Degree of Certainty of Wetland Health
6051			-2.760163694	-3.286653	1.712342024	5.85633088000	-0.4645611394	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
6054			-2.297322127	-9.574231	1.761878967	9.80191422000	0.20922761491	1	High Degree of Certainty of Wetland Health
6055			-2.789696261	-11.31625	4.602264881	8.29722213000	0.42378823074	1	Low Degree of Certainty of Wetland Health
6056			-1.646195147	-16.447808	1.686894059	6.28738785000	0.15619037251	1	High Degree of Certainty of Wetland Health
6059			-1.646106969	-8.740301	1.394518018	9.96883011000	0.48189506754	1	High Degree of Certainty of Wetland Health
6060			-3.372612073	-13.437787	7.454495907	8.16623878000	1.48013055068	1	High Degree of Certainty of Wetland Health
6061			-3.10911647	-16.003763	2.061686993	6.89174461000	0.89236045430	1	Low Degree of Certainty of Wetland Health
6062			-3.307826445	-14.767694	1.576300979	5.78803825000	-1.1274406085	1	High Degree of Certainty of Wetland Health
6064			-2.579949203	-16.756681	1.908493996	6.76518059000	0.32555128304	1	High Degree of Certainty of Wetland Health
6069			-2.370148834	-16.078594	1.908493996	7.17576599000	0.48309889608	1	High Degree of Certainty of Wetland Health
6072			-2.88683883	-12.90622	6.378910065	8.89269066000	-0.4962149308	1	Low Degree of Certainty of Wetland Health
6073			-3.998707696	-12.03699	4.336044788	7.29858398000	0.98413828312	1	Low Degree of Certainty of Wetland Health
6074			-1.766957475	-14.311367	2.466176987	7.93705177000	0.85308589863	1	High Degree of Certainty of Wetland Health
6075			-4.056020948	-12.972806	5.569663048	8.38857460000	0.72077874780	1	Low Degree of Certainty of Wetland Health
6076			-2.404505034	-16.011266	2.466176987	8.11687660000	0.42823075558	1	Low Degree of Certainty of Wetland Health
6077			-2.37584124	-16.581414	1.984701991	8.00914955000	0.33214635246	1	High Degree of Certainty of Wetland Health
6079			-1.439707168	-13.337758	2.466176987	7.45189286000	0.60033264618	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
6080			-2.795260253	-16.626609	2.24236989	7.84255791000	0.62890363663	1	Low Degree of Certainty of Wetland Health
6083			-2.127445471	-15.191847	1.984701991	7.95977974000	0.60482940703	1	High Degree of Certainty of Wetland Health
6084			-3.540308254	-11.169413	6.44568491	7.70984459000	1.23429287168	1	High Degree of Certainty of Wetland Health
6085			-2.58467587	-14.053126	5.569663048	8.08681679000	-0.0610226851	1	Low Degree of Certainty of Wetland Health
6086			-2.144445855	-6.412744	5.770081043	8.69912147000	0.28459944557	1	Low Degree of Certainty of Wetland Health
6087			-2.803465404	-13.138663	2.109323025	8.24973679000	0.65236267502	1	Low Degree of Certainty of Wetland Health
6088			-2.059284025	-13.600869	2.109323025	8.85155106000	0.93617340465	1	Low Degree of Certainty of Wetland Health
6089			-2.030298744	-10.539338	2.369544029	8.41365624000	1.27960117946	1	High Degree of Certainty of Wetland Health
6090			-3.060586114	-14.998124	1.933889985	9.57266807000	0.49217926112	1	High Degree of Certainty of Wetland Health
6091			-2.917963119	-9.089912	5.114116192	7.97432709000	1.51700546864	1	High Degree of Certainty of Wetland Health
6092			-2.084215484	-11.43975	2.033375025	9.40599823000	0.87011710257	1	High Degree of Certainty of Wetland Health
6093			-2.080543787	-14.289886	1.681143045	9.59187508000	0.06041855016	1	High Degree of Certainty of Wetland Health
6094			-2.268688526	-9.966034	5.114116192	8.73973847000	0.96761918632	1	Low Degree of Certainty of Wetland Health
6095		□	-3.167460717	-7.940903	7.35876894	8.86938858000	3.32641263484	1	High Degree of Certainty of Wetland Health
6097			-1.993149631	-7.627385	1.350075006	9.17443466000	0.42985337119	1	High Degree of Certainty of Wetland Health
6098			-1.955127367	-7.627265	1.350075006	9.17443466000	0.48843594900	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
6099			-1.432216663	-9.47192	1.883483052	9.07307625000	0.27831867857	1	High Degree of Certainty of Wetland Health
6100			-1.740951875	-12.015523	1.859107018	9.52796936000	0.20691788719	1	High Degree of Certainty of Wetland Health
6101			-2.079916724	-12.596595	1.859107018	9.90707779000	0.00061210642	1	High Degree of Certainty of Wetland Health
6102		□	-2.821031416	-2.420479	6.48039484	8.26110649000	2.89693619771	1	High Degree of Certainty of Wetland Health
6103			-2.064307532	-10.007095	2.033375025	9.54803467000	0.44280724309	1	High Degree of Certainty of Wetland Health
6104			-1.546470717	-9.484826	1.883483052	9.16968536000	0.12243000803	1	High Degree of Certainty of Wetland Health
6106		□	-2.992440683	-5.360654	5.765416145	8.95166778000	2.39741994696	1	High Degree of Certainty of Wetland Health
6107			-2.206532707	-12.052921	1.859107018	10.03278923000	-0.0754621429	1	High Degree of Certainty of Wetland Health
6108			-1.731080232	-4.804424	4.329584122	9.44434929000	0.68817206070	1	High Degree of Certainty of Wetland Health
6109			-1.992514725	-9.369769	1.597869992	9.54318810000	0.49962668422	1	High Degree of Certainty of Wetland Health
6110			-2.442883927	-8.985834	1.597869992	9.66498185000	0.26226217105	1	High Degree of Certainty of Wetland Health
6111		□	-2.743813997	-3.529395	1.564326048	8.57340812000	0.44041323139	1	High Degree of Certainty of Wetland Health
6112		□	-2.08528999	-4.680815	3.567019939	9.10432244000	2.15187399952	1	High Degree of Certainty of Wetland Health
6115			-1.652820519	-3.696031	3.567019939	8.79350853000	0.91448718222	1	High Degree of Certainty of Wetland Health
6121			-1.701096524	-3.5764	2.546874046	7.96787453000	0.35261008654	1	High Degree of Certainty of Wetland Health
6123			-2.054875816	-1.0411	0.861989021	7.34740067000	0.48802776301	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
6124			-2.003444823	-5.385198	2.734631062	5.60121346000	0.15048402684	1	Low Degree of Certainty of Wetland Health
6125			-2.001150314	-3.895502	1.578099012	4.61717415000	0.97288186729	1	High Degree of Certainty of Wetland Health
6137			-2.26286109	-6.745628	2.129097939	2.13876915000	1.21648917311	0	Low Degree of Certainty of Wetland Health
6139			-2.123597085	-5.913328	2.482820034	3.67388534000	1.55302673689	0	Low Degree of Certainty of Wetland Health
6143			-1.491787574	-7.426844	0.143978998	3.78876304000	0.95290569311	1	High Degree of Certainty of Wetland Health
6147			-1.545593085	-6.597592	0.143978998	3.77428055000	0.95890911590	1	High Degree of Certainty of Wetland Health
6149			-2.330953392	-4.936984	2.374458075	0.77641487000	1.54157429536	0	Low Degree of Certainty of Wetland Health
6153			-1.586002681	-6.989375	0.128776997	2.72679519000	1.03987497373	1	High Degree of Certainty of Wetland Health
6154			-2.533999241	-4.207449	2.46519804	-1.51786613000	1.93271187459	0	High Degree of Certainty of Wetland Health
6157			-1.869996099	-3.87297	2.45215106	-2.16057587000	1.88668195960	0	High Degree of Certainty of Wetland Health
6159			-1.90028533	-5.215668	0.128776997	2.25063514000	0.91992451102	1	High Degree of Certainty of Wetland Health
6160			-2.672824075	-4.122076	2.371404886	1.37693787000	1.66753814221	0	Low Degree of Certainty of Wetland Health
6163			-1.962788417	-4.266236	2.694926977	-3.72432327000	2.56281270211	0	High Degree of Certainty of Wetland Health
6165			-2.005703363	-4.376249	2.694926977	-3.11137009000	2.27434616547	0	High Degree of Certainty of Wetland Health
6168			-3.047027502	-6.164713	2.569317102	0.77712822000	1.75279864832	0	Low Degree of Certainty of Wetland Health
6169			-2.357872246	-2.790471	1.987211943	-4.43577575000	1.46620800382	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
6172			-1.241771914	-3.035593	0.667218983	-4.92571640000	1.47038487874	1	High Degree of Certainty of Wetland Health
6200			-2.078262258	-2.69004	1.987211943	-4.58922958000	1.49552022848	0	High Degree of Certainty of Wetland Health
6202			-1.857744646	-4.480759	1.833624959	-0.39124107000	0.70701754166	0	High Degree of Certainty of Wetland Health
6203			-2.497141655	-7.044518	2.110032082	3.25757217000	0.05105450543	1	Low Degree of Certainty of Wetland Health
6204			-2.877278767	-5.288874	2.129097939	0.90043449000	0.80980611801	0	Low Degree of Certainty of Wetland Health
6205			-2.407260102	-6.351275	2.129097939	1.95791626000	1.11424608091	0	Low Degree of Certainty of Wetland Health
6206			-2.727713069	-7.221769	2.129097939	1.82279778000	1.03614405261	0	Low Degree of Certainty of Wetland Health
6207			-2.070090344	-3.661618	0.875216007	-0.10302925000	0.97085136030	1	High Degree of Certainty of Wetland Health
6214			-1.857323303	-10.29206	0.789905012	-0.69570351000	1.39274758738	1	High Degree of Certainty of Wetland Health
6217			-2.286132462	-4.344727	2.106707096	4.90823364000	0.59399712941	1	Low Degree of Certainty of Wetland Health
6225			-2.089914348	-4.662031	1.777452946	3.50014496000	0.94281168325	1	High Degree of Certainty of Wetland Health
6232			-1.876335683	-4.843592	0.169841006	5.24057961000	0.68350765876	1	High Degree of Certainty of Wetland Health
6246			-1.988450933	-3.771653	2.489891052	-3.63997650000	2.20843372835	0	High Degree of Certainty of Wetland Health
6247			-1.694647212	-8.071506	1.445952058	4.14038658000	1.07385296308	1	High Degree of Certainty of Wetland Health
6251			-1.724956471	-1.524226	0.826267004	8.16287803000	0.63987826774	1	High Degree of Certainty of Wetland Health
6252			-2.368717153	-1.70313	2.458857059	8.39595985000	-0.2028822609	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
6253	□		-2.393192921	-1.603296	2.169708967	8.53385162000	-0.2330068780	1	High Degree of Certainty of Wetland Health
6254			-1.808405298	-5.517431	3.755040884	3.41841507000	0.38089563647	1	Low Degree of Certainty of Wetland Health
6258			-2.108628904	-4.529358	2.556399107	3.72917366000	0.72308233088	1	Low Degree of Certainty of Wetland Health
6259			-2.125974974	-4.559808	2.556399107	3.85754299000	0.80751868829	1	Low Degree of Certainty of Wetland Health
6260			-2.024569556	-4.304171	2.556399107	4.15133953000	0.94895670638	1	Low Degree of Certainty of Wetland Health
6262			-3.074815549	-4.659724	2.082005024	3.74299907000	1.48086619098	1	High Degree of Certainty of Wetland Health
6266			-2.487300919	-4.307595	1.872480989	3.46843529000	1.40119150804	1	High Degree of Certainty of Wetland Health
6268			-2.384624381	-4.5919	2.264003992	4.73638535000	1.39068385378	1	High Degree of Certainty of Wetland Health
6280			-2.166247955	-7.826493	1.406826973	5.30072022000	-0.4071501731	1	High Degree of Certainty of Wetland Health
6281			-2.607309097	-5.39664	5.077103138	5.08587456000	0.97813603024	1	Low Degree of Certainty of Wetland Health
6282			-2.742789013	-6.049892	5.077103138	5.39143943000	1.99588376904	1	High Degree of Certainty of Wetland Health
6296	□		-2.395961613	-7.756409	2.276654959	3.20424080000	0.20478876924	1	High Degree of Certainty of Wetland Health
6298			-2.140175948	-5.887059	0.992348015	4.78539657000	0.35351994517	1	High Degree of Certainty of Wetland Health
6299			-2.184213547	-5.362594	4.191854954	2.42165947000	0.57380838145	1	Low Degree of Certainty of Wetland Health
6304			-2.170491088	-12.950587	1.681143045	10.19478416000	0.09772579267	1	High Degree of Certainty of Wetland Health
6305			-1.938053871	-12.950587	1.037377954	9.90181541000	1.05025273252	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
6309			-2.084763354	-13.869654	1.752225995	6.44953156000	0.84892225951	1	High Degree of Certainty of Wetland Health
6310			-1.823272759	-12.772021	1.752225995	7.30283165000	0.72440948243	1	High Degree of Certainty of Wetland Health
6311			-3.1207571	-16.475836	2.651942968	7.30143738000	1.14629445543	1	High Degree of Certainty of Wetland Health
6312			-1.550407172	-13.173849	1.946261048	7.26837349000	0.45183168340	1	High Degree of Certainty of Wetland Health
6313			-2.200548156	-14.023296	1.860139012	7.01951027000	0.86565175010	1	High Degree of Certainty of Wetland Health
6314			-1.603384091	-14.95833	1.860139012	8.00158119000	0.65882189558	1	High Degree of Certainty of Wetland Health
6315			-2.330012324	-17.935211	1.860139012	8.36532402000	0.12453294682	1	High Degree of Certainty of Wetland Health
6316			-1.641886352	-12.89904	1.860139012	8.52952385000	0.77293194729	1	High Degree of Certainty of Wetland Health
6317			-3.126810596	-16.268079	2.651942968	9.13751411000	1.49628626106	1	High Degree of Certainty of Wetland Health
6318			-2.041829544	-15.652479	2.015564919	10.01034927000	0.25499653486	1	High Degree of Certainty of Wetland Health
6320			-2.016177349	-14.783279	1.459233046	9.19089890000	0.44248095799	1	High Degree of Certainty of Wetland Health
6322			-2.254318362	-17.847901	2.015564919	9.69309616000	0.30601851969	1	High Degree of Certainty of Wetland Health
6325			-2.473363398	-15.321848	1.681143045	9.17800331000	-0.2078736646	1	High Degree of Certainty of Wetland Health
6328			-2.581116557	-11.497317	2.694243908	7.66330909000	1.40190665594	1	High Degree of Certainty of Wetland Health
6331			-2.317631244	-10.359786	5.818572044	5.89162635000	0.04882200261	1	Low Degree of Certainty of Wetland Health
6333			-1.890851818	-6.77544	0.828414023	8.63110351000	0.32315083880	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
6334			-1.70278243	-10.195666	3.556233883	7.68541717000	0.25199322078	1	High Degree of Certainty of Wetland Health
6336			-2.280901795	-9.605567	1.761878967	9.48554992000	0.09951471185	1	High Degree of Certainty of Wetland Health
6339	□		-2.444783242	-6.327176	2.876813889	-1.02511596000	5.84942576495	1	High Degree of Certainty of Wetland Health
6358	□	□	-1.967347114	-26.317158	0.085205004	3.12288971000	3.50483147044	0	High Degree of Certainty of Wetland Health
6410			-3.347986188	-3.545216	6.780176163	-0.77765465000	5.73791847370	1	High Degree of Certainty of Wetland Health
6411	□		-2.808042438	-5.33174	1.059394956	2.62671470000	3.41120428397	1	High Degree of Certainty of Wetland Health
6413			-2.437281514	-5.983984	1.411996961	-2.08959007000	2.52796947120	1	High Degree of Certainty of Wetland Health
6415			-2.49621545	-4.935849	1.836125016	-2.49398423000	2.19705028500	1	High Degree of Certainty of Wetland Health
6480	□	□	-5.157746288	-12.00068	2.473766088	3.60941124000	3.22752524969	0	Low Degree of Certainty of Wetland Health
6481	□	□	-3.228003154	-9.521522	0.045481	5.15036011000	5.16263087782	0	High Degree of Certainty of Wetland Health
6489			-4.680039549	-4.726964	1.698446989	0.58233261000	1.94632889146	0	High Degree of Certainty of Wetland Health
6494		□	-8.984537912	-27.43497	3.712862968	7.77141380000	4.17358715614	0	Low Degree of Certainty of Wetland Health
6498			-4.55328922	-5.454991	1.480206966	1.17755890000	2.10061389901	0	High Degree of Certainty of Wetland Health
6499		□	-3.633872951	N/A	N/A	8.13221550000	7.48463951991	1	High Degree of Certainty of Wetland Health
6500			-2.704620241	-8.161952	2.714864016	12.75284767000	2.51058291626	0	Low Degree of Certainty of Wetland Health
6579		□	-2.64514314	-1.02681670	1.883327961	-5.09948910310	2.20068473318	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
6670			-2.364186749	-9.590575	0.853595018	0.02744195330	3.32689587402	1	High Degree of Certainty of Wetland Health
6671			-1.785285938	-8.0879995	1.035446048	0.55536754990	1.28477577973	1	High Degree of Certainty of Wetland Health
6673			-2.336711293	N/A	0.890856981	0.28999723570	3.10134368260	1	High Degree of Certainty of Wetland Health
6675	□		-2.023940285	N/A	0.546150982	-2.99885463370	1.43529010719	1	High Degree of Certainty of Wetland Health
6676	□		-1.936128744	-4.33519805	0.492917001	-2.36921346090	0.44923371211	1	High Degree of Certainty of Wetland Health
6681			-1.807596372	-4.873891	1.368123055	-1.17881898020	1.33594756901	1	High Degree of Certainty of Wetland Health
6683			-1.916122514	-4.8267555	1.284964085	-3.16928175800	3.81337556814	1	High Degree of Certainty of Wetland Health
6774		□	-2.832535375	-6.00799034	1.735592008	-0.04328647190	2.35016018222	1	High Degree of Certainty of Wetland Health
6776			-2.415396535	-3.558699	1.666355371	-1.86837981540	1.65538715096	1	High Degree of Certainty of Wetland Health
6777			-2.4039711	-4.504244	1.739420652	-2.79767500760	2.11496286035	1	High Degree of Certainty of Wetland Health
6780			-2.278632639	-6.48874839	0.7729882	-0.04785781150	0.86463157001	1	High Degree of Certainty of Wetland Health
6783			-2.274211646	-4.52663817	1.910140038	-0.04156233460	1.24359708927	1	High Degree of Certainty of Wetland Health
6804		□	-2.272298646	N/A	1.985982418	-5.04728687640	2.46266350113	1	High Degree of Certainty of Wetland Health
6805	□	□	-1.537165954	-2.694322	0.544364989	-4.77459295480	1.52126521452	1	High Degree of Certainty of Wetland Health
6806		□	-2.411353208	N/A	0.835757971	-4.99932606340	2.53517085271	1	High Degree of Certainty of Wetland Health
6988	□	□	-2.727123298	-7.592773	0.818683028	2.37123394000	1.04416573889	1	High Degree of Certainty of Wetland Health

Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
Site ID	Connected	Xeric	NPO RF 2008-2014	Median Depth to UFAS 2008-2014	Median SAS Drawdown 2008-2014	Predevelopment Potentiometric Surface minus 2008-2014 median UFAS	NPO 08-14 minus NPO 96-02	WHA Score 2016	Status Based on New Unmonitored Assessment
7007			-2.595752387	-6.704229	0.792205989	3.95100784000	0.22572552651	1	High Degree of Certainty of Wetland Health
7012	□		-2.3394638	-4.211694	1.409649968	9.54331208000	1.18546096585	1	High Degree of Certainty of Wetland Health
7013	□		-2.035712167	-9.156901	0.850275993	3.44157600000	0.71157651513	1	High Degree of Certainty of Wetland Health
7044			-2.502840069	-2.98696640	1.478911996	-2.48338706470	1.89172856647	1	High Degree of Certainty of Wetland Health
7102	□		-2.541668852	-2.472593	1.245625019	2.83024597000	1.31040200256	1	High Degree of Certainty of Wetland Health
8121	□		-1.93336704	-6.144052	0.735794008	-0.26567173000	1.31341489471	1	High Degree of Certainty of Wetland Health
10045			-2.154678385	N/A	1.968032956	3.98975468000	1.20519242953	1	High Degree of Certainty of Wetland Health
11000			-2.602324348	N/A	0.634967029	7.14047137790	0.54446193478	0	Low Degree of Certainty of Wetland Health
11001		□	-2.515736269	N/A	1.984344363	-0.24389559750	1.49664820136	1	High Degree of Certainty of Wetland Health
11002		□	-2.615451321	-5.192813	2.107647896	1.32097203460	1.43168749031	0	High Degree of Certainty of Wetland Health
12001	□		-2.171155362	N/A	1.906417251	-0.94449236250	3.47358669932	1	High Degree of Certainty of Wetland Health
12002			-1.485157652	N/A	0.752973974	-2.15641105650	1.17471527245	1	High Degree of Certainty of Wetland Health
12003		□	-2.369660308	N/A	1.20055294	-5.15159385060	3.02112248587	1	High Degree of Certainty of Wetland Health
12004			-3.024139774	N/A	1.614657521	1.60679480740	2.88095707586	0	High Degree of Certainty of Wetland Health
12005			-1.890345691	N/A	2.091997147	-2.92384051370	1.57717673816	1	High Degree of Certainty of Wetland Health
12006			-1.659673909	N/A	2.062771082	-3.04327646680	1.68811923745	1	High Degree of Certainty of Wetland Health

Tampa Bay Water staff assembled the datasets needed to assess the 845 unmonitored sites using the six criteria described in the prior section. The six data values (where available) for each unmonitored site were compared to the threshold value identified for each applicable criterion as described in Appendix 10.1. The results for the 845 unmonitored sites are presented in Table 10.2 which shows the data values for each criterion. The individual boxes in this table are color-coded according to whether or not the site passed or failed each criterion threshold. Boxes that are shaded green indicate that the site passed that particular criterion and the boxes that are shaded red indicate the criteria that were failed for each site. Those sites where data was not available for a particular criterion are designated as N/A on the table for that criterion. The revised weight-of-evidence approach for the unmonitored sites was applied by adding the number of criterion that passed for each site and those sites that met two or more criteria were designated as having a “High Degree of Certainty of Wetland Health” (617 sites). Those sites that passed one or no criteria were designated as having a “Low Degree of Certainty of Wetland Health” (228 sites). The final unmonitored site assessment results are also presented in map form in Figures 10.15 through 10.22.

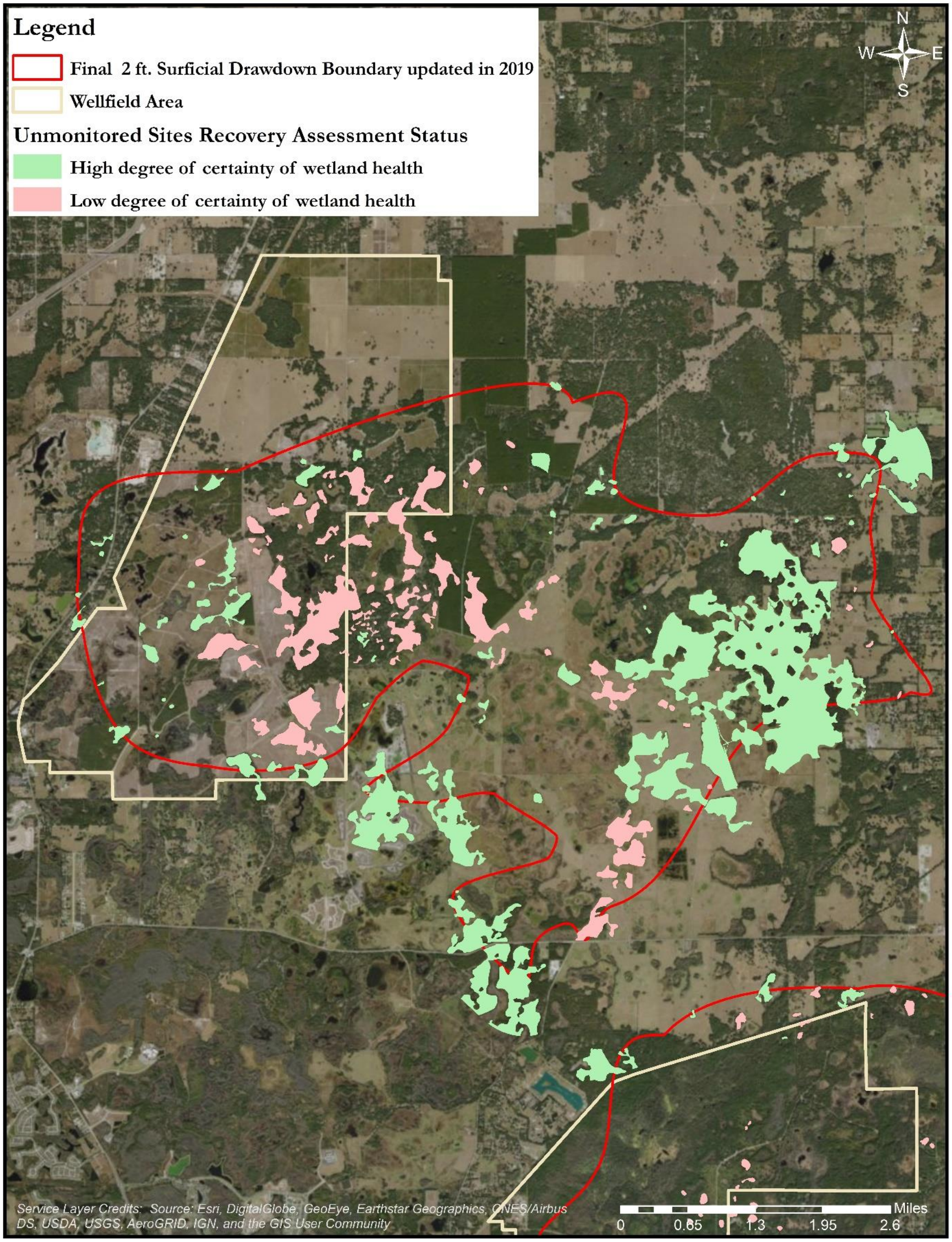


Figure 10.15: Map of Final Unmonitored Site Bin Designations near the Cross Bar Ranch Wellfield

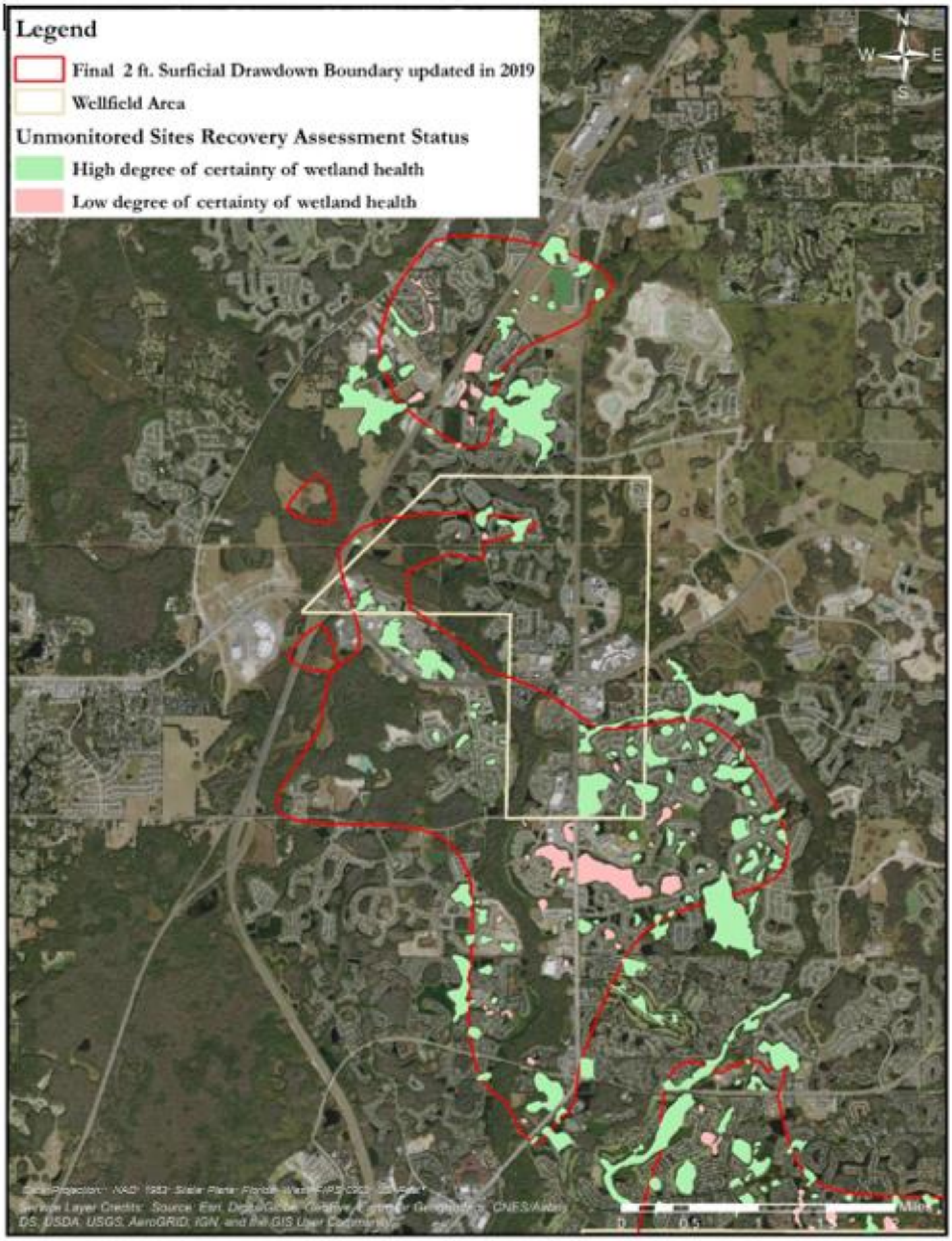


Figure 10.16: Map of Final Unmonitored Site Bin Designations near the Cypress Bridge Wellfield

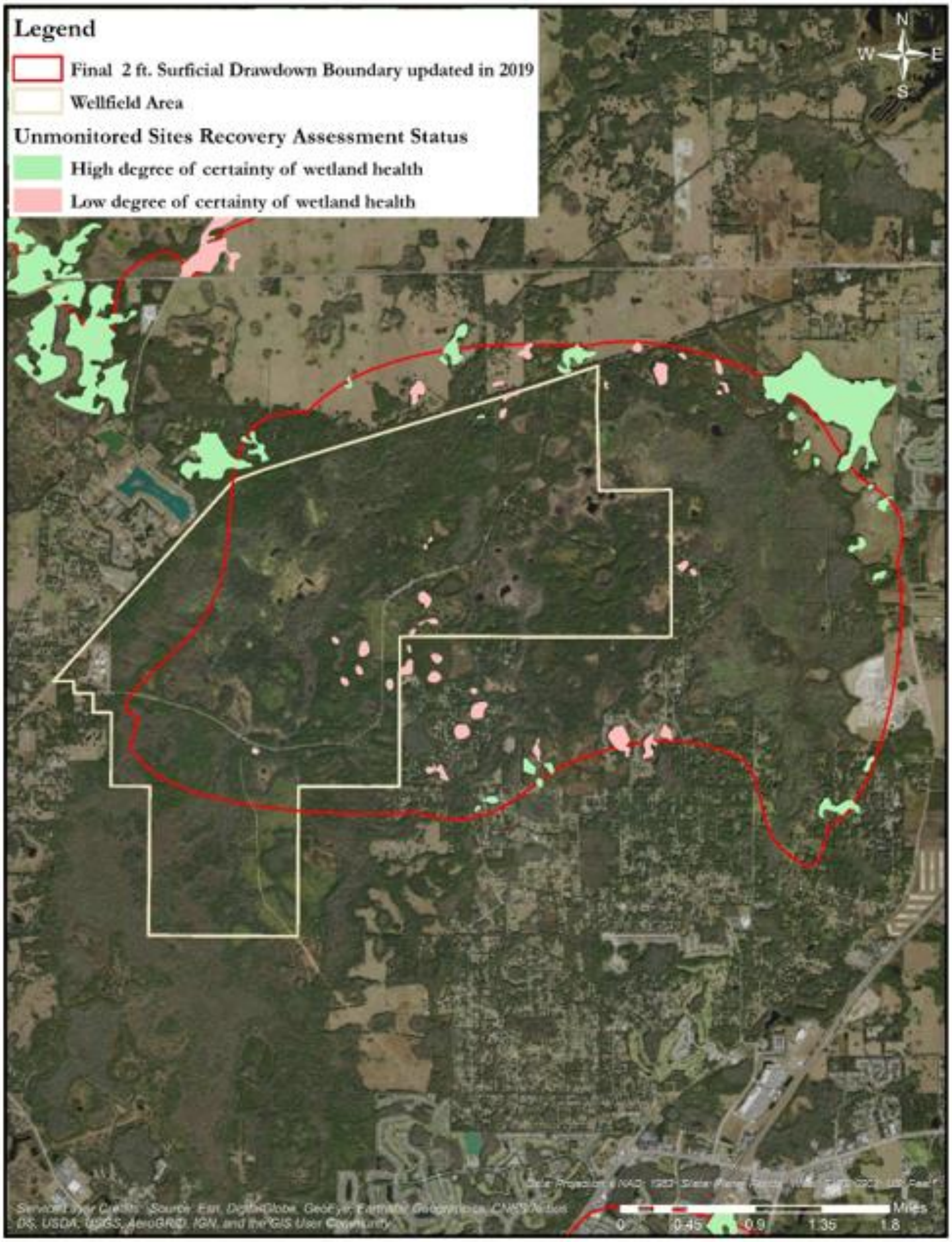


Figure 10.17: Map of Final Unmonitored Site Bin Designations near the Cypress Creek Wellfield

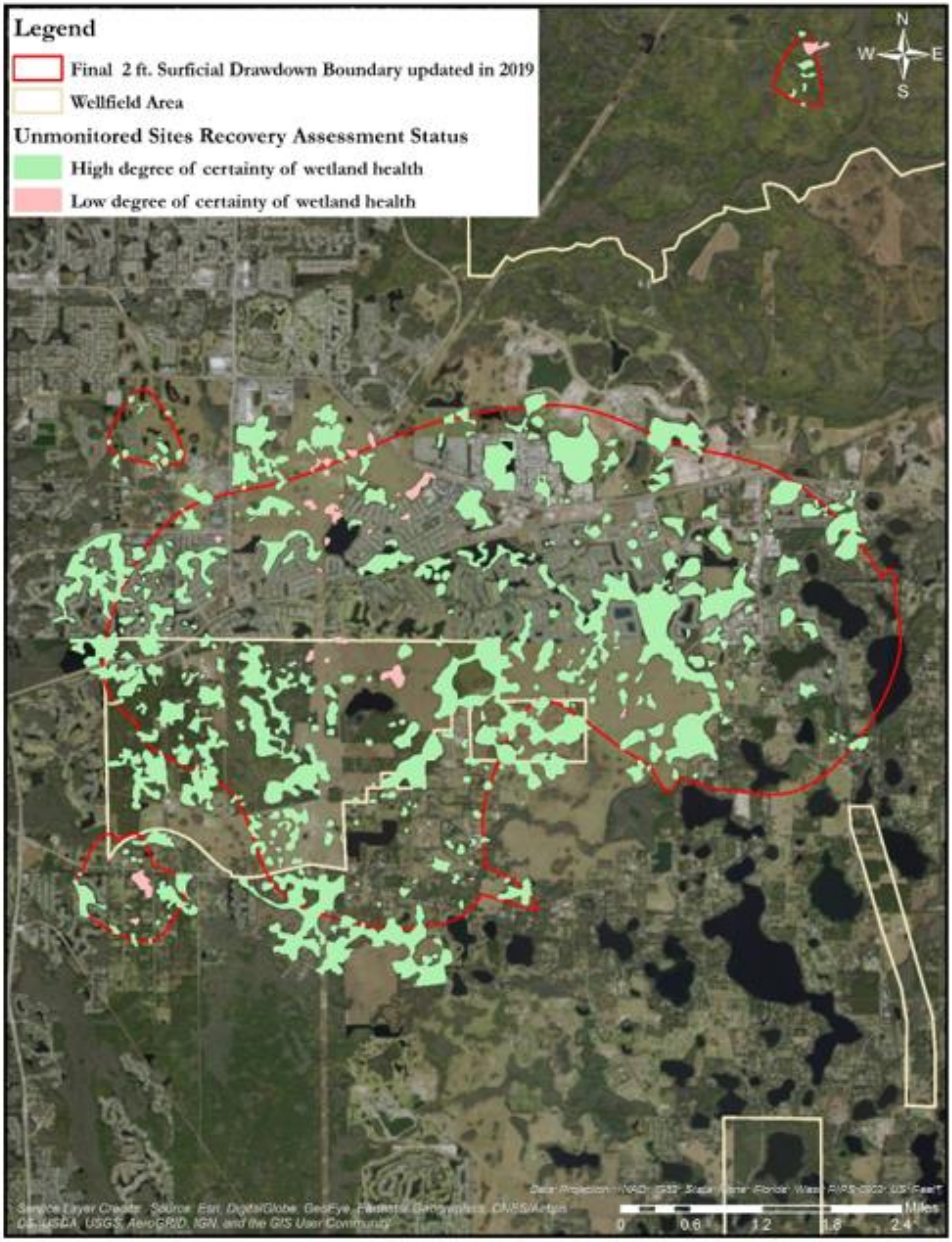


Figure 10.18: Map of Final Unmonitored Site Bin Designations near the Eldridge-Wilde Wellfield

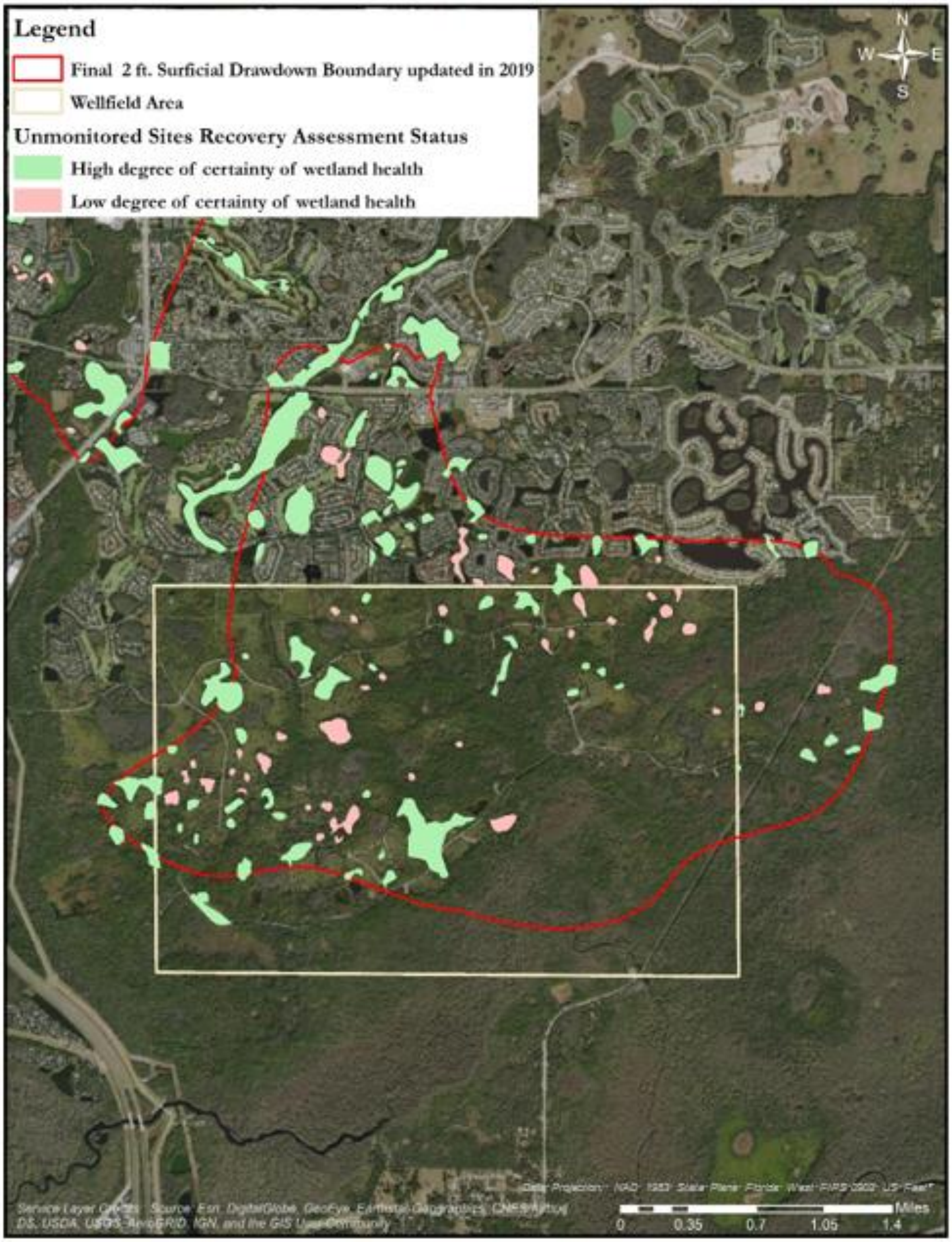


Figure 10.19: Map of Final Unmonitored Site Bin Designations near the Morris Bridge Wellfield

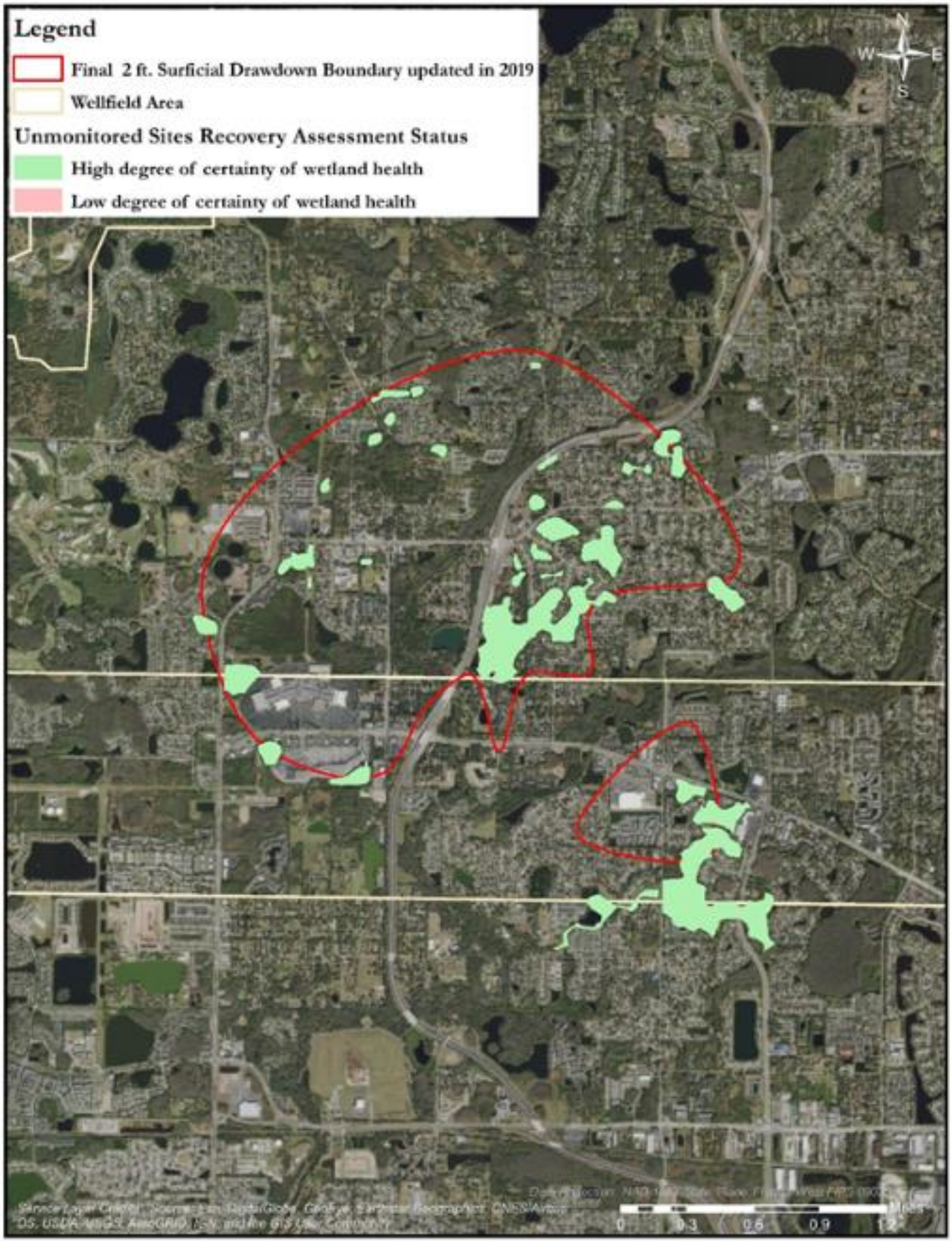


Figure 10.20: Map of Final Unmonitored Site Bin Designations near the Northwest Hillsborough Reginal Wellfield

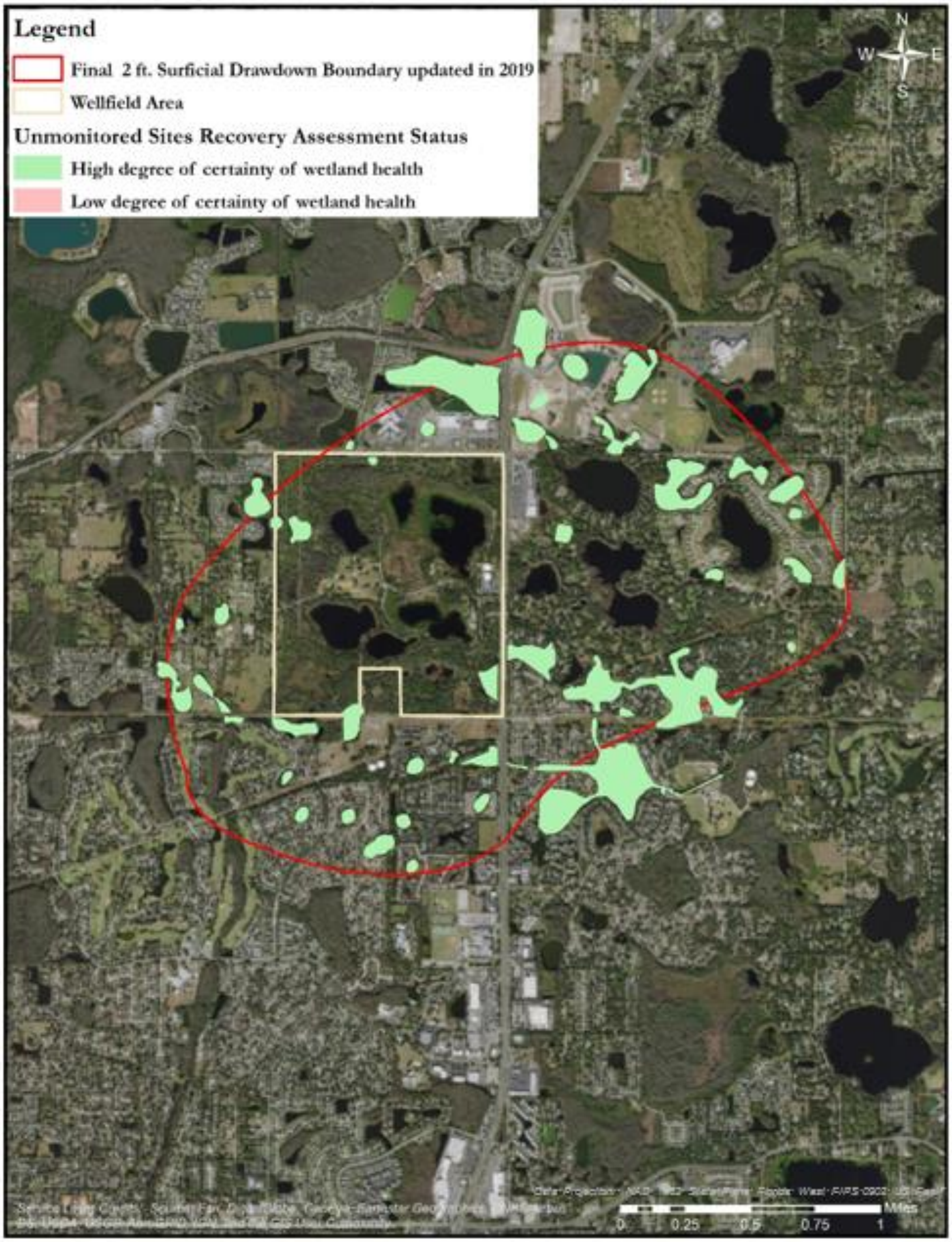


Figure 10.21: Map of Final Unmonitored Site Bin Designations near the Section 21 Wellfield

Figure 10.22: Map of Final Unmonitored Site Bin Designations near the J.B. Starkey Wellfield

The final results of the unmonitored site assessment indicate that 73% of these sites are predicted to have a high degree of certainty of wetland health based on the weight-of-evidence approach. It is important to note that the results of this qualitative assessment of wetland health matches well with the results of recovery at monitored sites within the wellfields. A total of 71% of monitored wetlands are designated as Never Impacted or Recovered/Meets Metric in this final assessment report. This validation of the final unmonitored site assessment method is logical since many of the spatial datasets used to assess unmonitored sites are based on data collected from monitored wetlands in the same vicinity as the unmonitored wetlands.

The final assessment results for these unmonitored sites are not directly comparable to the results for the monitored lakes and wetlands; however, the results for the monitored and unmonitored sites are considered together in Chapter 12 of this report. Maps of each wellfield area show the results of the quantitative assessments for monitored sites and qualitative assessment of unmonitored sites. The spatial similarities and differences in the two types of results are also discussed, but the site-specific assessment results for the monitored sites have not changed based on the predictions of health for unmonitored sites. The results for the unmonitored sites may confirm the results of the monitored sites where the results are similar and add validity to the monitored site assessments. Alternatively, different results in health assessments of proximal monitored and unmonitored wetlands may indicate uncertainty in either result. In cases where there is a low degree of certainty of unmonitored wetland health, but proximal monitored wetlands appear to be healthy, Tampa Bay Water and the District staff will determine if additional monitoring is needed in the area. Any sites proposed to be added to Tampa Bay Water's monitoring site list will be determined during the permit renewal process and sites will be added where they add valuable data with respect to determining the potential influence of wellfield pumping on lake and wetland water levels.

Tampa Bay Water and District staff have agreed that the final Recovery Assessment Plan report will not contain any recommended mitigation action for any of the unmonitored sites given the error and uncertainty in the data and analysis used for these sites. Tampa Bay Water and District staff also agreed that Tampa Bay Water should investigate any reports of low water level in these unmonitored wetlands if reported by a landowner during the next term of the Consolidated Permit. If a landowner contacts Tampa Bay Water or the District alleging that low water levels in an unmonitored wetland are due to wellfield pumping, Tampa Bay Water will perform a site-specific evaluation of that wetland or lake to determine if the wetland is significantly hydrologically impacted by wellfield pumping. This site-specific investigation assumes access to the site will be granted by the property owner and may include the collection of water level and/or vegetation data over time. If Tampa Bay Water and the District agree that wellfield pumping is causing an adverse impact to the subject wetland or lake, Tampa Bay Water will take appropriate action at that time to remedy the adverse impact, subject to agreement with the District and the property owner.

11: Hydrologic Recovery

11. Hydrologic Recovery

The water levels in the surficial and Upper Floridan aquifers beneath a wetland have a significant influence on the water level within that wetland, affecting both depth and duration. When water levels in the aquifers are low relative to the water level in the wetland, this increased difference creates a downward potential gradient that can result in lower water levels in the wetland. If this downward gradient persists for an extended period of time, the water level in the wetland will leak more rapidly through the bottom sediments into the underlying aquifer, resulting in a low or absent wetland water level. When water levels in the aquifers are higher and closer to the water level elevation within a wetland, there is little or no potential for the water level in the wetland to leak downward into the underlying aquifer. This was the logic behind the reduction in pumping from the Consolidated Permit wellfields; a significant reduction in wellfield pumping would result in higher aquifer water levels and reduced leakage of water from lakes and wetlands into the aquifer. Over time, this new condition was expected to allow water level recovery in the wetlands and lakes on and near the wellfields; this water level recovery is a critical step for the environmental recovery and health of a wetland.

The evaluation of recovery at individual lakes and wetlands is supported by an understanding of the improvement in water levels in the underlying aquifers following the reduction of wellfield pumping. These improved conditions can be demonstrated by both predictive modeling and by water level data collected by Tampa Bay Water and the District through the extensive network of monitor wells in the surficial and Upper Floridan aquifers across the northern Tampa Bay area. A combination of these methods produces both predictions and confirmation using actual water level data. These lines of evidence further our understanding of lake and wetland recovery and the degree of water level recovery that can be achieved at the wellfields.

11.1 Predicted Surficial and Upper Floridan Aquifer Drawdown

The predicted drawdown in the surficial and Upper Floridan aquifers from wellfield pumping is useful information for understanding the condition, and assessing the degree of recovery achieved, at specific lakes and wetlands. Tampa Bay Water staff simulated aquifer drawdown related to wellfield pumping using the Unit Response Matrix (URM), an application derived from the Integrated Northern Tampa Bay (INTB) model [see Section 3.14.5 for additional details]. The drawdown coefficients in the URM were generated from the calibrated INTB model and it has been demonstrated that using the URM to represent the physical pumping/drawdown relationship in the aquifer system is a valid approach. The URM is a computationally-efficient application and is the groundwater modeling tool that Tampa Bay Water used to create the Recovery Assessment Area of Investigation (Section 5.3) and datasets for assessing recovery at unmonitored sites (Section 6.5 and Chapter 10).

The predicted aquifer drawdown attributed to wellfield pumping was generated for three time periods, both before and after the reduction in wellfield pumping. The drawdown from two, seven-year time periods were simulated to represent the pre-cutback and post-cutback pumping periods; 1996 – 2002 and 2008 – 2014, respectively. These two time periods are the same as used in the preliminary recovery assessment analyses for monitored wetlands as described in Chapter 9. These time periods were selected since they represented the two different wellfield pumping conditions and the average annual rainfall during both seven-year periods were similar. The third time period simulated was 2012 – 2018 which is the current period of time when all of the wellfields are interconnected to the Regional System and pumping can be rotated between all wellfields. This recent seven-year time period is important as the recent years leading up to the present time reflect the hydrologic condition in the aquifer beneath the wellfield-area lakes and wetlands. This current time period was helpful in understanding the current condition of lakes and wetlands during field reviews.

Figure 11.1 shows the predicted median drawdown in the surficial aquifer for the time periods 1996 – 2002 and 2008 – 2014 and Figure 11.2 compares the predicted median drawdown in the surficial aquifer for the time periods 1996 – 2002 and 2012 – 2018. Drawdown is significantly reduced at all wellfields except the Cypress Bridge Wellfield during the two time periods following the reduction in regional wellfield pumping. The Cypress Bridge Wellfield was the last of the regional wellfields to be developed and has not experienced a reduction in the annual average pumping rate. The 2012 – 2018 period shows that there is less than two feet of predicted drawdown in the surficial aquifer at the Starkey, North Pasco, South Pasco, Cosme-Odessa, and Northwest Hillsborough Wellfields as well as the inter-wellfield area along U.S. Highway 41. The predicted surficial aquifer drawdown at the Eldridge-Wilde and Cypress Creek Wellfields have been reduced by almost half since the 1996 – 2002 period and the areas of highest drawdown are largely located on the wellfield properties. The area and extent of predicted drawdown in the surficial aquifer at the Cross Bar Ranch Wellfield are significantly reduced during the recent 2012 – 2018 time period.

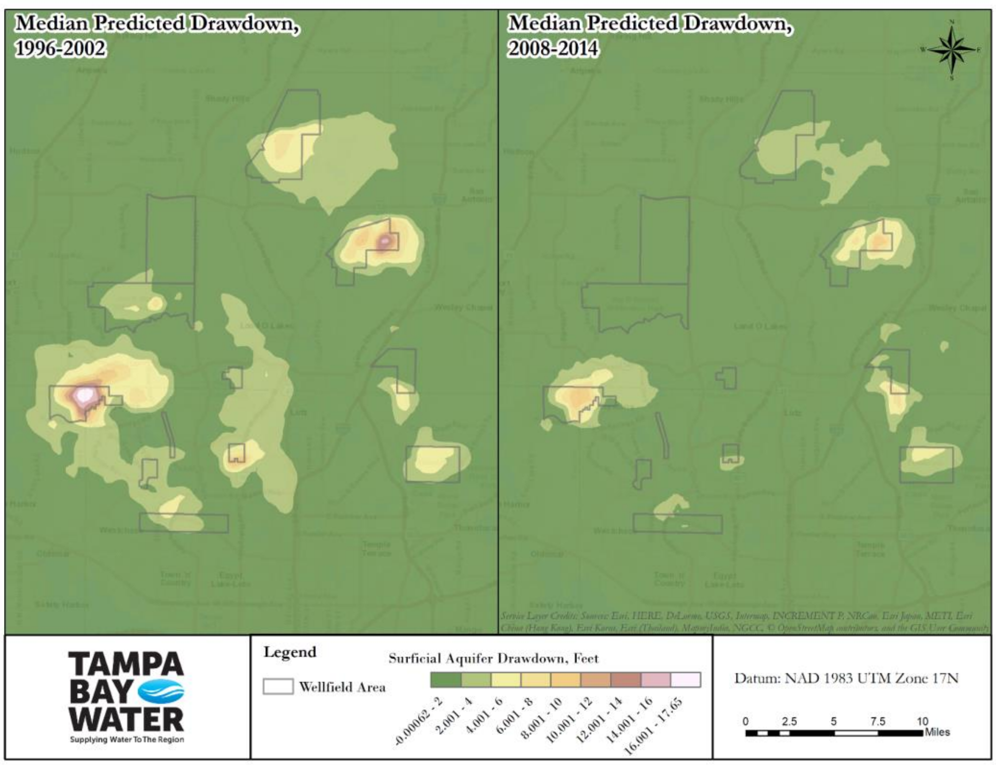


Figure 11.1: Median Predicted Drawdown in the Surficial Aquifer; 1996 – 2002 and 2008 – 2014

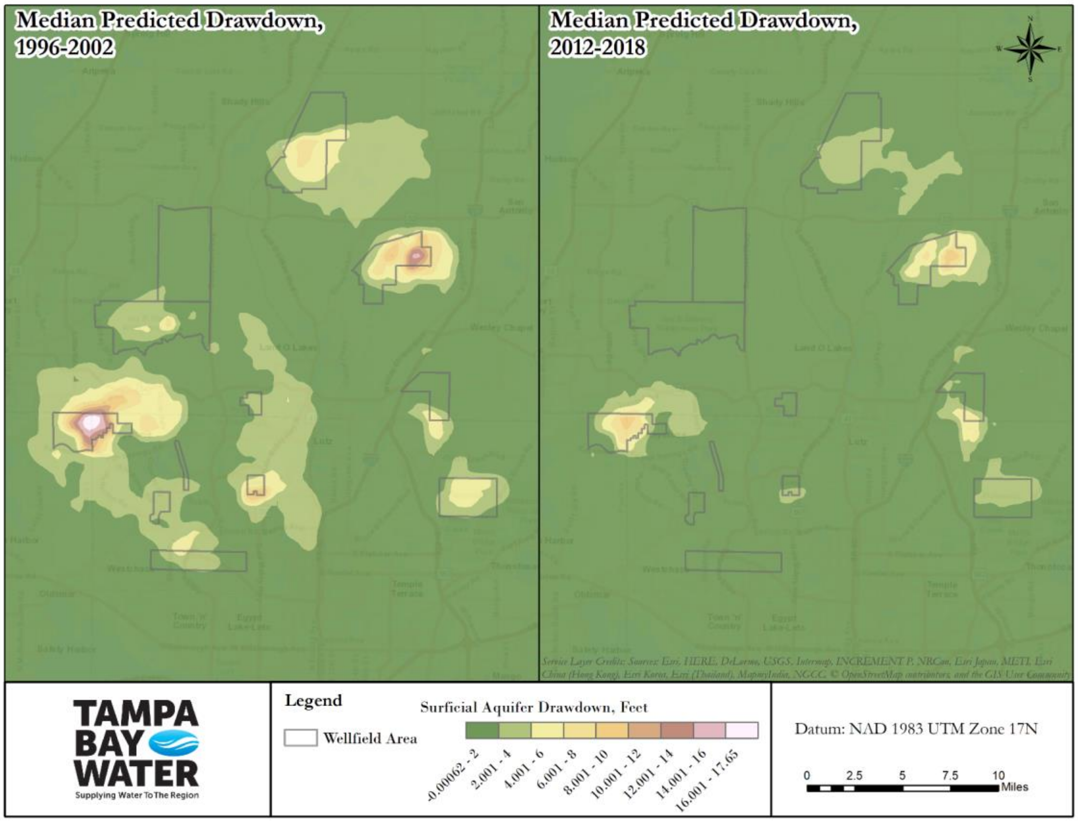


Figure 11.2: Median Predicted Drawdown in the Surficial Aquifer; 1996 – 2002 and 2012 – 2018

Figure 11.3 shows the predicted median drawdown in the Upper Floridan Aquifer for the time periods 1996 – 2002 and 2008 – 2014 and Figure 11.4 compares the predicted median drawdown in the Upper Floridan Aquifer for the time periods 1996 – 2002 and 2012 – 2018. Similar to the drawdown maps for the surficial aquifer, the predicted drawdown in the Upper Floridan Aquifer is significantly less in the two post-cutback time periods, with the exception of the Cypress Bridge Wellfield. The area of greatest predicted drawdown in the 2012 – 2018 period is in the east-central portion of the Cypress Creek Wellfield and the predicted drawdown has been reduced by almost half as compared to the predicted drawdown in the 1996 – 2002 period.

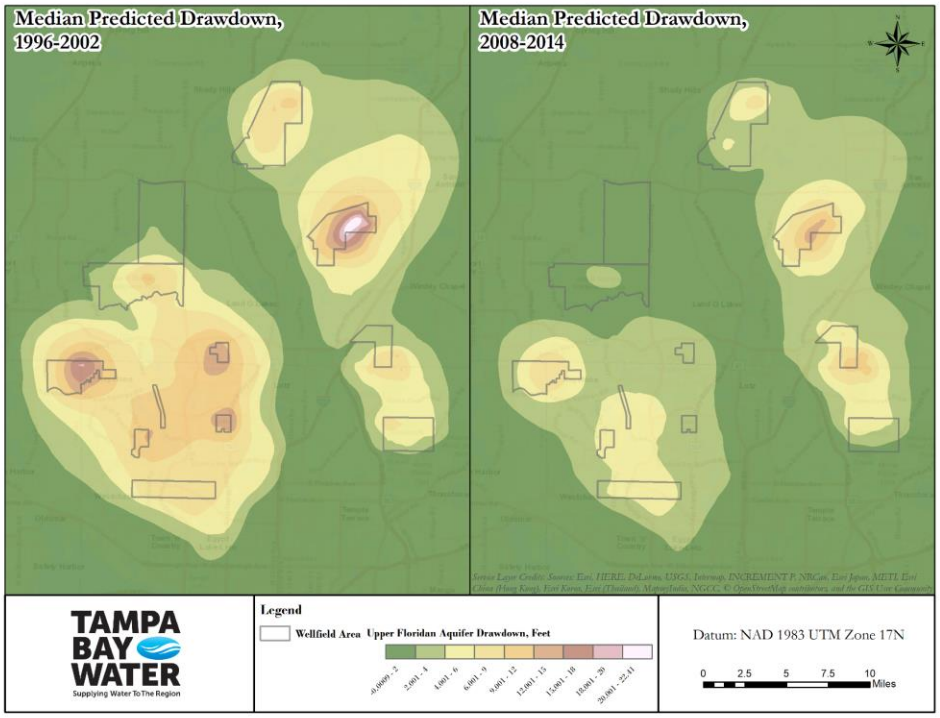


Figure 11.3: Median Predicted Drawdown in the Upper Floridan Aquifer; 1996– 002 and 2008–2014

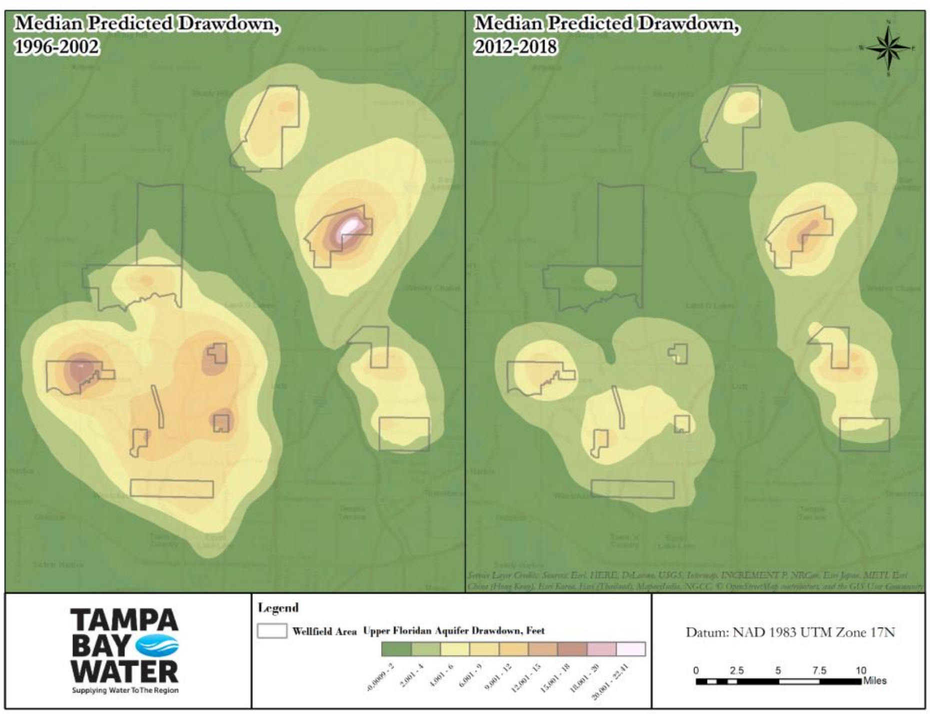


Figure 11.4: Median Predicted Drawdown in the Upper Floridan Aquifer; 1996–2002 and 2012–2018

The predicted drawdown in these comparison figures was based on actual wellfield pumping data from the calendar years noted on the figures. Table 11.1 shows the average calendar year pumping rate for each wellfield during these three seven-year periods. The URM simulated drawdown from wellfield pumping on a weekly basis for each calendar year and the median of the 52 weekly drawdown values at each grid cell was compiled. The median drawdown values at each grid cell for the selected seven-year periods were computed to produce these predicted drawdown maps (the long-term median drawdown from the seven annual median drawdown analyses). The median predicted drawdown is representative of the long-term pumping condition for these time periods. These maps do not represent any particular distribution of wellfield pumping since Tampa Bay Water uses the OROP to guide production based on actual hydrologic conditions. Since the operation of the wellfields is variable due to changing hydrologic conditions and multiple system constraints, it is most appropriate to examine multiple long-term pumping scenarios to understand the water level recovery and the current aquifer condition in the wellfield areas.

Table 11.1: Average Annual Pumping Rates for Consolidated Permit Wellfields - Calendar Year Basis

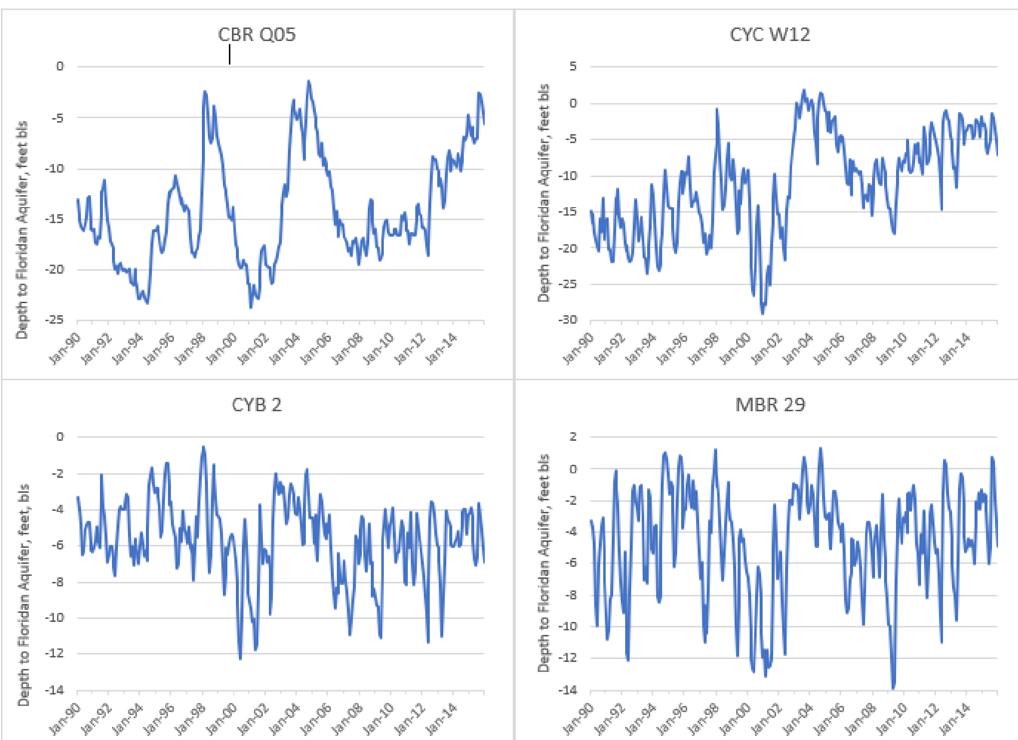
Years	CBR	CYC	CYB	MBR	COS	S21	SOP	ELW	NWG	STK	NP	TOTAL
1996-2002 Average	21.9	25.4	8.7	11.6	10.7	9.5	13.9	24.7	9.3	11.5	1.9	149.0
2008-2014 Average	14.0	15.5	12.4	7.6	4.6	2.0	4.6	11.7	5.4	4.0	0.2	82.1
212-2018 Average	13.9	15.2	11.9	7.2	6.0	3.0	4.7	11.2	2.4	4.3	0.5	80.3

All values in million gallons per day (mgd)

11.2 Upper Floridian Aquifer Potentiometric Surface Time Series

The information presented in this chapter focuses primarily on the potentiometric surface of the Upper Floridan Aquifer. This is the aquifer that is most directly affected by wellfield pumping and the potentiometric surface within this aquifer is continuous and can be mapped with a high degree of confidence. The monthly average potentiometric surface maps of the Upper Floridan Aquifer (1990 – 2015) that are described in Section 5.5.4 (Appendices 5.16 and 5.17) provide a time series of high-quality data that has been used to support the Recovery Assessment analyses. This times series of data and maps form the basis for multiple assessments and were used in the evaluation of individual wetlands and lakes as described in Chapters 8 and 9 and in the assessment of unmonitored sites described in Chapter 10. These data are also interpreted in multiple formats to evaluate the recovery of the potentiometric surface at the Consolidated Permit wellfields.

The spatial time series data was imported into the ArcGIS Online application that was created to support the Recovery Assessment analyses as described in Chapter 7. The 26-year time series of monthly data is accessible in the ArcGIS Online application as hydrographs showing the monthly average depth to the Upper Floridan Aquifer potentiometric surface beneath each lake and wetland represented in the application. Since these data cover the periods of time before and after the reduction in wellfield pumping, trends in potentiometric surface elevation can be seen in the hydrographs. The change in relative depth below the bottom of the individual lakes and wetlands is also informative as supporting lines of evidence of recovery. Figure 11.5 shows this time series data below a wetland at each of the 11 Consolidated Permit wellfields.



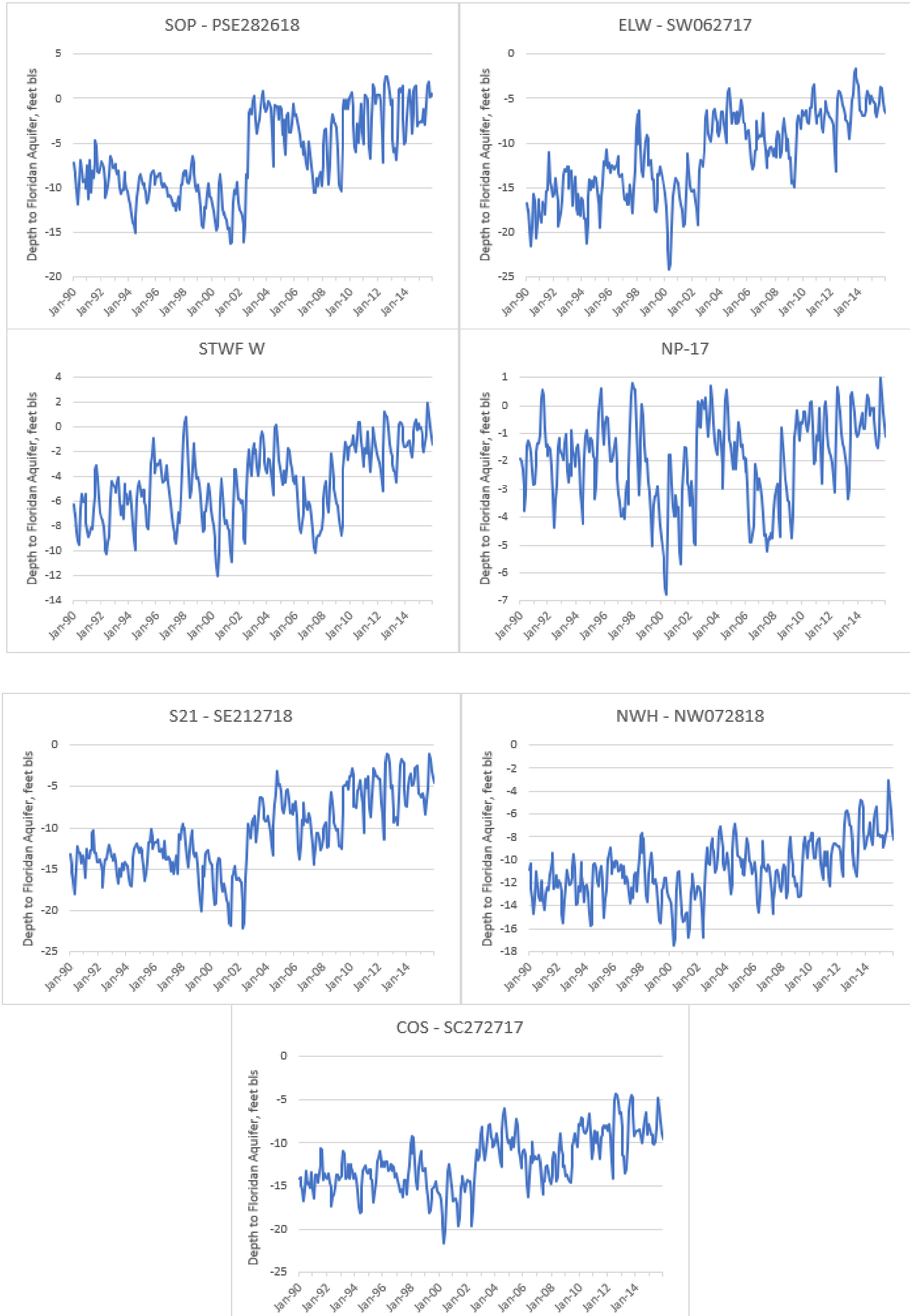


Figure 11.5: Depth to Upper Floridan Aquifer Potentiometric Surface Below Selected Monitored Wetlands

The individual hydrographs in Figure 11.5 show the improvement in the potentiometric surface elevation beneath the wetlands following the reduction in wellfield pumping. For many of these wetlands, the potentiometric surface is just beneath or often above the bottom of the wetland in recent years. This condition promotes the sustained recovery of the wetlands since water will not readily leak downward into the underlying aquifers when the potentiometric surface is at or close to the bottom of the wetland. Since the reduction in wellfield pumping, the potentiometric surface is often at or above the bottom of wetlands PSE282618 at the South Pasco Wellfield, STWF W at the Starkey Wellfield, and NP-17 at the former North Pasco Wellfield. In addition, the potentiometric surface is often less than five feet below the bottom of wetlands W-12 at the Cypress Creek Wellfield, CYB-2 at the Cypress Bridge Wellfield, MBR-29 at the Morris Bridge Wellfield, SW062717 at the Eldridge-Wilde Wellfield, and SE212718 at the Section 21 Wellfield.

One component of the Lee and Fouad work presented in Section 5.5.4 was a comparison of the potentiometric surface time series to the land surface elevation at Recovery Assessment Plan wetlands. This comparison was made to describe the depth of the potentiometric surface beneath the wetlands and to demonstrate the change in potentiometric surface elevation in the pre-and post-pumping cutback periods (HSW Engineering, Inc., 2018a and Appendix 5.18). The wetlands were classified as recharging or discharging depending on the elevation of the potentiometric surface relative to the bottom elevation of the wetlands. A time series of monthly maps was produced showing those wetlands in a discharging condition and the depth of the potentiometric surface beneath the remaining wetlands (recharging condition). An animation showing this monthly time series of potentiometric surface maps from January 1990 to December 2015 can be viewed by accessing the MP4 video file contained in Appendix 11.1.

An example from the Lee and Fouad work is presented in Figure 11.6 which shows a comparison of the discharging and recharging groundwater conditions in the Northern Tampa Bay area before and after the reduction in wellfield pumping. The monthly average potentiometric surface relative to land surface is shown for September 1991 and September 2012. These two years had slightly above-average rainfall across the wellfield areas with total average rainfall of 57.9 and 57.3 inches, respectively. The main difference in the two years is that all of the wellfields were connected to Tampa Bay Water's regional system in 2012 and all but the Cypress Bridge Wellfield had a reduced rate of pumping. The maps contain color-coded depth bins with blue polygons representing conditions where the potentiometric surface is above the bottom of that wetland or in a state of discharge. The comparison of the 1991 and 2012 time periods shows recovery in the potentiometric surface across the wellfield areas. Of note are the discharge conditions on and east of the Cypress Creek Wellfield, on and surrounding the Starkey and North Pasco Wellfields, and the inter-wellfield area that extends from the southern portion of the Cross Bar Ranch Wellfield to the South Pasco Wellfield and east of the Section 21 Wellfield. The Northwest Hillsborough area including the Cosme-Odessa, Northwest Hillsborough, and Section 21 Wellfields show an approximate 10 to 15 foot improvement in the potentiometric surface elevation in 2012 due to the reduction in wellfield pumping.

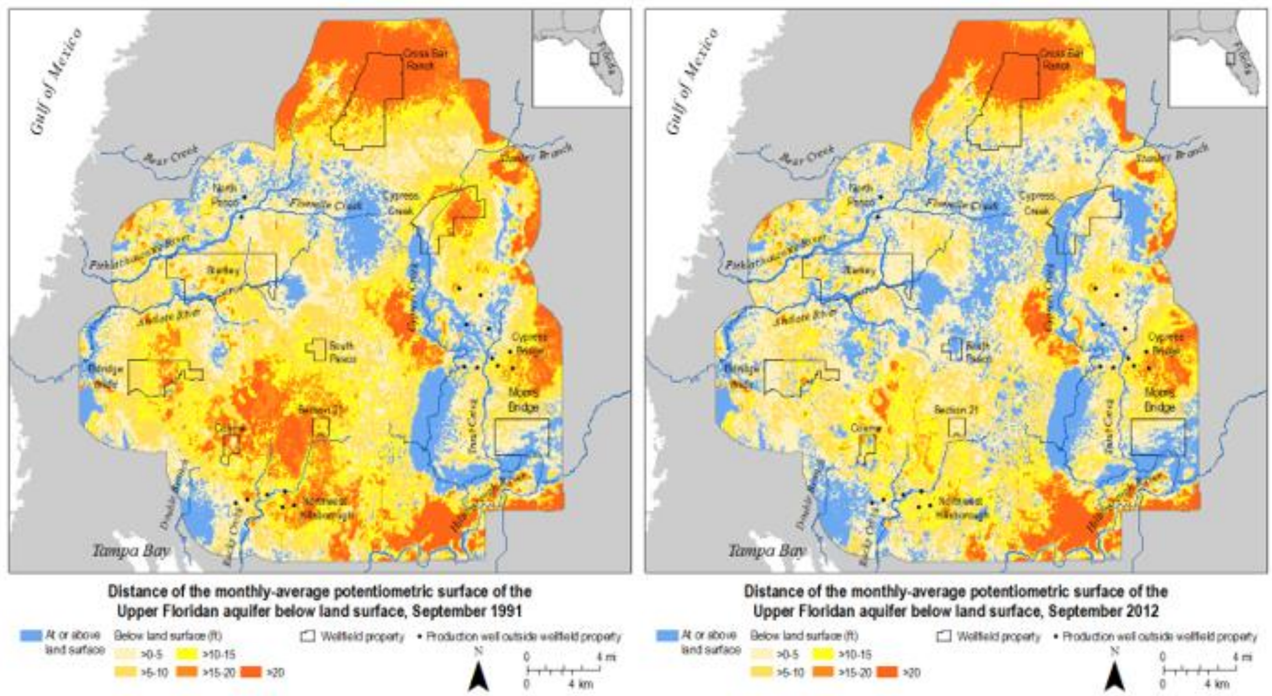


Figure 11.6: Depth of the Upper Floridan Aquifer Below Land Surface in September 1991 and September 2012

The change in the average depth of the potentiometric surface relative to land surface for the 13-year periods before (1990 – 2002) and after (2003 – 2015) the reduction in wellfield pumping is shown in Figure 11.7 for the month of September. Regional improvement is evident in these two maps and several wellfield areas show particularly strong improvement for the month of September after the reduction in pumping. The average potentiometric surface for most of the floodplain and isolated wetlands on and surrounding the Cypress Creek Wellfield is within 5 feet of land surface at the end of the summer rainy season, an improvement of 5 to 10 feet over the pre-pumping reduction period. The south portion of the Cross Bar Ranch Wellfield and the area between these two wellfields also demonstrates a 5 to 10 foot increase in the potentiometric surface. The average potentiometric surface beneath almost all wetlands on the South Pasco, Eldridge-Wilde, Starkey, and former North Pasco Wellfields is within 5 feet of land surface in the 2003 – 2015 period. Five to 10 feet of potentiometric surface improvement at the Section 21 Wellfield and in the northwest Hillsborough County area is also evident in the post-pumping reduction map. The September map (B) in Figure 11.7 is an average of conditions during 2003 – 2015 which contains very wet and very dry years. During years with above-normal rainfall, the potentiometric surface in September can be in a discharge state around many of the Consolidated Permit Wellfields and can be seen in the time series map animation included in Appendix 11.1.

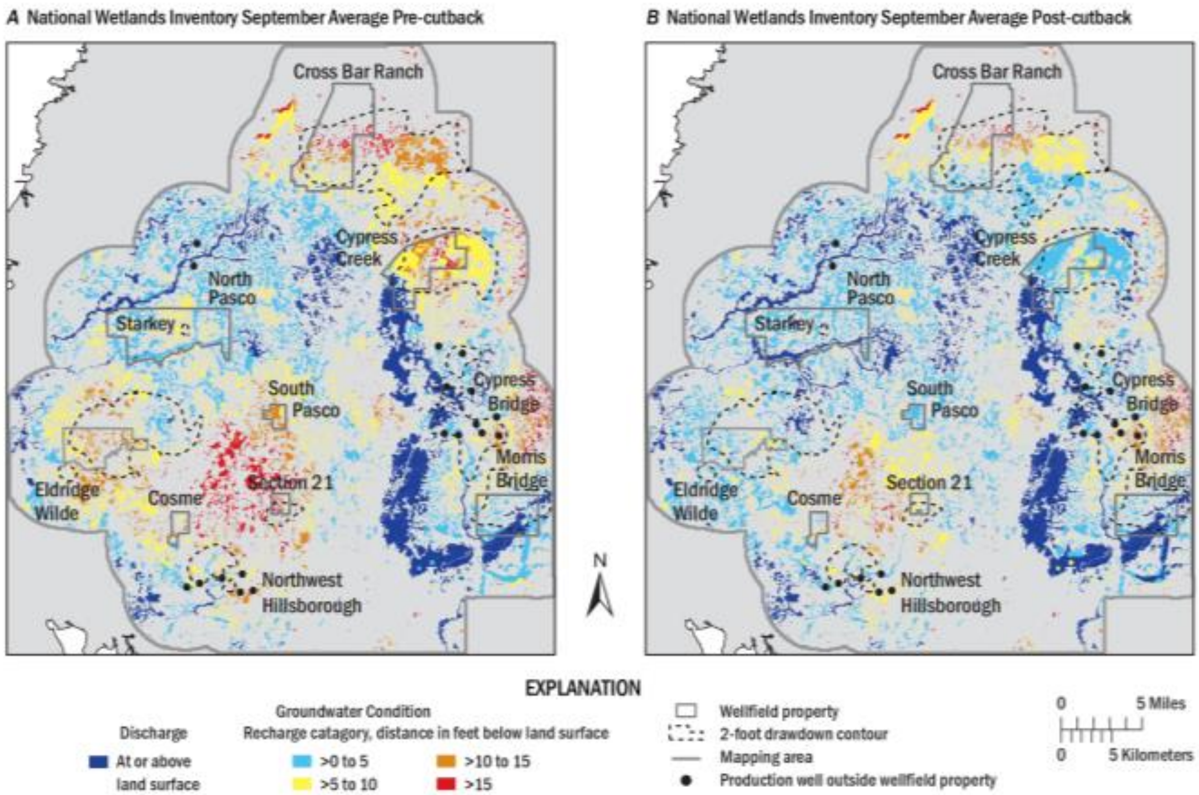


Figure 11.7: Groundwater Condition Classification at Regional Wetlands in September (a) Before and (b) After Reduction in Wellfield Pumping

Lee and Fouad (HSW Engineering, Inc., 2018a) assessed the depth to the Upper Floridan Aquifer potentiometric surface in additional ways to describe the improvement in this surface following the reduction in wellfield pumping. The change in groundwater condition beneath 1,092 wetlands that are either monitored wetlands or are unmonitored wetlands within the original Area of Investigation is shown in Figure 11.8. These three bar graphs compare the average depth of the potentiometric surface below land surface for the 13-year periods before and after the reduction in wellfield pumping as described above. This data is presented for the annual period, May, and September during these two time periods. The data has been assigned to classification bins that show the improvement in the potentiometric surface elevation due to the reduction in wellfield pumping. For all three time periods (annual, May, and September), the data clearly demonstrate that the potentiometric surface is closer to land surface in the recent time period. The percentage of wetlands where the potentiometric surface is above or within 5 feet of land surface increased from 22.6% to 42.8% for the annual time period and increased from 32.8% to 58.4% for the month of September following the pumping reduction. The Upper Floridan Aquifer is in a state of discharge for 14.7% of these wetlands during the month of September during 2003 – 2015 based on average monthly data for this month of the year. There is a corresponding decrease in the percentage of these wetlands where the potentiometric surface is greater than 10 feet below land surface after the reduction in pumping for the annual, May, and September time periods.

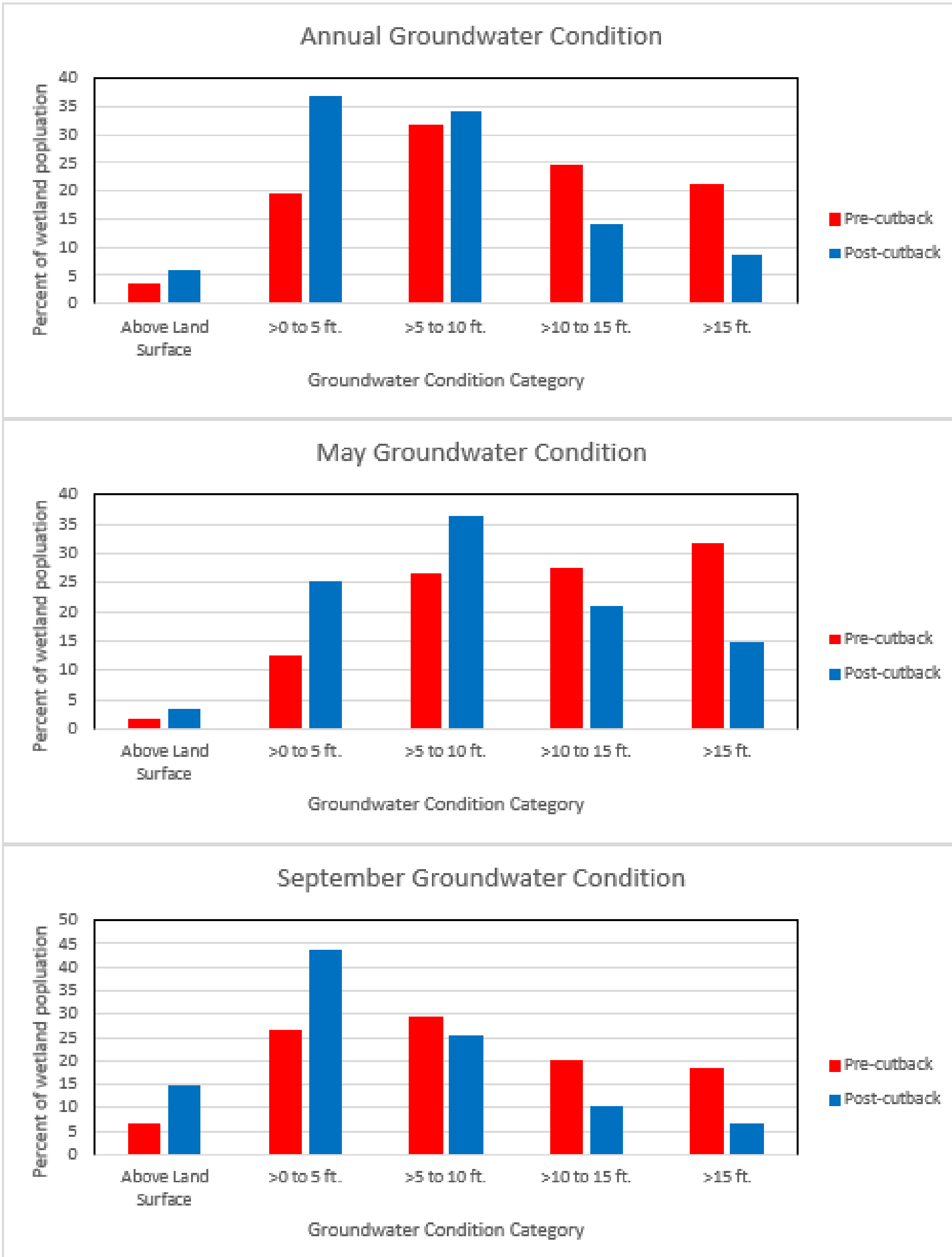


Figure 11.8: Changes in Groundwater Conditions for the Tampa Bay Water Wetland Population After Pumping Reduction

The average depth to the potentiometric surface (relative to land surface) for May and September of each year between 1990 and 2015 is shown in Figure 11.9 (a reproduction of Figure 18 from the HSW Engineering, 2018a report). A box and whisker plot for each year summarizes the average potentiometric surface beneath the 1,092 monitored or unmonitored wetlands described above. The white boxes represent data from the years before and the gray boxes represent data from the years after the wellfield pumping reduction. The elevation range of 0 to 5 feet below land surface is shaded gold on the graphs as a visual reference. The variation in depth to the potentiometric surface for May and September decreased following pumping reductions as demonstrated by the smaller interquartile ranges (the size of the boxes between the 75th and 25th percentiles). The median depth to the potentiometric surface is less (closer to land surface) and the 25th percentile values are also improved following the reduction in pumping for both May and September. The graph of September data indicates that the median depth of the potentiometric surface was less than five feet below land surface for 10 of the 13 years after the wellfield pumping reduction as compared to 1 of 13 years before the reduction in pumping at the study wetlands. This improvement reflects the reduced wellfield pumping rates during the summer rainy season when the regional surface water supply sources are abundant. This improvement in the potentiometric surface beneath the wetlands has resulted in improved water levels in the wetlands and lakes on and around the wellfields.

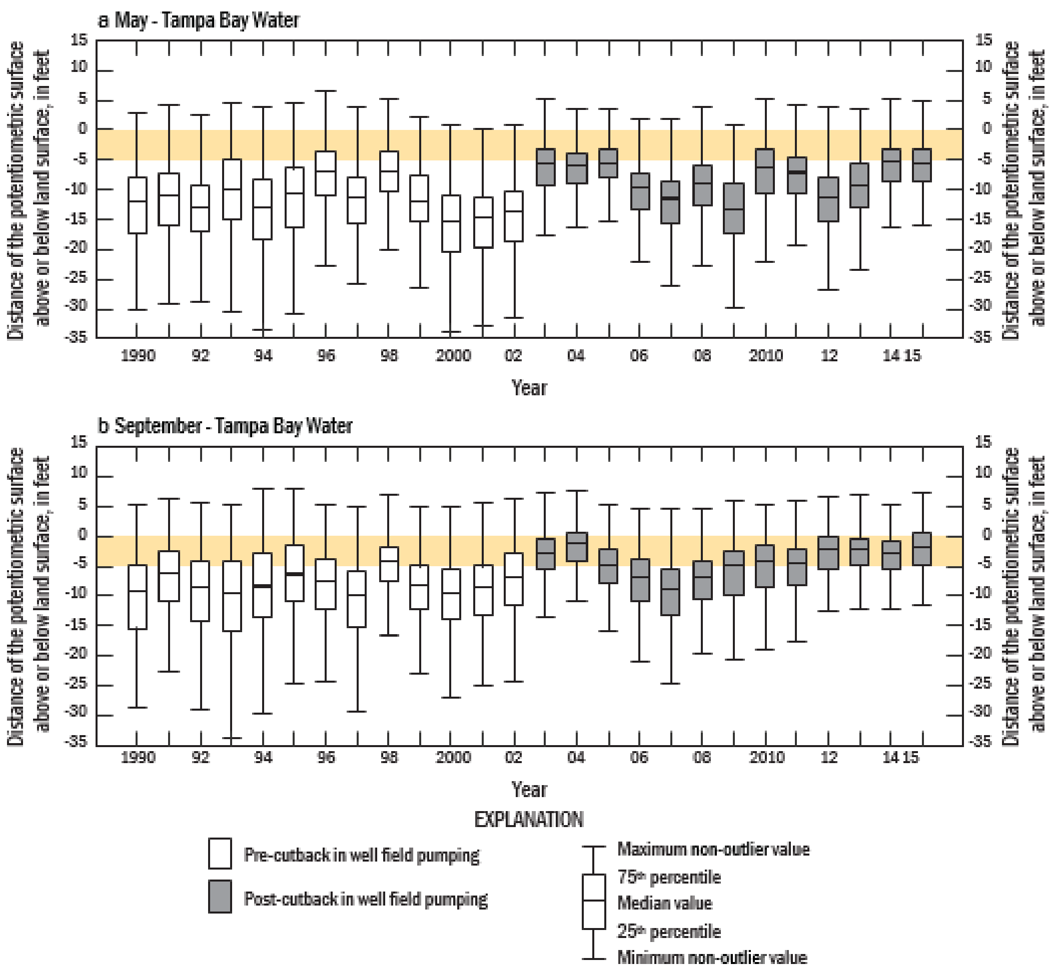


Figure 11.9: Monthly Average Groundwater Conditions in the Tampa Bay Water Wetland Population in (a) May and (b) September from 1990 to 2015

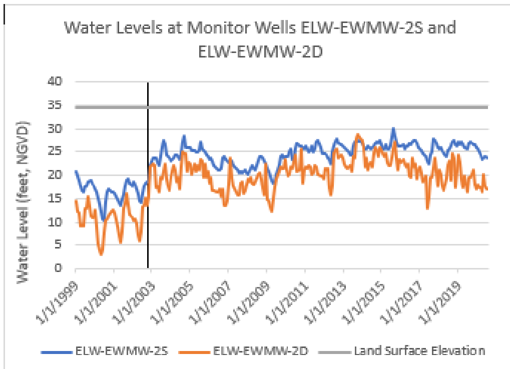
11.3 Empirical Water Level Data Assessment

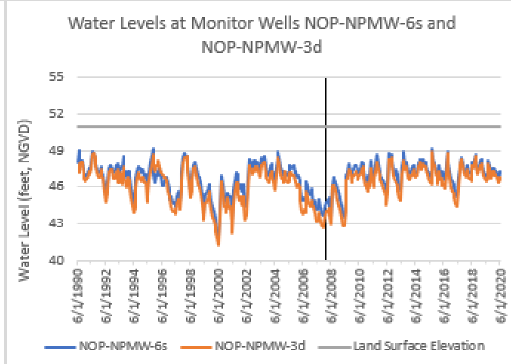
The period-of-record water level data collected by Tampa Bay Water and the District for surficial and Upper Floridan aquifer monitor wells, wetlands, and lakes on and near the Consolidated Permit Wellfields are presented in the annual reports produced for each wellfield. These hydrographs were not included in this Recovery Assessment Plan Final Report of Findings since the period-of-record graphs were produced for the Water Year 2019 annual reports completed in June 2020 (Tampa Bay Water, 2020 a-j). These reports are available from Tampa Bay Water upon request and will be included with the Consolidated Permit renewal application that will be submitted to the District in late 2020, concurrent with the submittal of this Final Report of Findings.

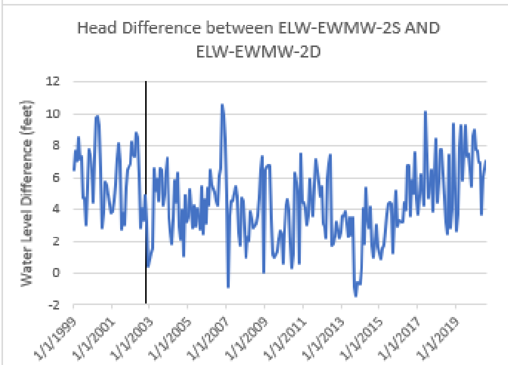
The water table in the surficial aquifer is difficult to spatially map on a regional basis with a high degree of confidence as compared to what was shown above for the potentiometric surface of the Upper Floridan Aquifer. Regional maps of water table improvements were not produced for this report; however, local-scale maps of water table improvement following the reduction in pumping at individual wellfields were produced to assist in the assessment of monitored lakes and wetlands. This data is summarized and presented in multiple reports produced by Wise Consulting Group that are included with Appendices 9.1, 9.7, 9.8, 9.10, and 9.13.

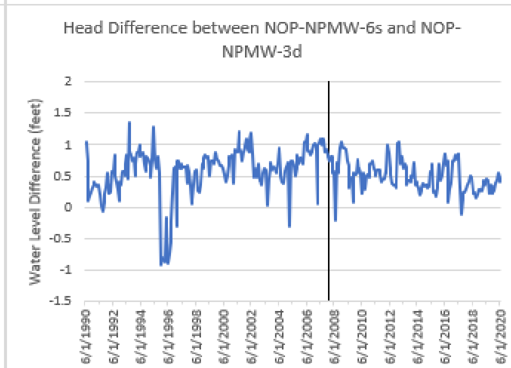
The improvement in water levels in the surficial and Upper Floridan aquifers following the reduction in wellfield pumping is evident in the long-term hydrographs from monitor wells maintained by Tampa Bay Water and the District. Many of these sites have monitor wells that record data in both aquifers allowing the comparison of the two water level records. The water level or head difference in these two aquifers gives an indication of the degree of confinement between the two aquifers and the rate of leakage from the water table to the underlying Upper Floridan Aquifer. Where these two water levels are vertically separated at a pair of monitor wells, the head difference indicates that there is more confinement between the aquifers and a greater potential for downward leakage from the water table. Where these surfaces are vertically close, there may be less confinement between aquifers and less potential for downward leakage. In those instances where the potentiometric surface is higher than the water table, there is no potential for downward leakage from the water table.

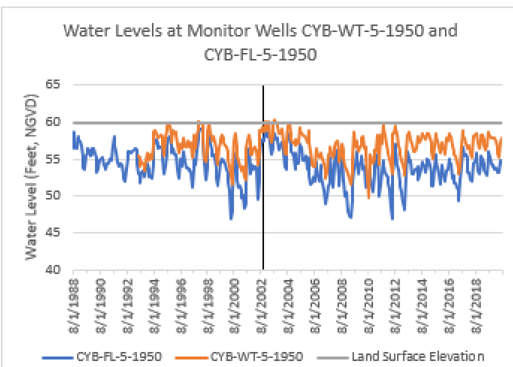
Figure 11.10 presents two graphs for a pair of surficial and Upper Floridan aquifer monitor wells at each of the 11 Consolidated Permit wellfields using monthly average water level data. The top graph of each pair shows the long-term water table and potentiometric surface elevations. The land surface elevation at that monitor site is indicated on the hydrographs and the vertical black line on each graph indicates when pumping at that wellfield was first reduced by Tampa Bay Water. In the case of the monitor well pair at the Cypress Bridge Wellfield, the vertical black line represents the late 2002 date when regional wellfield pumping was reduced since the pumping rate from this wellfield has not been reduced. The bottom graph of each pair shows the head difference between the water table monitor well and the Upper Floridan Aquifer monitor well. A positive head difference indicates that the water table elevation is higher than the potentiometric surface at that location.

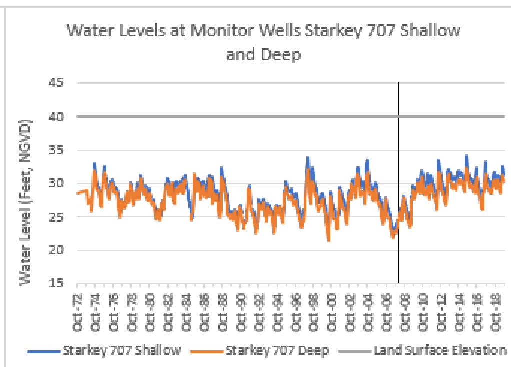

Water Levels at Monitor Wells ELW-EWMW-2S and ELW-EWMW-2D
Water Level (feet, NGVD)
ELW-EWMW-2S
ELW-EWMW-2D
Land Surface Elevation

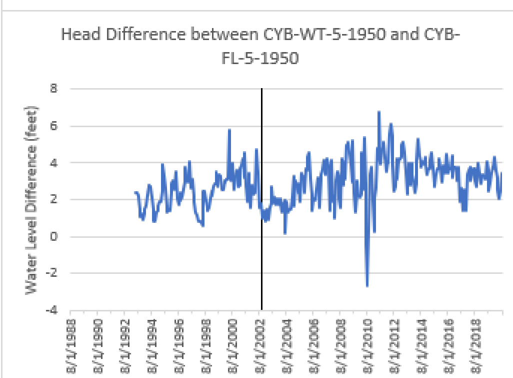

Water Levels at Monitor Wells NOP-NPMW-6s and NOP-NPMW-3d
Water Level (feet, NGVD)
NOP-NPMW-6s
NOP-NPMW-3d
Land Surface Elevation

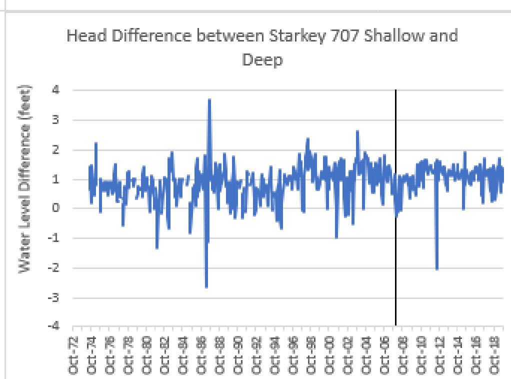

Head Difference between ELW-EWMW-2S AND ELW-EWMW-2D
Water Level Difference (feet)

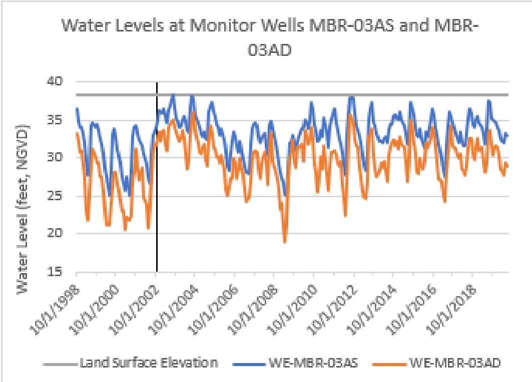

Head Difference between NOP-NPMW-6s and NOP-NPMW-3d
Water Level Difference (feet)

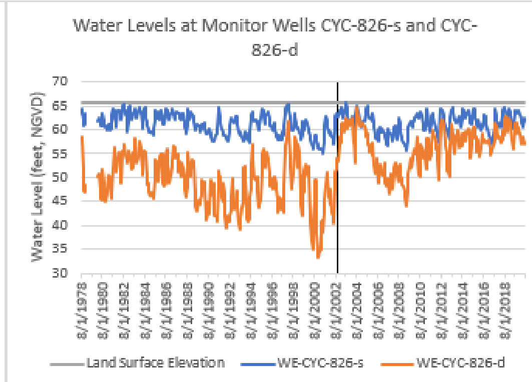

Water Levels at Monitor Wells CYB-WT-5-1950 and CYB-FL-5-1950
Water Level (Feet, NGVD)
CYB-FL-5-1950
CYB-WT-5-1950
Land Surface Elevation

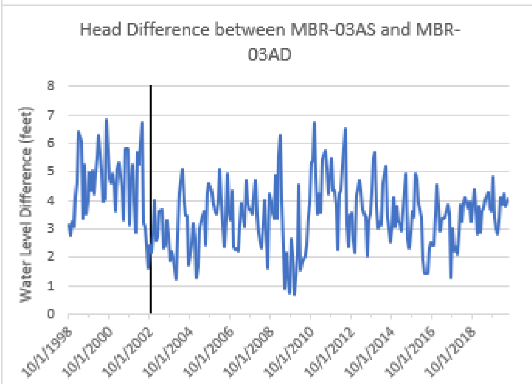

Water Levels at Monitor Wells Starkey 707 Shallow and Deep
Water Level (Feet, NGVD)
Starkey 707 Shallow
Starkey 707 Deep
Land Surface Elevation

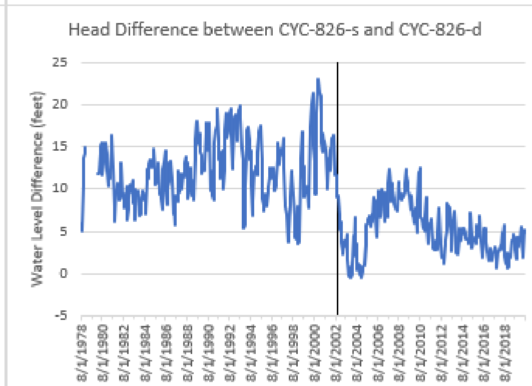

Head Difference between CYB-WT-5-1950 and CYB-FL-5-1950
Water Level Difference (feet)

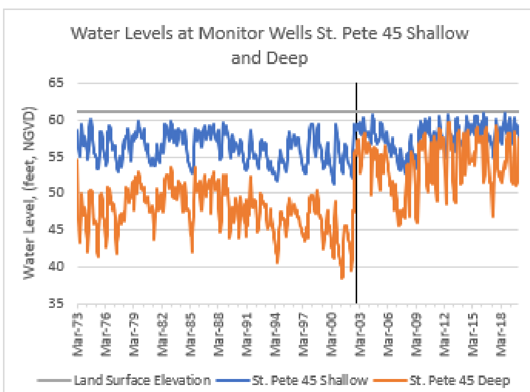

Head Difference between Starkey 707 Shallow and Deep
Water Level Difference (feet)

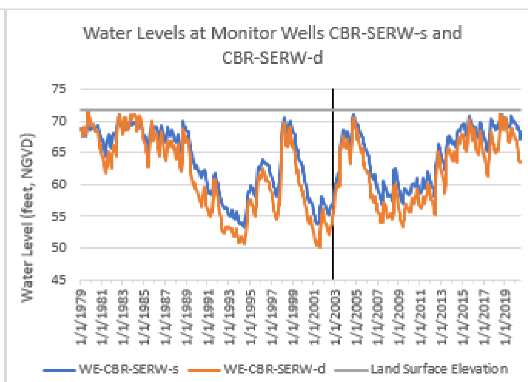

Water Levels at Monitor Wells MBR-03AS and MBR-03AD
Water Level (feet, NGVD)
Land Surface Elevation
WE-MBR-03AS
WE-MBR-03AD

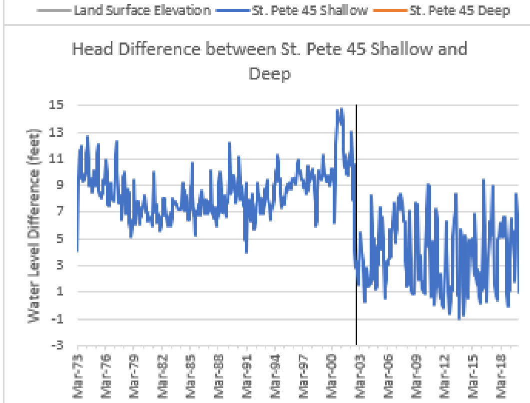

Water Levels at Monitor Wells CYC-826-s and CYC-826-d
Water Level (feet, NGVD)
Land Surface Elevation
WE-CYC-826-s
WE-CYC-826-d

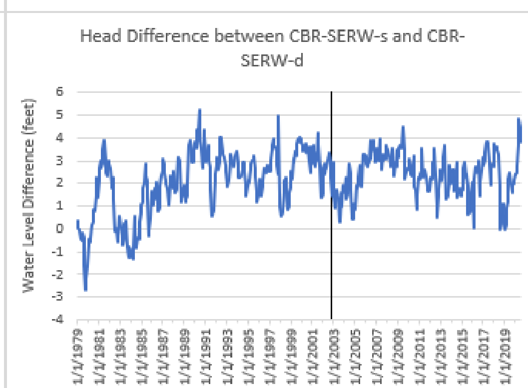

Head Difference between MBR-03AS and MBR-03AD
Water Level Difference (feet)


Head Difference between CYC-826-s and CYC-826-d
Water Level Difference (feet)


Water Levels at Monitor Wells St. Pete 45 Shallow and Deep
Water Level, (feet, NGVD)
Land Surface Elevation
St. Pete 45 Shallow
St. Pete 45 Deep


Water Levels at Monitor Wells CBR-SERW-s and CBR-SERW-d
Water Level (feet, NGVD)
WE-CBR-SERW-s
WE-CBR-SERW-d
Land Surface Elevation


Head Difference between St. Pete 45 Shallow and Deep
Water Level Difference (feet)


Head Difference between CBR-SERW-s and CBR-SERW-d
Water Level Difference (feet)

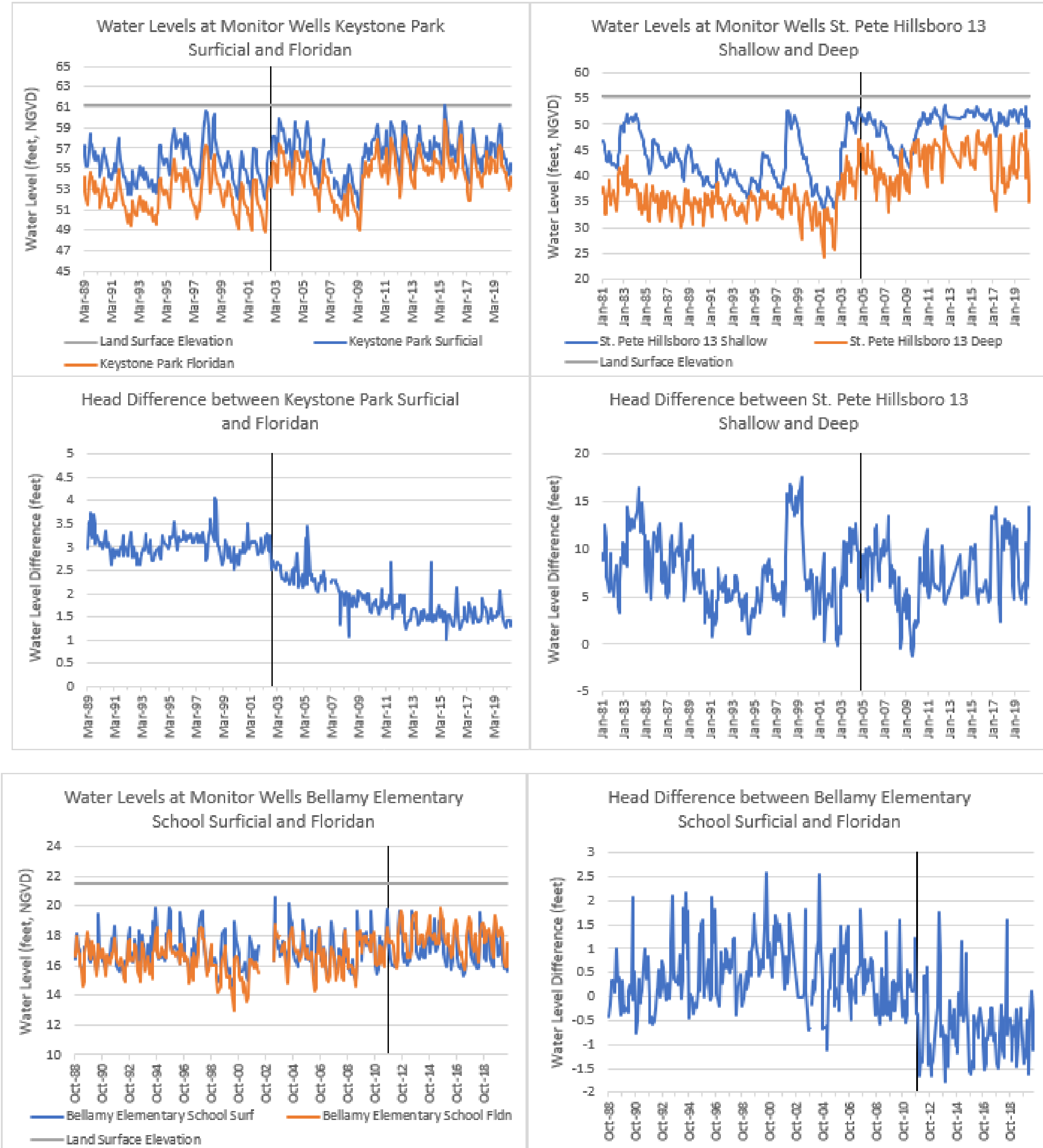


Figure 11.10: Long-term Water Levels at Paired Surficial and Upper Floridan Aquifer Monitor Wells and Head Difference Between the Paired Monitor Wells – one pair at each of the 11 Consolidated Permit Wellfields

Water level improvement and a general decrease in head difference between the surficial and Upper Floridan aquifers is visible in the graphs for each well pair. Specific observations for each well pair are presented below.

- Monitor wells EWMW-2S and EWMW-2D are located on the northern border of the Eldridge-Wilde Wellfield where the Hillsborough, Pasco, and Pinellas County boundaries meet. The Trinity Development lies on the northern side of the border in Pasco County. Water levels in these two wells increased in late 2002 in response to the reduction in wellfield pumping and the end of a severe drought. The water table has maintained these higher levels, generally fluctuating between 5 and 15 feet below land surface. The potentiometric surface has also maintained higher levels following the reduction in pumping and has varied with rainfall and pumping fluctuations. The head difference between aquifers decreased with the reduced wellfield pumping rate and fluctuated between approximately 2 to 4 feet during 2012 through 2015 with months in late 2013 where the head gradient reversed and the potentiometric surface was higher than the water table at this location. Rainfall during Water Year 2013 was near average and the wellfield pumping rate was approximately 10 mgd (Figures 3.48 and 3.38).

- Monitor wells NPMW-6s and NPMW-3d are located at the northern end of the former North Pasco Wellfield near the location of the test production well NOP-2. The annual average pumping rate for this wellfield never exceeded 3 mgd before the pumping reduction at the beginning of 2008. The water levels in these two monitor wells have been relatively stable after the pumping reduction and the head difference has generally fluctuated between 0 and 1 foot. This wellfield has been decommissioned and the final water withdrawal was in August 2017 (Figure 3.46).

- Monitor wells WT-5-1950 and FL-5-1950 are located in the center of the Cypress Bridge Wellfield, 1950 feet north of production well CYB-5 and just east of Interstate 75. The vertical line on the graphs for these two wells represents the time when pumping was reduced at the regional wellfields. This wellfield has not experienced a reduction in pumping as shown on Figure 3.47. The potentiometric surface at is generally 2 to 3 feet lower than the pre-pumping surface at this location and has remained stable for the past 7 years. The water table at this location has remained stable and generally fluctuates between 0 and 5 feet below land surface. The head difference has generally fluctuated between 2 to 4 feet during the period of record.

- Monitor wells Starkey 707 Shallow and Deep are located on the western portion of the Starkey Wellfield. The water levels in this well pair increased following the reduction in wellfield pumping in December 2007. The water levels in both aquifers have been stable and are slightly higher than in the early to mid-1970's before wellfield pumping began (Figure 3.45). There is minimal head difference between the two aquifers at this location, averaging approximately 1 foot for the period of record.

- Monitor wells MBR-03AS and MBR-03AD are located in the center of the Morris Bridge Wellfield. The improvement in the water table and potentiometric surface following the pumping reduction in late 2002 (Figure 3.43) are evident in the hydrograph for these two wells with the water table increasing to within 1 to 2 feet below land surface most years since 2003. The potentiometric surface has increased to within 5 to 6 feet of land surface during many summers since 2003 and the dry season minimum elevations are 5 to 7 feet higher than before the reduction in wellfield pumping, except during prolonged dry conditions. The head difference at this location has also decreased after the wellfield pumping reduction and has generally ranged from 2 to 5 feet for the past 8 years.

- Monitor wells 826-s and 826-d are located in the center of the Cypress Creek Wellfield near production well CYC-07. The pumping rate from this wellfield has been reduced approximately 50% since Water Year 2003 (Figure 3.41). A significant and sustained increase in the potentiometric surface at this site was recorded with the reduction in pumping at the Cypress Creek Wellfield in late 2002 and the water table has been within 1 foot of land surface during most summers since 2011. The head difference between these two aquifers dramatically decreased with the reduction in wellfield pumping; before the pumping reduction, the head difference ranged from 5 to more than 20 feet but has decreased to 0.5 to 7.5 feet for the past 9 years.

- Monitor wells St. Pete 45 Shallow and Deep are located in the southeast portion of the South Pasco Wellfield close to eastern property boundary. The potentiometric surface at this site increased over 15 feet in the fall of 2002 when the pumping rate decreased at the wellfield (Figure 3.40) and the region emerged from a severe drought. The water table at this location increased about 7 to 8 feet during the same time period and both the water table and potentiometric surface have sustained their much higher levels following the wellfield pumping reduction. The head difference between these two aquifer decreased in late 2002 and now ranges between -1 to 9 feet given pumping and rainfall conditions. The minimum head difference has been between -1 and 1 foot almost every year since late 2002 indicating little to no downward leakage of the water table into the Upper Floridan Aquifer during these time periods.

- Monitor wells SERW-s and SERW-d are located on the eastern boundary of the Cross Bar Ranch Wellfield east of production wells CBR-04 and CBR-05. This wellfield pumping rate was reduced in late 2002 along with other regional wellfields (Figure 3.42) and an increase in the water table and potentiometric surface was observed with the reduced pumping rate and above-normal rainfall in Water Years 2003 and 2004 (Figure 3.48). Water levels in both aquifers declined during the drought years of 2005 – 2009 but since that time have increased to sustained levels not observed since 1987 when the annual average wellfield pumping first increased above 15 mgd. The head difference between the two aquifers has remained relatively stable over the period of record but often reaches annual minimum differences between 0 and 1 foot since 2010.

- Monitor wells Keystone Park Surficial and Floridan are located at the northern end of the Cosme-Odessa Wellfield south of production well COS-30. The water table and potentiometric surface increased at this location by about 2 to 3 feet following the reduction in wellfield pumping in late 2002 (Figure 3.37). The water table is within 2 feet of land surface during the summer of most years since 2003 and the head difference between these two aquifers has steadily declined since the wellfield pumping rate was reduced. The head difference is approximately 1.5 to 2 feet since 2011 compared to 2.5 to 3.5 feet before the wellfield pumping reduction.

- Monitor wells St. Pete Hillsboro 13 Shallow and Deep are located in the southeast portion of the Section 21 Wellfield west of production wells S21-09 and S21-10. The water table and potentiometric surface increased at this wellfield in late 2002 with the reduction in regional wellfield pumping and the end of a severe drought. These levels increased even though the pumping rate from this wellfield did not reduce until Water Year 2005 as shown by the vertical line on the graphs (Figure 3.39). Following the reduction in pumping from the Section 21 Wellfield, the potentiometric surface at this site increased by 5 to 10 feet and the water table elevation increased to within 2 to 7 feet of land surface, except during dry years. The head difference between the two aquifers at this site has remained relatively stable over the period of data shown in these graphs.

- Monitor wells Bellamy Elementary School Surficial and Floridan are located southwest of the Northwest Hillsborough Regional Wellfield production wells near the intersection of Linebaugh Avenue and Wilsky Blvd. Pumping reductions at this wellfield did not occur until Water Year 2012 when this wellfield was fully connected to the regional system (Figure 3.44). The potentiometric surface increased following the reduction in wellfield pumping, often approaching 2 feet below land surface and the water table elevation has remained relatively stable for the period of record. The head difference between the two aquifers at this location decreased since Water Year 2012 with the potentiometric surface almost always higher than the water table.

Overall, the water level data indicates that reductions in groundwater pumping have promoted increased aquifer levels and this recovery supports the resumption of normal, expected fluctuations in regional wetland water levels, a critical step to continued environmental recovery.

12: Wellfield-Specific Discussion of Results

12. Wellfield-Specific Discussion of Results

The preceding chapters have individually described the recovery analyses and final assessment results for monitored lakes (Chapter 8), monitored wetlands (Chapter 9), unmonitored sites (Chapter 10), and the hydrologic recovery documented in the surficial and Upper Floridan aquifers (Chapter 11). These weight-of-evidence assessments for the 1,360 sites evaluated under the Recovery Assessment Plan examined the condition of each site with respect to its individual numeric of health or recovery. This chapter pulls together the final results for the individual sites at each of the 11 wellfields to describe the environmental recovery on a wellfield scale. Discussing environmental recovery for each of the wellfields allows an examination of the many factors that influence the health and recovery of lakes and wetlands. These wellfield-scale assessments consider the underlying geology and any geologic or hydrologic features that are unique to individual wellfields. They also allow the consideration of unique environmental features at a wellfield and the timing of historical wellfield pumping and when environmental impacts occurred.

The recovery of lakes and wetlands at individual wellfields, and how those systems function within their local drainage basins, allows water managers to look beyond whether or not a site has met the specific numeric water level recovery target and understand the factors that may be limiting sites from achieving these metrics. In specific wellfield cases, historic development and land-surface alterations within the local drainage basin(s) have limited the degree of environmental recovery that can be achieved at those wellfields as presented in this chapter. The documented environmental recovery and local-scale implications in these individual wellfield discussions are summarized on a regional scale in Chapter 13. This chapter contains a discussion of the current state of the environment in and around the wellfields, referred to as the new baseline condition.

12.1 Starkey Wellfield

The District purchased approximately 8,200 acres in west Pasco County in the mid 1970's from Mr. J.B. Starkey to create the Starkey Wilderness Park. The purchase agreement allowed for the development of potable water resources and the City of New Port Richey constructed six production wells on the property in the mid-1970s. The West Coast Regional Water Supply Authority (Authority) assumed responsibility for the operation of the Starkey Wellfield in the early 1980s. Since that time, this wellfield has provided potable water to the City of New Port Richey and the West Pasco Service Area. The Authority constructed nine additional production wells in the central and eastern portions of the wellfield throughout the 1980s to serve the growing demand in these two service areas (Figure 12.1). Additional information about the development of the Starkey Wellfield is found in Section 3.6 of this report.

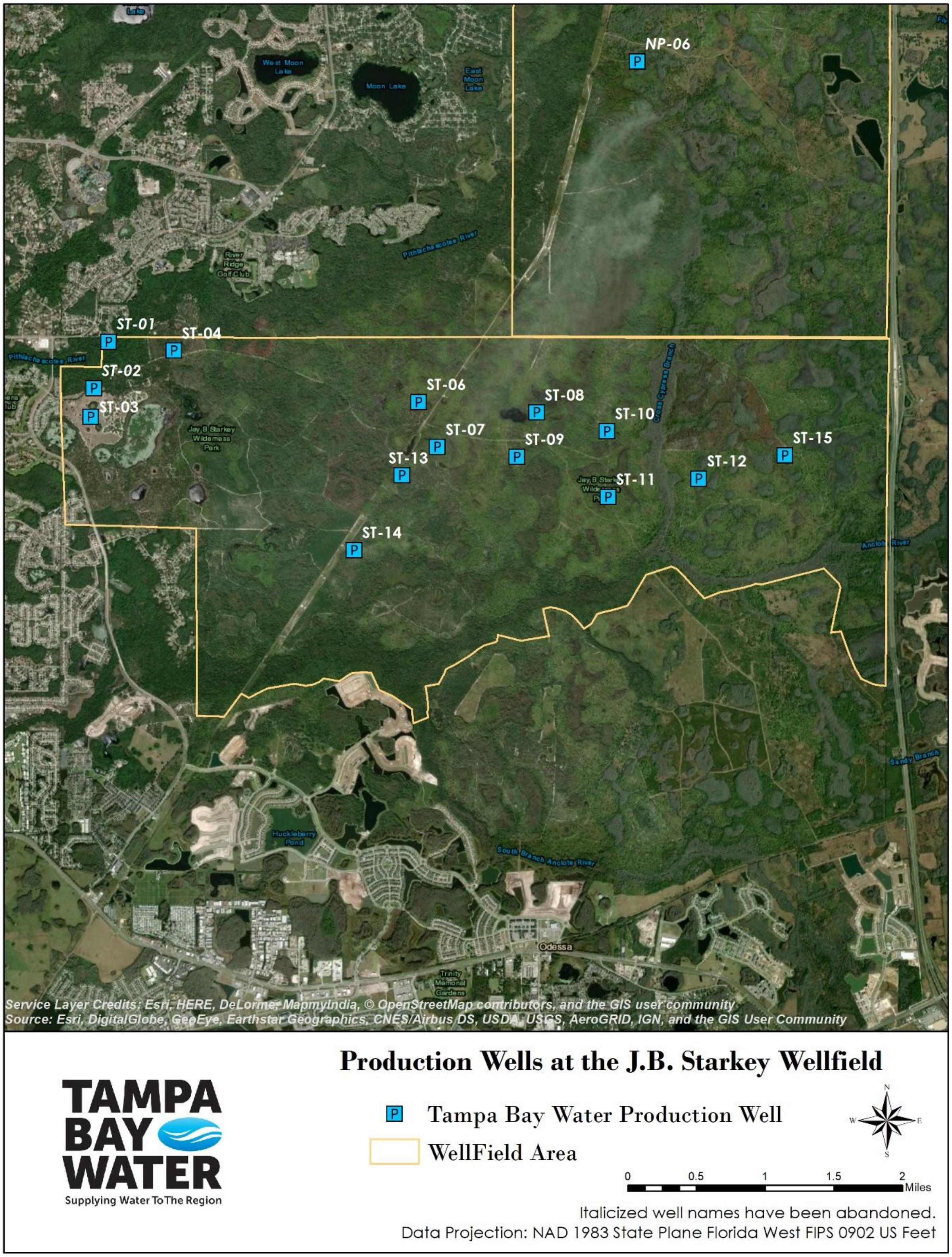


Figure 12.1: Map of Production Wells at the Starkey Wellfield

The average annual pumping rate at the Starkey Wellfield remained low through 1982 with only the western production wells in service. The annual average pumping rate increased from about 7.5 mgd in 1984 to about 13 mgd in 1989 as additional production wells were constructed. The average pumping rate from the wellfield remained at about 12 mgd until late 2007 when the West Pasco Transmission Main interconnected the Starkey Wellfield to the regional system (Figure 12.2). The construction of the regional transmission main allowed a considerable reduction in pumping from the wellfield; the annual average has remained at or below 5 mgd since 2008.

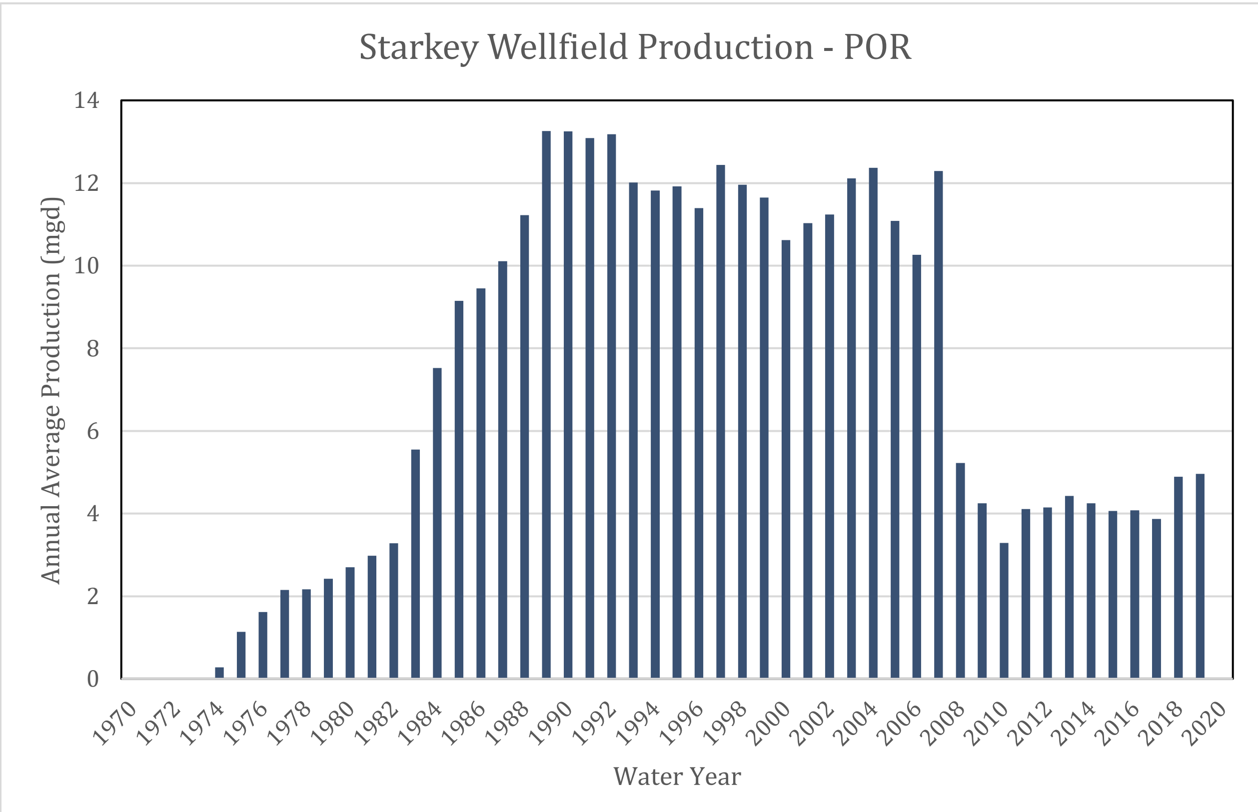


Figure 12.2: Period of Record Production at the Starkey Wellfield

Rainfall has been monitored at the STK-14 gage located in the central part of the wellfield since 1989. The period of record mean annual rainfall for at this gage is 55.4 inches (Figure 12.3) as calculated on a calendar year basis. Over the 30-year rainfall record, there have been several notable extended multi-year drought and rainfall surplus periods. From 1999 through 2001 and 2005 through 2009, rainfall was below the long-term average. Above-average rainfall periods occurred between 2002 and 2004, and during calendar years 2014, 2015, 2018 and 2019.

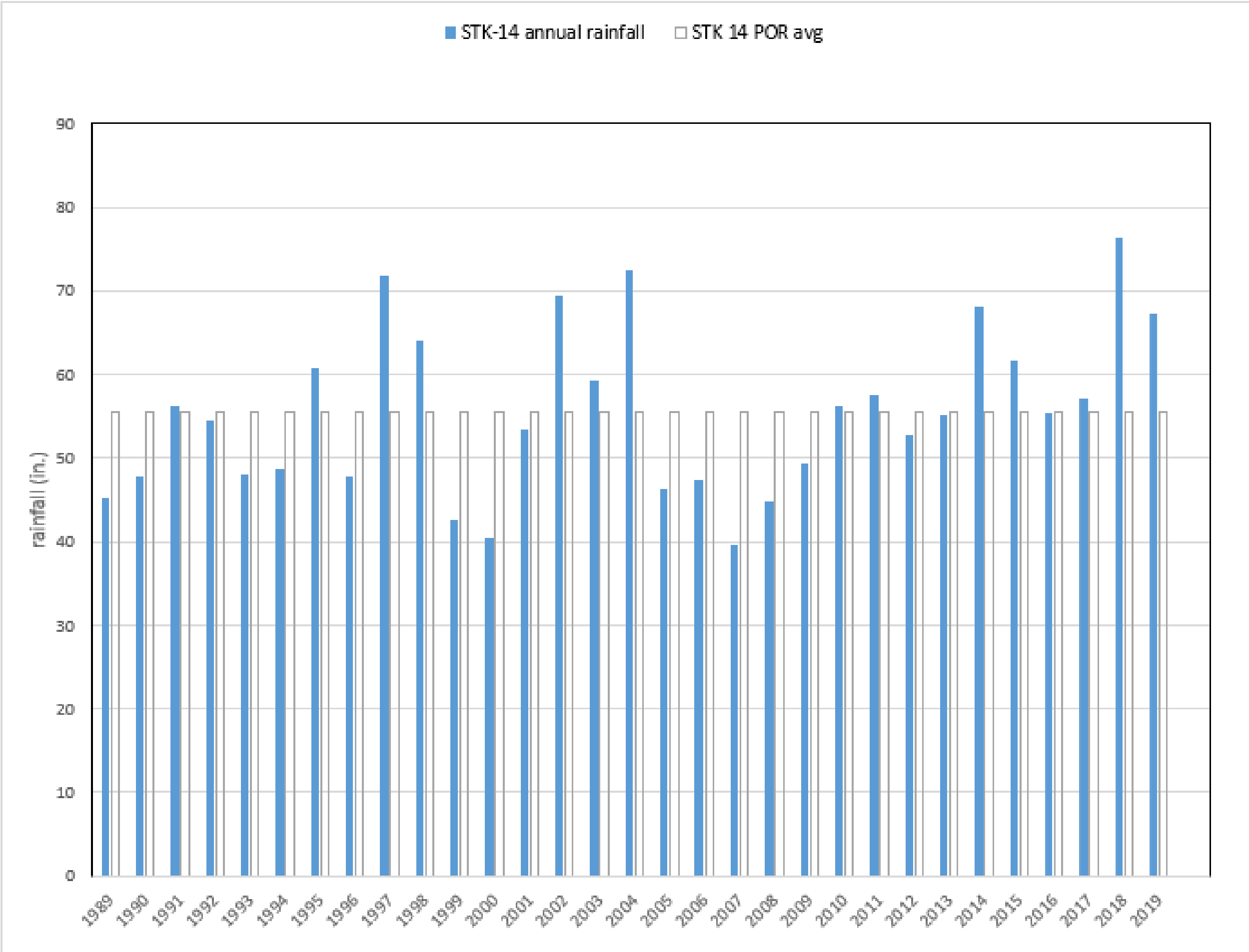


Fig 12.3: Period of Record Annual Rainfall (Calendar Year) at the STK-14 Gage

While in private ownership, the J.B. Starkey property was mostly used as unimproved pasture. Both uplands and wetlands remain in a relatively natural condition, with only isolated patches of improved pasture and no evidence of significant ditching or draining. The historical aerial photographs of the wellfield property from 1967 through 2019 (Figures 3.16 through 3.18) show this natural condition with only minor alterations on the western side of the wellfield for passive recreation and an environmental education center. Development has only encroached on the western border of the wellfield and some new construction on the southwest border in the most recent aerial photograph. The western and south-western portions of the property are notable as having soil types that are well-drained and many of the wetlands located on these areas of the wellfield are classified as xeric-associated due to the soils surrounding the wetlands.

The District began monitoring wetlands on the Starkey Wellfield property in the 1970's and the Authority began an expanded ecological monitoring program in Water Year 1983. Historical environmental impacts on the Starkey Wellfield related to groundwater pumping and drought have been documented in ecological monitoring and assessment reports by the District and Tampa Bay Water. The Candidate Sites Evaluation Study report (Berryman and Henigar, Inc., 2000a) discussed in Section 3.13.1 identified 18 monitored wetlands at the Starkey Wellfield that were not predicted to fully recover at the reduced pumping rate scenario evaluated in that report. However, at the time of the report, interconnecting the Starkey and North Pasco Wellfields to the regional system had not been planned. The 7.7 mgd projected post-cutback pumping rate for the Starkey Wellfield used in the study was higher than the actual post-cutback pumping rate of 4.3 mgd achieved at this wellfield starting in 2008.

The Water Year 2006 Starkey Wellfield Annual Report (GPI Southeast, Inc., 2007b) documented vegetative and hydrological changes in wetlands located in the western and central areas of the wellfield consistent with a drying trend. The report also noted areas of low Wetland Assessment Procedure scores in the central part of the wellfield. Other historic changes in wetland plant communities documented include the invasion of shrubs, pines and hardwoods (documented in wetlands S-06, S-08, S-18, S-62), soil subsidence (extensive occurrence in wetlands S-36A and S-44) and the expansion of cypress into interior marsh zones (documented in wetlands S-31 and S-35). High water levels during El Niño rainfall events (1998) and from tropical storms (2004), coupled with reduced wellfield pumping, have resulted in significant mortality of pines within wetland limits. Pine mortality in S-08 (Bonnet Lake) was noted in 1998, 2004, 2011 and 2015 (Tampa Bay Water, 2020f).

Wildfire has occurred in the wetland communities on-site, both before and after the initiation of pumping and wetland monitoring at the wellfield. Cypress and marsh wetlands in the Northern Tampa Bay Area are adapted to fire and most wildfires and prescribed fires have little long-term effect on plant community structure under normal conditions and can even maintain the wetland plant community by limiting hardwood and shrub encroachment (Myers and Ewel, 1990). However, destructive fires can occur under particularly dry conditions that can result in significant tree mortality (including cypress trees) and soil loss through consumption of dry organic soils. During dry periods, wellfield pumping at high rates can contribute to the conditions that may promote destructive fires. Adverse fire effects have been noted in wetlands S-39, S-42, S-44, S-51, and S-80, among others. Deleterious effects of fire on wetlands in the Starkey Wellfield have included tree mortality and soil loss.

Treefall has been noted at monitored wetlands at the Starkey Wellfield over the years, including wetlands S-16, S-31, S-36A, S-44, S-51, S-52, S-53, S-55 (treefall noted post-cutback), and S-84 (with soil loss). In some wetlands, such as S-36A and S-44, treefall associated with soil loss and subsidence has resulted in the loss of nearly the entire cypress canopy, changing the wetland community type. In the case of wetland S-51, both soil subsidence and an extensive peat fire in 2007 (Tampa Bay Water, 2010b) resulted in canopy loss. Some instances of treefall have continued in the post-cutback period, as has occurred in wetland S-55 (Tampa Bay Water, 2020f) and may be due to previous soil subsidence.

12.1.1 Site-Specific Results

There are 94 monitored wetlands on the final recovery assessment list associated with the Starkey Wellfield. The final recovery assessment classification for these wetlands are presented in Section 9.2.1 and the final assessment bin for each of these wetlands is included in Table 9.8. The final recovery assessment results for these wetlands are summarized as:

- Never Impacted – 29 wetlands
- Recovered – 48 wetlands

- Improved – 7 wetlands
- High Degree of Certainty of Wetland Heath – 10 wetlands

The wetlands assigned to the recovery bin of Never Impacted are generally more distant from the production wells than the Recovered wetlands. The 10 wetlands assigned to the recovery bin of High Degree of Certainty of Wetland Health are sites where monitoring has ceased and insufficient data exists following the reduction in wellfield pumping to assign the wetland to one of the quantitative assessment bins. These wetlands were assessed with the unmonitored sites (Chapter 10) and were assigned to this qualitative assessment bin.

The seven monitored wetlands at the Starkey Wellfield that did not meet their respective recovery metrics show hydrologic improvement after the reduction of wellfield pumping and are binned as "Improved, Not Fully Recovered". Four of the seven improved wetlands are wet prairies: S-46, S-80, Anclote South Wet Prairie and Starkey Wet Prairie. Wet prairies are shallow marshes with generally sandy soils. Since there was an insufficient number of wet prairies in the Recovery Assessment Plan to establish a separate recovery metric, these four wet prairies were tested against the isolated mesic recovery metric used for cypress and marsh wetlands. It is possible that this metric is not appropriate for wet prairies since the Anclote South Wet Prairie and Starkey Wet Prairie are classified as Improved and these two wetlands are located in areas of little drawdown. It is also possible that due to their shallow nature, wet prairies are particularly vulnerable to drawdown impacts.

The three remaining improved wetlands at the Starkey Wellfield (wetlands S-53, S-63 and S-113) are shallow cypress wetlands. The three improved cypress wetlands are:

12.1.1.1 Wetland S-53

Located in the central portion of the Starkey Wellfield, in an area of considerable aquifer recovery. Although listed as an isolated cypress wetland, field inspection and LiDAR contours indicate that it may be part of a cypress strand system which eventually connects to the Anclote River (Tampa Bay Water, 2016c and Appendix 9.1). Although the post-cutback median water levels in wetland S-53 do not meet the isolated mesic cypress recovery metric, they meet the connected wetland metric (Figure 12.4) and this wetland would have been classified as Recovered using the alternative metric.

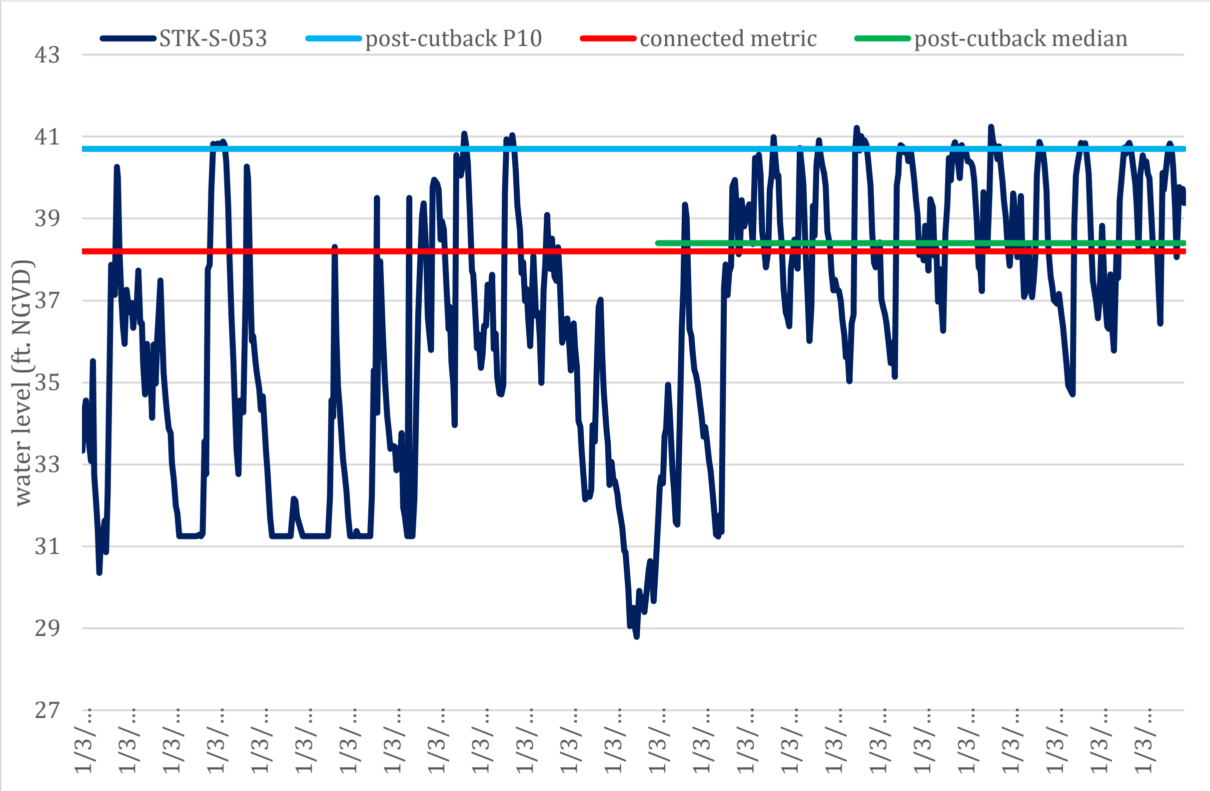


Fig. 12.4: Period of Record Hydrograph for Wetland S-53

12.1.1.2 Wetland S-63

Located in the central portion of the Starkey Wellfield near production well STK-10. It is in an area with greater than 3 feet of recovery in the Upper Floridan Aquifer potentiometric surface (Wise Consulting Group, 2016a and Appendix 9.1). Wetland S-63 is a relatively shallow wetland; the difference between the normal pool elevation and the wetland bottom (i.e. staff gage land surface elevation) is one foot. This wetland was previously augmented until 2007 from a connection to production well STK-10. Although the Water Year 2008 – 2019 median normal pool offset was below the isolated mesic metric at -2.5 feet, the wetland does not show signs of adverse environmental impacts and Wetland Assessment Procedure scores remain high

12.1.1.3 Wetland S113

This is a shallow cypress wetland located in the south-central portion of the Starkey Wellfield close to the Anclote River. It is also in an area with greater than 3 feet of recovery in the Upper Floridan Aquifer potentiometric surface (Wise Consulting Group, 2016a and Appendix 9.1). The Water Year 2008 – 2019 median normal pool offset was below the isolated mesic metric at -2.5 feet. The post-cutback percent exceedance presented in the Tampa Bay Water 2016 report is generally higher than the pre-cutback curve, including a 15% increase in hydroperiod at this wetland.

Six of the seven Improved wetlands on the Starkey Wellfield missed meeting their respective recovery metrics by 0.08 to 0.84 foot during the final assessment period of Water Year 2008 – 2019. The Anclote South Wet Prairie wetland, located approximately 2 miles south of the wellfield near State Road 54, missed meeting its recovery metric by 1.78 feet; however, all other monitored wetlands in that area were classified as Recovered.

Bonnet Lake (STK-S-08) is the only lake included on the recovery assessment monitored lake list within the Starkey Wellfield. Moon Lake, located approximately 1.5 miles north of the Starkey Wellfield, is also included on the monitored lake list. Both lakes met their recovery metrics and are listed as Recovered as depicted on Figure 8.7.

There is a relatively small Area of Investigation defined at the Starkey Wellfield as described in Section 5.3. Seven unmonitored wetlands are either contained within or intersect this area (Figure 10.8) and the final qualitative recovery assessments for these wetlands are depicted in Figure 10.22. Six of the seven wetlands are binned as having a high degree of certainty of wetland health and one unmonitored wetland (#3461) as having a low degree of certainty of wetland health. Of the criteria tested in the unmonitored wetland study performed by Tampa Bay Water (described in Chapter 10), Wetland 3461 met the criteria for modeled increase in normal pool offset between the pre and post-cutback periods but did not meet any of the other assessment criteria. These results generally match the high degree of recovery documented for the monitored wetlands at the Starkey Wellfield.

12.1.2 Discussion of Recovery

Three Phase 1 Mitigation Plan projects have been evaluated at the Starkey Wellfield as described in Section 3.13. Tampa Bay Water has deferred any further action on the Starkey Wellfield Reclaimed Water Pilot Project and the Starkey Ecosystem Enhancement Project due to the degree of recovery achieved with the reduction in wellfield pumping. Construction of the Bonnet Lake restoration project began when this lake had a preliminary assessment classification of Improved. This high-water connection to Grass Prairie will ensure that water levels in the xeric-associated Bonnet Lake will continue to meet the recovery metric.

A map showing the final recovery assessment results for all sites associated with the Starkey Wellfield are shown on Figure 14.5. Almost all monitored wetlands meet their respective recovery metrics in the Water Year 2008 – 2019 assessment period including mesic and xeric-associated wetlands and the connected wetlands on the wellfield. These combined results demonstrate that the monitored wetland systems on and surrounding the wellfield have recovered since the reduction in pumping at the wellfield that began in December 2007. The pumping rate has remained slightly below 5 mgd since that time.

12.2 North Pasco Wellfield

The North Pasco Wellfield was initially conceived as a linear extension of the Starkey Wellfield to help meet the growing water demand in the West Pasco Service Area. The wellfield was to be developed in phases to match the increase in demand. Four of the six permitted production wells were drilled between 1990 and 1993 but only production wells NP-4 and NP-6 were connected to the transmission main and put into service (Figure 12.5). Additional information about the development of the North Pasco Wellfield is found in Section 3.8 of this report.

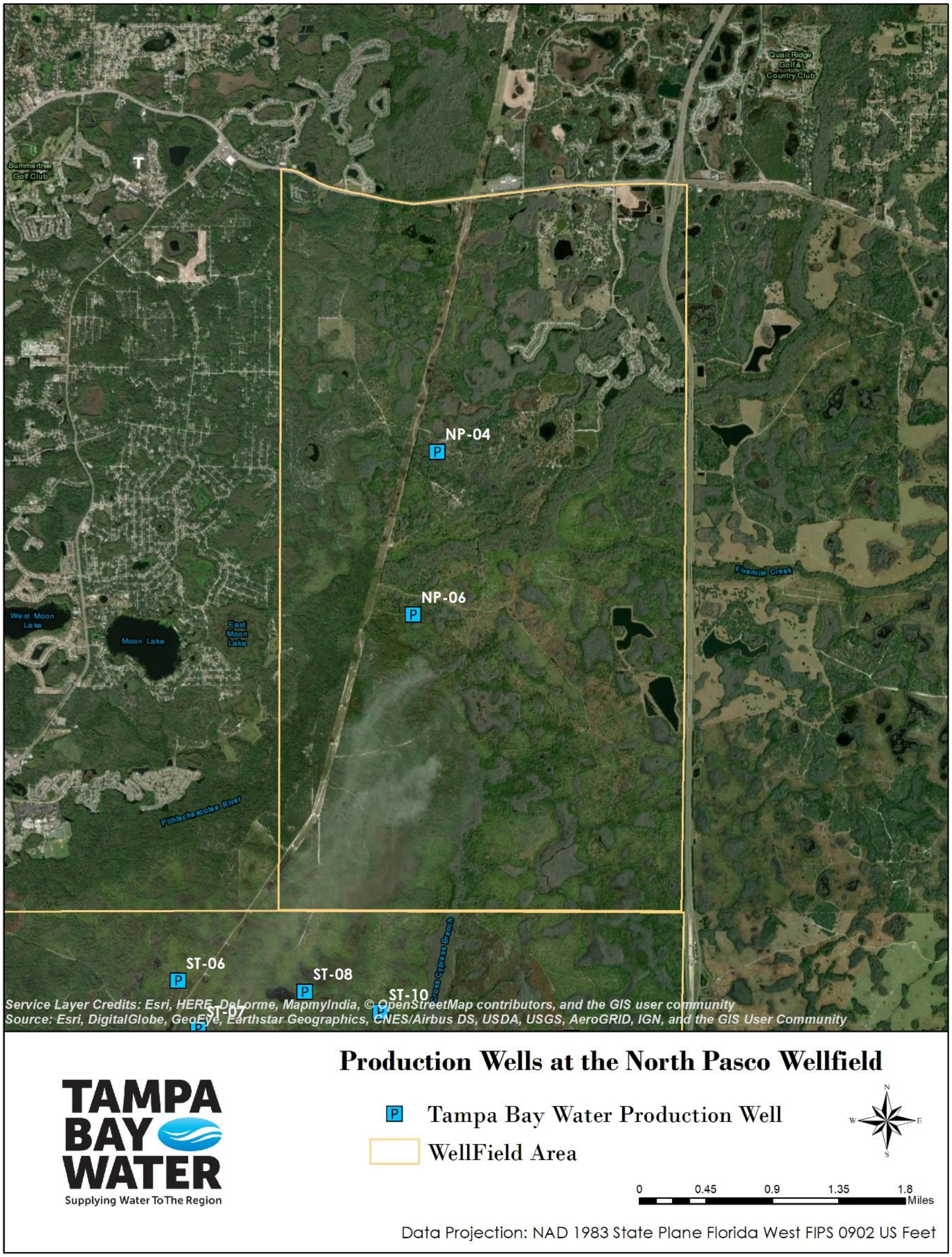


Figure 12.5: Map of Production Wells at the North Pasco Wellfield

The North Pasco production wells were operated as an extension of the Starkey Wellfield and produced an annual average of 1.2 to 2.9 mgd between 1992 and 2006 (Figure 12.6). Production from the two North Pasco wells decreased to approximately 0.5 mgd in 2007 and in December 2007, a pipeline was completed to connect the Starkey and North Pasco Wellfields to the regional system. This new pipeline brought regional system water to the New Port Richey and West Pasco County Service areas allowing for a long-term reduction in pumping rate at the two wellfields. The North Pasco Wellfield production wells produced between 0.1 and 1.1 mgd from 2008 through 2017, averaging 0.4 mgd for that ten-year period. The combined pumping rate from the Starkey and North Pasco Wellfields had been reduced to such a degree that maintaining production wells NP-4 and NP-6 was not cost-effective. The two wells were plugged and abandoned; the North Pasco Wellfield was decommissioned in Water Year 2018.

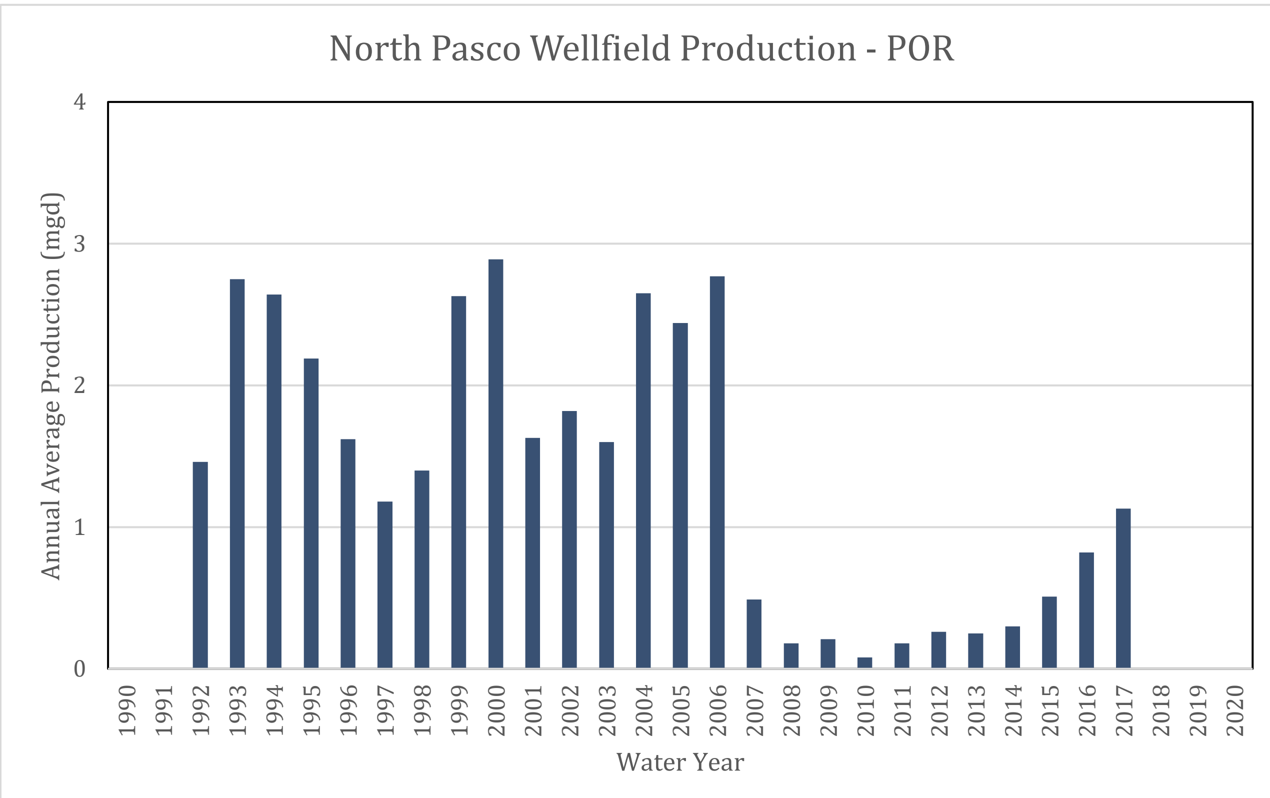


Figure 12.6: Period of Record Production at the North Pasco Wellfield

Rainfall has been monitored at the North Pasco Wellfield since 1990. Mean annual rainfall calculated on a calendar year basis from 1990 to 2019 is 53.9 inches (Figure 12.7). Over the 30-year rainfall record, there have been several notable extended multi-year drought and rainfall surplus periods. From 1999 through 2001 and 2005 through 2008, rainfall was below the long-term average. Above-average rainfall periods occurred between 2002 and 2004, and from 2014 through 2018.

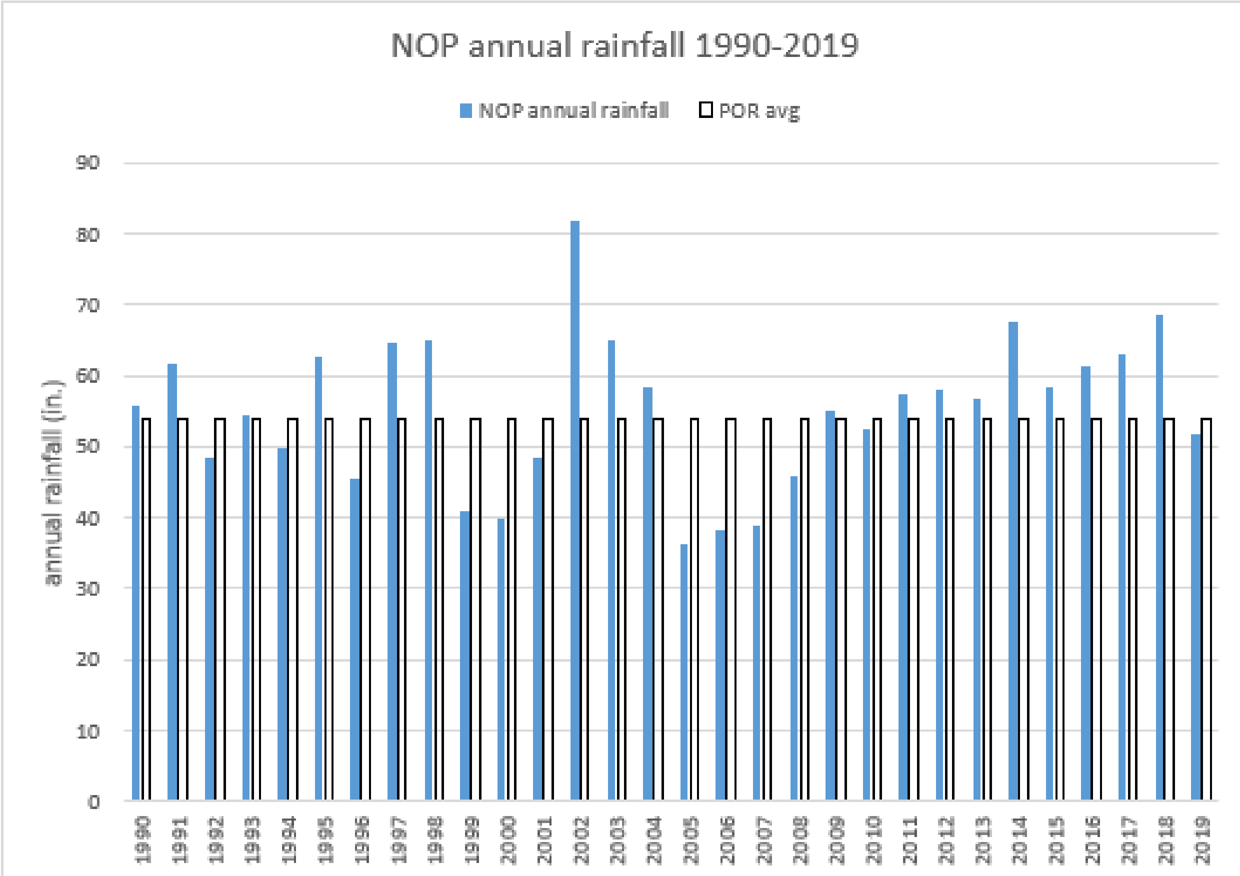


Figure 12.7: Period of Record Annual Rainfall (Calendar Year) at the North Pasco Rain Gage

The property on which the North Pasco Wellfield is located was known as the Serenova property. Initially in private ownership with a development planned, the site was purchased by the Florida Department of Transportation and preserved in its natural state as mitigation for wetland impacts associated with the Suncoast Parkway in 1997. The property was transferred to the District for management in November 2000 as part of the Starkey Wilderness Preserve. This property has experienced relatively little land use impact (Figures 3.32 and 3.33). Both the uplands and wetlands on this property are in a relatively natural condition, with only isolated patches of improved pasture and no significant ditching or draining. The property contains soil types that are associated with both mesic and xeric landscapes. The wetlands associated with a xeric-landscape are generally located in the northern part of the wellfield or along the power line corridor with a mixture of mesic and xeric wetlands in these areas.

The West Coast Regional Water Supply Authority began ecological monitoring at the North Pasco Wellfield in Water Year 1990. Historical impacts on the wellfield related to groundwater pumping and drought were documented in ecological monitoring and assessment reports by Tampa Bay Water. The Water Year 2006 Annual Monitoring and Assessment Report (GPI Southeast Inc., 2007b) stated that some wetlands near production wells NP-4 and NP-6 had lower water levels and Wetland Assessment Procedure scores. The Ecological Site Description section of the annual wellfield monitoring and assessment reports contains a section for each monitored wetland called “Notable Changes” that describes impacts and changes in ecological conditions, whether from wellfield pumping, drought, wildfire, land use or other factors. Historic changes in plant communities documented in these annual reports (e.g. Tampa Bay Water, 2020f) include the invasion of pines and hardwoods (documented in wetlands NOP-05, NOP-07 and NOP-10), soil subsidence (suspected to have occurred in wetland NOP-10 and NOP-17) and expansion of cypress trees into interior marsh zones (documented in wetland NOP-17). Higher water levels in recent years have resulted in significant mortality of pines within the wetland limits; the pines in wetland NOP-10 died between 2012 and 2015 and by 2014 most of the pines in wetland NOP-05 “appear to have died or were very stressed” (Tampa Bay Water, 2019d).

Wildfire has occurred in the wetland communities on-site, both before and after the initiation of pumping and wetland monitoring at the wellfield. Cypress and marsh wetlands in the Northern Tampa Bay Area are adapted to fire and most wildfires and prescribed fires have little long-term effect on plant community structure under normal conditions and can even help maintain the wetland plant community by limiting hardwood and shrub encroachment (Myers and Ewel, 1990); however, destructive fires can occur under particularly dry conditions. These fires can result in significant tree mortality (including cypress trees) and soil loss through consumption of dry organic soils. Fire effects have been noted in wetlands NOP-04, NOP-05, NOP-10 and NOP-17. The noted effects included tree mortality and “canopy thinning”. There is evidence that fire damage occurred at some wetlands (e.g. NOP-17) prior to the onset of wellfield pumping.

Semi-annual analyses at the Consolidated Permit wellfields, conducted in accordance with the Environmental Management Plan, identify persistent statistical outliers in hydrologic parameters such as hydroperiod and normal pool offsets. During the 1990s, some of the isolated cypress wetlands at the North Pasco Wellfield (e.g. NOP-04, NOP-05, NOP-07, NOP-21) had statistically low annual hydroperiods for several years in a row (Tampa Bay Water, 2011). This has not occurred since, with the exception of wetland NOP-07, which is discussed in the following section. A similar pattern existed with the analysis of normal pool offsets. For example, wetlands NOP-04, NOP-07, NOP-21 and NOP-25 had statistically low September normal pool offsets for three or more consecutive years in the 1990s. This situation has not recurred at these wetlands since that time.

12.2.1 Site-Specific Results

There are 25 monitored wetlands on the final recovery assessment list associated with the North Pasco Wellfield. The final recovery assessment classification for these wetlands are presented in Section 9.2.2 and the final assessment bin for each of these wetlands is included in Table 9.8. The final recovery assessment results or these wetlands are summarized as:

- Never Impacted – 10 wetlands
- Recovered – 8 wetlands
- Improved – 1 wetland
- High Degree of Certainty of Wetland Heath – 6 wetlands

The wetlands assigned to the recovery bin of Never Impacted are generally more distant from the production wells than the Recovered wetlands. The six wetlands assigned to the recovery bin of High

Degree of Certainty of Wetland Health are sites where monitoring has ceased and insufficient data exists following the reduction in wellfield pumping to assign the wetland to a one of the quantitative assessment bins. These wetlands were assessed with the unmonitored sites as presented in Chapter 10 and assigned to this qualitative assessment bin.

12.2.1.1 Wetland NOP-07

This is classified as Improved, Not Fully Recovered in this final assessment report. This is a two-acre wetland that is 700 feet from production well NP-6. The recovery assessment type for this wetland is listed as isolated cypress on Table 5.2, although field work and aerial imagery indicate it overflows into a swale on the northeastern corner of the wetland that is connected to the Pithlachascotee River. Tested against the recovery metric for mesic isolated wetlands, the median post-cutback water levels missed meeting the metric by 0.33 foot during the final assessment period of Water Year 2008 – 2019. Wetland NOP-07 is a very shallow wetland and has a mix of hardwoods (e.g. oaks) and cypress.

The swale connecting NOP-07 and the Pithlachascotee River was inspected during an August 2, 2016 site inspection. The invert to the swale appears lower than the wetland edge and it is unclear if it is a natural feature. However, this is an historic drainage feature as the swale appears in the earliest available aerial photography image from the early 1970’s in the Recovery Assessment GIS application as shown in Figure 12.8. When tested against the connected wetland metric, NOP-07 passes that metric for both the initial assessment period of Water Years 2008 – 2013 and the final assessment period of Water Years 2008 – 2019. Due to the type of wetland (shallow mixed-hardwood/cypress), the existence of the swale in pre-wellfield historic imagery, and the field inspection indicating that the swale is functional and has positive outfall from the wetland, it is recommended that Tampa Bay Water and the District reclassify wetland NOP-07 as a connected wetland for future monitoring and assessment. Analyzing wetland NOP-07 as a connected wetland was discussed with the District staff at the July 14, 2017 technical coordination meeting.

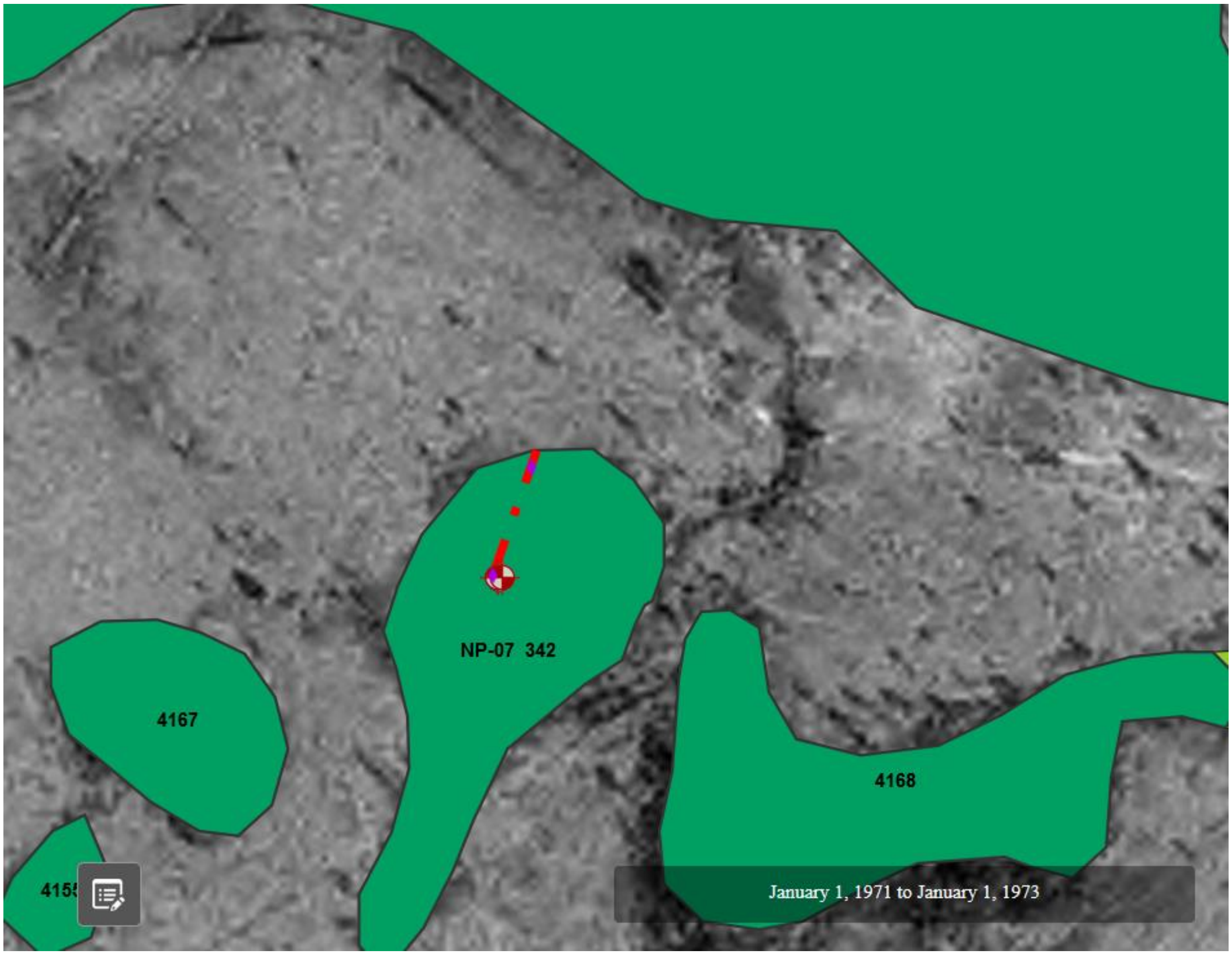


Figure 12.8: Screen Shot from the Recovery Assessment GIS Application Showing the Swale Connecting Wetland NOP-07 (see NE corner) to the Pithlachascotee River.

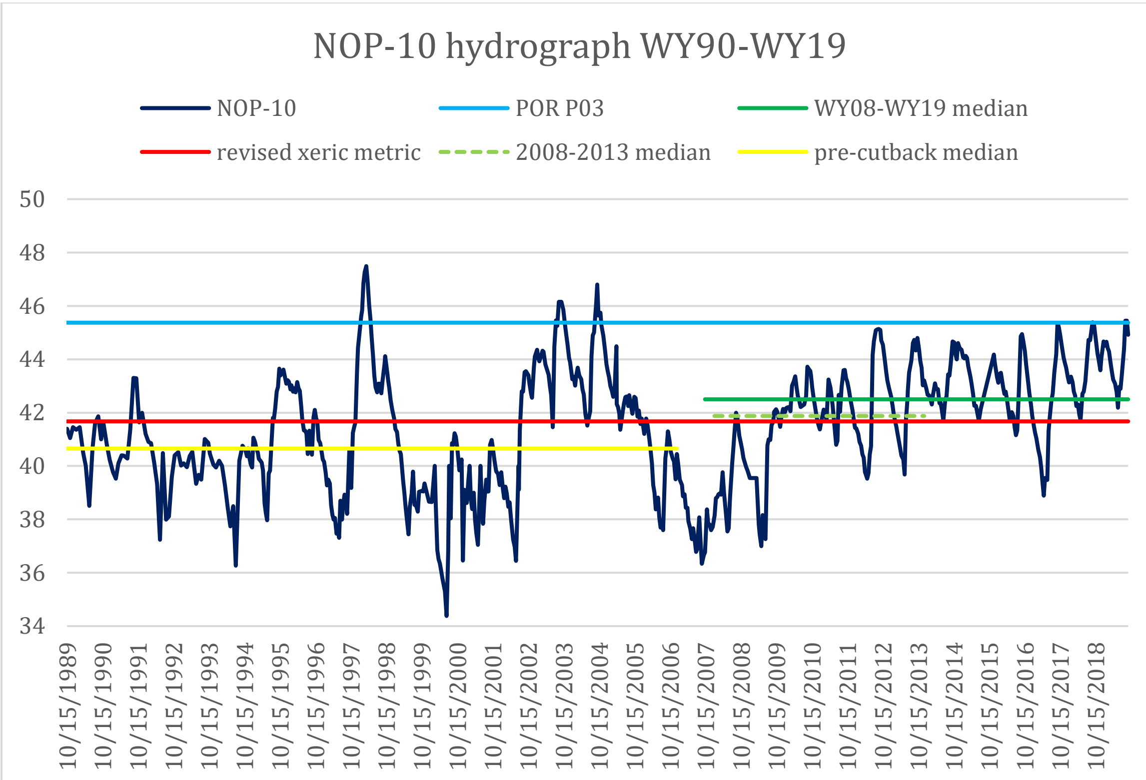


Figure 12.9: Wetland NOP-10 Hydrograph, Water Year 1990 through Water Year 2019

The monitored wetlands at the North Pasco Wellfield were analyzed in a technical report titled "North Pasco Recovery Assessment – monitored geographically-isolated wetlands" (Tampa Bay Water, 2017c). The District approval letter contained in Appendix 9.5 provides comments on the recovery assessments for wetlands NOP-10 and NOP-11, which are discussed below. The updated and final recovery assessment for all of the monitored wetlands at the North Pasco Wellfield are presented in Chapter 9.

12.2.1.2 Wetland NOP-11

This is a large isolated cypress wetland approximately 1.2 miles north of production well NP-4. In the Tampa Bay Water 2017 North Pasco Recovery Assessment Report, wetland NOP-11 was classified as Never Impacted because both the pre-cutback and post-cutback median water levels met the recovery metric for mesic isolated wetlands. In their letter, the District questioned the normal pool elevation for this wetland. The most up-to-date normal pool elevation for wetland NOP-11 was used in this final assessment of recovery. The District also commented that since the dry season low water levels are higher after the reduction in wellfield pumping, a classification of Recovered may be more appropriate than Never Impacted. A review of the period of record hydrograph for this wetland (Figure 12.10) through WY19 indicates that the seasonal low water levels following the reduction in wellfield pumping are 2 to 3 feet higher than before the pumping reduction. However, a rigorous analysis of rainfall and pumping data would be needed to determine if this increase in seasonal low water levels is due to a reduction in pumping. A wetland can be classified as either Never Impacted or Recovered if it meets the recovery metric; NOP-11 meets the established recovery metric in either case.

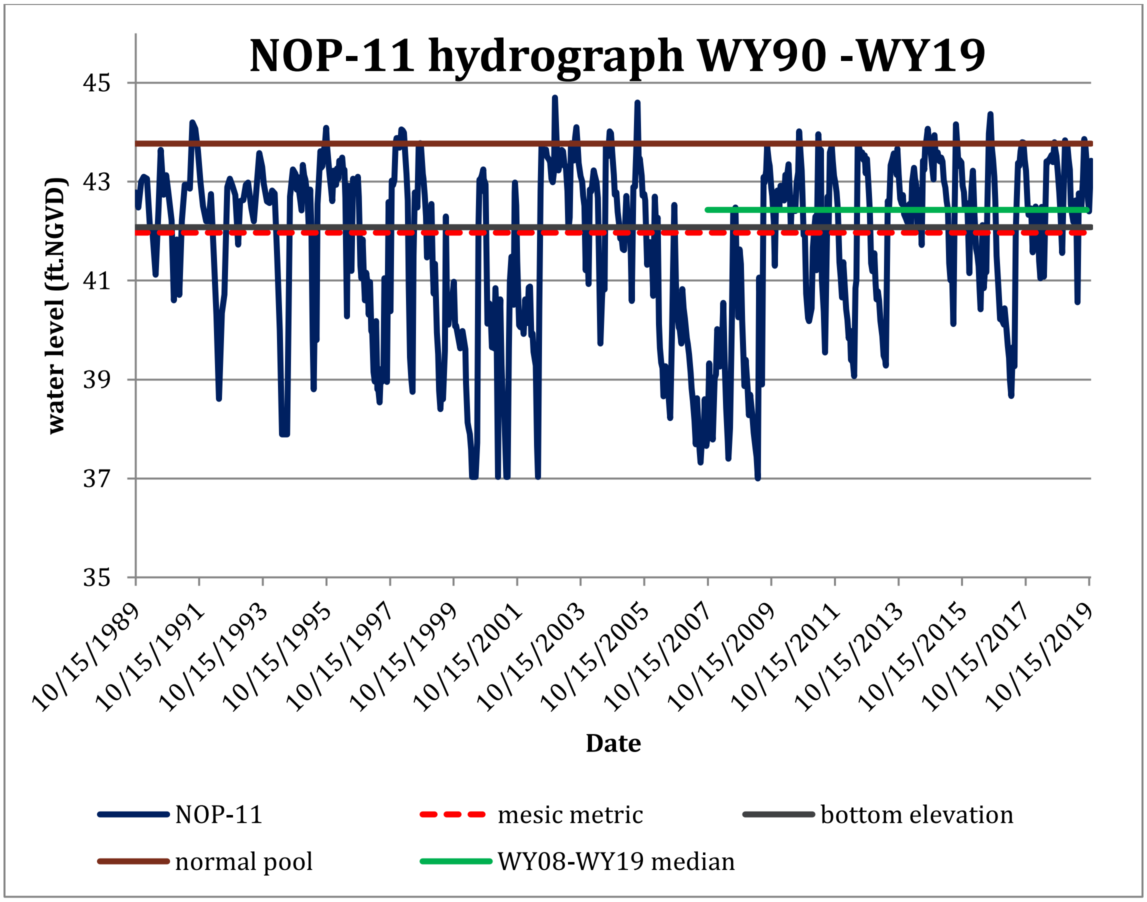


Figure 12.10: Wetland NOP-11 Hydrograph, Water Year 1990 through Water Year 2019

Ryals Lake is the only lake included on the recovery assessment monitored lake list within the North Pasco Wellfield. Moon Lake, located approximately one mile west of the North Pasco Wellfield, is also included on the monitored lake list. Both lakes met their recovery metrics and are listed as Recovered as depicted on Figure 8.7.

There is no Area of Investigation defined for the North Pasco Wellfield (Section 5.3); therefore, there were no unmonitored wetlands associated with North Pasco Wellfield in the Recovery Assessment Plan.

12.2.2 Discussion of Recovery

All of the monitored wetlands and lakes associated with the North Pasco Wellfield were classified as Never Impacted, Recovered, or having a High Degree of Certainty of Wetland Health in this final assessment with the exception of wetland NOP-7. From the field information presented, this wetland should be assessed as a connected wetland which would result in a final recovery classification of Recovered. Since this wellfield was decommissioned in 2018, the production wells have been properly abandoned, and all sites have or should be Recovered. Therefore, no further action is warranted for the monitored wetlands associated with this wellfield. Some of these wetlands may continue to be monitored in the future as reference or regional control wetlands.

12.3 Cross Bar Ranch Wellfield

Pinellas County purchased the Norris Cattle Tract in northern Pasco County in 1975 for water supply purposes and the West Coast Regional Water Supply Authority developed the Cross Bar Ranch Wellfield in the late 1970's. The property had been used for cattle ranching and citrus production for approximately 30 years prior. The wellfield was developed in two phases under permits from the District; a total of 17 production wells were drilled between 1978 and 1980 in a general south to north alignment along the center of the property (Figure 12.11). The wellfield began pumping water in 1980. Additional information about the development of the Cross Bar Ranch Wellfield is found in Section 3.6 of this report.

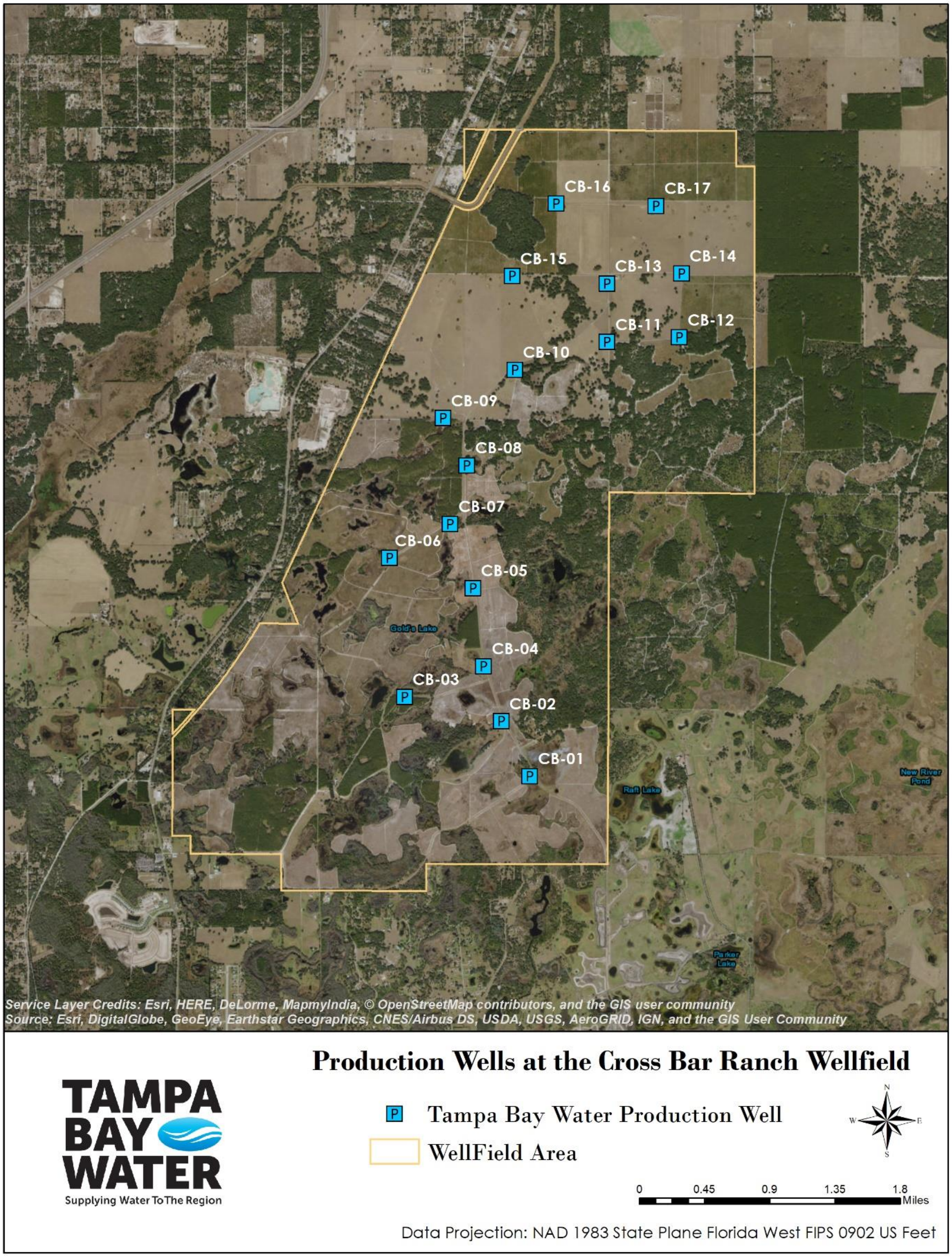


Figure 12.11: Map of Production Wells at the Cross Bar Ranch Wellfield

The complex geology of the Cross Bar Ranch Wellfield (Section 2.2.1) makes it a unique environment when compared to the other wellfields. This wellfield property is geologically characterized as having a karst, sandy northern portion, without a clay-rich confining layer. This means that the Upper Floridan Aquifer is unconfined and the northern portion of the wellfield contains few wetlands. South of this unconfined region and bisecting the wellfield is a hydrologic anomaly. The origin, width, and hydrologic effects of this anomaly are not clearly understood but it creates a transition zone from unconfined conditions in the north to areas of increasing Upper Floridan Aquifer confinement to the south. It has been documented that the potentiometric surface is higher to the south of the anomaly than to the north and pumping of production wells on one side of the anomaly has little to no effect on water levels on the other side. Because of these unique features, the southern portion of the wellfield contains almost all the wellfield wetlands. The wellfield and adjacent properties contain a mixture of soil types consistent with this geologic transition area and contain wetlands that are associated with both mesic and xeric soils. Xeric-associated wetlands are generally located in the central portion of the wellfield and off-site to the east. Xeric and mesic-associated wetlands are interspersed throughout the area with no clearly-defined distribution.

The land use history of this wellfield and the physical alterations made to the land as part of its management also makes it unique. As its name suggests, the property was managed for decades as a cattle ranch. A review of historical aerial images of the property shows extensive ditch systems constructed or under construction by 1941 (Figure 3.28). These ditches are connected to most of the wetland systems on the property in a south-to-north direction to a larger ditch (known as Jumping Gully) that flows off the property to the west, and eventually to Crews Lake. The effect of this system was to move standing water off the property making the property more suitable for the cattle ranch operation. In the late 1950’s and early 1960’s, some citrus was grown on the central and southern portion of the property (see Figure 3.29) but this was phased out by the early/mid 1980’s (see Figure 3.30). The historic images show that there was very little development in this area through the 1960’s and the predominant local land use in the 1970’s was agriculture (Figure 12.12).

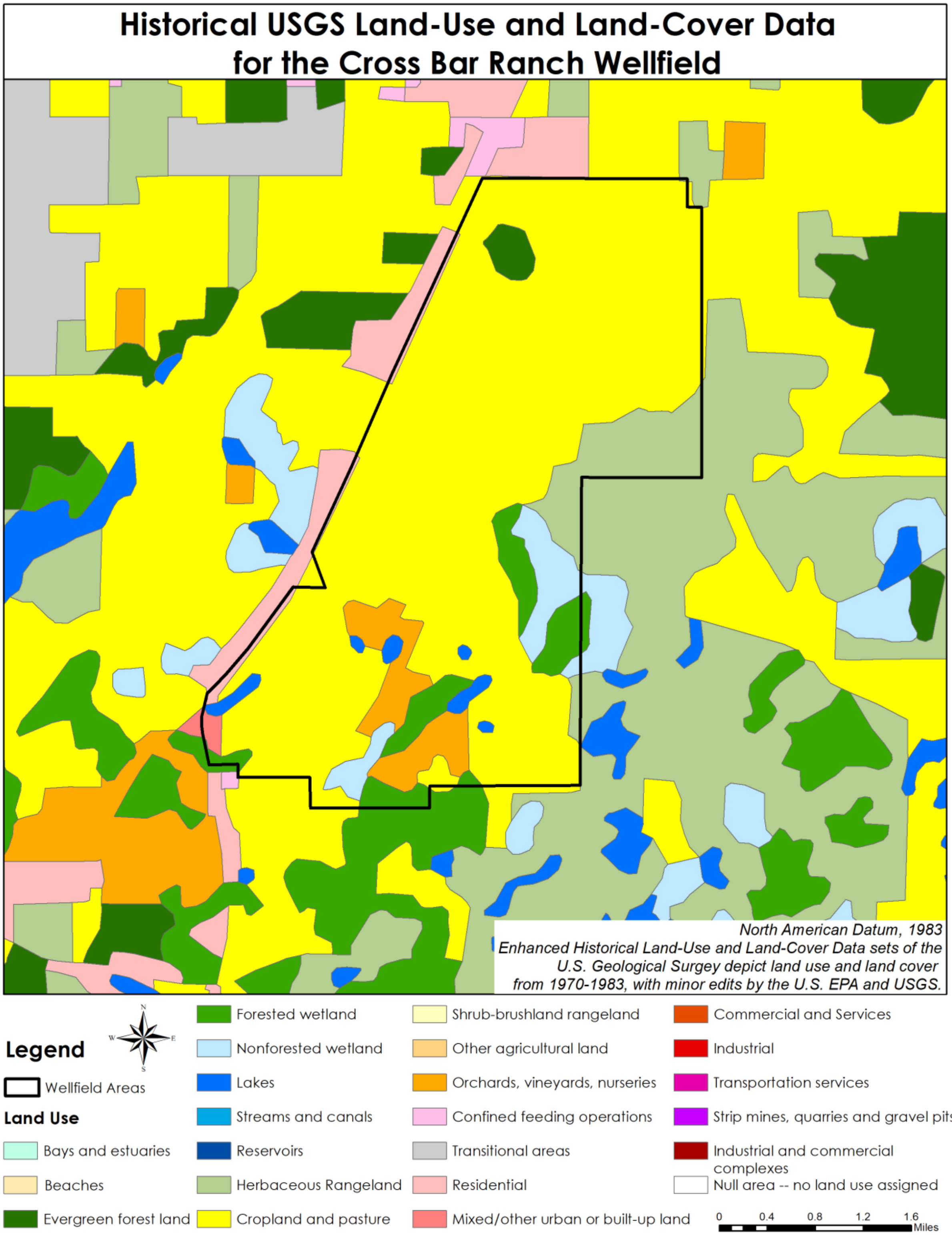


Figure 12.12: Historical Land Use and Land Cover Data for the Cross Bar Ranch Wellfield Area from 1970 – 1983

The Cross Bar Ranch continued to be operated as a cattle ranch under a lease from Pinellas County and land use remained generally similar with the exception of wellfield operation (Figure 12.13). In 1990, the County also purchased the 4,092-acre Al Bar Ranch, located on the eastern border of the Cross Bar Ranch, to provide a natural buffer and wellhead protection area for the wellfield (Pinellas County Utilities, 2009). The County has continued to manage the Cross Bar Ranch with cattle ranching operations on the north side of the property and began planting pine trees in the mid-1990's on the south and central portions of the property for pine needle harvest and timber production. Cattle ranching and timber planting and harvesting has continued through the current day (Figure 12.14) on the property. Several areas of the adjacent Al Bar Ranch have also been planted with pine trees and parts of the property have been enhanced for scrub jay habitat.

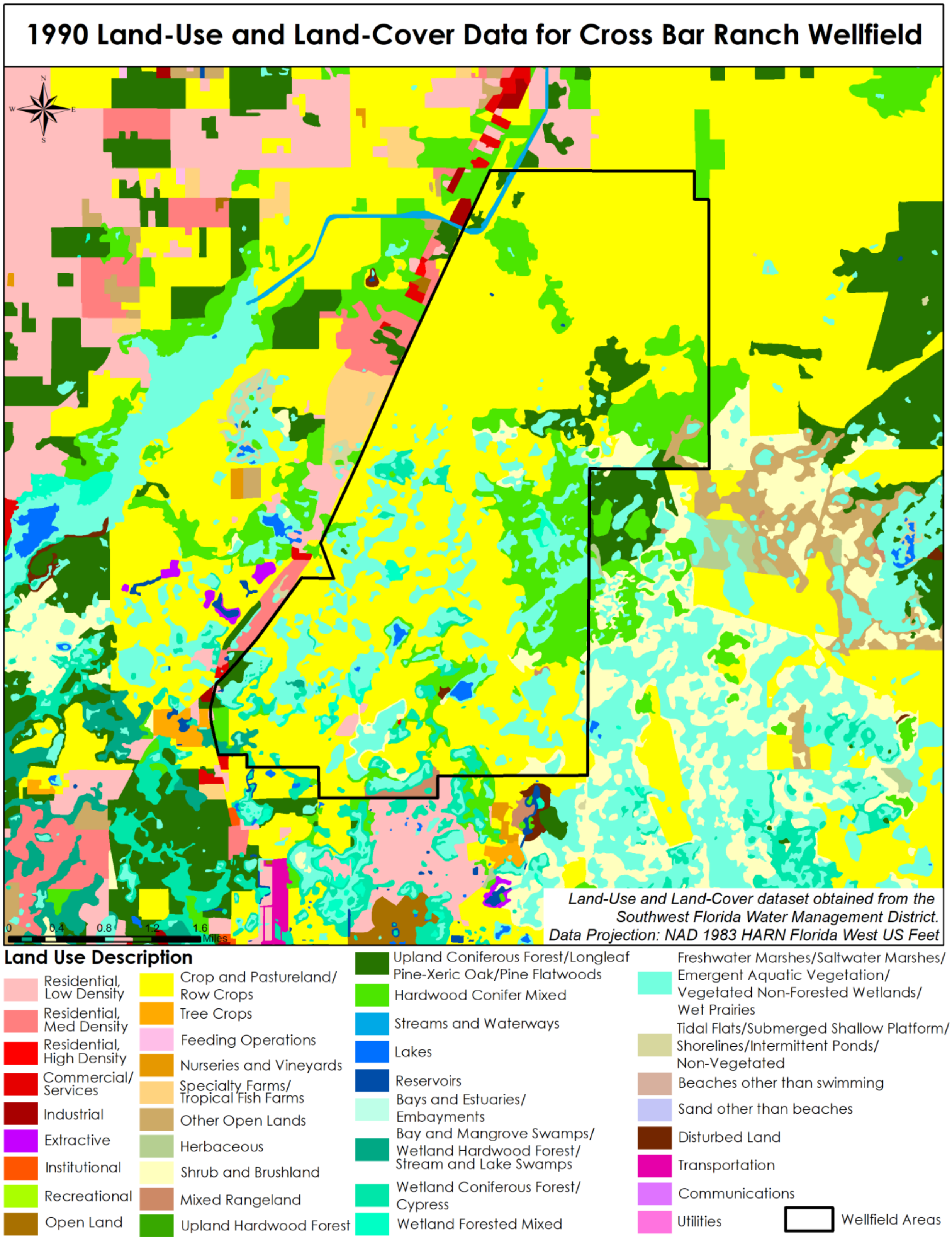


Figure 12.13: 1990 Land Use and Land Cover Data for the Cross Bar Ranch Wellfield Area

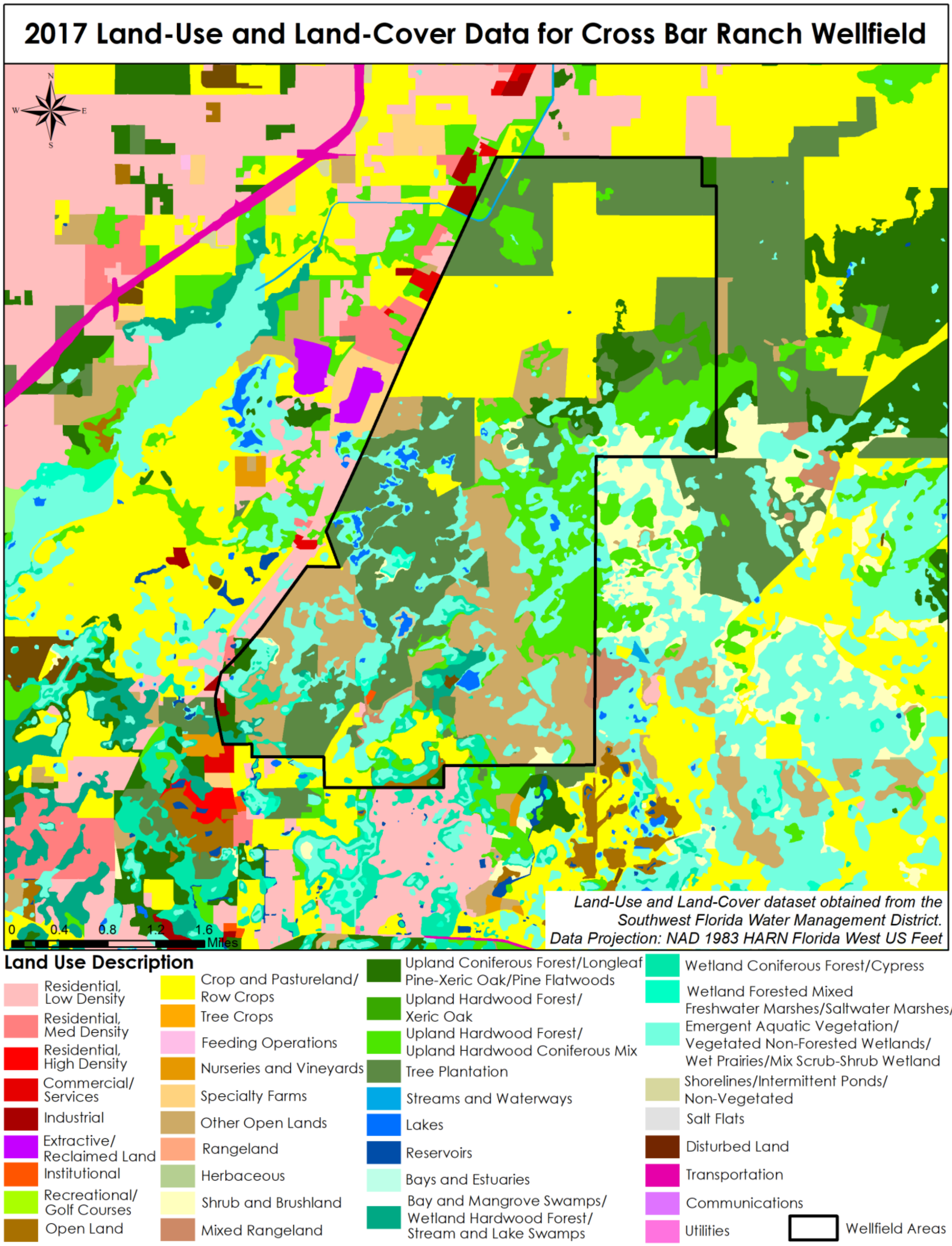


Figure 12.14: 2017 Land Use and Land Cover Data for the Cross Bar Ranch Wellfield Area

The wellfield began pumping water for the region in Water Year 1980 at an annual average quantity of approximately 4 mgd (Figure 12.15). Annual average pumping rates remained at or below 15 mgd until Water Year 1987 when the average annual withdrawal quantity increased to 22.8 mgd. The annual average pumping rate remained above 20 mgd through Water Year 2002. The reduction in wellfield pumping began in Water Year 2003 and wellfield production declined in Water Years 2003 and 2004 to around 12.5 mgd. Since the reduction in pumping at this wellfield, the annual withdrawal rate has remained relatively stable, averaging 14.2 mgd.

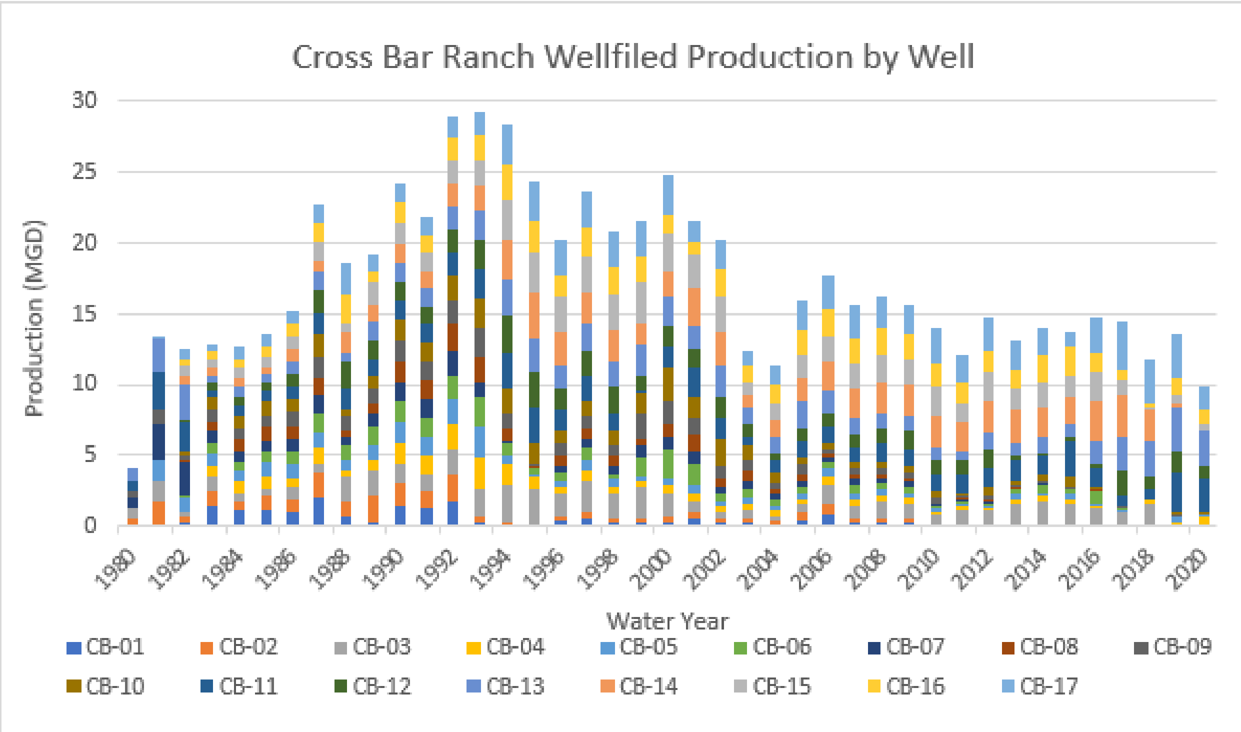


Figure 12.15: Period of Record Production at the Cross Bar Ranch Wellfield by Production Well

Rainfall has been monitored at the Cross Bar Ranch Wellfield since 1982 and is currently recorded at six gages: CB01, GREGG, CB13, S-1S, BFISH, and Elliot. The mean annual rainfall calculated for WYs 1982 to 2019 is 55.7 inches (Figure 12.16). Over the past 38 years of rainfall observations at the wellfield, there has been no statistically-significant positive or negative rainfall trend (Ormiston, 2020). However, droughts and periods of extended rainfall surplus have been noted during the period of record matching the general regional rainfall pattern. Notable deficits in rainfall at the wellfield occur between Water Years 1999 – 2002 and Water Years 2005 – 2011. A return to near-normal rainfall conditions during Water Years 2012 – 2019 is seen in the period of record annual rainfall graph, with a period average of 59.0 inches. Average rainfall has been recorded during this time period with the exception of Water Years 2015 and 2018, both of which exceeded 60 inches of rain. The rainfall average for the period used in the final assessment of wetland recovery (Water Years 2008 – 2019) is 56.5 inches, only 0.8 inch greater than the period of record average.

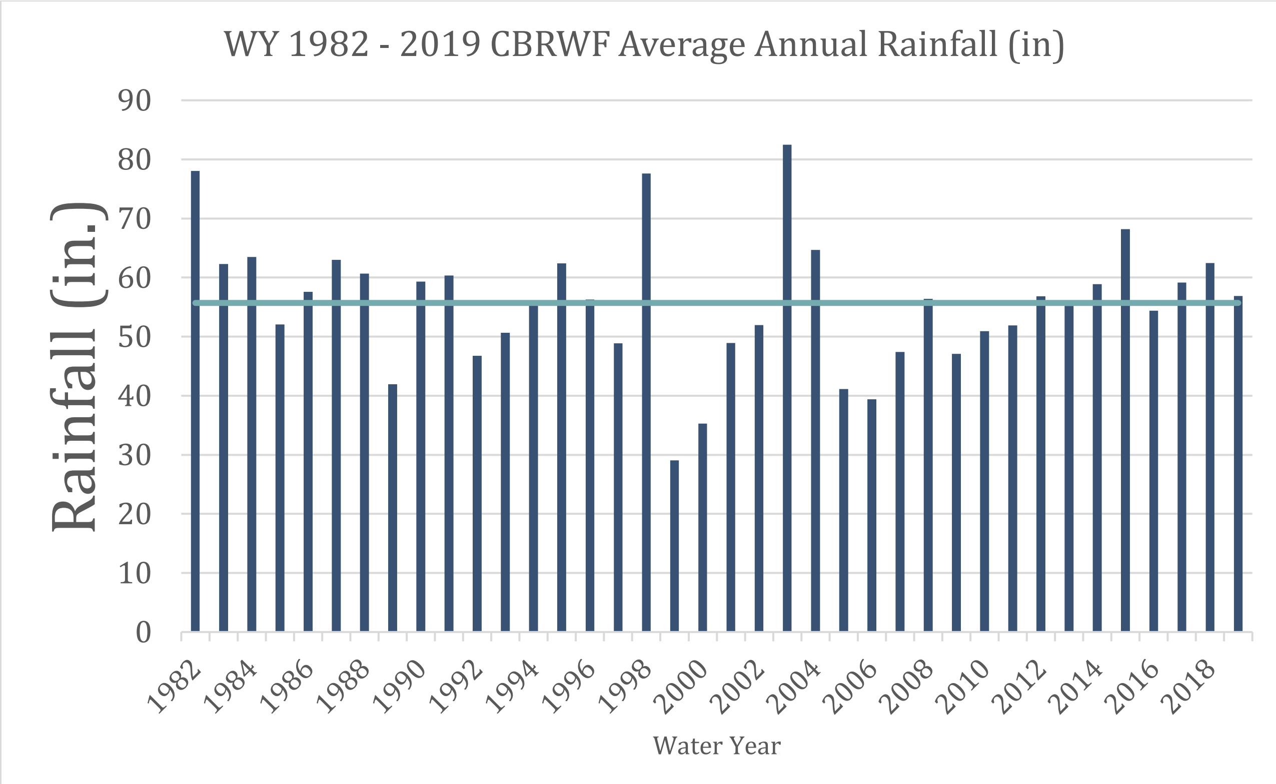


Figure 12.16: Total Annual Rainfall Measured at the Cross Bar Ranch Wellfield. The period of record average is 55.7" (orange line)

The Cross Bar Ranch Wellfield remains in a rural and agricultural setting; however, homes have been constructed adjacent to the wellfield on the south and west-central portions of the property. The first homes appear in 1974 aerial photographs for this area but at that time, there were very few homes and none existed on the west side of U.S. Highway 41. A few additional homes appear on or near Pasco Lake by 1985 and the first houses built west of U.S. Highway 41 appear in 1985 aerial photography (see Figure 3.30); more homes were constructed in this area between the wellfield and Crews Lake by 1990 and 1995. The Pasco Trails Estates neighborhood is located immediately south of the wellfield and north of State Road 52. The first few houses in this neighborhood appear in 1985 aerial photography but many additional homes were constructed in the late 1980's and early 1990's. The current landscape and location of homes around the wellfield can be seen in the 2018 – 2019 aerial photograph presented in Figure 3.31.

The construction of the deep drainage ditch known as Jumping Gully and the network of ditches that feed surface waters into this main ditch dramatically altered wetland hydrology on this property. This ditch system is visible in the 1941 aerial photograph (Figure 3.28) and the associated impacts are documented in early wellfield monitoring and assessment reports (Biological Research Associates, 1980). Sustained periods of high wellfield pumping between the late 1980s and late 1990s resulted in further hydrologic alterations of the wetland systems. Low wetland water levels on the wellfield resulted in drying soils and the movement of upland plant species into wetland areas. Treefall was also noted at some sites including wetlands CBR-Q01 and CBR-Q02 where some canopy-size cypress trees have fallen during hurricane events. Soil subsidence of 6 to 12 inches also occurred at these site due to extended periods of low water (Cardno ENTRIX 2013). Complaints of dry wetlands and lakes were filed with Tampa Bay Water between the early 1990's and 2001. These complaints were mainly located in the Pasco Trails neighborhood south of the wellfield, the lakes located west of the wellfield and east of Crews Lake, and Big Fish Lake to the east of the wellfield (Figure 12.17).

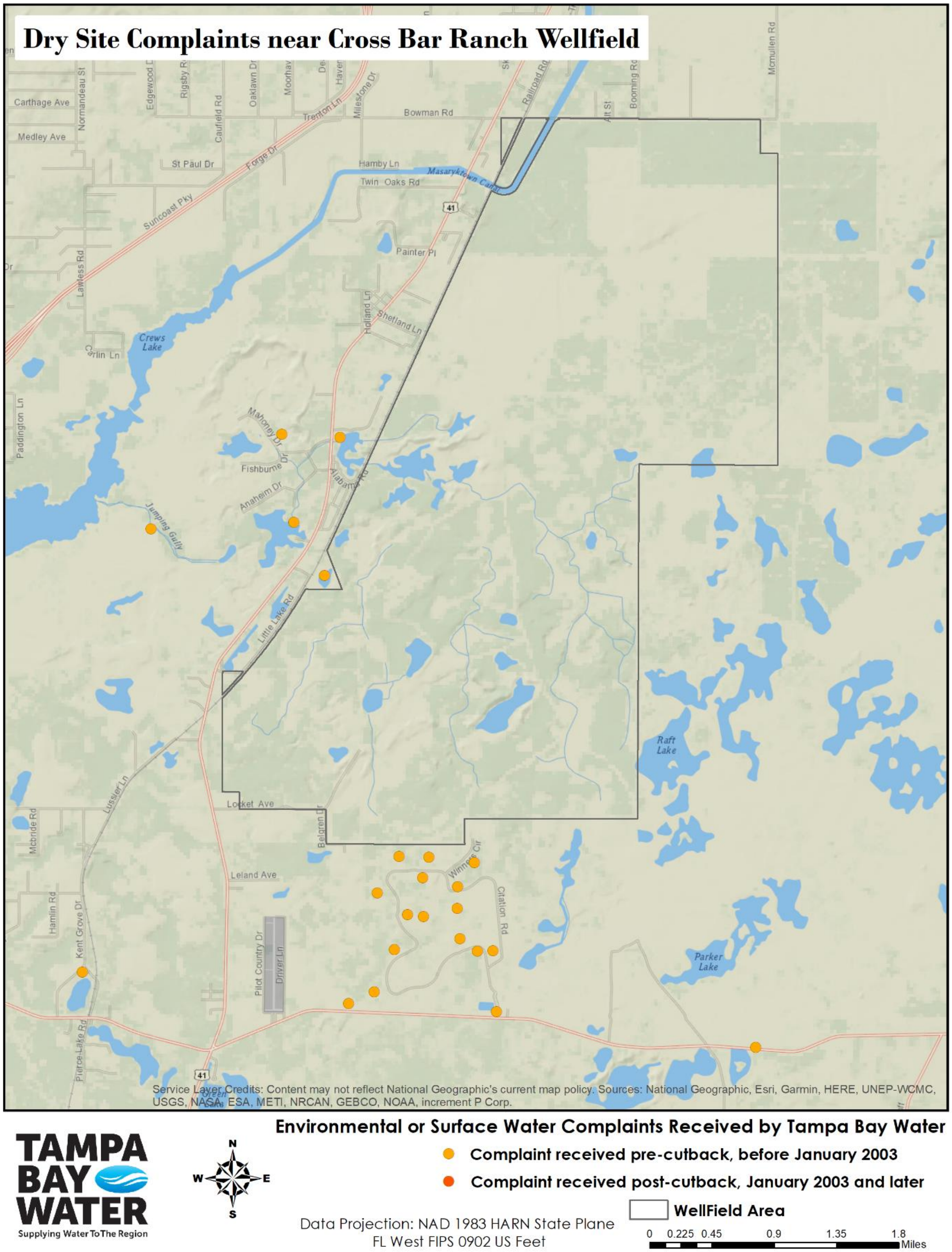


Fig. 12.17: Map of Dry Lake and Wetland Complaints at the Cross Bar Ranch Wellfield

12.3.1 Site-Specific Results

Wetland water levels have improved at all monitored wetlands at the Cross Bar Ranch Wellfield following the reduction in wellfield pumping that began in Water Year 2003. Isolated and connected systems have recovered or significantly improved, with steadily increasing wetland and aquifer levels. There are 31 monitored wetlands on the final recovery assessment list associated with the Cross Bar Ranch Wellfield. The final recovery assessment classification for these wetlands are presented in Section 9.2.3 and the final assessment bin for each of these wetlands is included in Table 9.8. The final recovery assessment results for these wetlands are summarized as:

- Recovered – 14 wetlands
- Improved – 14 wetlands
- High Degree of Certainty of Wetland Heath – 1 wetland
- Low Degree of Certainty of Wetland Health – 2 wetlands

As described previously, the Cross Bar Ranch Wellfield has unique hydrogeological characteristics as compared to the other area wellfields and the surficial soils are very sandy and well-drained. The soils in the wellfield area tend to have a greater xeric-to-mesic soil ratio than the other wellfields. The hydrologic response of water levels in wetlands with a higher xeric soil ratio led to the development of the isolated xeric wetland recovery metric as described in Section 6.3.4. Mesic-associated wetlands were compared to 1.8-foot offset from normal pool elevation to determine recovery status, while xeric-associated wetlands were compared to a 3.7-foot offset from the P03 water level elevation. While the 3.7-foot offset from the P03 elevation represents the single best xeric recovery metric value, a discussion of the range of certainty is detailed in Section 6.3.4.2. Wetlands with measured offset values either below 4.3 or above 3.0 feet could be assigned to their most likely classification of stressed or unstressed, respectively, with greater confidence based on the misclassification error analysis completed in the development of the isolated xeric wetland recovery metric.

The only connected wetland at the Cross Bar Ranch Wellfield (CBR-Ann Denker) was classified as Recovered. Eight of the 27 isolated wetlands assessed at the wellfield are categorized as mesic wetlands. Of those eight, three are classified as Recovered and five as Improved. On average, the Improved mesic wetlands missed their recovery metric by a median of 1.01 feet (with a range of 0.43 to 3.6 feet). Nineteen of the 27 isolated wetlands assessed at the wellfield are categorized as xeric wetlands. Of those 19 xeric wetlands, 10 are classified as Recovered and nine as Improved. On average, the Improved xeric wetlands missed their recovery metric by a median of 1.61 feet (with a range of 0.34 to 7.39 feet).

One of the Improved wetlands is CBR Q-01 which is also known as Cross Bar Q-1 Wetland by the District and is a wetland with an adopted Minimum Level. This wetland is located just inside the south property boundary of the wellfield across from homes in Pasco Trails Estates and the 4-G Ranch. Section 9.7 summarizes the final status assessment of this wetland as Improved with a median wetland water level that was 0.43 foot below its metric for the Water Year 2008 – 2019 time frame. This wetland was reviewed by District Regulatory staff and they concluded that there was no adverse impact at this site (Appendix 9.25). The site review indicated that normal zonation of wetland vegetation is present and the habitat does not appear to be impacted.

Within the wellfield boundary, the Recovered xeric wetlands tend to be located in the southern part of the wellfield with a few in the central wellfield area. The Improved xeric wetlands tend to be located toward the central portion of the wellfield where the clay confining unit disappears and the Upper Floridan Aquifer transitions to an unconfined condition (Figure 12.18). The density of Improved xeric wetlands closer to the hydrogeologic anomaly may indicate that xeric wetlands in this confinement transition zone of the Upper Floridan Aquifer have greater natural water level fluctuations or may have a different classification of recovery than those further from this area. Support for this interpretation is evident through the District staff field review of eight of the Improved wetlands at the wellfield that found no evidence of adverse environmental impact (Section 9.6.2). The locations of the Recovered and Improved mesic wetlands are shown in Figure 12.19 and tend to occur only along the southern portion of the wellfield and south of the wellfield boundary. Wetland CBR-Q21 is a hydrologically perched mesic wetland and an anomalous wetland in regard to location for wetland occurrence on the Cross Bar Ranch Wellfield.

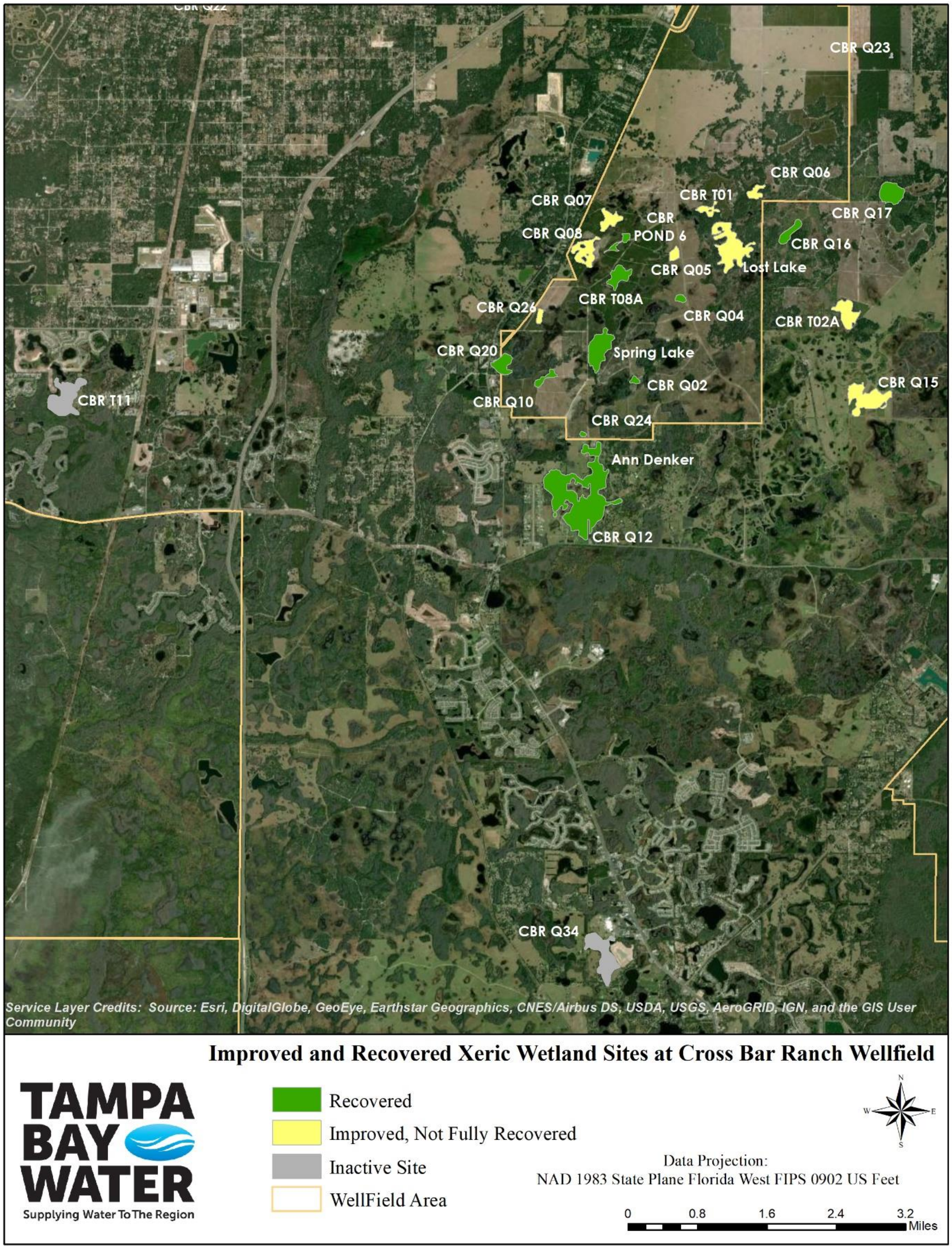


Figure 12.18: Location of Improved and Recovered Xeric Wetlands at the Cross Bar Ranch Wellfield

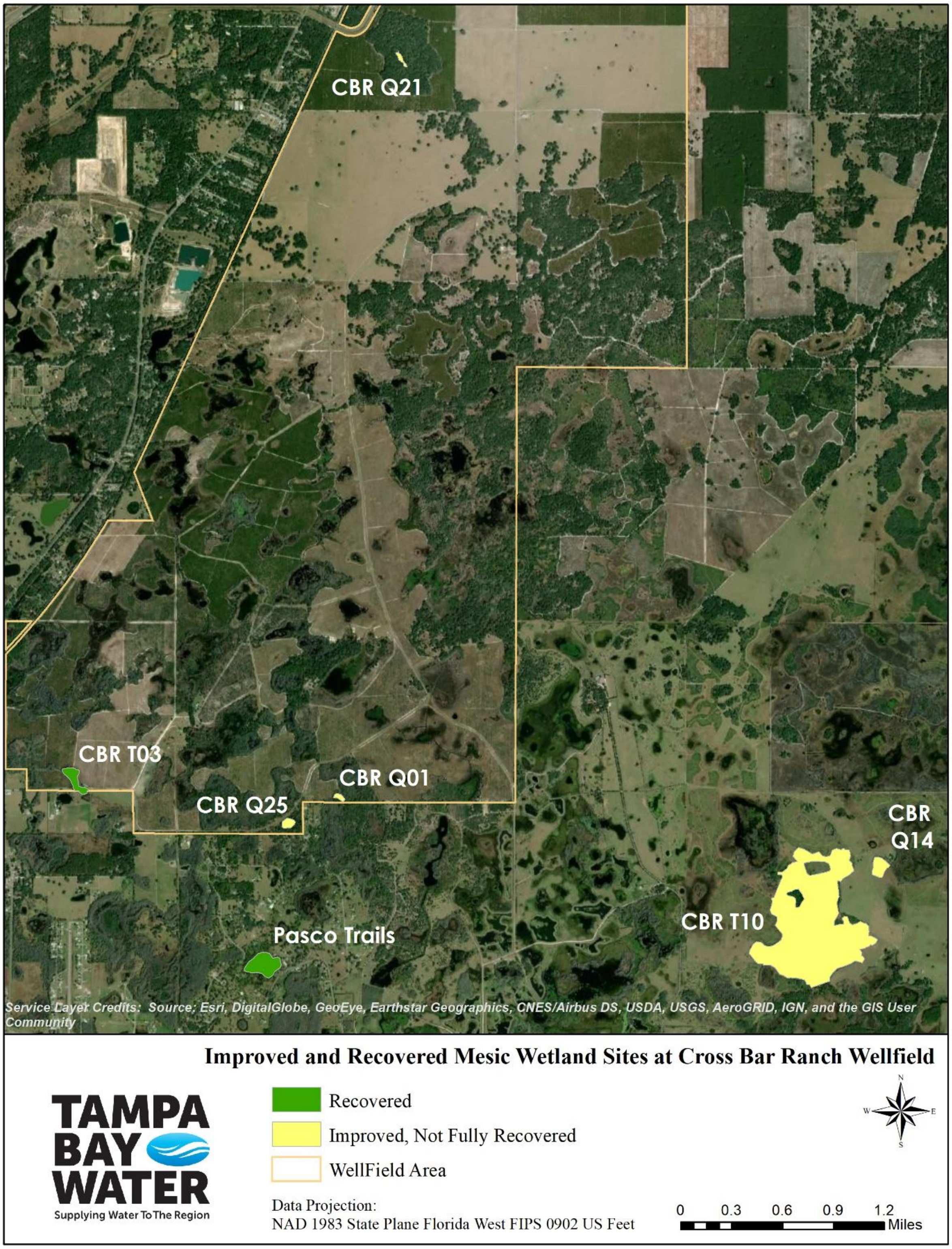


Figure 12.19: Location of Improved and Recovered Mesic Wetlands at the Cross Bar Ranch Wellfield

Monitoring has ceased at three additional wetlands, CBR-Q23, CBR-Q34, and CBR-T11**,** and insufficient data exists following the reduction in wellfield pumping to assign the wetlands to one of the quantitative assessment bins. These three wetlands were assessed with the unmonitored sites as presented in Chapter 10; wetland CBR-Q34 was assigned to the qualitative assessment bin of High Degree of Certainty of Wetland Health and wetlands CBR-Q23 and CBR-T11 were assigned to the qualitative assessment bin of Low Degree of Certainty of Wetland Heath.

A small number of monitored lakes on and near the Cross Bar Ranch Wellfield were analyzed and assigned to a final classification bin as detailed in Chapter 8. The final assessment status of these lakes is included in Tables 8.2 and 8.5 and shown in Figure 8.6. Two lakes within the wellfield boundary, Clear Lake and Goose Lake, are Recovered. Raft Lake, which intersects the southwest corner of the wellfield, is also classified as Recovered. Big Fish Lake is located to the east of the wellfield and is Improved with clear evidence of water level recovery for a sustained period of time in recent years. Pasco Lake is located just off the west-central border of the wellfield and is also classified as Improved. District staff anticipate removing Pasco Lake from their MFL Lake List in Chapter 40D-8, F.A.C. in late 2020 due to technical issues with the established level; a new Minimum Level may be set in the future pending further technical investigations. The largest lake in the area, Crews Lake, is Recovered; Lake Loyce on the western side of the wellfield is also Recovered. Lost Lake, Spring Lake, and CBR Pond 6 are located on the wellfield property and were assessed with monitored wetlands. The results of these lakes are included in the wetland summary above with Lost Lake classified as Improved and Spring Lake and CBR Pond 6 classified as Recovered.

The Area of Investigation for the Cross Bar Ranch Wellfield is described in Section 5.3 and the unmonitored wetlands within this defined area were qualitatively assessed as described in Chapter 10. The qualitative recovery assessment of these unmonitored sites is shown in Figure 10.15 and the final assessment results for all monitored and unmonitored sites on and near the wellfield is presented in Figure 14.1. The final qualitative assessment results for the unmonitored wetland sites follow a general pattern with wetlands along the edges of the Area of Investigation having a High Degree of Certainty of Wetland Health, while wetlands central within the Area of Investigation generally have a Low Degree of Certainty of Wetland Health. This pattern generally agrees with the final assessment results for the monitored wetlands and lakes that were binned as Recovered. Monitored wetlands assessed as Improved are generally surrounded by unmonitored wetlands that have a Low Degree of Certainty of Wetland Health.

Water level recovery in the water table and increases in the potentiometric surface of the Upper Floridan Aquifer following the reduction in wellfield pumping have been demonstrated in multiple formats within this report. Hydrologic recovery is presented in Chapter 11 and Figures 11.2 and 11.4 show the improvement in the surficial and Upper Floridan aquifers for the periods of 1996 – 2002 and 2012 – 2018. The predicted drawdown in the water table based on actual pumping during the recent period shows a significantly smaller 2-foot contour. The period of record hydrographs for monitor wells CBR-SERW-s and SERW-d (included in Figure 11.10) show a sustained increase in the water table in the Upper Floridan Aquifer along the southeast border of the wellfield for the past several years. Statistically significant increasing trends in the water table and potentiometric surface were documented in the wetland assessment reports for the Cross Bar Ranch Wellfield as discussed in Section 9.2.3. Wise (2016) also analyzed the recovery in the surficial and Upper Floridan aquifers (Appendix 9.7) and noted that the greatest recovery in the surficial aquifer was noted in the southwestern portion of the wellfield (between production wells CBR-3 and CBR-7), while the greatest increase in the UFAS was observed in the northwestern corner of the wellfield near production well CBR-15.

12.3.2 Discussion of Recovery

Wetland water levels and health on and around the Cross Bar Ranch Wellfield have been and continue to be influenced by many factors. The earliest influence was the construction of the drainage ditch network that made the property suitable for cattle ranching and citrus production. Pinellas County and Tampa Bay Water installed a series of ditch blocks in Jumping Gully and the contributing drainage ditches to manage the water flow through this system during periods of high water and promote ecological recovery of target wetlands by retaining more water on the property. This project is described in greater detail in Section 3.13.2.3 but since construction, the ditch blocks have been operated only in Water Years 2018 and 2019 and for limited periods of time. Operation of the ditch blocks has been limited due to the permit-specified control elevations in downstream lakes and residential flooding concerns both upstream (south of the wellfield) and downstream (between Pasco Lake and Crews Lake) of the Jumping Gully system. Hydroperiods and overall hydrologic health at target wetlands and system lakes have improved due to production cutbacks, a return to normal rainfall, and the limited management of the ditch block system (VHB, 2019).

High water and residential flooding complaints have been registered by the District and Pasco County in areas west and south of the Cross Bar Ranch Wellfield both before and after the reduction in pumping (Figure 12.20). In most recent years, flooding occurs in residential areas west of U.S. 41 during the height of the summer rainy season. High water conditions in this area surrounding Lake Loyce and Buzzard Lake have threatened homes and made some roads impassable. This area receives water from the Jumping Gully system as it flows from Pasco Lake toward Crews Lake. The Pasco Trails neighborhood south of the wellfield has also experienced flooding during the height of the rainy season in recent years, prompting residents to request additional pumping from the wellfield. Both of these neighborhoods were the source of dry wetland and lake complaints in the mid-1990s before the reduction in pumping from the wellfield.

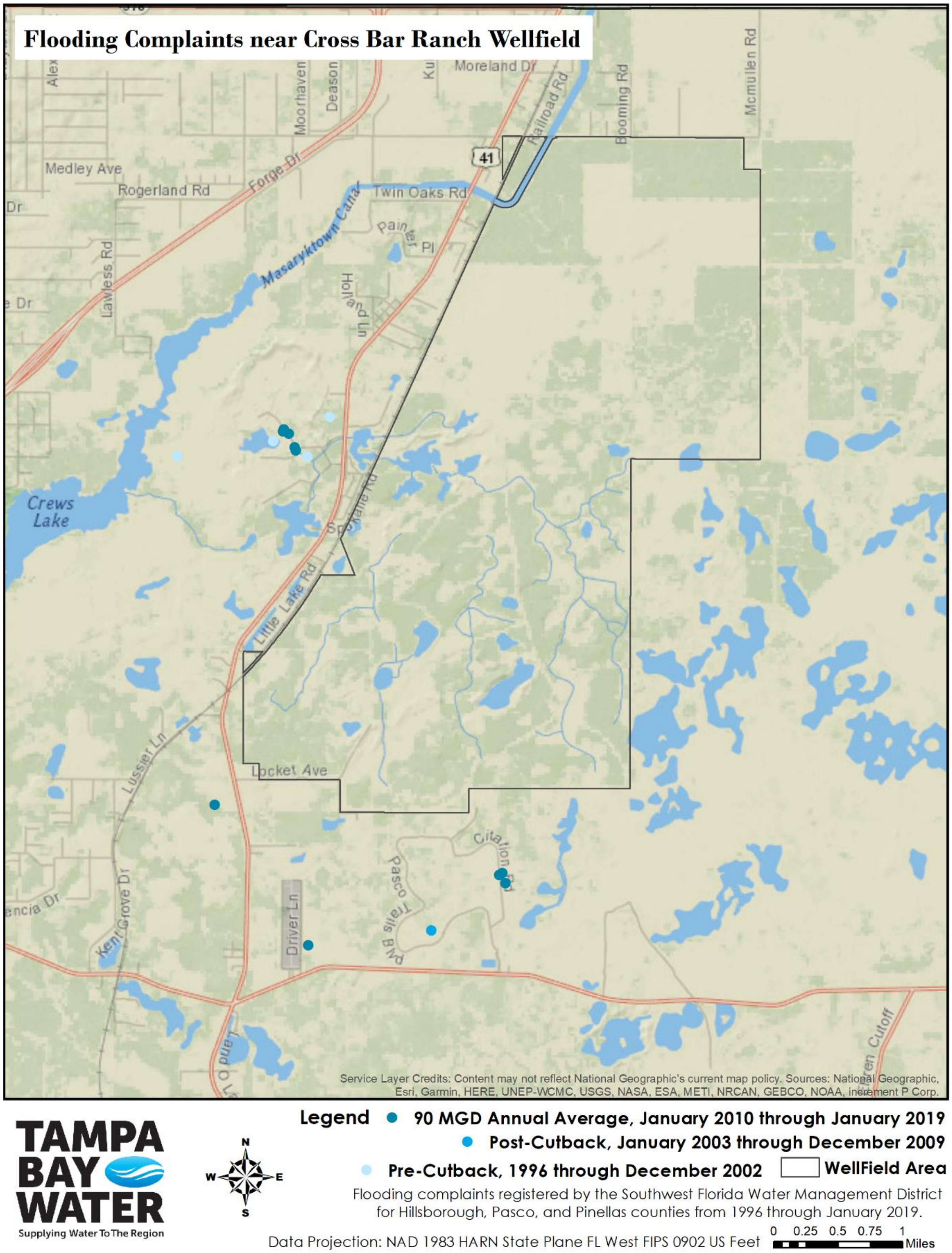


Figure 12.20: Map of Flooding Complaints at the Cross Bar Ranch Wellfield

The final recovery assessment results for all sites associated with the Cross Bar Ranch Wellfield are shown on Figure 14.1. These final results indicate that many of the lakes and wetlands on and around the wellfield have recovered with the reduced rate of wellfield pumping and all sites that are classified as Improved show strong signs of water level recovery in the wetlands, surficial aquifer, and Upper Floridan Aquifer. The eight Improved wetlands that were assessed by District Regulatory staff do not show ecological signs of adverse impact even though they do not fully meet their hydrologic recovery metric. The remaining Improved sites were inaccessible in late 2019 and early 2020 at the time of the field assessment due to flooding on the property. The degree of wetland recovery and improvement on the property is likely influenced by the unique geology and hydrogeology of this area and the presence of a high percentage of xeric-associated wetlands. Given the limited opportunity for surface water management on the property due to off-site flooding concerns and on-site land uses, and the historical alterations to on-site wetlands (ditching, subsidence, and soil loss), the wetland systems on the Cross Bar Ranch Wellfield have recovered or are recovered to the greatest extent possible. If pumping were further reduced at the wellfield, it is highly likely that on-site and off-site flooding issues would become more frequent and be sustained for longer periods of time.

12.4 Cypress Creek Wellfield

The Cypress Creek Wellfield was the first regional water supply source developed by the West Coast Regional Water Supply Authority. The property in central Pasco County was conceived as a water supply wellfield to be constructed in conjunction with the U.S. Army Corps of Engineers Four Rivers Basin Project. It was expected that infiltration from the proposed surface water reservoir on the property into the underlying aquifer would offset the effects of drawdown from wellfield pumping; however, the surface water reservoir part of the project was never constructed. Instead, the wellfield access road was elevated to form a low berm across the Cypress Creek Floodplain and the District constructed a water control structure where the creek intersected the berm. The District also developed a schedule to retain and manage the water behind the berm to maintain water levels for the floodplain system, manage the growth of nuisance vegetation species, and reduce fire risk. The Authority completed the construction of the first 10 production wells in a north to south-west alignment near the eastern part of the property between 1974 and 1977. Three additional production wells were constructed in 1980 on a west to east alignment from the existing production wells toward the eastern property boundary, crossing a surface water flow-way named Dye's Crossing (Figure 12.21). Additional information about the development of the Cypress Creek Wellfield is found in Section 3.6 of this report.

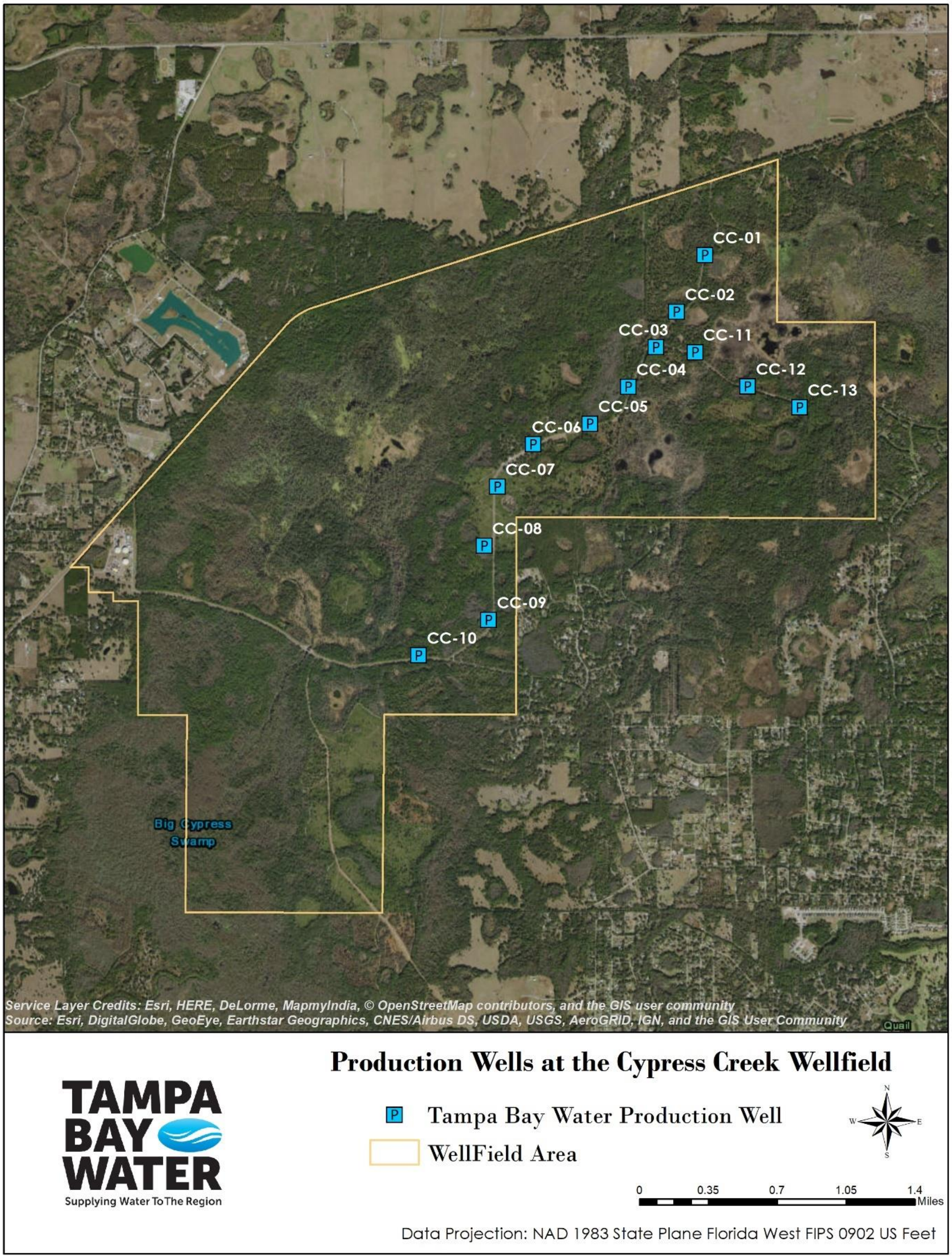


Figure 12.21: Map of Production Wells at the Cypress Creek Wellfield

The wellfield began operation in 1976 under a Consumptive Use Permit authorizing an annual average quantity of 30 mgd. The production wells were brought online in groups as shown in the wellfield pumping graph (Figure 12.22) with the final production wells CYC-11, CYC-12, and CYC-13 brought online in Water Year 1981. The average annual pumping rate from the wellfield increased quickly to 30 mgd by 1979 and remained at this rate for many years. The annual average pumping rate varied between 21 and 29 mgd from Water Years 1994 through 2002 before the regional reduction in pumping in Water Year 2003. Since Water Year 2003, the annual average pumping rate from the wellfield has averaged 15.2 mgd.

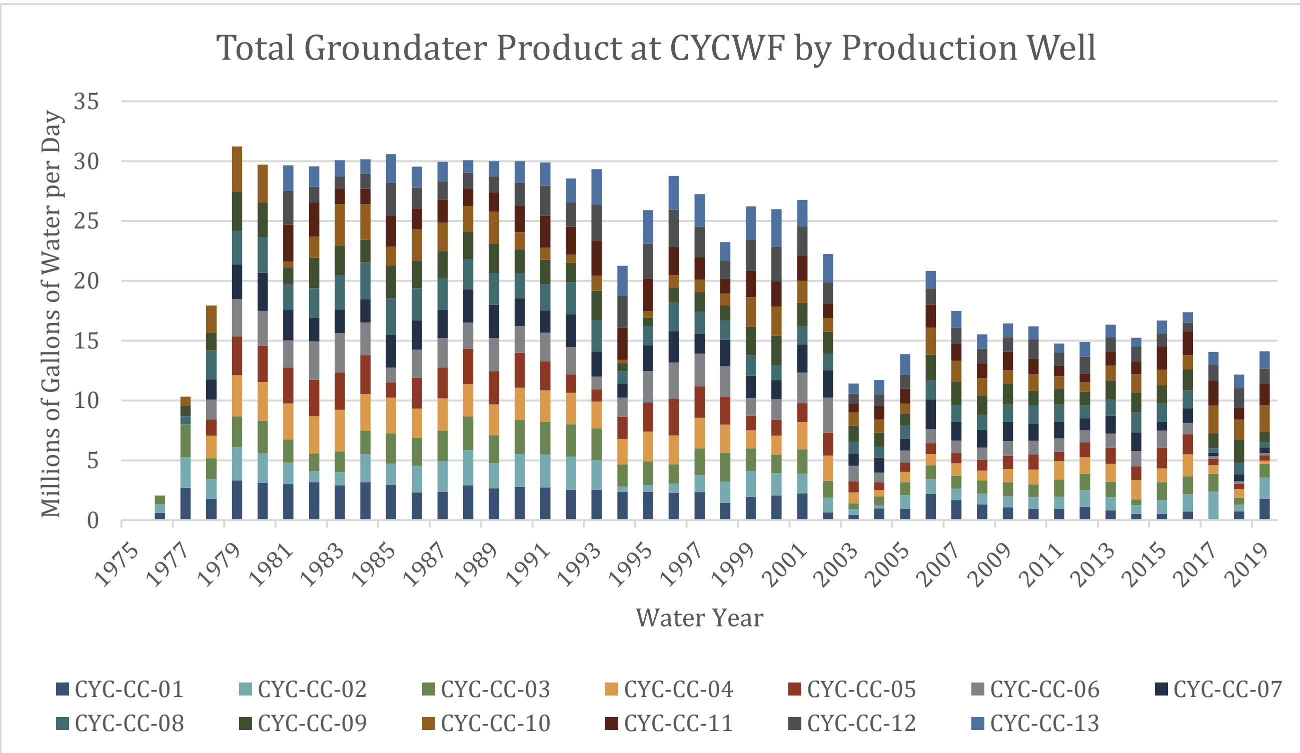


Figure 12.22: Period of Record Production at the Cypress Creek Wellfield by Production Well

Rainfall has been monitored at the Cypress Creek Wellfield since 1976 and is currently recorded at three Tampa Bay Water gages and one District gage on the wellfield. Mean annual rainfall for Water Years 1976 to 2019 at the wellfield is 53.6 inches. Notable rainfall deficits occurred between Water Years 1990 and 1998, 2000 and 2003, and between 2006 and 2010 (Figure 12.23). A return to approximate average rainfall conditions has occurred during Water Years 2011 through 2019 with four of the nine years recording annual rainfall of 60 to 71 inches. The average rainfall for the period used in the final assessment of wetland recovery (Water Years 2008 – 2019) is 56.3 inches, slightly above the long-term average rainfall at this wellfield.

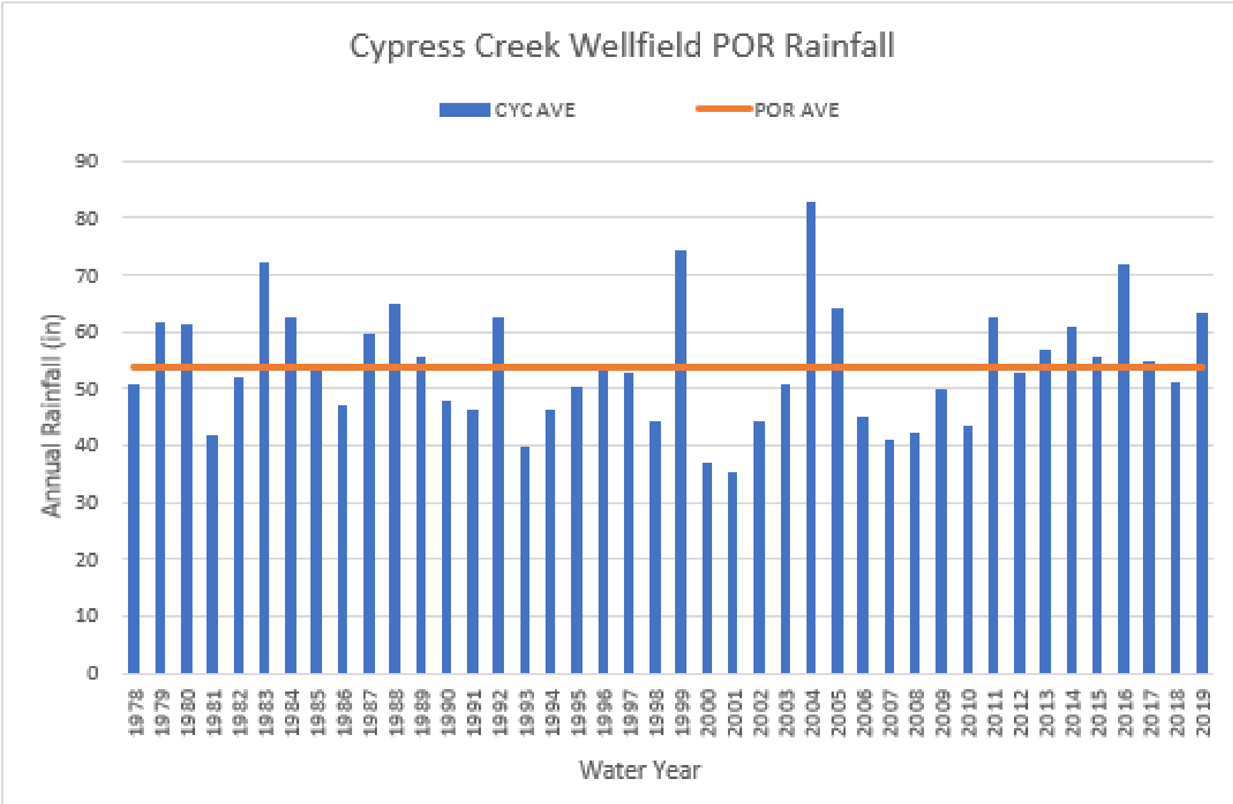


Figure 12.23: Total Annual Rainfall Measured at the Cypress Creek Wellfield

There was very little residential development near the wellfield property prior to its construction (Figure 3.19). Two communities were developed during the period of time when the Cypress Creek Wellfield was pumping at approximately 30 mgd. Homes in the Quail Hollow subdivision were constructed after 1974 and continued through 1995, including those along Quail Run Drive immediately south of the wellfield property boundary. The homes in this community are evident in the 1988 – 1991 aerial photograph (Figure 3.20). Development of the two phases of the Saddlewood Estates community, located adjacent to the east side of the wellfield property boundary occurred between 1990 and 2004 and can be seen in aerial photography from 2018 – 2019 (Figure 3.21). The homes in both developments are served by individual septic tank systems for sanitation purposes.

During the initial wellfield testing in 1978, the water table in some areas of the wellfield was very low or dry for periods of time and some wetlands in these areas had low or no standing water for long periods. The Authority began a limited augmentation program in 1978 and 1979 for two marshes on the northern part of the wellfield that had been dry and were experiencing soil cracking and the loss of wetland vegetation. Two isolated cypress wetlands on the east side of the wellfield were added to the augmentation program in 1980 using groundwater from nearby production wells. The augmentation of these four wetlands has continued on an as-needed basis during the history of the wellfield as these sites dry out quickly in the absence of augmentation. Tampa Bay Water has documented a reduction in the quantity of water needed to sustain these wetlands following the reduction in wellfield pumping in Water Year 2003 (Attachment 21 of the Consolidated Water Use Permit Renewal Application No.

20011771.002). During Water Years 1999 to 2002, Tampa Bay Water augmented these four wetlands with an annual average quantity of 0.44 mgd; between Water Years 2003 and 2019, the annual average augmentation rate was 0.19 mgd.

The District began an ecological monitoring program at the Cypress Creek Wellfield in 1975 and the Authority assumed and expanded the program in 1978. The historical environmental monitoring reports include descriptions of low water level conditions and environmental impacts that began during the initial wellfield startup testing period and continued after several years of wellfield pumping at an average rate of 30 mgd through the 1980's and periodic dry conditions. The ecological impacts that have been observed include invasion of nuisance and exotic vegetation, transition of upland plants into wetland areas, soil subsidence and oxidation, and extensive tree fall in the floodplain areas of the wellfield. These conditions are discussed in detail in Section 3.9.3. Historical impacts have been noted mainly in the central wellfield area, within the wellfield boundary. Both geographically isolated systems and flow-through systems such as the Cypress Creek and the Dye's Crossing floodplains, have experienced hydrological changes due to a combination of historically high pumping rates and anthropogenic changes within the basin.

Treefall monitoring began on the wellfield in 1983 based on visual observations, following earlier notes of small wind-blown treefall events in the late 70s and late 80s. This impact has been documented in large portions of connected wetland systems on the wellfield including the Cypress Creek and Dye's Crossing floodplains. Throughout the 1980's and 1990's, treefall occurred due to a combination of soil dehydration, subsidence, and wind. However, water impoundment in floodplains as a result of a return to average to above-average rainfall and reduced groundwater pumping exacerbated treefall in the 2000s. Cycles of drying and rehydration combined with wind events resulted in a complex treefall history within the Cypress Creek Wellfield as described in Section 3.9.3.1. With the reduced wellfield pumping and a return to more normal rainfall conditions on a long-term basis, recent environmental monitoring reports have noted slow but evident improvement in the recovery of the tree canopy in these floodplain forests as new trees become established (Tampa Bay Water, 2019c).

Wetland soil subsidence was studied at several wellfields as described in Section 3.9.3.1 including the Cypress Creek Wellfield. These conditions can occur when a wetland is dry for long periods of time or the wetland soils are infrequently saturated. Soil elevation change is a very slow process on the order of years or decades and soil subsidence is moderate to severe when it becomes readily visible. Measured soil subsidence at the Cypress Creek Wellfield was as much as 0.25 feet over a 9.5 year period of monitoring at wetlands CYC W06 and W39. Soil subsidence was also been documented in the center of wetland CYC W19 along with significant treefall. Slight soil subsidence was documented at wetland CYC W30 with a maximum decline of 0.08 ft. over a 9.5 year period (Berryman and Henigar, 2000b). Indications of soil subsidence are also noted as part of the annual Wetland Assessment Procedure (WAP) monitoring. In 2015, RS&H, Inc. summarized the historical soil subsidence at 31 wetlands on the Cypress Creek Wellfield and the subsidence noted between 2005 – 2015. A summary of these results is presented in Table 12.1.

Table 12.1 - Soil Subsidence in Wetlands on the Cypress Creek Wellfield

Monitoring Site	Historic Subsidence Evident	2005 - 2015 WAP Observations of Soil Subsidence
CYC-Site W02A	Yes - oxidation, sandy soils throughout wetland	No new notes.
CYC-Site W03	No subsidence noted	No subsidence noted
CYC-Site W04	No subsidence noted	2015 - Yes: minor subsidence at bases of oaks
CYC-Site W05	No subsidence noted	No subsidence noted
CYC-Site W09	No subsidence noted	No subsidence noted
CYC-Site W10	No subsidence noted	2010 - some subsidence in the upper portions of wetlands; 2011 - soils sandy in upper portion
CYC-Site W11	No subsidence noted	No subsidence noted
CYC-Site W12	No subsidence noted	2015 - some subsidence evident
CYC-Site W16	Yes - soils sandy and small sinkholes	No new notes.
CYC-Site W17	Yes - 12 - 24 inches	No new notes.
CYC-Site W19	Yes - 2 - 8 inches	2013 - subsidence evident throughout the wetland, some severe.
CYC-Site W20	No subsidence noted	No subsidence noted
CYC-Site W23	Yes - 2 - 6 inches	No new notes.
CYC-Site W27	Yes	2015 - minor subsidence evident
CYC-Site W29	Yes - soil is sandy and somewhat oxidized	2012 - soils dry and crusty with dry algae mats
CYC-Site W31	No subsidence noted	2012, 2013 - some oxidation in upper parts of the transect and sandy patches in the upper portion of the transect
CYC-Site W32	No subsidence noted	2015 - fire induced oxidation
CYC-Site W33	Yes - minimal	2007 - soil very dry and shrunken around tree bases
CYC-Site W36	No subsidence noted	No subsidence noted
CYC-Site W37	No subsidence noted	No subsidence noted
CYC-Site W39	No subsidence noted	No subsidence noted
CYC-Site W40	Yes - 8 inches	No new notes.
CYC-Site W41	Yes - 6 inches	No new notes.
CYC-Site W45	Yes	No new notes.
CYC-Site W46	Yes - soils sandy with little organics	No new notes.
CYC-Site W50	Yes - minor	No new notes.
CYC-Site W51	No subsidence noted	No subsidence noted
CYC-Site W52	No subsidence noted	2006 & 2013 - minor evidence of subsidence; 2014 - trees in upper zones have exposed roots
CYC-Site W55	Yes - well bottom above ground	2005 - obvious in the system; 2015 - evidence of at least 4 inches of subsidence in the wetland
CYC-Site W56	Yes - minor	No new notes.
CYC-Site W58	No subsidence noted	No subsidence noted

12.4.1 Site-Specific Results

There are 78 monitored wetlands on the final recovery assessment list associated with the Cypress Creek Wellfield. The final recovery assessment classification for these wetlands is presented in Section 9.2.4 and the final assessment bin for each of these wetlands is included in Table 9.8. The final recovery assessment results for these wetlands are summarized as:

- Never Impacted – 3 wetlands
- Recovered – 45 wetlands
- Improved – 21 wetlands
- Not Fully Recovered with Continuing Wellfield Impacts – 5 wetlands
- High Degree of Certainty of Wetland Heath – 4 wetlands

The wetlands assigned to the recovery classification bin of Never Impacted are on the Connor Preserve, distant from the Cypress Creek Wellfield. The four wetlands assigned to the recovery bin of High Degree of Certainty of Wetland Health are sites where monitoring ceased and insufficient data exists following the reduction in wellfield pumping to assign the wetlands to one of the quantitative assessment bins. These wetlands were assessed with the unmonitored sites as presented in Chapter 10. Of the 20 connected wetlands that are actively monitored, 18 are classified as Recovered and two are classified as Improved. Of the 43 isolated wetlands that are actively monitored, three were Never Impacted, 22 are classified as Recovered, 13 are classified as Improved, and five were assessed as Not Fully Recovered, Continuing Wellfield Impact.

Approximately 67% of the monitored wetlands associated with the Cypress Creek Wellfield were assigned a final recovery classification of Never Impacted, Recovered, or as having a High Degree of Certainty of Wetland Health. The Recovered wetlands include both connected and isolated systems and their distribution across the wellfield and surrounding area can be seen in Figure 9.23. There are 21 wetlands that were assigned a final recovery bin of Improved (27% of the total) including 19 isolated sites and two connected systems. Six of these wetlands do not have monitoring data that extends to the present time and their assessment of Improved condition is based on the limited period-of-record data. The Improved wetlands missed meeting their recovery metrics by 0.42 foot on a median basis and by an average of 1.1 feet (range of 0.06 to 5.29 feet). Six of the Improved wetlands missed meeting their recovery metric by more than 1 foot; however, four of the six have documented historic soil subsidence as listed in Table 12.1. The remaining two Improved sites that missed their recovery metric by more than 1 foot were not assessed for soil subsidence.

Two of the Improved wetlands, CYC W-12 and CYC W-56 have adopted Minimum Levels. Wetland CYC W-12 is located in the approximate center of the wellfield to the east of the Cypress Creek Floodplain and this site missed its recovery metric by 0.08 foot for the final assessment period of Water Years 2008 – 2019. Wetland CYC W-56 (District site name CC-G) is a 0.7-acre isolated wetland located in the southern part of the wellfield and this site missed its recovery metric by 0.26 foot for the same period. Wetland CYC W-56 is located south of the area of drawdown in the surficial aquifer related to pumping from the Cypress Creek Wellfield. Based on actual pumping data from 2012 through 2018 shown in Figure 11.2, the predicted median water table drawdown in this area based on recent wellfield pumping data is less than 2 feet.

Five wetlands at the Cypress Creek Wellfield are classified as Not Fully Recovered, Continuing Wellfield Impact in this final assessment report. These wetlands are mainly located in the central wellfield area with highest historical drawdown and impact and are described below.

Wetland CYC-W16 (Ted's Marsh) has a long history of hydrologic impacts beginning in the 1980s and has been the subject of multiple investigation studies. This wetland was included in the Cypress Creek Surface Water Management project and receives water during times of the year when surface water flows through the constructed swales of this restoration project (Section 3.13.2.3). Although the wetland hydroperiod has been short, water has been documented in this wetland during Water Years 2015 through 2019 following the completion of the first two phases of this project. This wetland continues to provide surface water storage capacity in an area that is near the Dye's Crossing floodplain and the Quail Hollow neighborhood.

Wetland CYC W-32 is an isolated marsh located in the central portion of the wellfield, adjacent to the main wellfield road and production well CC-06. It has been monitored since 1978. This wetland was initially binned as Improved with a median water level offset from normal pool of 3.6 feet during Water Years 2008 - 2019. However, a site review by District Regulatory staff reported that adverse ecological impacts at the wetland are present and the classification of the wetland was changed to Not Fully Recovered, Continuing Wellfield Impact.

Wetland CYC W-45 is an isolated cypress wetland located in the central portion of the wellfield, located between production wells CC-05 and CC-06 and adjacent to wetland CYC W-32. It has been monitored since 1981 and is a target site for surface water flow in the Cypress Creek Surface Water Management project described above and in Section 3.13.2.3. This wetland was initially binned as Improved with a median water level offset from normal pool of 3.7 feet during Water Years 2008 - 2019. However, a site review by District Regulatory staff reported that adverse ecological impacts at the wetland are present and the classification of the wetland was changed to Not Fully Recovered, Continuing Wellfield Impact.

Wetland CYC W-55 (Sims Property) is an isolated wetland bisected by the south-east wellfield property line; half of the wetland is on the wellfield property and the other half is on private property in the Quail Hollow neighborhood. The private property on which the wetland is half located also contains a private home served with a septic tank for sanitation purposes. The median water level offset from the site normal pool elevation was 9.0 feet for the final assessment period of WY 2008 – 2019 and this site is within the area of greatest median drawdown in the surficial and Upper Floridan aquifers related to 2012 – 2018 pumping from the Cypress Creek Wellfield as shown in Figures 11.2 and 11.4. Based on a review of wetland condition with District staff, the final assessment classification of this wetland is Not Fully Recovered, Continuing Wellfield Impact.

Wetland CCWF F is a District-monitored shallow marsh located just north of the Dye's Crossing wellfield road, between production wells CC-03 and CC-11. This wetland is also adjacent to the portion of the Dye's Crossing floodplain that is upstream of the wellfield road. The median water level offset from the site normal pool elevation was 7.2 feet for the final assessment period of WY 2008 – 2019 and this site is near the area of greatest median drawdown in the surficial and Upper Floridan aquifers related to 2012 – 2018 pumping from the Cypress Creek Wellfield as shown in Figures 11.2 and 11.4. It is unknown what portion of the low wetland water levels in recent years may be attributed to the surface water that was pumped out of the northern side of the Dye's Crossing floodplain in 2015 and 2017 to alleviate flooding in the Saddlewood Estates neighborhood as described in Section 3.13.2.3.

Only Stanford Lake is located close to the Cypress Creek Wellfield and Lakes Green and Pierce are located northwest of the wellfield (Figure 8.6). All three of these monitored lakes have been classified as Recovered as described in Chapter 8. There are no lakes within the wellfield boundary.

Monitoring has ceased at four wetlands associated with the wellfield, Wetlands CYC-C15, C16, C22A, C23**,** and insufficient data exists following the reduction in wellfield pumping to assign the wetlands to one of the quantitative assessment bins. These four wetlands were assessed with the unmonitored sites as presented in Chapter 10 and their location and predicted status are shown in Figures 10.12 and 14.2. All four wetlands were assigned to the qualitative assessment bin of High Degree of Certainty of Wetland Health.

The Area of Investigation for the Cypress Creek Wellfield is described in Section 5.3 and the unmonitored wetlands within this defined area were qualitatively assessed as described in Chapter 10. The qualitative recovery assessment of these unmonitored sites is shown in Figure 10.17 and the final assessment results for all monitored and unmonitored sites on and near the wellfield is presented in Figure 14.2. With the exception of one wetland, all unmonitored wetlands on the wellfield are considered to have a Low Degree of Certainty of Wetland Health. Wetlands to the southeast of the wellfield and close to the property boundary are predicted to have a Low Degree of Certainty of Wetland Health, except for some unmonitored sites near the boundary of the Area of Investigation. The unmonitored site located north and east of the wellfield were generally classified as having a High Degree of Certainty of Wetland Health. The results of the unmonitored wetland assessment are generally consistent with the results of the monitored wetlands and lakes assessments.

12.4.2 Discussion of Recovery

The Wise Consulting Group (2016b) compared water levels in surficial and Upper Floridan aquifer monitor wells during two, 12-year periods before and after the reduction in pumping at the Cypress Creek Wellfield (Water Years 1987 to 1998 and Water Years 2005 to 2016). During these two time periods, rainfall was approximately average at 52.5 inches and 52.3 inches, respectively. The water levels in both aquifers were contoured to estimate the improvement due to the reduction in wellfield pumping (Figures 12.24 and 12.25). The greatest water level improvements were noted in the very north-central portion of the wellfield near productions well CC-2, CC-3, and CC-11 of approximately 4 to 4.5 feet in the surficial aquifer SAS and about 11 to 12 feet in the Upper Floridan Aquifer. In areas south of the wellfield, in the area of the Quail Hollow neighborhood, water level increases in the surficial aquifer were estimated between 0 and 2.5 feet, while increases in the Upper Floridan Aquifer were estimated between 5 and 8 feet after the reduction in wellfield pumping.

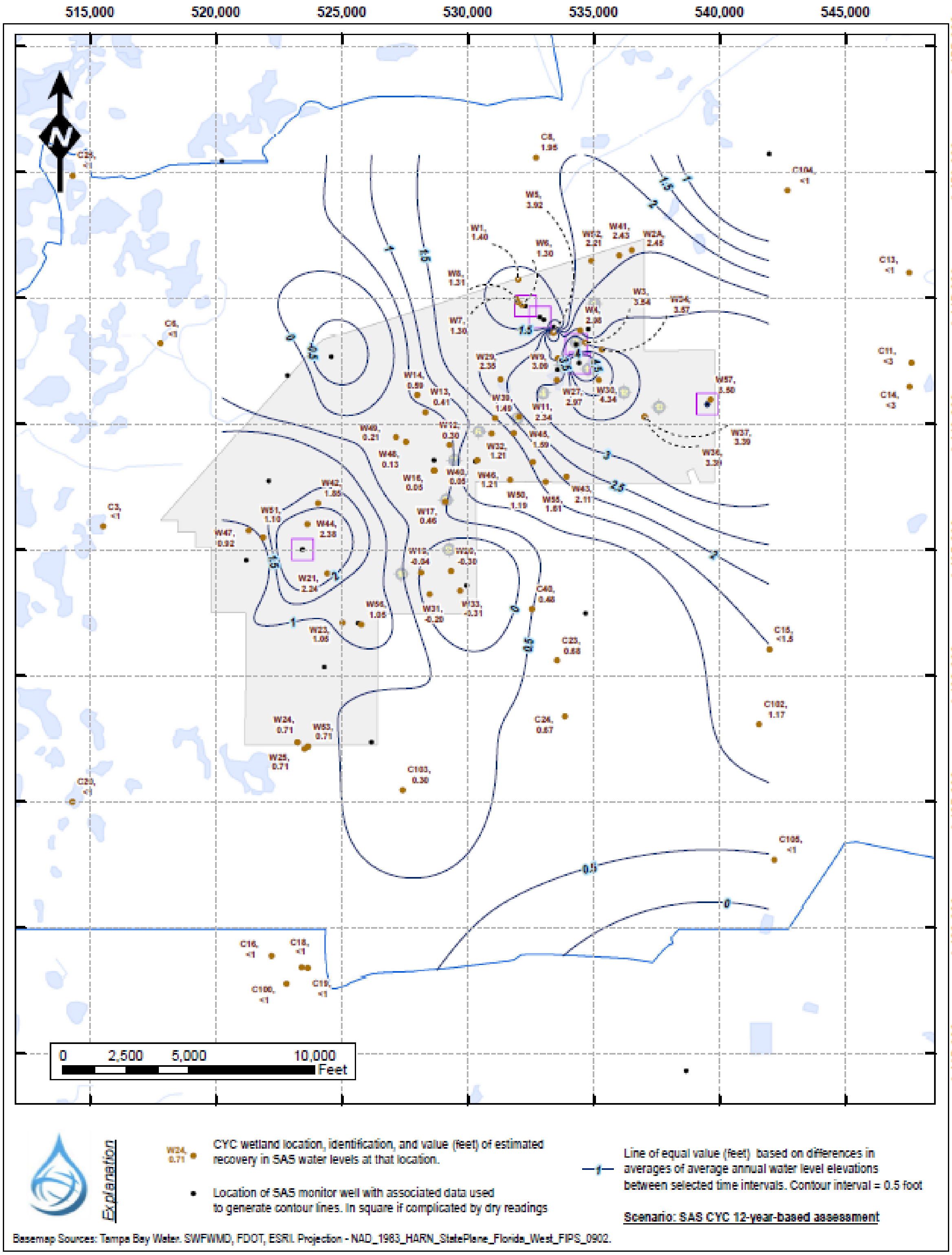


Figure 12.24: Mapped Values of Estimated Recovery in Surficial Aquifer Water Levels at the Cypress Creek Wellfield (from Wise, 2016b).

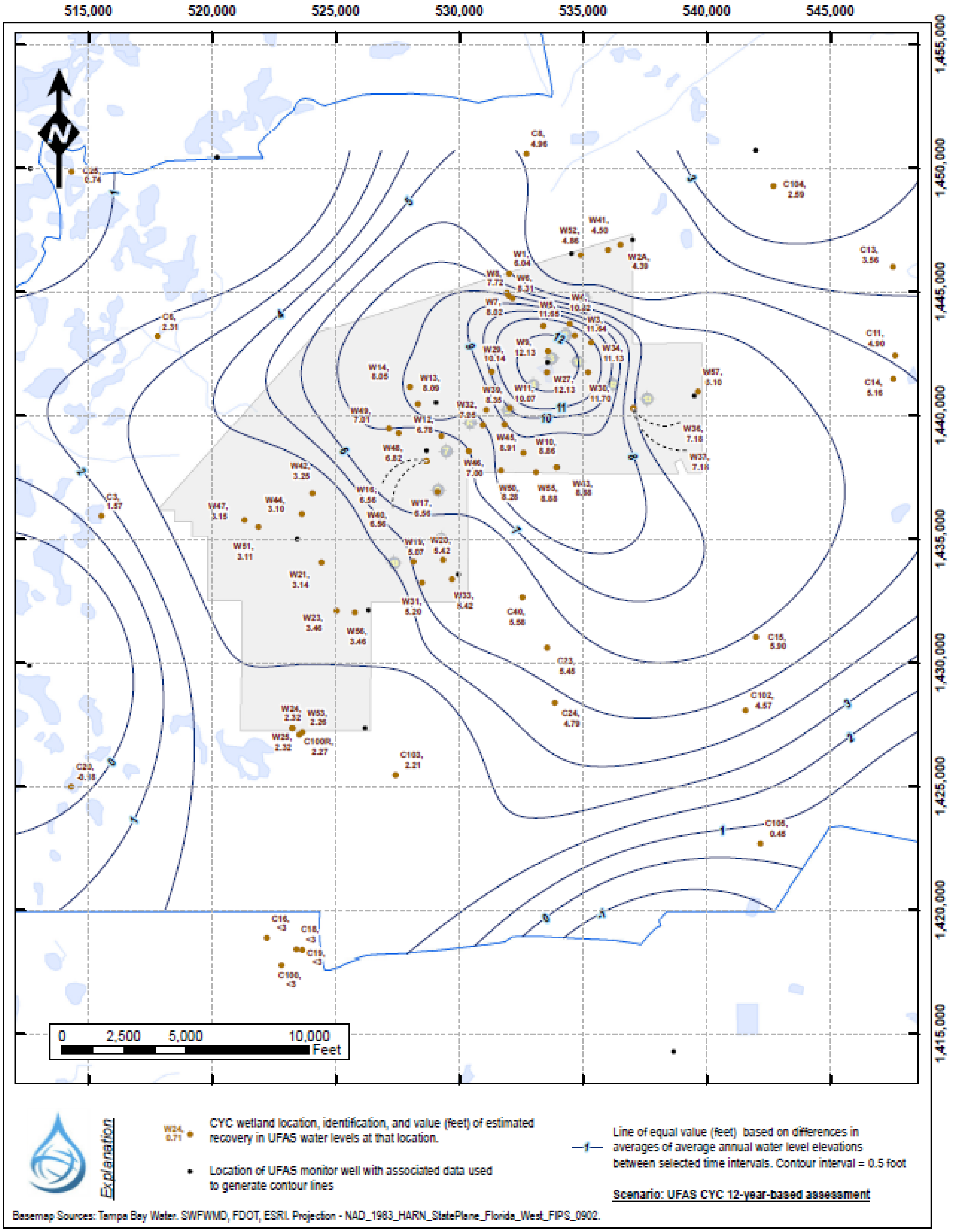
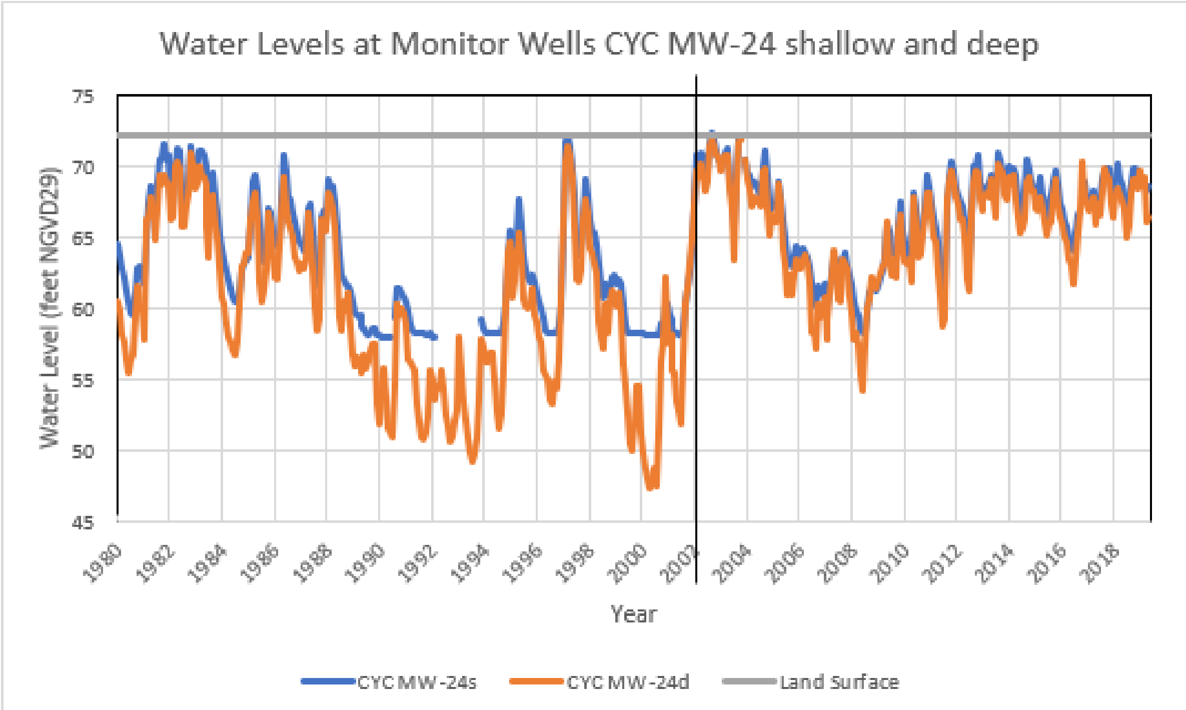


Figure 12.25: Mapped Estimated Recovery in Upper Floridan Aquifer Water Levels at the Cypress Creek Wellfield (from Wise, 2016b)

Chapter 11 discusses the hydrologic recovery that has been documented around the 11 Consolidated Permit Wellfields. Predicted water level improvement in the surficial and Upper Floridan aquifers are shown in Figures 11.2 and 11.4 for two time periods, before and after the reduction in groundwater pumping. In the areas east and southeast of the wellfield, the predicted median drawdown in the surficial aquifer from 2012 – 2018 is approximately 4 to 8 feet as compared to 8 to 12 feet in the 1996 – 2002 time frame when the wellfield was pumping at a much higher rate. The predicted drawdown in the Upper Floridan Aquifer during the recent timeframe is also much less than before wellfield pumping was reduced. Figure 11.7 shows the improvement in the potentiometric surface of the Upper Floridan Aquifer for the month of September following the reduction in wellfield pumping. This figure shows that the average potentiometric surface for all Septembers between 2003 and 2015 is within 0 to 5 feet below the bottom of many of the Cypress Creek and Dye's Crossing floodplain wetlands after the wellfield pumping reduction. Data for September 2015 is shown in Figure 5.10 where the potentiometric surface was in a state of discharge into many of these floodplain wetlands.

When the Cypress Creek Wellfield was constructed between 1974 and 1977, the wellfield was surrounded by rural agricultural land, floodplain forests, and very few residences in the vicinity. The District environmental assessment report for the Cypress Creek Wellfield and Flood Detention Project (1975) noted that the new housing developments to the south and east of the wellfield would benefit from a lower water table due to wellfield pumping. The benefits would be reduced flooding in the surrounding local wetlands and improved septic-tank operations. The Quail Hollow Subdivision was developed to the southeast of the wellfield from the mid-1970's through 1995 when pumping was at a sustained annual average rate of approximately 30 mgd. Construction of the two phases of Saddlewood Estates, located adjacent to the east side of the wellfield property boundary, occurred between 1990 and 2004, also the time of higher wellfield pumping. During this period of construction, wellfield drawdown in the surficial and Upper Floridan aquifers facilitated the construction of homes and individual septic tank systems in these two neighborhoods adjacent to the wellfield property.

The water level improvement in the surficial and Upper Floridan aquifers on the property boundary adjacent to Saddlewood Estates is shown in Figure 12.26. For most of the period between 1989 and late 2002, the water table and potentiometric surface were greater than 15 feet below land surface. During this period, there was a sustained head difference between the water table and the potentiometric surface resulting in downward leakage of the water table into the Upper Floridan Aquifer. Following the reduction in pumping at the Cypress Creek Wellfield, there is very little head difference between the two aquifers (generally between 0 and 2 feet) and the water levels at this site are about 2 to 3 feet below land surface each year during the summer rainy season.



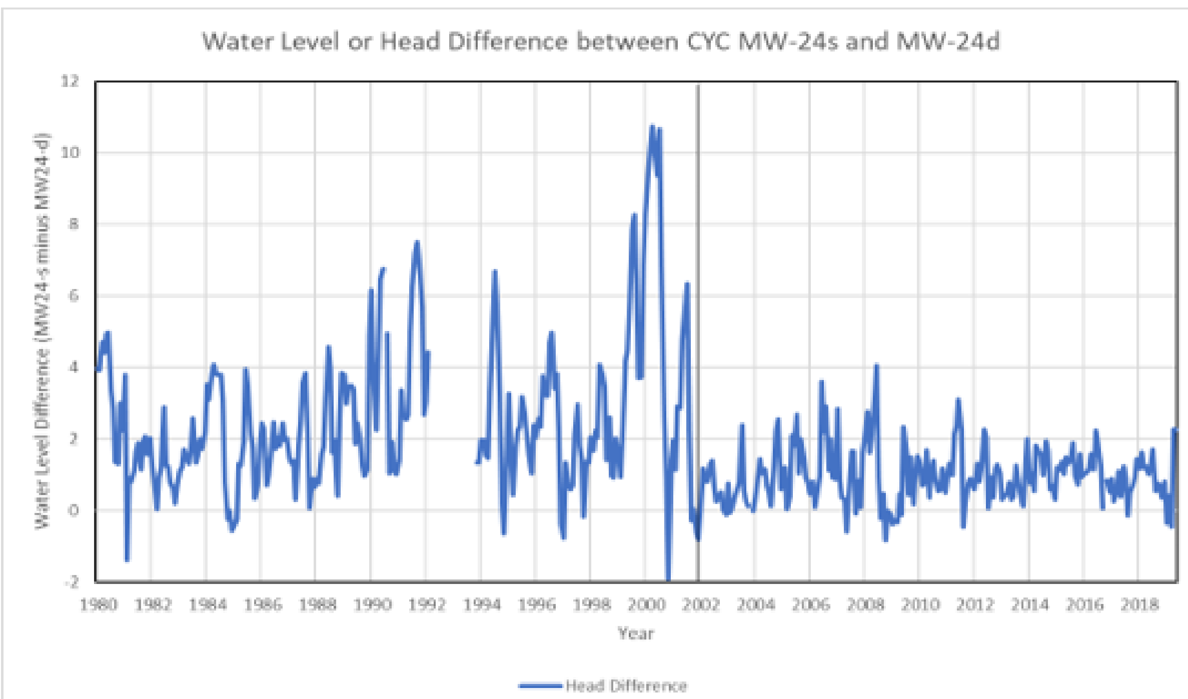


Figure 12.26: Period of Record Water Levels in Monitor Wells MW-24 deep and shallow at the Cypress Creek Wellfield

The Saddlewood Estates and Quail Hollow communities have experienced flooding conditions both before and after the reduction in wellfield pumping as shown in Figure 12.27. The flooding within these two communities led to the creation of the Cypress Creek Surface Water Management System on the eastern side of the wellfield. This project is intended to alleviate some of the flooding now experienced in these communities on a frequent basis and restore impacted wetlands on the east and central part of the wellfield; it is described in detail in Section 3.13.2.3. A summary map of the ditches, berms, culverts, and targeted wetland monitoring stations is shown in Figure 12.28. This project has been successful in reducing the magnitude and duration of flooding in these two communities as well as restoring stressed wetlands on the wellfield (Pritchett Steinbeck Group, 2019). Although this project has provided relief in the Saddlewood Estates community, they have requested emergency pumping over the Dye's Crossing Road in four of the last five years due to high water levels in the community. The District has directed Tampa Bay Water to pump additional water over the Dye's Crossing structure in two of those four years. In 2015 and 2017, the combined emergency pumping moved approximately 287 million gallons out of the Dye's Crossing floodplain north of the wellfield access road. It is reasonable to conclude that the water pumped out of the floodplain wetlands during those two years would have sustained the upstream wetlands for longer periods of time in the subsequent dry seasons.

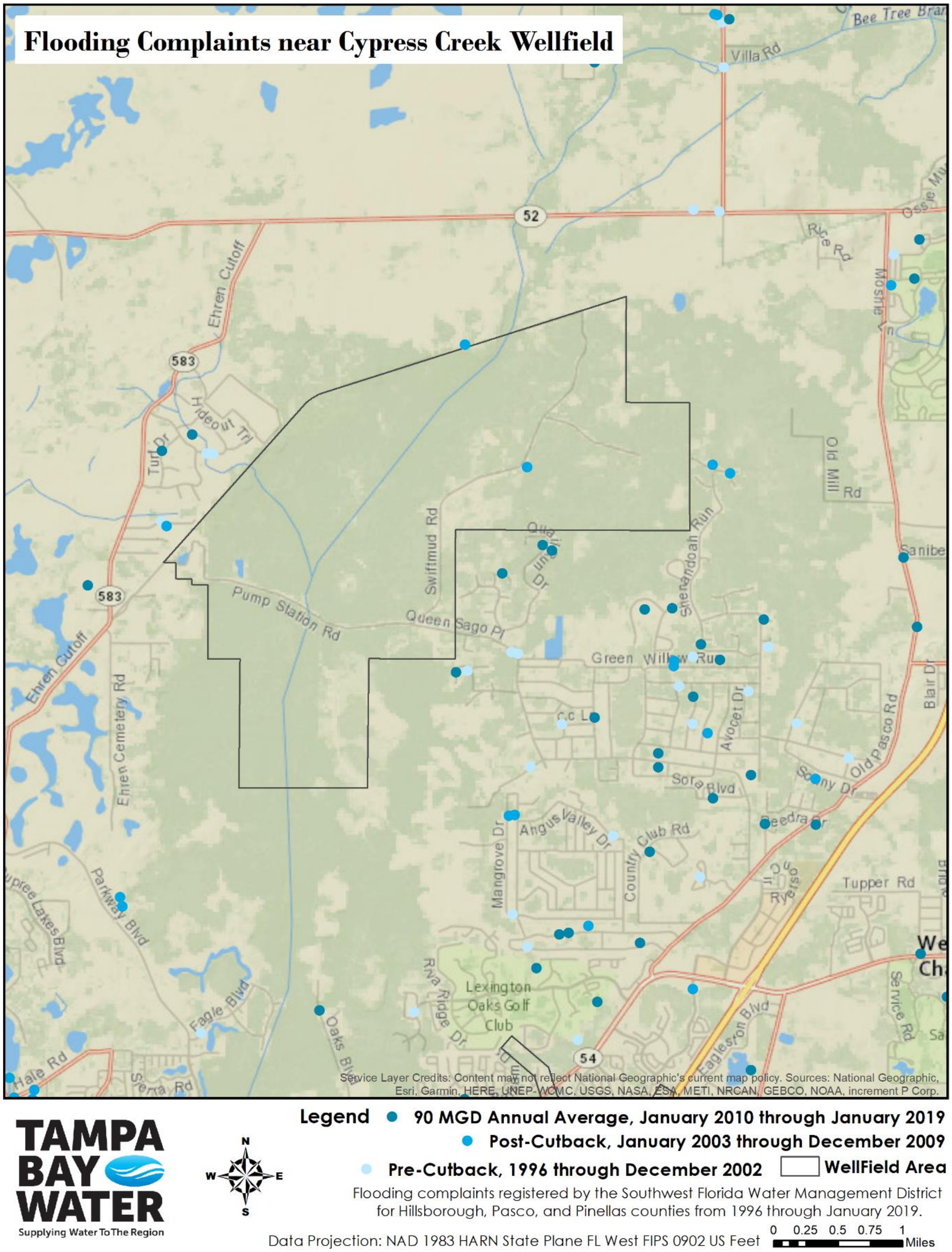


Figure 12.27: Flooding Complaints Near the Cypress Creek Wellfield since WY 1996

Figure 12.28: Cypress Creek Wellfield Surface Water Management Project Surface Water Improvements (from PSG 2019)

The final recovery assessment results for all sites associated with the Cypress Creek Wellfield are shown on Figure 14.2. These results indicate that approximately 67% of the monitored wetlands on and surrounding the wellfield have recovered with the reduced rate of wellfield pumping that has averaged 15.2 mgd since Water Year 2003. Hydrologic improvement has been documented at the remaining wetlands, mostly located in the east-central portion of the wellfield, and the wetlands classified as Improved missed meeting their recovery metrics by 0.42 foot on a median basis and by an average of 1.1 feet. Six of these Improved wetlands missed meeting their recovery metric by more than 1 foot; however, four of the six have documented historic soil subsidence that occurred during the time of high wellfield pumping. Five of the monitored wetlands continue to show signs of hydrologic and ecological impact as previously described; however, only one will require mitigation as described in Chapter 15. These wetlands were assessed against the baseline protocol developed for this Recovery Assessment Plan and four of the five wetlands were determined to be in the same or better condition than before their baseline assessment date.

The residential neighborhoods that now exist on the east and south-east boundaries of the wellfield were developed when the annual average wellfield pumping rate was approximately 30 mgd and the drawdown in the surficial aquifer facilitated the construction of these homes and their septic tank systems. When these developments were permitted and constructed, a sustained reduction in wellfield pumping had not been considered and lower water table conditions were expected to continue in perpetuity. Higher water levels due to the sustained reduction of wellfield pumping to approximately 15 mgd have resulted in significant recovery in area wetlands; however, these two adjacent communities are experiencing sustained higher water table conditions and regular flooding concerns. The surface water management system constructed on the wellfield has alleviated some of the flooding concerns in the neighborhoods but flooding persists. Although some wetlands on the wellfield have not completely recovered, additional increases in water levels in the surficial and Upper Floridan aquifers will exacerbate flooding as well as poor septic tank performance and failures at the homes adjacent to the wellfield. The presence of these homes and septic tank systems limit the recovery that can be achieved at the Cypress Creek Wellfield.

12.5 Cypress Bridge Wellfield

The Cypress Bridge Wellfield is the last of the 11 Consolidated Permit wellfields to become fully operational. This wellfield is comprised of ten groundwater production wells located between the Cypress Creek and Morris Bridge Wellfields in a general north to south alignment shown in Figure 12.29. In the early-to-mid 1980’s, the only residential developments in this area were the Pebble Creek subdivision in northern Hillsborough County and the Williamsburg subdivision in southern Pasco County, both located on the east side of County Road 581. Both of these communities were served by their own permitted water supply wells. These two neighborhoods and the Tampa Downs Heights subdivision located adjacent to the Top of Tampa Executive Airport are the only visible developments in the 1988 – 1991 aerial photograph shown in Figure 3.34. The initial construction work for the Saddlewood Corporate Park located south of State Road 54 and west of Interstate I-75 is also visible in this early aerial photograph.

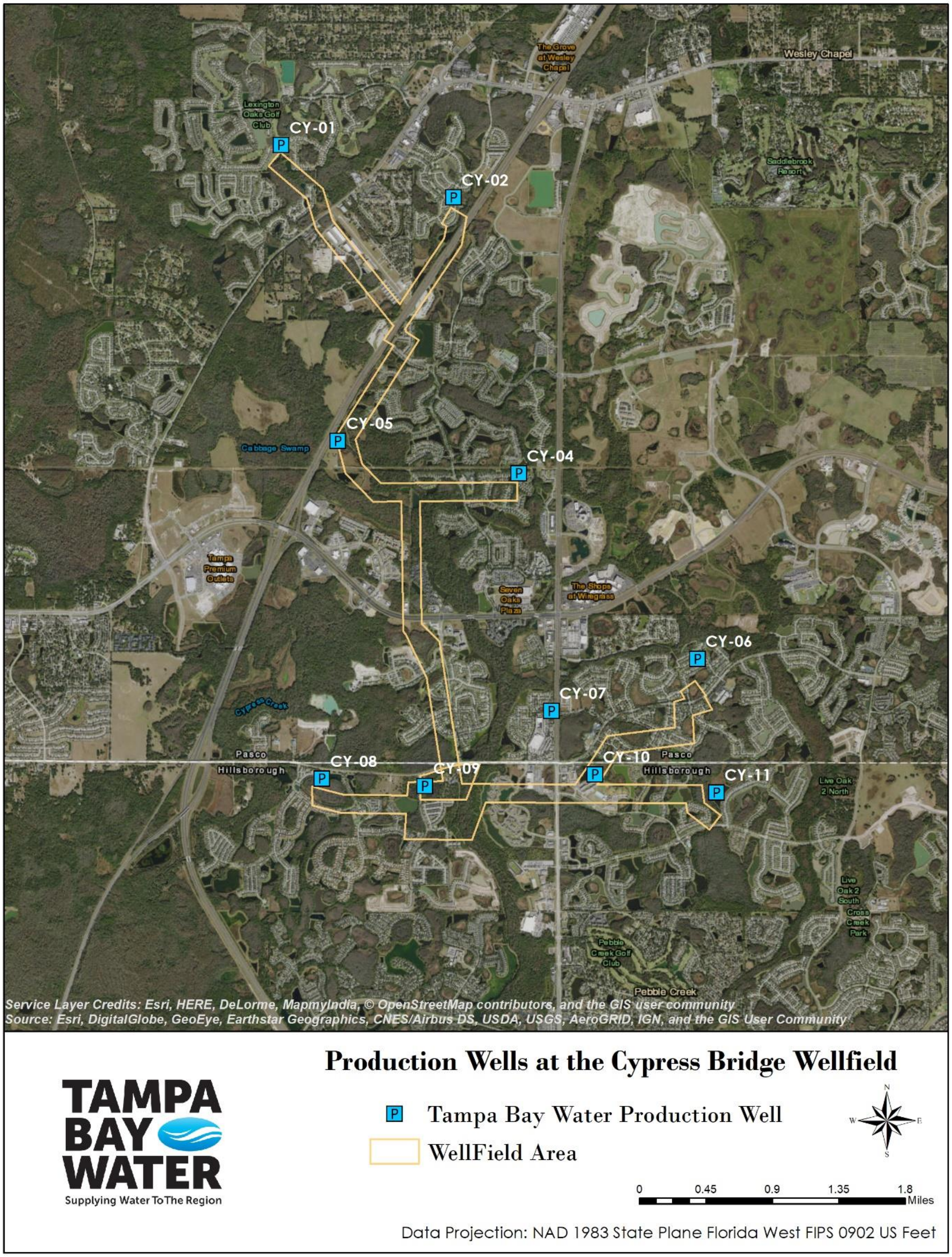


Figure 12.29: Map of Production Wells at the Cypress Bridge Wellfield

The first three production wells (CYB-2, CYB-5, and CYB-7) were drilled and tested between 1986 and 1988. Production wells CYB-5 and CYB-7 began pumping at very low rates during Water Year 1988 to serve residential subdivisions in central Pasco County. The annual average pumping rate from these two production wells gradually increased between Water Years 1990 and 1995 with the combined annual average pumping rate from the two wells remaining below 2 mgd. A graph of annual average production by Water Year is shown in Figure 12.30. The remaining production wells at this wellfield were constructed in 1992 and the remaining production wells came online in Water Year 1996. The wellfield pumping rate gradually increased between Water Years 1996 and 2001 from approximately 6 to over 10 mgd. The average pumping rate from this wellfield has not decreased, except for Water Years 2003 – 2005 when alternative water supplies were first introduced into the Regional System. Additional information about the development history of the Cypress Bridge Wellfield is presented in Section 3.8 of this report.

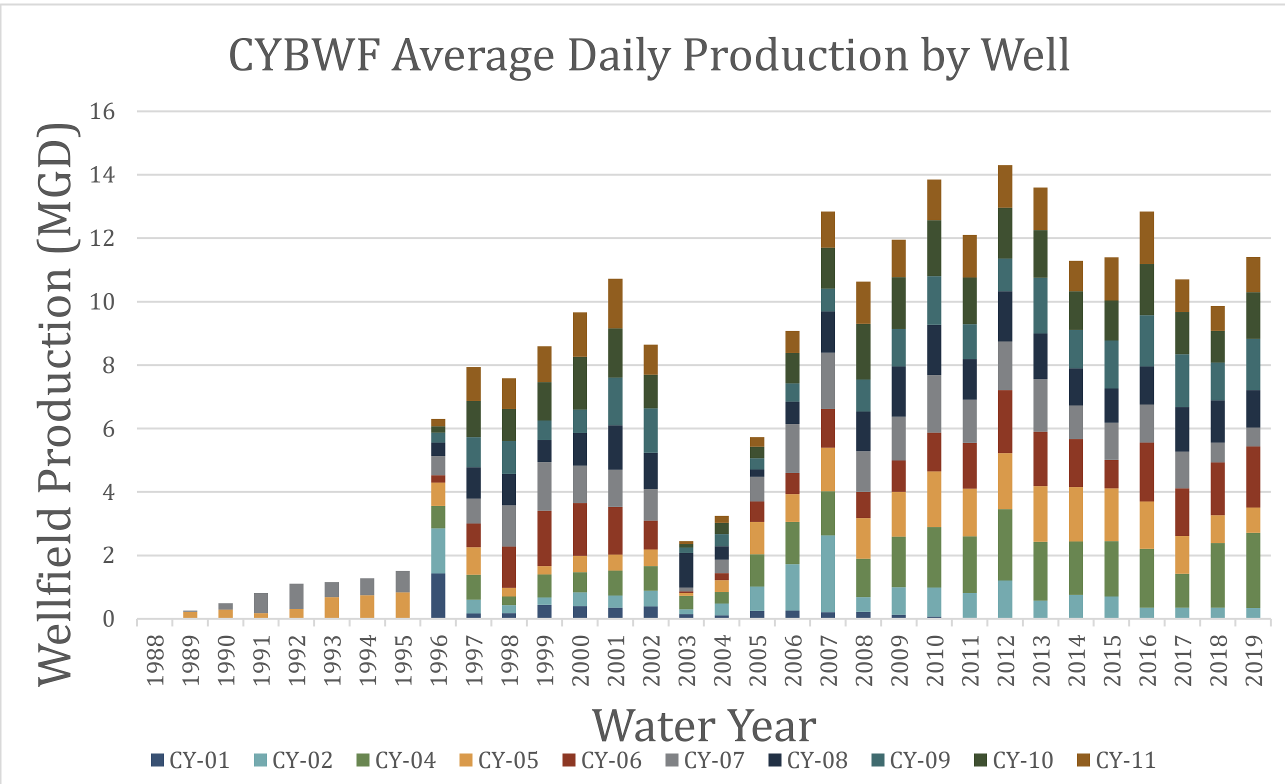


Figure 12.30: Period of Record Production at the Cypress Bridge Wellfield by Production Well

Rainfall has been monitored at the Cypress Bridge Wellfield since WY 1989 (Figure 12.31). Rainfall patterns typically follow regional trends of droughts and extended rainfall surpluses, with few exceptions. Notable annual peaks in rainfall above the 53.2-inch annual mean occurred in 1998 due to an El Niño rainfall event and during 2003 – 2004 due to active hurricane seasons. Drought conditions persisted in Water Years 2001 – 2002. Consistent with regional rainfall observations, rainfall deficits appear in the Cypress Bridge Wellfield rainfall record during Water Years 2005 – 2009. Since Water Year 2010, annual rainfall at the wellfield has been approximately average with four years at or slightly above 60 inches of rainfall and only Water Year 2018 below the historical mean rainfall total.

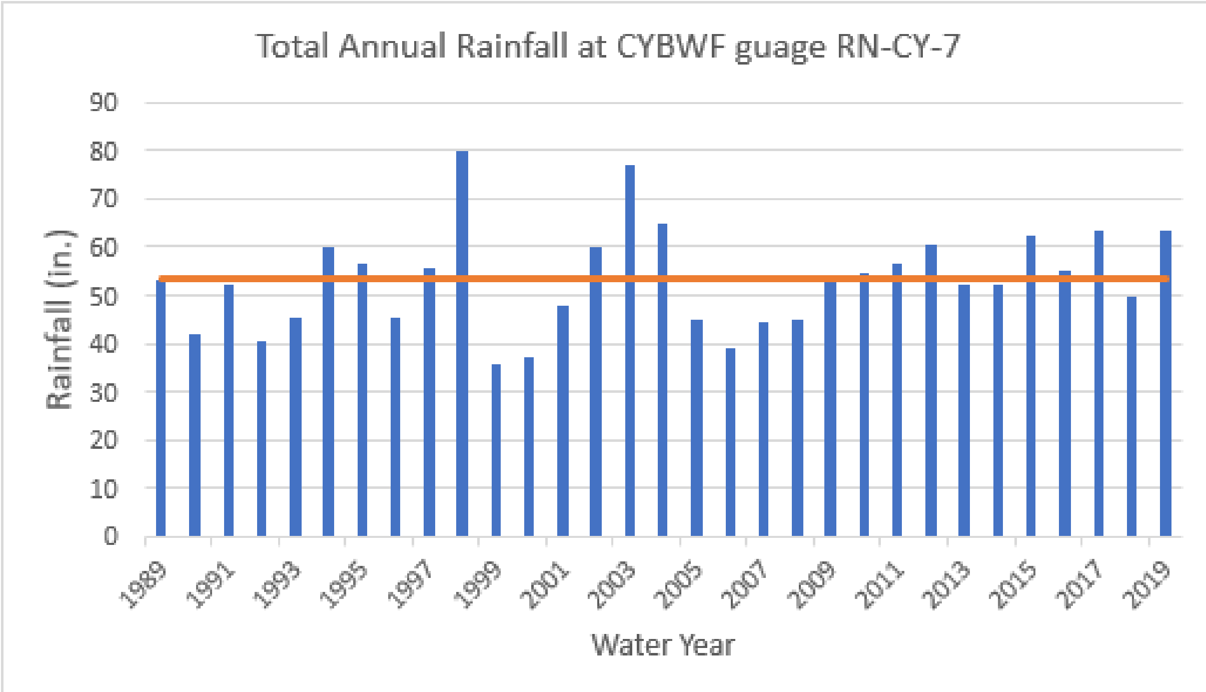


Figure 12.31: Total Annual Rainfall Measured at Gauge RN-CY-7 at the Cypress Bridge Wellfield. The period of record average is 53.2" (orange line)

At the time when the final wellfield production wells were constructed in 1992, the wellfield area was largely in a rural setting with much of the land used for cattle ranch operations or in a natural state. The land use quickly changed to an urban setting with multiple planned communities and permitted stormwater management systems. At the time of this report, most of the formerly open land has been developed with the exception of some of the land in Pasco County to the east of County Road 581, between the County line and State Road 54; however, developments have been permitted in this area and phases of those developments are currently under construction (Figure 3.35).

The residential and commercial development in and around the Cypress Bridge Wellfield has been significant and dramatic, leading to the rerouting of surface water flow, runoff augmentation of drainage basins, and impacts on wetland and lake water budgets. Land use comparisons between 1990, just prior to full wellfield development, and 2017 show an almost complete shift from agricultural, forested, and natural lands to primarily medium- to high-density residential and commercial areas within the bounds of the wellfield and in the surrounding areas (Figures 12.32 and 12.33).

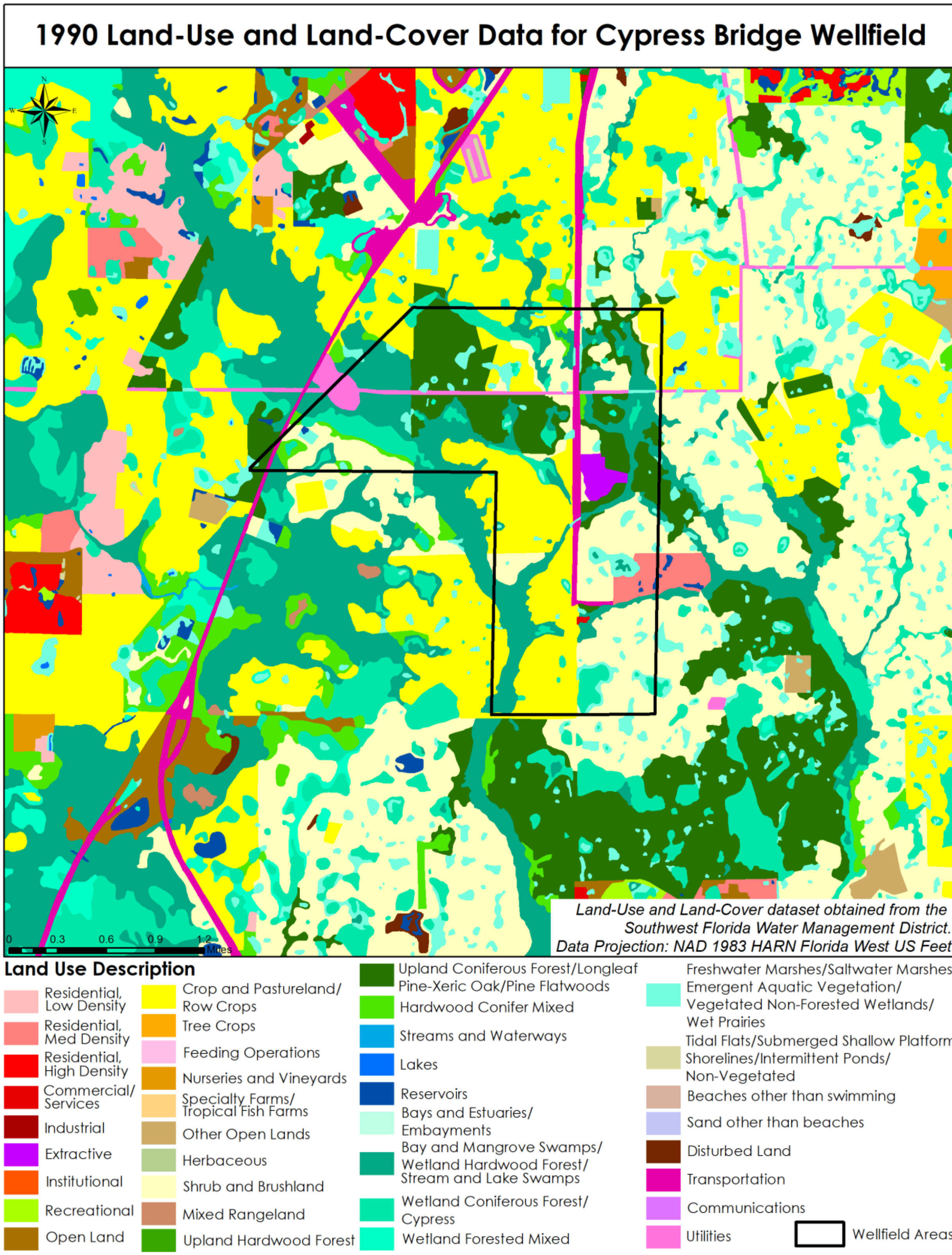


Figure 12.32: Land Use and Land Cover in the Cypress Bridge Wellfield Area in 1990

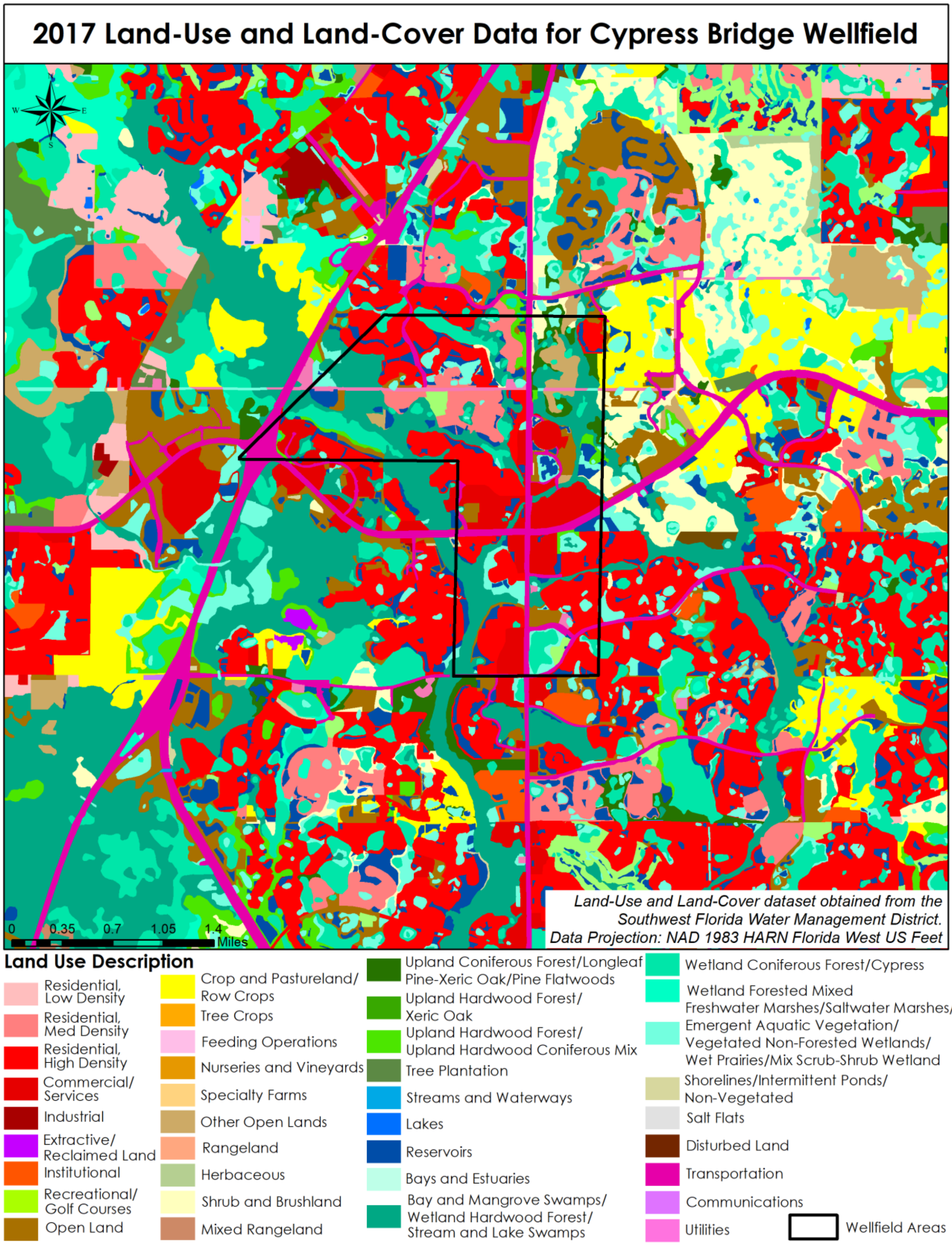


Figure 12.33: Land Use and Land Cover in the Cypress Bridge Wellfield Area in 2017

When the wetland monitoring plan for the wellfield was conceived and implemented in 1988, a variety of wetland types with varying degrees of previous impact unrelated to wellfield production were chosen as part of the wetland monitoring program. These wetlands were selected to document existing conditions and monitor for any future changes. Some wetlands such as CYB-1 and CYB-2 contained documented pre-existing sinkholes. These sinkholes have since stabilized without significant noted changes in recent years. Residential and commercial development around the Cypress Bridge Wellfield has dramatically changed the landscape of the area. Large areas that were once pastureland, forest, and other natural areas before the wellfield production began are now houses, shopping centers, roadways, and storm water ponds. Many of the monitored wetlands are now part of, or immediately adjacent to, large stormwater management systems designed to prevent flooding in developed communities. These types of changes are documented through wetland site descriptions in annual monitoring and assessment reports for the wellfield.

Examples of development-related impacts on wetland health are also documented in several special investigation studies at wetlands associated with the wellfield that exhibit signs of impact or stress. A special investigation of wetlands on the Cypress Bridge Wellfield by Dooris and Associates (2012) describe potential drainage pattern alterations, catchment basin size alterations, and adjacent stormwater pond construction that may or may not have affected nearby wetland hydrology. Further study of some of the wetlands of interest with anomalously low hydrology was performed by Atkins in 2015 to address some of the recommendations in the Dooris report. When aerial photographs were reviewed, Atkins noted ditches that were dredged in 1985 that diverted flow away from wetland CYB-11 and possibly from wetland CYB-6. Wetland CYB-6 was later noted to have an incorrect normal pool elevation that was resurveyed and subsequently used in this final assessment report. Other drainage alterations in the area of wetland CYB-17 were noted, including a significantly lowered outfall elevation that allows water to drain out of the wetland. Construction of major highways and residential developments has also affected outfall elevations and the size of the contributing runoff basin for some wetlands in the area (Atkins, 2015).

12.5.1 Site-Specific Results

The Cypress Bridge Wellfield is different from the other Consolidated Permit wellfields in that wellfield began pumping after the 1989 change to Water Use Permitting rules (Section 3.7) and the wellfield never experienced a sustained reduction in pumping rate. Because of these differences, the monitored wetlands and lakes at this wellfield were assessed differently from those at the other 10 Consolidated Permit wellfields. Instead of an assessment of environmental recovery, an assessment of monitored wetland health was performed with respect to the criteria found in the Water Use Permit rules. Tampa Bay Water and the District agreed that the recovery metrics for the different wetland types are applicable to the Cypress Bridge Wellfield wetlands since all metrics were established based on maintaining the ecological health of a wetland. If the long-term water level in a wetland is above the appropriate metric for that wetland, it is assumed that there is no significant harm occurring in the wetland for that period of time. The wetlands at the Cypress Bridge Wellfield have been assessed against the established wetland metrics on a pass/fail basis. The wetland either meets its metric of health or it does not; the Recovery Assessment Plan bin of Improved, Not Fully Recovered is not applicable to wetlands associated with this wellfield (see Section 6.2 for a discussion of the development of assessment classification bins).

There are 36 monitored wetlands on the final recovery assessment list associated with the Cypress Bridge Wellfield. The final recovery assessment classifications for these wetlands are presented in Section 9.2.5 and the final assessment bin for each of these wetlands is included in Table 9.8. The final recovery assessment results for these wetlands are summarized as:

- No Cutback, Meets Metric – 28 wetlands
- Impacted Due to Other Causes – 4 wetlands
- Not Fully Recovered with Continuing Wellfield Impacts – 2 wetlands
- High Degree of Certainty of Wetland Heath – 1 wetland
- Low Degree of Certainty of Wetland Health – 1 wetland

Four sites were classified as Impacted Due to Other Causes in the final assessment of wetlands at the Cypress Bridge Wellfield. Wetlands **CYB-01** and **CYB-02** have documented sinkholes that existed before wellfield pumping began. Details of these pre-existing sinkholes are documented in Dooris and Associates, 2012. During monitoring site selection in 1987 – 1988, at least nine sinkholes were noted as having opened in wetland CYB-01. Since then, some of the sinkholes have grown and others have not. Disturbance factors in wetland CYB-02 were also noted during 1987–1988 monitoring site selection. Canopy and vegetation stress were noted due to reduced hydroperiods and sinkholes at the site were also documented between May and August 1988. Dooris also documented drainage alterations at wetland **CYB-03** that are the result of adjacent residential development. This construction occurred during Water Years 1988 and 1989 and effectively reduced the hydroperiod of the wetland. Pumping from the northern production wells at the Cypress Bridge Wellfield did not begin until Water Year 1996 (Figure 12.30).

Wetland **CYB-11** is a connected wetland that is also classified as Impacted Due to Other Causes. A 1.3-acre stormwater pond is located adjacent to the west side of this wetland. Some questions about the stormwater pond liner are explored in Atkins, 2015 which raised issues as to the impact that the pond has on the hydrology of wetland CYB-11. Dredging of a ditch occurred in 1985 that substantially changes the historical drainage flows in the area, routing flow away from Wetland CYB-11 (Atkins, 2015). An electrical facility and access right-of-way are also located adjacent to this wetland.

Two wetlands, **CYB-A** and **CYB-15** are classified as Not Fully Recovered, Continuing Wellfield Impacts since they did not meet their water level metrics for the final time period of assessment. A new OROP control point has been approved for implementation by the District to address the wellfield-related drawdown at these two wetlands.

Monitoring has ceased at two additional wetlands, **CYB-12** and **CYB-24** and insufficient data exists following the reduction in wellfield pumping to assign the wetlands to one of the quantitative assessment bins. These two wetlands were assessed with the unmonitored sites as presented in Chapter 10; wetland CYB-12 was assigned to the qualitative assessment bin of Low Degree of Certainty of Wetland Health and wetland CYB-24 was assigned to the qualitative assessment bin of High Degree of Certainty of Wetland Heath.

There are no monitored lakes at or in the immediate vicinity of the Cypress Bridge Wellfield. The nearest monitored lakes are located directly east and are all Recovered.

There are separate Areas of Investigation at the Cypress Bridge Wellfield as described in Section 5.3 and the unmonitored wetlands within these defined areas were qualitatively assessed as described in Chapter 10. Two relatively large clusters of unmonitored wetlands are located in the north and south parts of the wellfield as shown in Figure 10.16. The northern cluster is centralized around production well CYB-2, along the I-75 corridor. This cluster is characterized as having a mixture of unmonitored wetlands that have a high and low degree of certainty of wetland health. This mix is consistent with the results of the monitored wetland final assessments which indicate mostly healthy wetlands and some stressed wetlands whose current condition is attributed to impacts not associated with wellfield production. The southern cluster of unmonitored wetlands appears to have a larger proportion of wetlands with a high degree of certainty of wetland health, with the exception of wetlands in the vicinity of production well CYB-10. The monitored wetlands near production well CYB-10 are binned as No Cutback, Meets Metric.

All of the wetlands in both the northern and southern clusters are surrounded by or adjacent to neighborhoods, major roads or the interstate, or in the direct vicinity of other commercial development in addition to be situated near groundwater production wells. Other unmonitored wetlands are situated within the wellfield boundary. Two unmonitored wetlands located between production wells CYB-04 and CYB-05 are binned as having a high degree of certainty of wetland health, while two other unmonitored wetlands in the direct vicinity are binned as having a low degree of certainty of wetland health. Another set of unmonitored wetlands to the southwest of the wellfield, near the intersection of I-75 and State Road 56, are predicted to have a high degree of certainty of wetland health. These mixed results are characteristic of the monitored wetlands in the area, with many anthropogenic factors impacting hydration and causing vegetative disturbance.

12.5.2 Discussion of Results

The combined final assessment results for all wetland types at the Cypress Bridge Wellfield are presented in Figure 14.3. A significant shift in land use occurred between the inception and development of the Cypress Bridge Wellfield and today. Residential and commercial development in and around the wellfield is significant, leading to the rerouting of surface water flow, runoff augmentation of drainage basins, and impacts on wetland and lake water budgets. The shift from agricultural and undeveloped lands in the late 1980s and early 1990s to medium- and high-density residential and commercial land use means that the hydrology of many wetlands throughout the wellfield has been altered by drainage improvements. Flooding complaints in the wellfield area have primarily been limited to older residential developments to the west of I-75 and SR-54 as well as the Wesley Chapel area east of I-75 (Figure 12.34). A few high-water complaints have been registered in areas south of the wellfield, though the complaints appear to be less geographically dense and/or less frequent. The lack of flooding complaints in the area of new residential developments likely means that the stormwater management systems in the center and southern edges of the wellfield are effectively moving excess water out of developed areas.

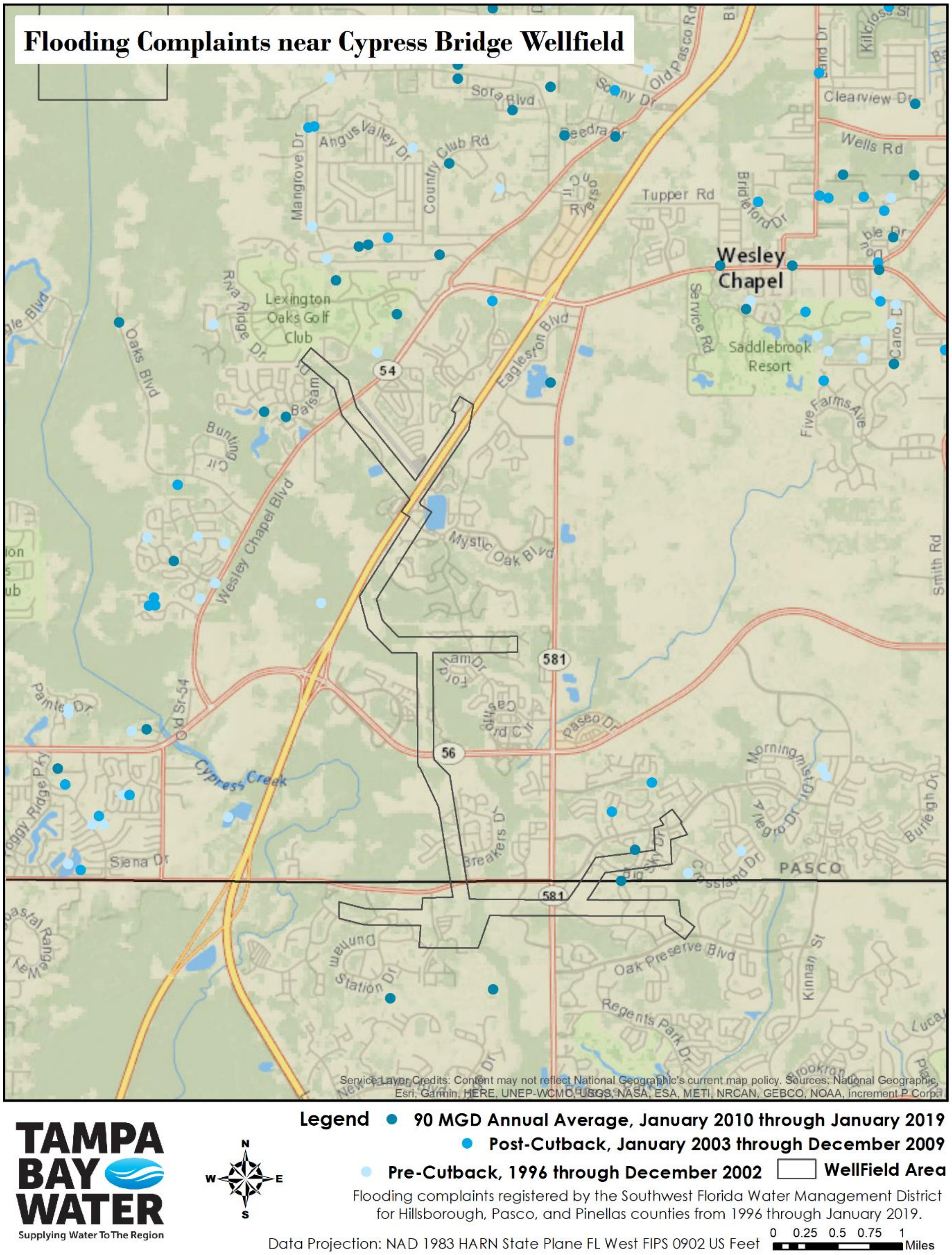


Figure 12.34: Flooding Complaints Registered with the District Between 1996 and 2019 in the Cypress Bridge Wellfield Area

Monitoring and documenting wetland hydrology and health in the Cypress Bridge Wellfield area will continue to be critical in the future. Investigation of potential wetland impacts in this now-urbanized landscape must consider all potential influences on wetland water levels including drawdown related to wellfield pumping, alteration of surface water flows, increases in impervious surface area, and the change in size of wetland catchment basins. All of these factors influence wetland hydrology and health and all are present in the Cypress Bridge Wellfield area. The combination of monitoring, assessment, and response under the Environmental Management Plan (EMP) and balanced groundwater production will help maintain wetland hydrology to the greatest extent possible given the existing and future land use changes. In areas where extensive development-related alterations to the landscape and wetland systems have occurred, unimpacted wetland hydrology cannot be expected. In some of these areas, Tampa Bay Water may have limited ability to influence future wetland water levels through operational changes in the distribution of wellfield pumping.

12.6 Morris Bridge Wellfield

The City of Tampa developed the Morris Bridge Wellfield within the Lower Hillsborough River Flood Detention Area to augment the City’s water supply during times of high demand and to meet future water needs. Twenty production wells were constructed on the 3,800 acre property in 1976. Much of this property was isolated wetland and stream systems and a loop access road was built through the property connecting each production wells (Figure 12.35). The wellfield was connected to the City’s water treatment and distribution system in Water Year 1978. Additional information about the development of the Cross Bar Ranch Wellfield is found in Section 3.6 of this report.

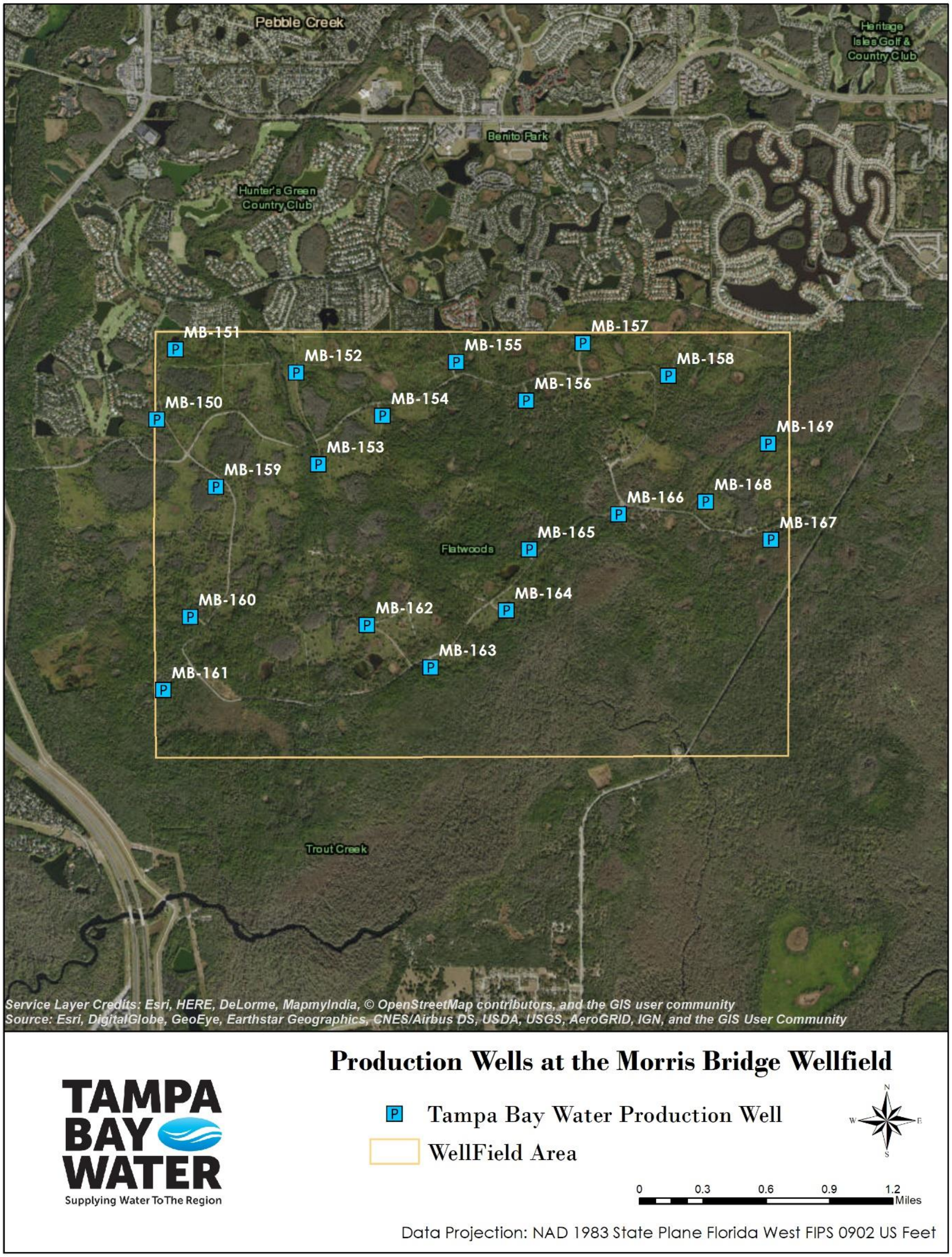


Figure 12.35: Map of Production Wells at the Morris Bridge Wellfield

Groundwater production at the Morris Bridge Wellfield began during Water Year 1978. Growing demand in the City's water system created the need to pump the wellfield at an average annual quantity of 13 to 18 mgd between 1979 and 1985 (Figure 12.36). The wellfield was pumped at reduced and variable rates through Water Year 1996 and pumping increased to meet demand during Water Years 1997 through 2002. The wellfield was acquired by Tampa Bay Water in 1998 and connected to the Regional System in 2002. Pumping reductions began in Water Year 2003 when alternative supply sources were available for the region. The annual average wellfield production rate during the recent period of Water Years 2008 through 2019 was 7.4 mgd. Production during this recent period was about half of the peak production rate of 15.6 mgd during Water Years 1979 through 1985.

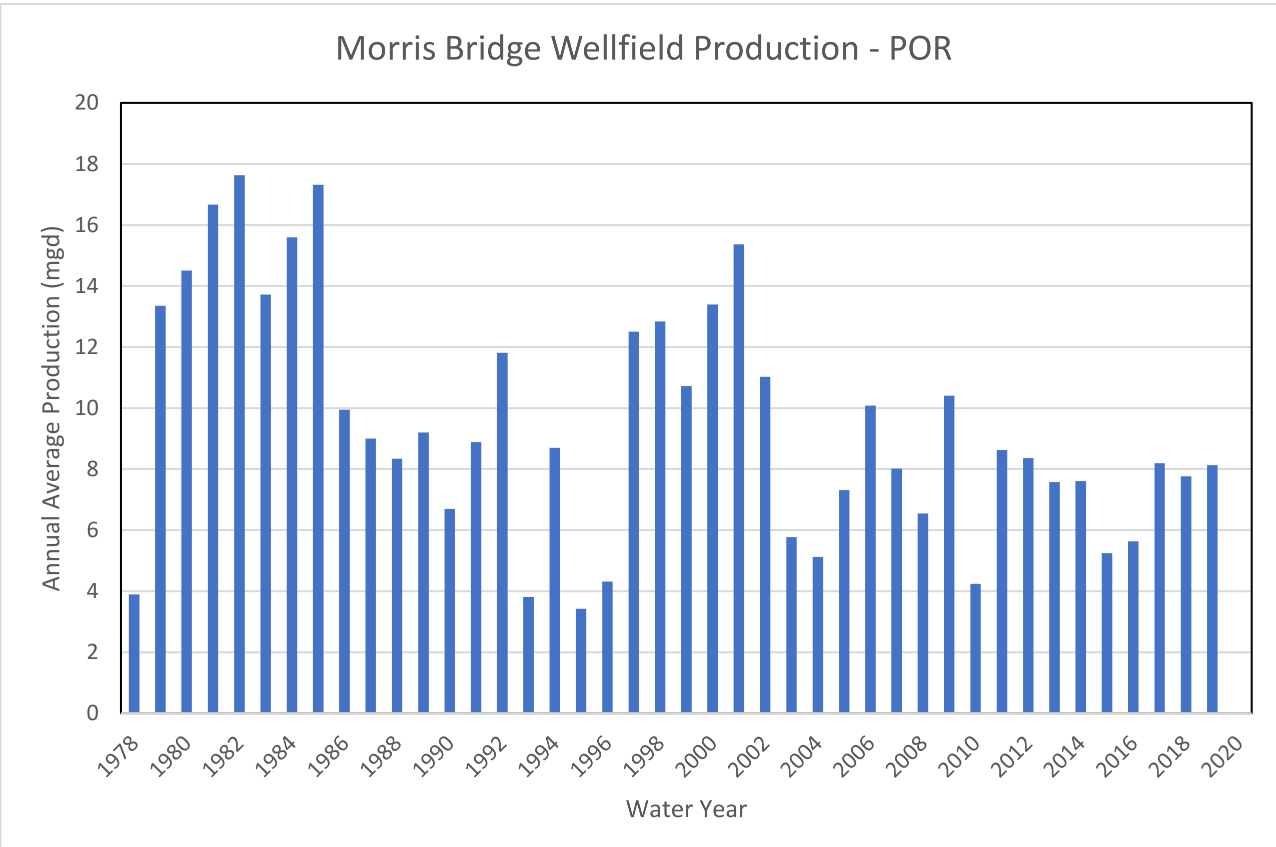


Figure 12.36: Period of Record Production at the Morris Bridge Wellfield

Rainfall at the Morris Bridge Wellfield from 1989 to 2019 is shown on Figure 3.48 along with other regional wellfields (data source: Ormiston, 2020). The rainfall at this wellfield generally follows regional trends with a period of very low rainfall in 1999 through 2002 followed by very high rainfall in 2003 and 2004 due to tropical storm activity. Annual rainfall recorded during the next nine years (2005 to 2012) was lower than the regional average. The annual total rainfall for 2013 through 2019 has been at or above 54.5 inches.

The wellfield property and the surrounding area were essentially undeveloped as shown in an aerial photograph from 1967 – 1969 (Figure 3.25) although an interconnected system of ditches was apparent to the northeast of the wellfield boundary. The wellfield property has generally remained in the same physical condition as when first developed by the City of Tampa. The wetlands on the wellfield are a mixture of isolated and flow-through systems with headwaters north of the wellfield. The headwaters connect to the wetlands on the wellfield through now-developed lands located just north of the wellfield. The Hunter's Green, Arbor Greene, and Cory Lake Isles developments were constructed in the 1990's and 2000's on the north and west borders of the wellfield. All three developments have permitted stormwater management systems and are located within the headwaters of the Clay Gully and Wild Hog Slough systems. Extensive urbanization to the north and west of the wellfield are clearly visible in the aerial photograph from 2018 – 2019 (Figure 3.27) and in land use and land cover maps from the 1970's (Figure 12.37) and 2017 (Figure 12.38).

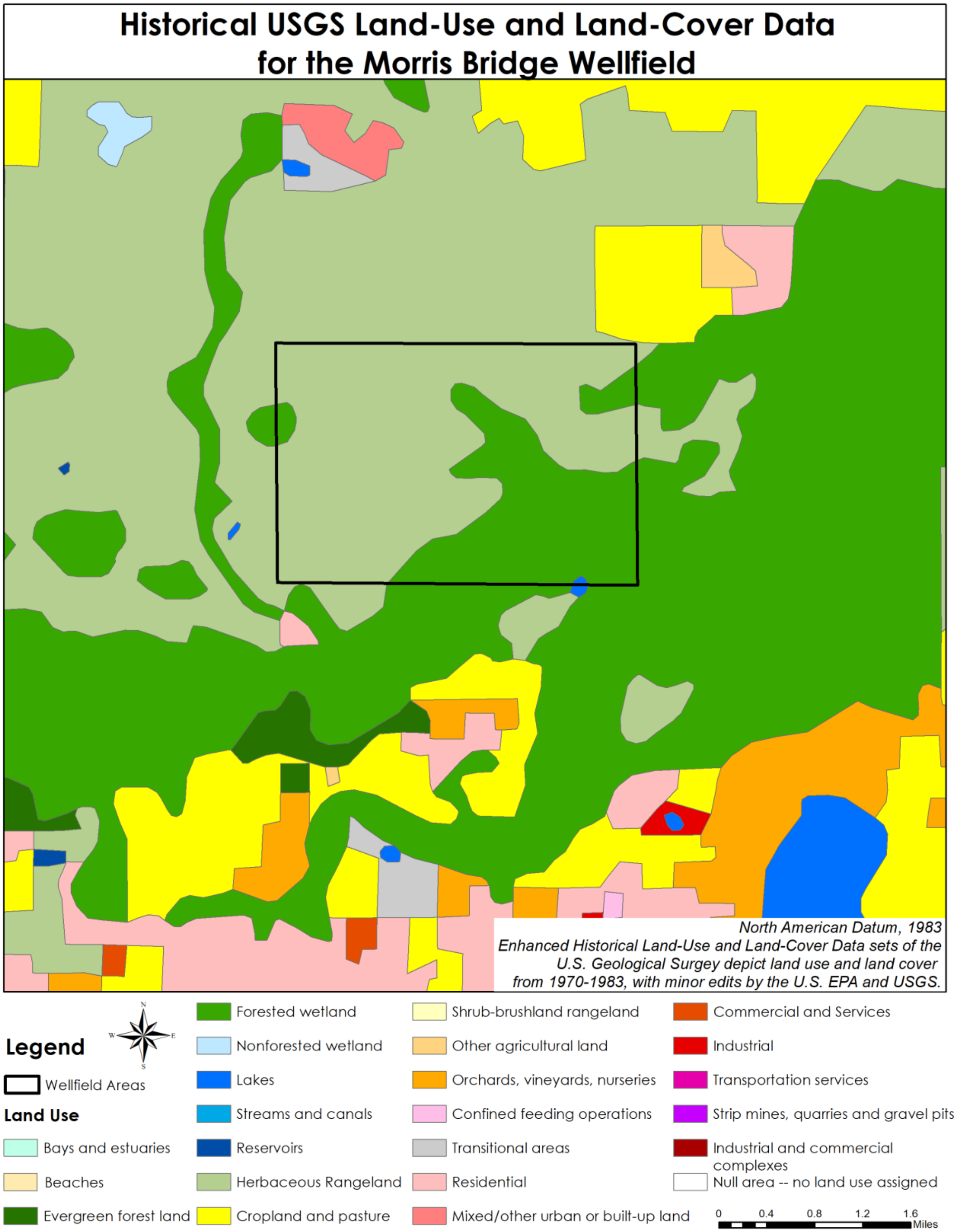


Figure 12.37: Historical USGS Land-Use and Land-Cover Data for the Morris Bridge Wellfield area from 1970 – 1983

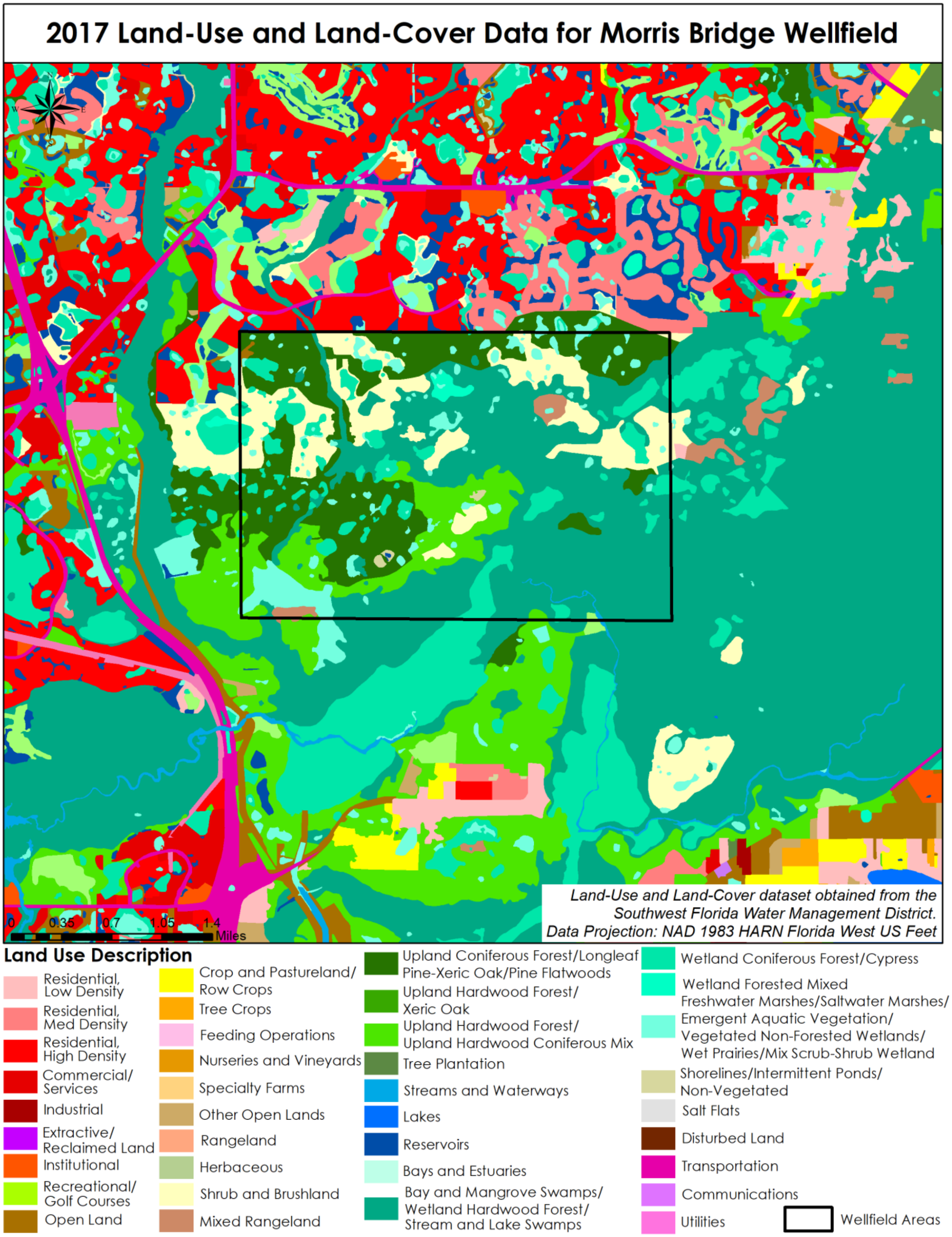


Figure 12.38: 2017 Land-Use and Land-Cover Data for the Morris Bridge Wellfield Area

The District raised concerns regarding potential unacceptable adverse impacts to the wetlands and uplands upstream of the loop access road structures in 1998. Tampa Bay Water removed the sluice gates at three of the drainage structures under the south loop road and made minor weir configuration alterations to the remaining three structures in 2005. These alterations were made to maintain new target water levels and hydroperiods and adequately accommodate storm water flooding problems (Reynolds, Smith & Hills, 2003). The modified structures also eliminated scouring of sediments near the structures by reducing the flow velocity in these channelized systems.

Environmental monitoring was conducted by the District on the Morris Bridge Wellfield beginning in the late 1970's. Analysis conducted for the City in 1986 assessed the current ecological condition of the wellfield and the predicted impacts of wellfield pumping on different wetland types. Some moderate impacts were predicted for some wetland types with 1.0 foot of drawdown in the water table with more significant impacts expected to marsh and isolated wetland communities with 1.5 to 2.0 feet of water table decline. The riverine systems flowing through the property were predicted to be relatively unaffected by pumping since the drainage basins feeding these riverine systems are located largely off the wellfield and pumping would not cause changes in these drainage basins. The ecological discussion of this report stated that some wetlands in the northern part of the wellfield had low water levels and may not be underlain by a clay confining layer making them more susceptible to the effects of pumping (Dyer, Riddle, Mills & Precourt, Inc., 1986).

A later analysis performed for the City identified impacts to marsh wetlands throughout the wellfield in an analysis of 1988 data and aerial photographs. These were vegetative impacts largely focused in the central and northern parts of the wellfield. Field inspection of cypress systems showed vegetation and tree impacts including impacts due to insect and fire damage in the early 1980's. The analysis identified a marsh between production wells MB-154 and MB-155 with depressions that were known to have occurred prior to 1989; this location corresponds to the currently-monitored wetland MBR-10 (Dyer, Riddle, Mills & Precourt, Inc., 1990). Tampa Bay Water assumed environmental monitoring of the wellfield in 1998 and annual assessment reports have since been prepared for the District.

12.6.1 Site-Specific Results

There are 41 monitored wetlands on the final recovery assessment list associated with the Morris Bridge Wellfield. The final recovery assessment classification for these wetlands are presented in Section 9.2.6 and the final assessment bin for each of these wetlands is included in Table 9.8. The final recovery assessment results for these wetlands are summarized as:

- Recovered – 25 wetlands
- Improved – 13 wetlands
- Not Fully Recovered with Continuing Wellfield Impacts – 1 wetland
- High Degree of Certainty of Wetland Heath – 2 wetlands

The two wetlands assigned to the recovery bin of High Degree of Certainty of Wetland Health are sites where monitoring ceased and insufficient data exists following the reduction in wellfield pumping to assign the wetlands to one of the quantitative assessment bins. These wetlands were assessed with the unmonitored sites as presented in Chapter 10 and were assigned to this qualitative bin. Of the 14 monitored connected wetlands, 11 are classified as Recovered and three are classified as Improved. The final assessment of the 27 monitored isolated or other type wetlands at the wellfield showed that 14 are classified as Recovered, 10 are classified as Improved, and one (MBR-10) was assessed as Not Fully Recovered, Continuing Wellfield Impact.

Approximately 66% of the monitored wetlands associated with the Morris Bridge Wellfield were assigned a final recovery classification of Recovered or as having a High Degree of Certainty of Wetland Health. The Recovered wetlands include both connected and isolated systems and their distribution across the wellfield and surrounding area can be seen in Figure 9.25. There are 13 wetlands that were assigned a final recovery bin of Improved including 10 isolated sites and three connected systems. The Improved isolated wetlands missed meeting their recovery metrics by 0.9 foot on a median basis with a range of 0.5 to 2 feet. Seven of the 10 Improved isolated wetlands were reviewed by District Regulatory staff and they concluded that there is no adverse impact at these sites (Appendix 9.25); the District field review included four of the five Improved isolated wetlands that missed the metrics by more than 1 foot.

The three Improved connected wetlands (MBR-102, MBR-105, and East Branch Clay Gully) missed meeting their recovery metrics by 0.5 foot on a median basis with a range of 0.2 to 0.9 foot. The period-of-record hydrographs for these three wetlands are included in Appendix 9.23. Each hydrograph also shows the 2003 – 2019 median water level as compared to the connected wetland water level metric for each site. The Wetland Health Assessment (WHA) score for wetland MBR-102 (aka WHA 409) improved from a one in 1998 to a three in 2004 and to a four in 2009 and 2016. The Vegetation Comments on the 2016 WHA field form indicate that wetland MBR-102 is a “healthy looking system with exception of fallen trees.” Wetland MBR-105 is located in the southwest corner of the wellfield and is part of the Clay Gully system. This wetland missed meeting its metric by 0.2 foot for the 2003 – 2019 period of assessment and the site hydrograph shows that the water levels staged up to the 90th percentile elevation two times between 2014 and 2019. Wetland East Branch Clay Gully is in the central portion of the wellfield and the site hydrograph indicates that the site water levels regularly exceed the 90th percentile elevation.

One of the Improved wetlands (MBR-88 also known as MBWF Clay Gully Cypress) has an adopted Minimum Level. This wetland is located in the northwest corner of the wellfield and this site missed its recovery metric by 1.55 feet for the final assessment period of Water Years 2008 – 2019. A report by ENTRIX (2010) documents observed changes in surface water flow due to the 1,400-acre Hunter’s Green development, located to the north of the wellfield. When effects on surface water flows were assessed, ENTRIX reported that development to the north of wetlands MBR-88 and MBR-97 reduces surface water flow to the wetlands by about 8.9% and 97%, respectively, for a 24 hour, 25-year storm event. The condition of this site was recently reviewed by District Regulatory staff who concluded that there is no adverse impact present at this wetland (Appendix 9.25). Their site review indicates the presence of distinct wetland vegetation zonation and that habitat appears to show no signs of adverse impact. They further stated in their field review notes that a review of aerial photography shows little change in this wetland since the 1980’s. The Hunger’s Green development located north and west of the wellfield was constructed during the late 1980’s (Figure 3.26).

One wetland at the Morris Bridge Wellfield (MBR-10) is classified as Not Fully Recovered, Continuing Wellfield Impact in this final assessment report. This wetland is located in the north-central portion of the wellfield and is a freshwater marsh that has been monitored since 1991. The wetland condition prior to monitoring is reviewed in VHB (2020a and Appendix 15.3) as part of the Functional Assessment of Wetland Recovery analysis. Descriptions of the wetland vegetation from Water Year 1986 indicate that changes consistent with drying conditions were present at that time. Multiple sinkholes were documented in this wetland prior to 1988 in several reports including a report for the City of Tampa by Dyer, Riddle, Mills & Precourt, Inc., (1990), a report for Tampa Bay Water by ENTRIX (2010), and Tampa Bay Water monitoring and assessment reports. The report by ENTRIX also reported that this wetland is "hydrologically linked to the Clay Gully sub-basin and (is) likely affected by a 25 percent direct reduction in overland flow regime" due to development of the Hunter's Green area.

The Area of Investigation for the Morris Bridge Wellfield is described in Section 5.3 and the unmonitored wetlands within this defined area were qualitatively assessed as described in Chapter 10. The qualitative recovery assessment of these unmonitored sites is shown in Figure 10.19 and the final assessment results for all monitored and unmonitored sites on and near the wellfield is presented in Figure 14.4. Unmonitored wetlands with a Low Degree of Certainty of Wetland Health are generally clustered in the west-central and northeast portions of the wellfield, though these sites are interspersed with those with a High Degree of Certainty of Wetland Health. These clusters of wetlands are also located near monitored sites that are Recovered suggesting that the general area is likely hydrologically healthy.

The model-simulated water level improvement in the surficial and Upper Floridan aquifers are shown in Figure 11.2 for 1996 – 2002 and 2012 – 2018 representing the predicted recovery due to the reduction in wellfield pumping. The simulated drawdown in the surficial aquifer has been reduced from 4 to 6 feet over much of the central and northern part of the wellfield to between 2 and 4 feet. The improvements in the Upper Floridan Aquifer potentiometric surface are shown in Figure 11.4. The improvement in water levels in both aquifers are shown for monitor wells MBR-03A shallow and deep in Figure 11.10 following the reduction in 2002 and the end of a severe drought. Following the reduction in wellfield pumping, the downward head gradient reduced from a range of 3 to 7 feet to approximately 2 to 5 feet. The depth of the Upper Floridan Aquifer potentiometric surface below land surface at four wetlands on the wellfield is shown in Figure 12.39 for the period of 1990 – 2015. At wetlands MBR-14 and MBR-35, the potentiometric surface is between two feet below and two feet above the wetland bottom during the summer rainy season after the reduction in pumping. The range of the potentiometric surface depth each summer at wetland MBR-91 after pumping was reduced is between four to zero feet below land surface and at wetland MBR-100 the range is two to four feet below land surface.

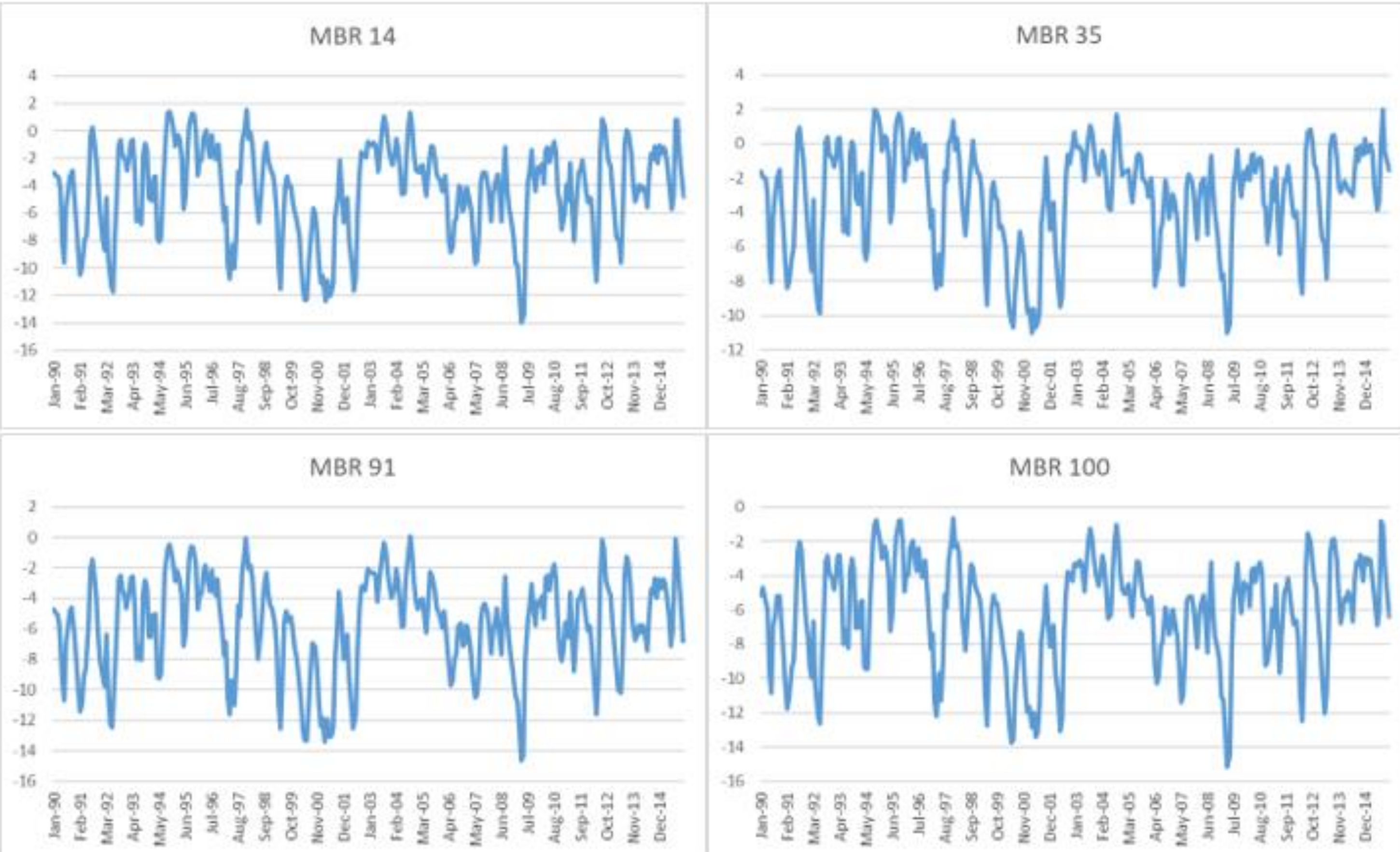


Figure 12.39: Depth to the Upper Floridan Aquifer Potentiometric Surface Beneath Four Wetlands at the Morris Bridge Wellfield

12.6.2 Discussion of Recovery

The Morris Bridge Wellfield property has remained mostly unchanged with regard to land use since the beginning of its development as a wellfield. Surface water management and control structures including the loop road and associated weirs were initially constructed to retain floodwaters on the wellfield property. However, operational adjustments have been necessary to better balance the need for water retention for flood control, restoring wetland hydrology, and avoiding impacts to natural systems. Urbanization of the northern and western boundaries of the wellfield with the development of the Hunter's Green, Arbor Greene, and Cory Lake Isles developments in the 1990's and 2000's has very clearly altered the upstream landscape. Permitted stormwater management systems located within the headwaters of the Clay Gully and Wild Hog Slough systems have documented impacts to the wellfield wetlands, reducing or delaying surface water flows to the connected systems on the wellfield. Historic production impacts have also been noted. High groundwater pumping rates resulted in reduced hydrology and physical changes to some wetlands, including subsidence and treefall. With a sustained reduction in pumping, hydrology has been restored and wetlands have recovered or improved.

The final recovery assessment results for all sites associated with the Morris Bridge Wellfield are shown on Figure 14.4. Forty of forty-one monitored wetlands have Recovered, have Improved hydrology, or have a High Degree of Certainty of Wetland Health since the reduction in wellfield pumping. Water Levels in the Improved wetlands have demonstrated an upward trend that is expected to be sustained with average rainfall. In this final assessment, the isolated Improved sites miss their metrics by an average of only 0.9 foot and the Improved connected sites miss their metrics by an average of 0.5 foot. The District field review of seven of the ten Improved isolated wetlands showed no sign of adverse environmental impact. The ability of Improved wetlands to fully recover to the appropriate metric is yet unknown given the past physical system changes that have occurred on the wellfield and within the larger wellfield drainage basin. The single site assessed as Not Fully Recovered, Continuing Wellfield Impacts has documented sink features within the wetland that occurred many years ago and the assessment in Chapter 15 shows that mitigation is not required for this site.

12.7 South Pasco Wellfield

The South Pasco Wellfield is located on a 589-acre parcel in south-central Pasco County, adjacent to the Hillsborough-Pasco county line (Figure 12.40). The topography in this area is generally flat with a water table historically close to ground surface resulting in many lakes and wetlands that flow from one to another, creating sloughs, strands, and stream systems. Over half of the wellfield is wetland, a large proportion of which comprise a large central multiple-wetland system. The wellfield receives surface water inflows from the north, east, and south which collects in the central wetland. This water then flows westward to discharge through an earthen berm with multiple culverts located near the west edge of the wellfield. This earthen berm was initially constructed to alleviate downstream flooding by retaining water within the wellfield; however, retaining water on the wellfield is believed to cause flooding in the nearby Sierra Pines subdivision to the south. The City of St. Petersburg drilled eight production wells on the property in 1970 and 1971 and the wellfield came online in 1973. A more comprehensive discussion of the history of the wellfield is included in Section 3.3.

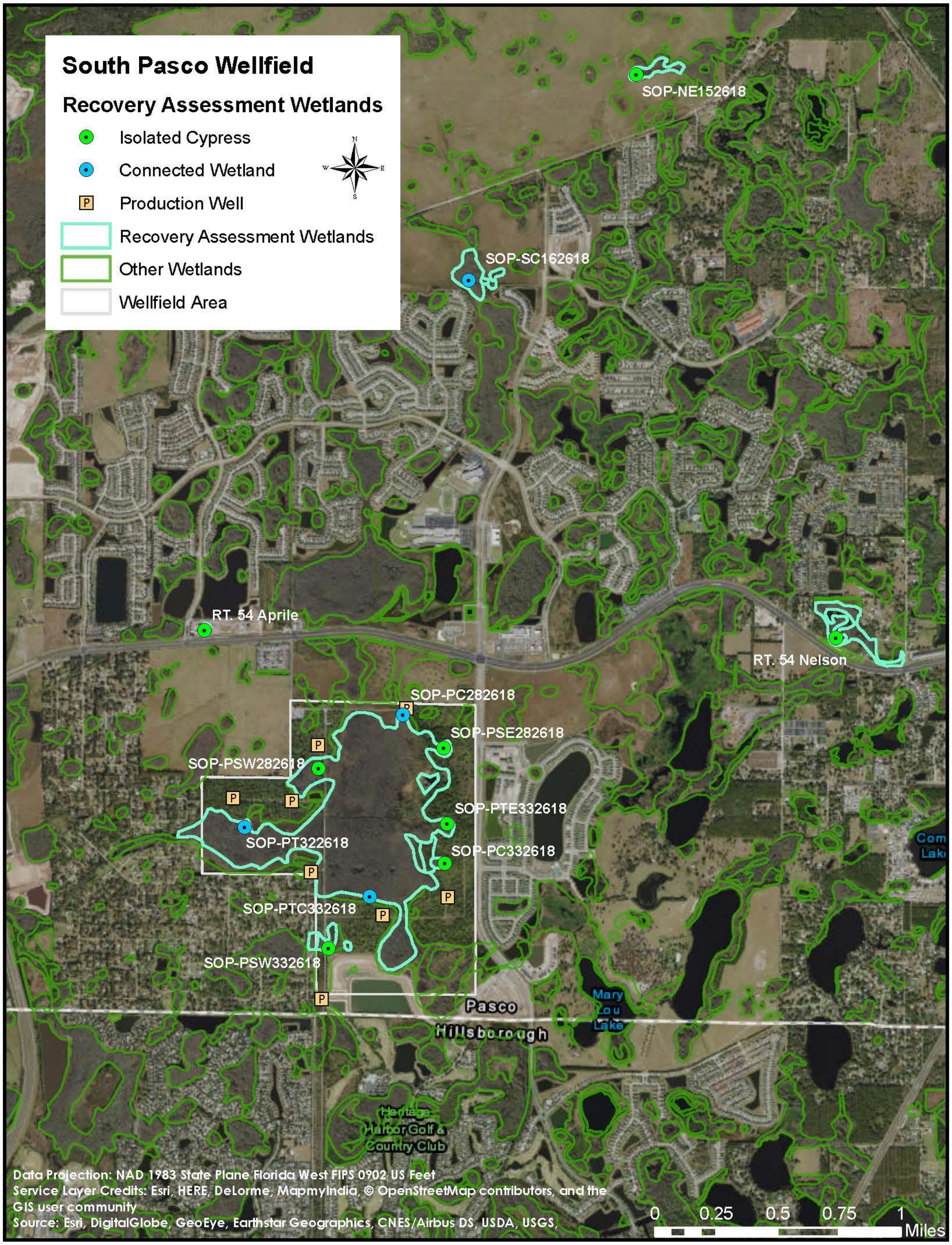


Figure 12.40: South Pasco Wellfield, Wetland Monitoring Sites and Production Wells

When the wellfield was constructed, the surrounding area was undeveloped with the exception of pastureland and other agricultural uses (Figure 3.13). This condition continued until the Sierra Pines subdivision to the south and west of the wellfield was constructed around the time the wellfield came online in 1973. The Meadowbrook Estates subdivision was constructed later, and by 1985 both subdivisions were completed (Figure 3.14). More important to hydrology on the wellfield was the larger developments, recently completed to the south, east, and north of the wellfield (Figure 3.15). These developments began with excavation of large borrow pits close to the east and south borders of the wellfield in the early 2000s. Additional borrow pits were constructed north of SR 54. Roads, buildings, and drainage systems were subsequently constructed in those areas and all of the area surrounding the wellfield now contains a mix of housing and commercial developments. These developments occupy the areas that contribute overland flow to the wellfield, but it is currently unclear what impact they have on the quantity and timing of surface inflows and subsequent impacts to the wellfield property.

The South Pasco Wellfield came online in late 1973 and pumped an annual average of more than 14 mgd between Water Years 1974 and 1978 (Figure 12.41). Water production decreased in Water Year 1979 and fluctuated between 10 and 12 mgd through Water Year 1993. Production increased in Water Year 1994 and ranged from 12 and 16 mgd through Water Year 2002 due to increasing demands and a multi-year period of below-average rainfall. The pumping rate at the wellfield was reduced in Water Year 2003 when alternative water supplies were introduced into the Regional System. Production has generally ranged between 2 and 6 mgd since Water Year 2003. Production decreased from an average pumping rate of 14.1 mgd during Water Years 1993 through 2002 to a post-cutback average of 5.1 mgd for Water Years 2003 to 2019. This represents a 64% reduction in the pumping rate at the wellfield.

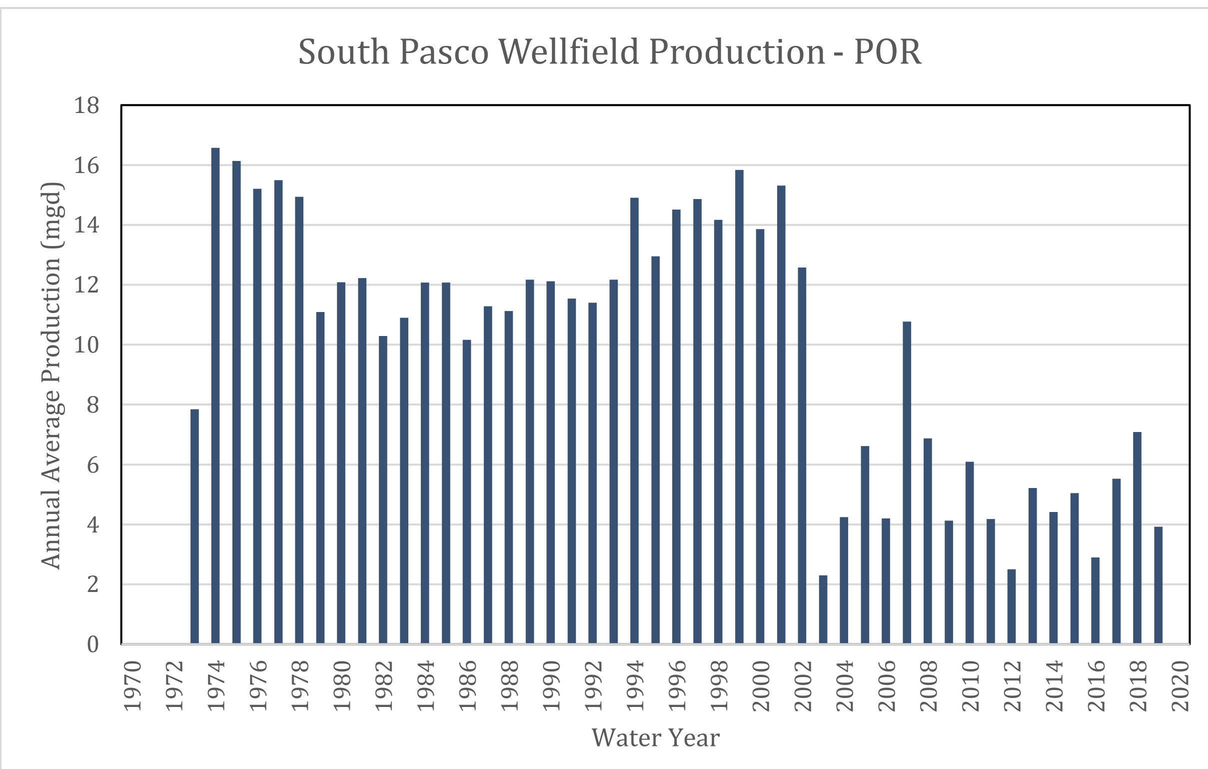


Figure 12.41: Period of Record Production at the South Pasco Wellfield

While wetlands and lakes in the Tampa Bay area can be affected by groundwater withdrawals and drainage activities, the primary factor influencing water levels is rainfall (Ormiston, 2020). Rain gages at the nearby Northwest Hillsborough Regional and Eldridge-Wilde Wellfields were used to assess environmental conditions on the South Pasco Wellfield (Figure 12.42). The average Water Year total rainfall at the long-term rainfall gage in nearby St. Leo, Florida is 54.05 inches and is considered representative of the area. Notable periods of drought in the Northwest Hillsborough area occurred during Water Years 1992 – 1997, 1999 – 2002, and 2005 – 2009. These periods were punctuated by periods of extreme rainfall in Water Years 1998 – 1999 and 2003 – 2004. These extreme events were sufficient to reset wetland, lake, and groundwater levels to normal levels. The 2003 rainfall coincided with the production cutbacks beginning in Water Year 2003, resulting in rapid recovery in most wellfield areas. Since Water Year 2009, rainfall typically has been near or above the long-term average with above-average rainfall in Water Years 2014, 2015, and 2019.

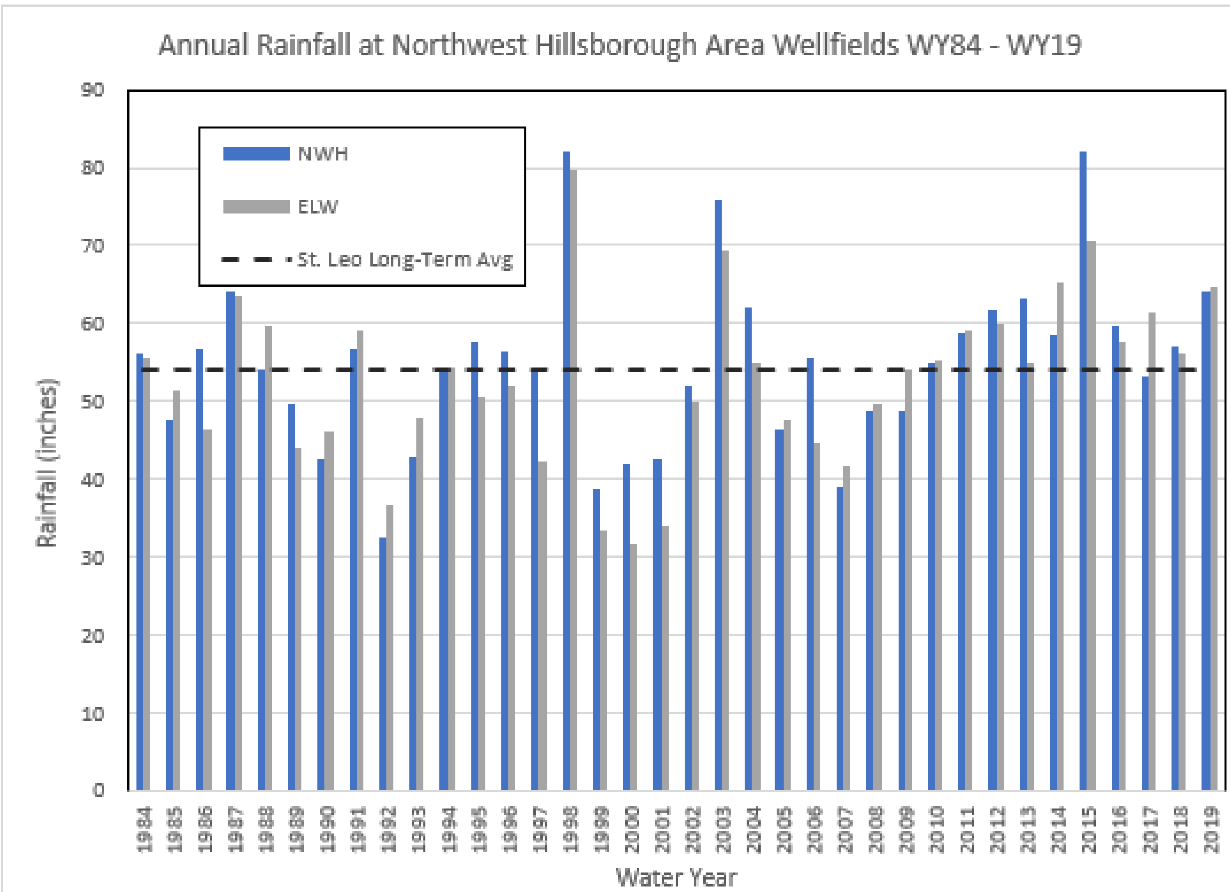


Figure 12.42: Annual Rainfall Totals at Northwest Hillsborough Area Wellfields

Within the first few years of pumping at the South Pasco Wellfield, the District detected lowered water levels in wetlands within the wellfield that resulted in reduced wetland hydroperiods and water levels. This in turn led to changes in wetland vegetation such as invasion of upland species into the wetlands, soil subsidence, and treefall. Monitoring of wetland water levels and vegetation by the Authority began in 1991 and has continued to the present. Before the reduction in wellfield pumping, median water levels at monitored sites were generally 1 to 3 feet below ground at most wetlands. Isolated wetlands in the north and eastern areas of the wellfield experienced the greatest water level reductions and monitored wetlands associated with the large central wetland generally had lesser impacts as these are connected systems and receive flow from off the wellfield property. After the reduction in wellfield pumping, median water levels at all sites are generally 1 to 2 feet above-ground. A period-of-record hydrograph of wetland PSE282618 is shown in Figure 12.43 demonstrating the rapid and sustained recovery of water levels following the reduction in pumping in late 2002. With the exception of the drought years of 2005 to 2009, water levels regularly reach the site normal pool elevation.

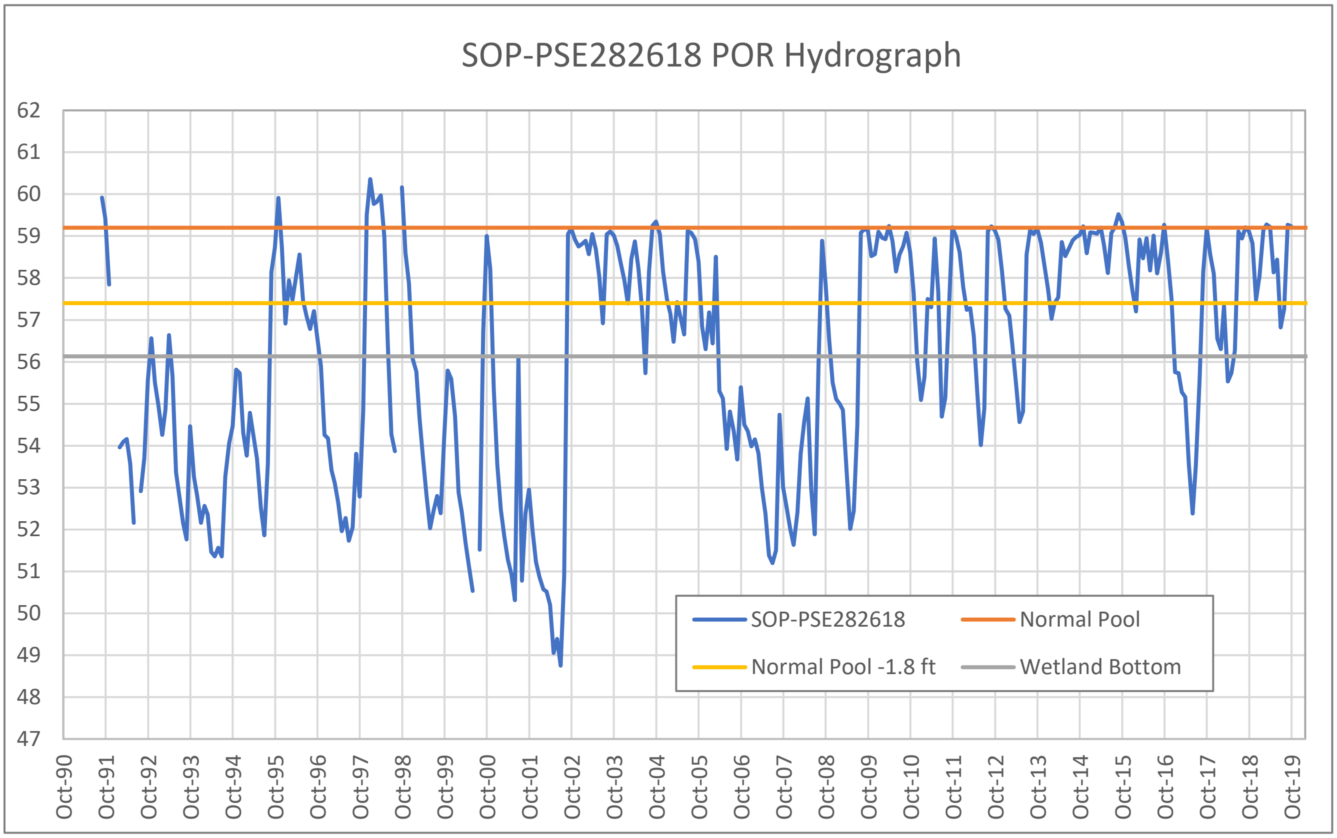


Figure 12.43: Hydrograph for Monitored Wetland SOP-PSE282618

An assessment of improved water levels in the surficial aquifer following the reduction in wellfield pumping conducted by the Wise Consulting Group (2016d) found greater than two feet of recovery in the northern half of the wellfield and 1.5 to 2 feet of recovery in the southern half (Figure 12.44). The sustained recovery in the surficial and Upper Floridan aquifers is shown for a pair of monitor wells in the northern part of the South Pasco Wellfield in Figure 12.45. The vertical head difference between these two aquifers has greatly diminished following the reduction in wellfield pumping.

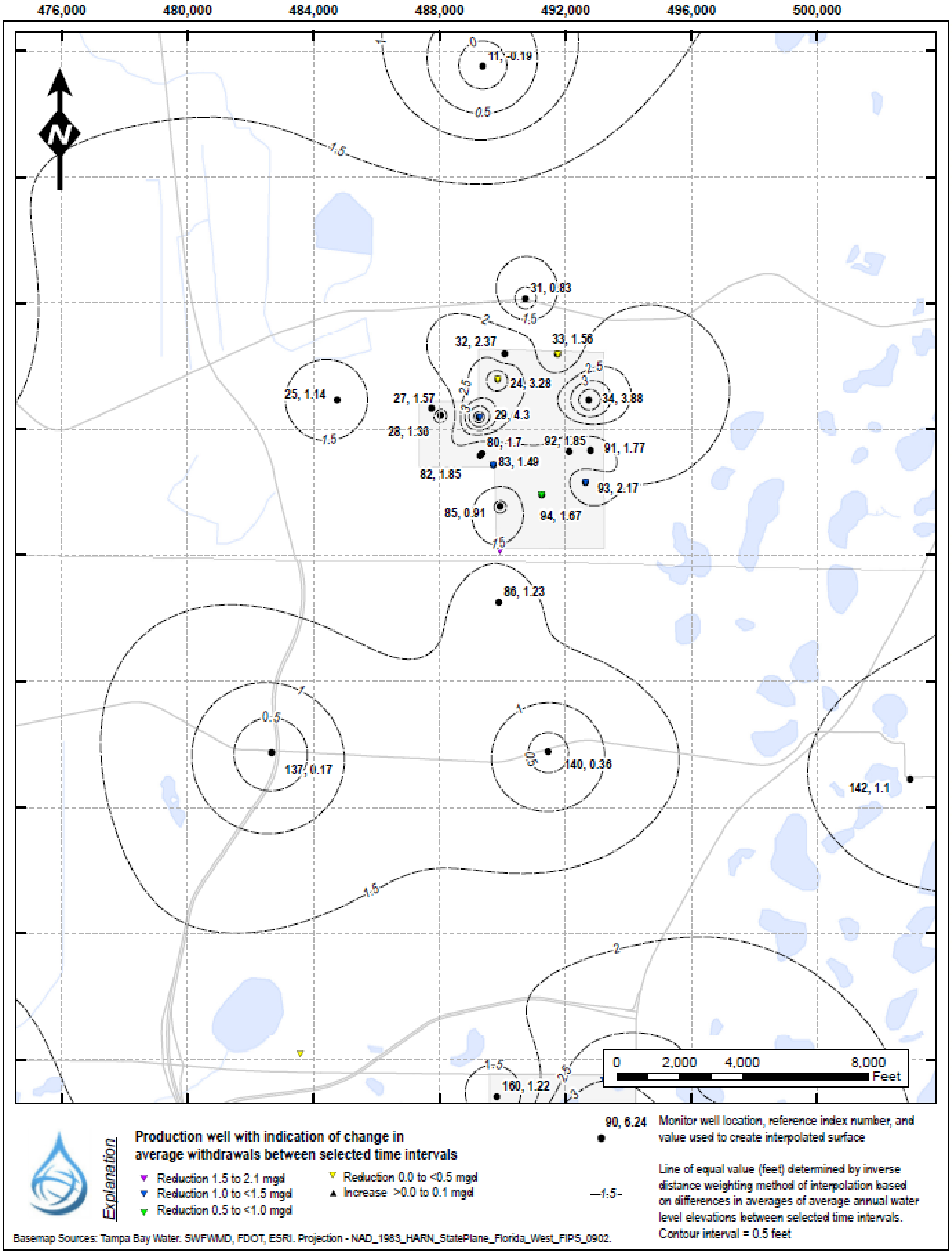


Figure 12.44: Post-Cutback Recovery in the Surficial Aquifer at the South Pasco Wellfield
(from Wise Consulting Group, 2016)

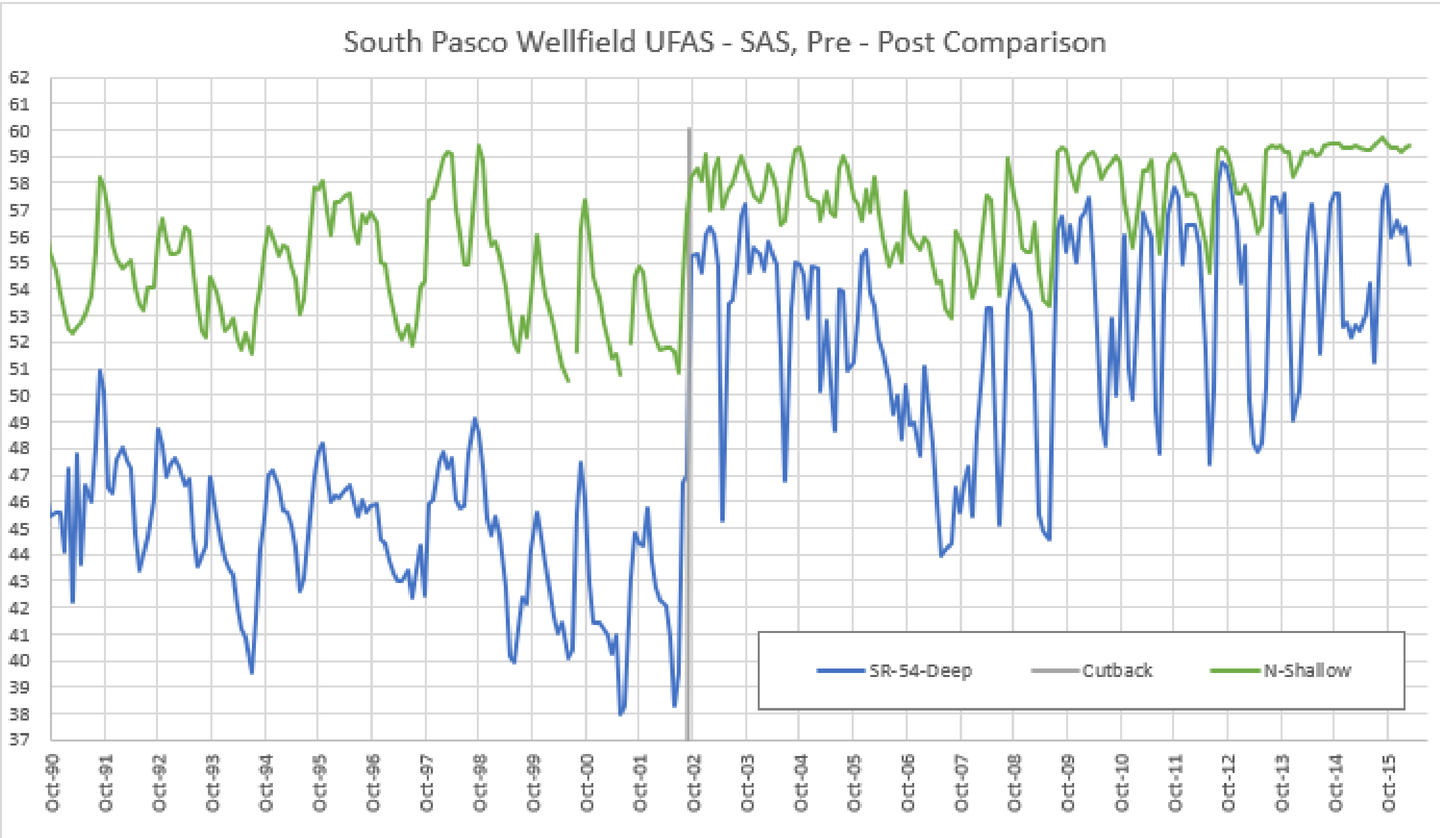


Figure 12.45: Upper Floridan and Surficial Aquifer Water Levels at the South Pasco Wellfield Before and After Pumping Reduction

12.7.1 Site-Specific Results

There are 12 monitored wetlands on the final recovery assessment list associated with the South Pasco Wellfield. The final recovery assessment classifications for these wetlands are presented in Section 9.2.9 and the final assessment bin for each of these wetlands is included in Table 9.8. All 12 sites met their respective metrics and are classified as Recovered in this final assessment of recovery. The location and final status of these 12 wetlands are shown in Figure 9.31.

There are many lakes in the South Pasco Wellfield area: 20 lakes are associated with this wellfield in the Recovery Assessment Plan. The lakes are shown in Figure 8.11 and extend from Lakes Padgett and Saxon northeast of the wellfield to Lakes Allen and Hobbs to the southeast. Lakes associated with other wellfields are also included in the figure but are not discussed here. The recovery of monitored lakes was assessed using a weight-of-evidence approach that emphasized statistical analyses of water levels, as described in Section 8. The final status for all Recovery Assessment lakes is presented in Tables 8.2 and 8.5 and shown in Figure 8.11 and all 20 of these lakes are classified as Recovered using the Recovery Assessment weight-of-evidence analyses. With the reduction in pumping at the South Pasco Wellfield to a post-cutback average of 5.1 mgd for Water Years 2003 to 2019 and a return to more normal rainfall conditions, these lakes have Recovered and are expected to maintain this status. Water levels in the lakes near the South Pasco Wellfield with established Minimum Levels (Allen, Camp, Hobbs, and Virginia Lakes) have met their Minimum Levels for the past 6 and 10 years and since the reduction of wellfield pumping in 2003. The recorded water levels in Camp Lake meet the Minimum Level for the past 6 and 10 years but the P50 water level for the 17-year period of Water Year 2003 – 2019 post-cutback period is 0.19 foot below the Minimum Level. The period of record hydrograph for Camp Lake is presented in Figure 12.46 showing that the lake has recovered to its Minimum Levels for the past 10 years.

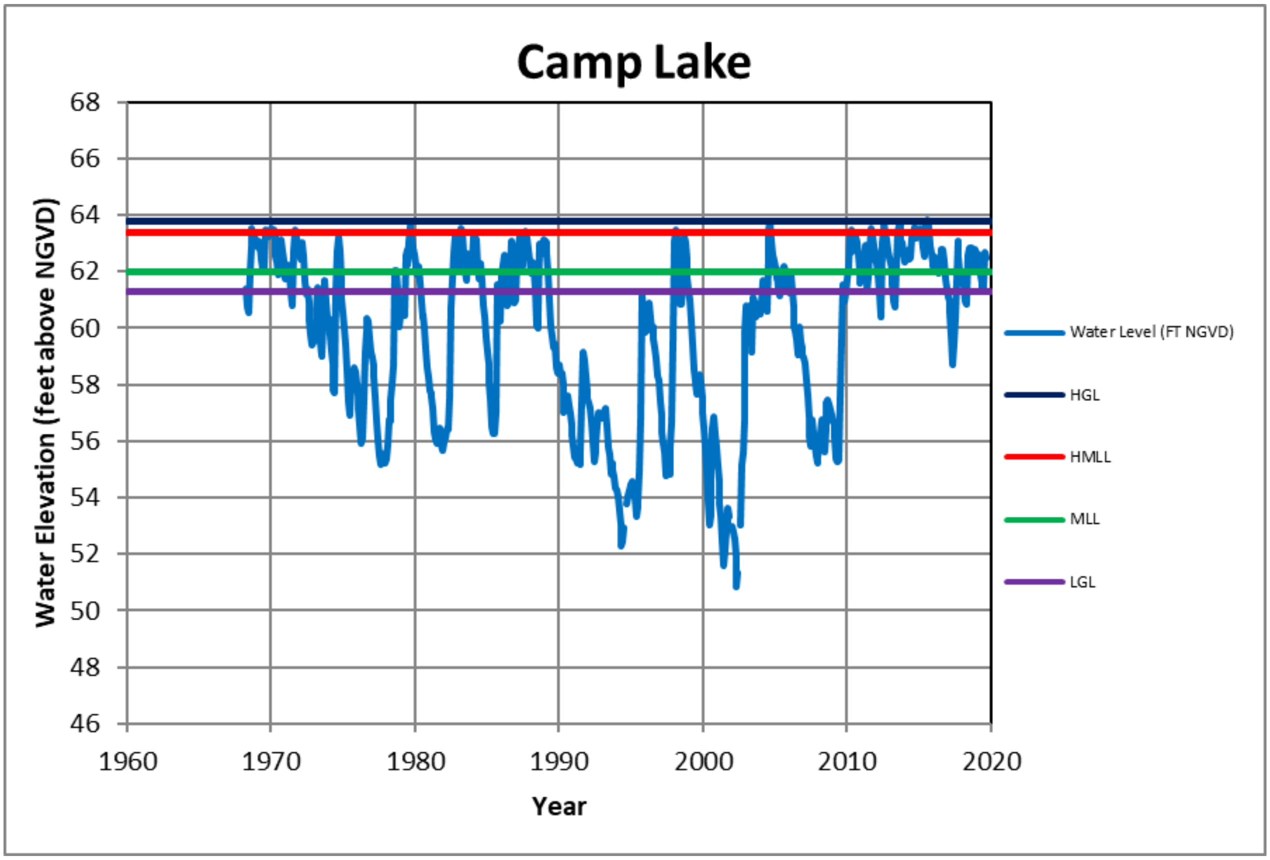


Figure 12.46: Period of Record Hydrograph for Camp Lake

The Area of Investigation described in Section 5.3 does not include the South Pasco Wellfield due to less than 2 feet of predicted drawdown in the surficial aquifer. Therefore, there are no unmonitored wetlands associated with the South Pasco Wellfield. The median predicted drawdown map for 2012 – 2018 shown in Figure 11.2 also shows that there is less than two feet of median predicted drawdown in the surficial aquifer based on actual pumping levels during this time period.

12.7.2 Discussion of Recovery

The South Pasco Wellfield Drainage Modifications Project was investigated under the Phase 1 Mitigation Plan to retain additional surface water on the wellfield property (Section 3.13.2.4). The feasibility study evaluated modifications to drainage features in two locations on the wellfield; an earthen berm with culverts on the western edge of the wellfield and the north-south wellfield maintenance road that is crossed by multiple culverts. The objective of the project was to retain additional water in the wellfield wetlands and potentially alleviate some of the downstream flooding problems by holding additional storm water on-site for longer periods of time. The feasibility study concluded that the effects of permittable drainage modifications (without causing additional off-site flooding) would be minor and suggested that wetlands might fully recover given the anticipated reduction in pumping (Berryman & Henigar, Inc., 2004).

This project was not implemented due to the limited benefit and to avoid the potential for additional off-site flooding in adjacent neighborhoods. Numerous flooding complaints (Section 3.16.3) have been received from the Sierra Pines and Meadow Brook Estates neighborhoods to the west and southwest of the wellfield area for many years. These two neighborhoods were constructed during the time of much higher wellfield pumping. Figure 12.47 shows the location of flooding complaints and indicates whether they were received before or after the pumping reduction. More complaints have been received after pumping reductions than before, although the El Nino event during the winter of 1997-1998 was responsible for widespread flooding in that area and generated many complaints prior to the reduction in pumping. The combination of the low-lying area and high water tables after cutbacks make that area prone to flooding. Water levels at a surficial aquifer monitor well close to the Sierra Pines subdivision (Figure 12.48) confirms that the water table in that area is very high on an annual basis since the reduction in pumping, often approaching the land surface

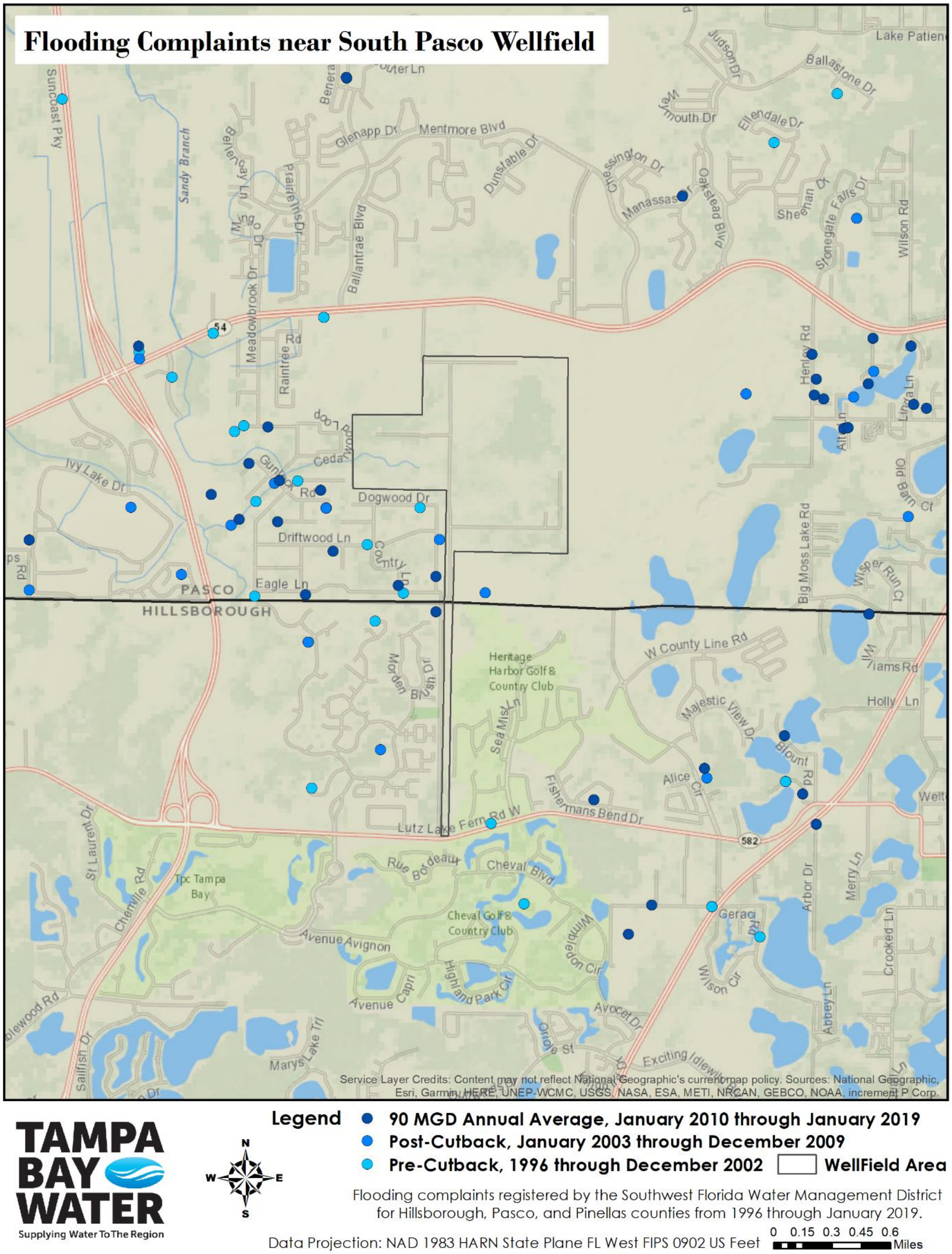


Figure 12.47: Flooding Complaints Near the South Pasco Wellfield

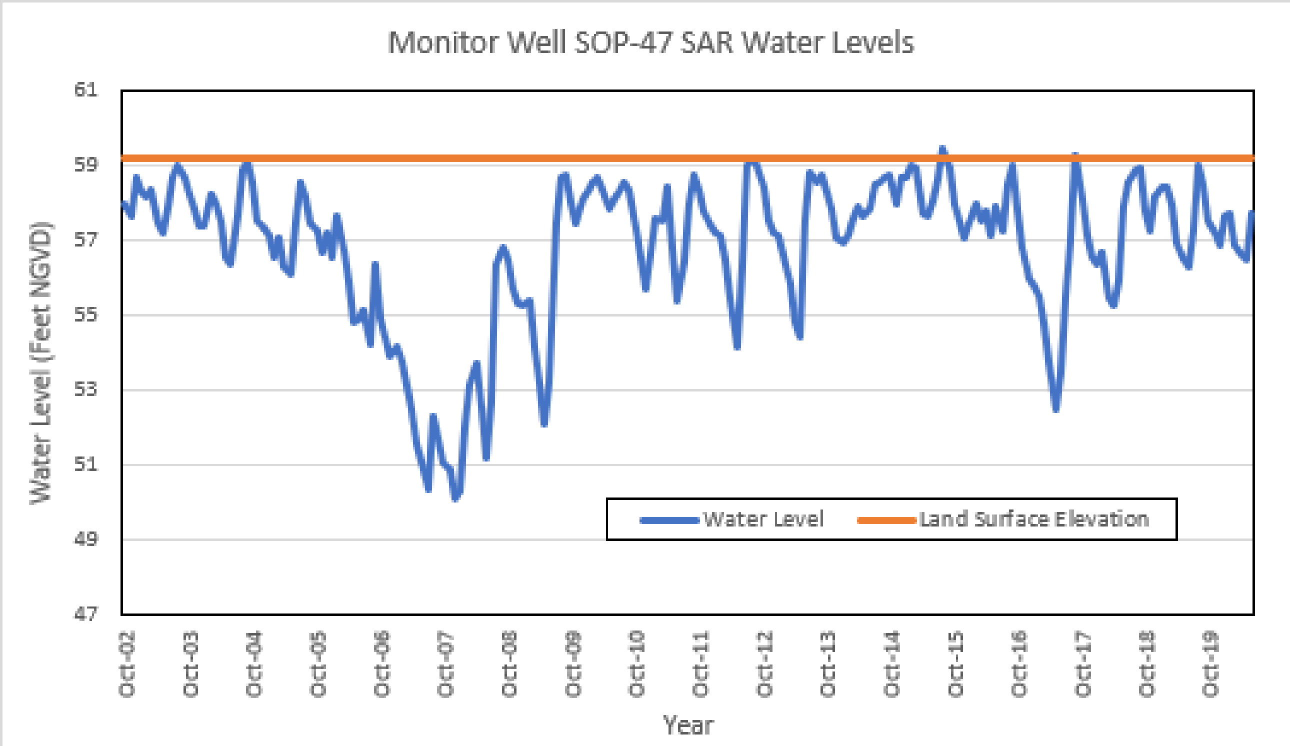


Figure 12.48: Surficial Aquifer Water Levels in Monitor Well SOP-47 SAR After the Reduction in Wellfield Pumping

The final recovery assessment results for all sites associated with the South Pasco Wellfield are shown on Figure 14.9. The wetland classified as Improved in this figure is associated with the Section 21 Wellfield. All monitored wetlands and monitored lakes in the area meet their hydrologic recovery metrics in the post-cutback period and are classified as Recovered. The classification results for the monitored wetlands and lakes are supported by the analyses of hydrologic recovery in the surficial and Upper Floridan aquifers as discussed in this section and in Section 9.2.9 and Chapter 11 of this report. No additional increase in the water table is desirable at the wellfield due to the already-high water table and the presence of regular off-site flooding complaints. The wellfield is surrounded by development, and the older developments to the west and south often flood. The sustained long-term lower level of pumping achieved after Water Year 2003 allows for full recovery of lakes and wetlands.

12.8 Eldridge Wilde Wellfield

The Eldridge-Wilde Wellfield (EWWF) straddles the northernmost border between Pinellas and Hillsborough Counties and is bounded on its north by Pasco County. The wellfield is bounded on the south by Keystone Road. The wellfield was constructed in phases by Pinellas County between 1952 and 1970 and a total of 58 production wells were drilled, mostly in Pinellas County, with nine on the Hillsborough County side of the wellfield (Figure 12.49). The wellfield came online in 1956 but saltwater intrusion became a concern in the 1970s, with annual average wellfield pumping ranging from 28 to 35 mgd. Water table drawdowns also had been noted by the District, observing that wetlands were suffering from subsidence, fire damage, tree loss, and a "general elimination of wetland plants". These on-site impacts were documented prior the existence of Consumptive Use Permitting rules and the subsequent issuance of the first permit for the EWWF. A more comprehensive discussion of the history of the wellfield is included in Section 3.3.

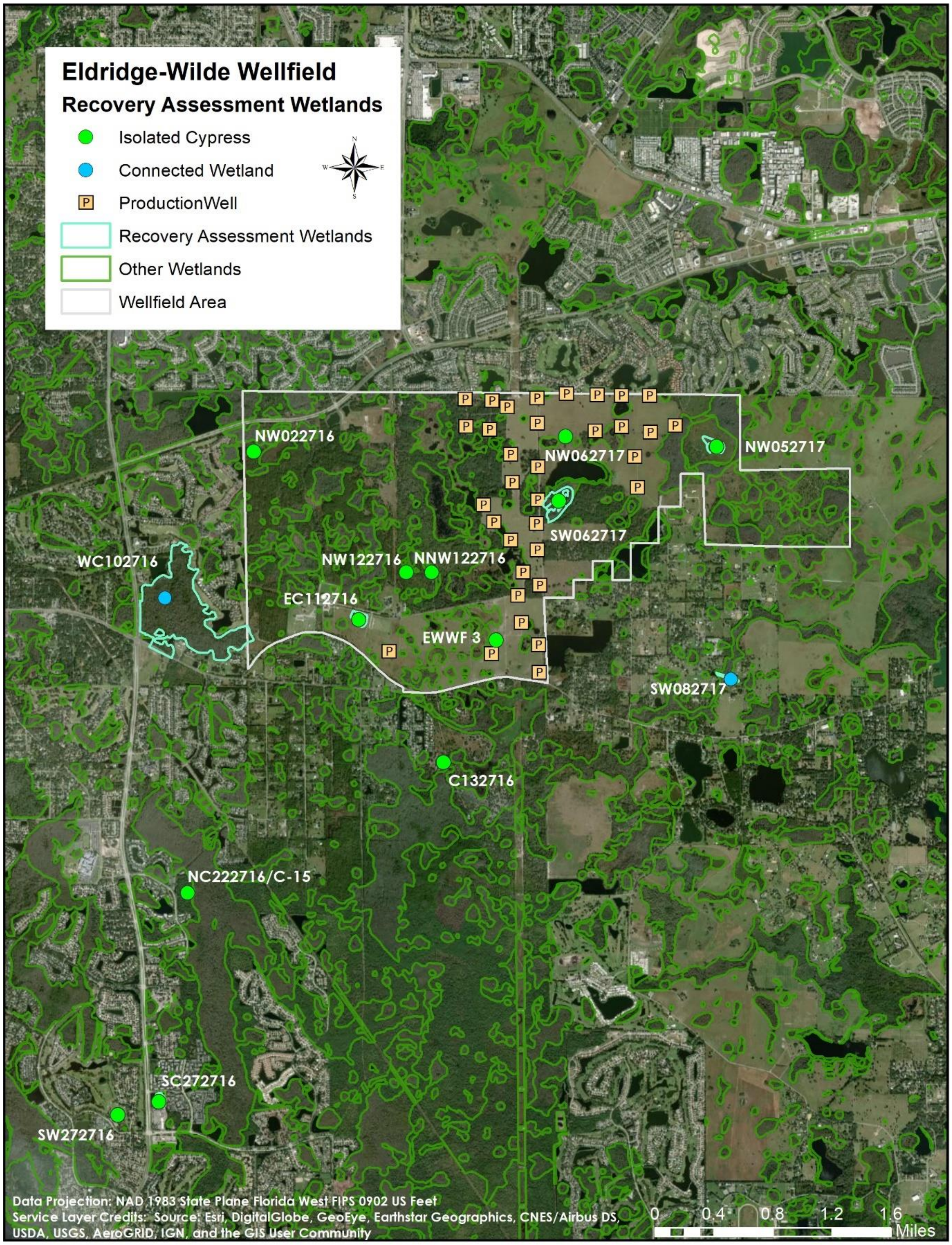


Figure 12.49: Eldridge-Wilde Wellfield, Wetland Monitoring Sites and Production Wells

The generalized geology in the EWWF area is typical of the northern Tampa Bay region with a clay semi-confining layer between the surficial sands and the limestone strata of the Upper Floridan Aquifer. However, lakes and wetlands within the wellfield can be affected by the thickness of the confining layer and sinkholes are common in the EWWF area (Tihansky, 2005). In areas where the thin confining layer is either breached or absent, surficial sediments can ravel down into solution pipes and cavities in the underlying limestone. This process creates depressional features ranging from shallow depressions to steep-sided sinkhole-type features (Tihansky, 2005). The confining layer is generally less than 25 feet thick in the EWWF and can be very thin or even absent in some locations. A study by Leggette, Brashears, and Graham (2006) using geophysical logging data of wellfield monitor wells found that significant areas of the wellfield have essentially no clay confining layer (Figure 12.50). In these areas, the surficial aquifer more readily leaks downward into the Upper Floridan Aquifer and the water levels in these two aquifers are closer in elevation. This area also coincides with an area of deep sandy soil and internally-drained depressions, many with significant subsidence. Lake Dan is also located in this area.

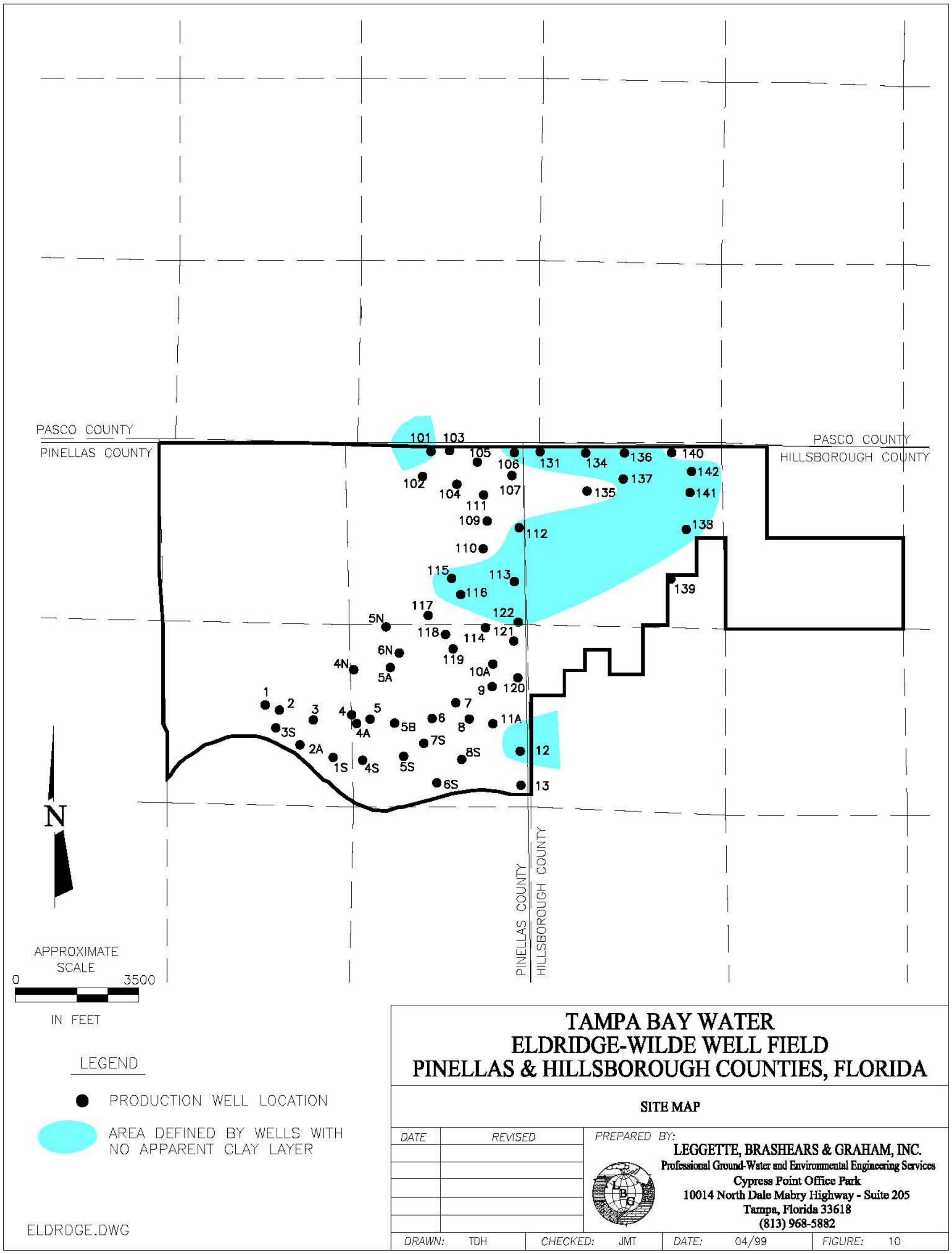


Figure 12.50: Eldridge-Wilde Wellfield, Areas with No Apparent Confining Layer (from LBG, 2006)

The EWWF also has areas where the confining layer is thicker and continuous. Stewart and Stedje (1990) sought to determine why two cypress wetlands that otherwise were similar in size and proximity to production wells, had such different responses to pumping. Wetland ELW-NW122716 (the "west comparative wetland") was noted for remaining in a nearly unimpacted condition with healthy vegetation assemblages and water levels, while wetland ELW-NW062717 (the "east comparative wetland") experienced severe subsidence and depression of water levels, and loss of almost all cypress trees. The authors confirmed that ELW-NW122716 had a competent confining layer below the surficial sands, while ELW-NW062717 had essentially no confining layer and surficial sediment strata had collapsed downward to form a sinkhole.

The EWWF came online in late 1956 and the average production rate from the wellfield steadily increased from 2.3 mgd in Water Year 1957 to 35.14 mgd in Water Year 1973, the highest annual average pumping rate in the period of record. The average annual production generally fluctuated between 22 and 32 mgd until the regional alternative water supplies were available and wellfield pumping decreased in Water Year 2003. Since that time, the annual average production from the EWWF has fluctuated between 8 and 16 mgd (Figure 3.38). The annual average pumping rate for the wellfield was 27.3 mgd during Water Years 1986 through 2002 and declined to an average of 12.6 mgd during Water Years 2003 through 2019, a reduction of 54%.

The average Water Year total rainfall at the long-term rainfall gage in nearby St. Leo, Florida is 54.05 inches and is considered representative of the area. At the EWWF, the Water Year total rainfall has fluctuated from approximately 32 inches during drought years to 80 inches in years with significant storm or hurricane activity (Figure 12.42). A single year of drought can result in noticeable decreases in water levels, but when back to back years of drought occur, water levels are not replenished during the wet season, and water levels continue to decline with each successive year. Notable periods of drought at the EWWF occurred during 1992 through 1997, 1999 through 2002, and 2005 through 2009. Most of the years during the period of 1989 through 2009 had rainfall totals below the long-term average. These periods were punctuated by periods of extreme rainfall in 1998 and 2003. These extreme events were sufficient to reset wetland, lake, and groundwater levels to normal levels. The 2003 rainfall coincided with the reduction in wellfield production, resulting in rapid water level recovery. Since Water Year 2009, rainfall typically has been near or above the long-term average with high rainfall recorded in Water Years 2014, 2015, and 2019.

The EWWF property has, for the most part, remained in its natural state since it came online in 1956. Aerial photography from 1938 shows that the area was almost completely undeveloped at that time and natural communities were prevalent (Figure 3.6). By 1967, more agricultural uses were present, primarily pasture and citrus (Figure 3.7), and the sandy shorelines of Lake Dan and other water bodies are exposed due to pumping-related drawdown and low rainfall. By 1998, citrus is gone from the area but pasture remained (Figure 12.51). Low-density residential areas existed in 1998 to the south of the wellfield and construction of adjacent developments were complete or underway. The Crescent Oaks subdivision was complete on the western property boundary and the Trinity development was partially complete on the northern border of the wellfield. Both of these communities were developed during the time of higher wellfield pumping and lower water levels in the surficial aquifer. The 2018 aerial photograph shows that the many of the remaining open areas have been developed with the exception of the Lake Francis Preserve immediately to the east of the wellfield (Figure 3.8).

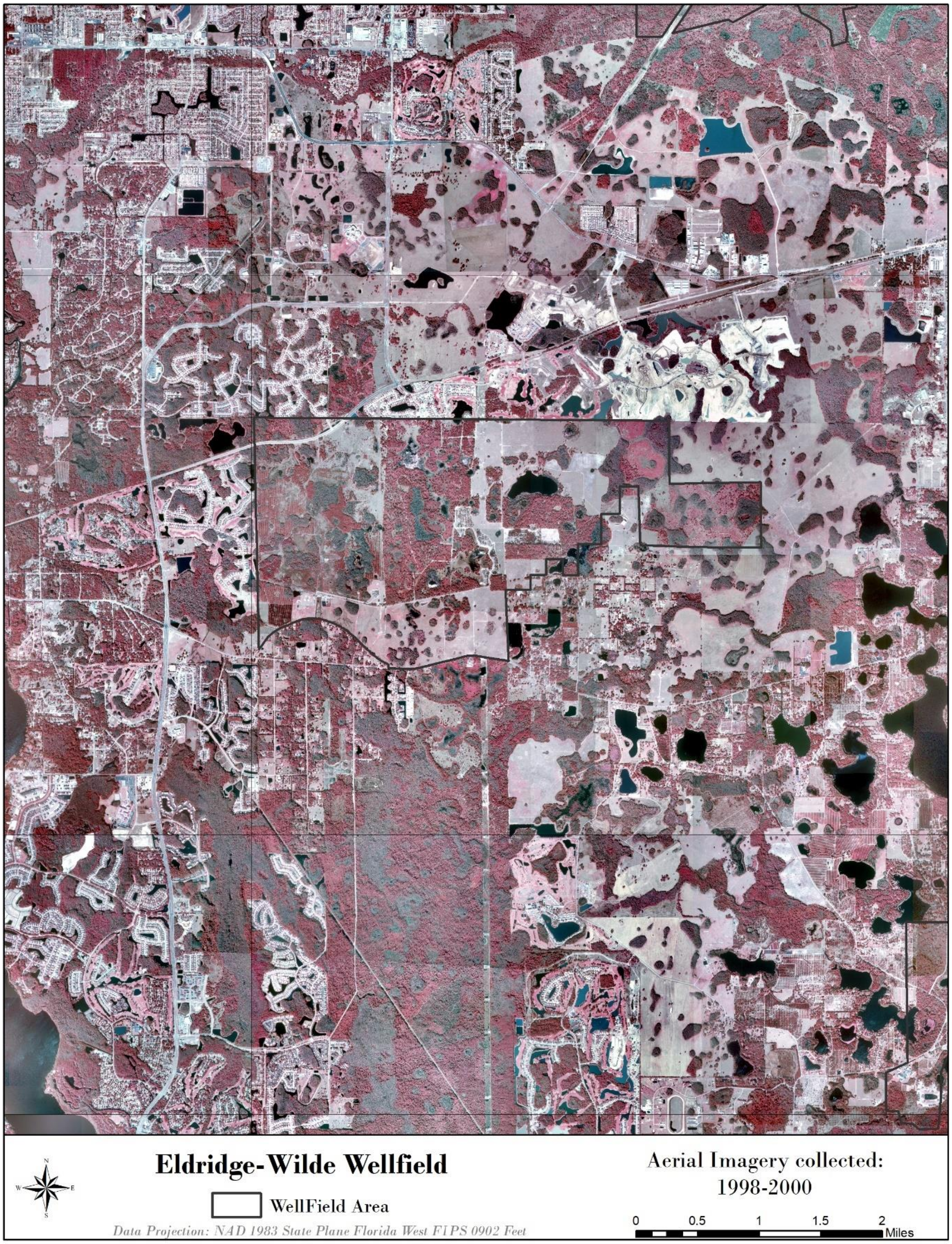


Figure 12.51: Aerial Photograph of the Eldridge-Wilde Wellfield Area from 1998

The reduction in wellfield pumping that began in Water Year 2003 resulted in significant recovery in the water table in and around the wellfield. Figure 12.52 shows the locations of flooding complaints filed with the District between 1996 and January 2019. The two main areas of complaints are the Trinity development just north of the wellfield and the Duck Slough area about one mile northwest of the wellfield. Flooding complaints were also received from the low-density residential area immediately south of the wellfield property boundary. Some flooding complaints predate the reduction in wellfield pumping, likely a result of the extreme El Nino rainfall during the winter of 1997-1998. The District and Pasco County continue working on long-term solutions to resolve the periodic but severe flooding that occurs in the Trinity community north of the wellfield.

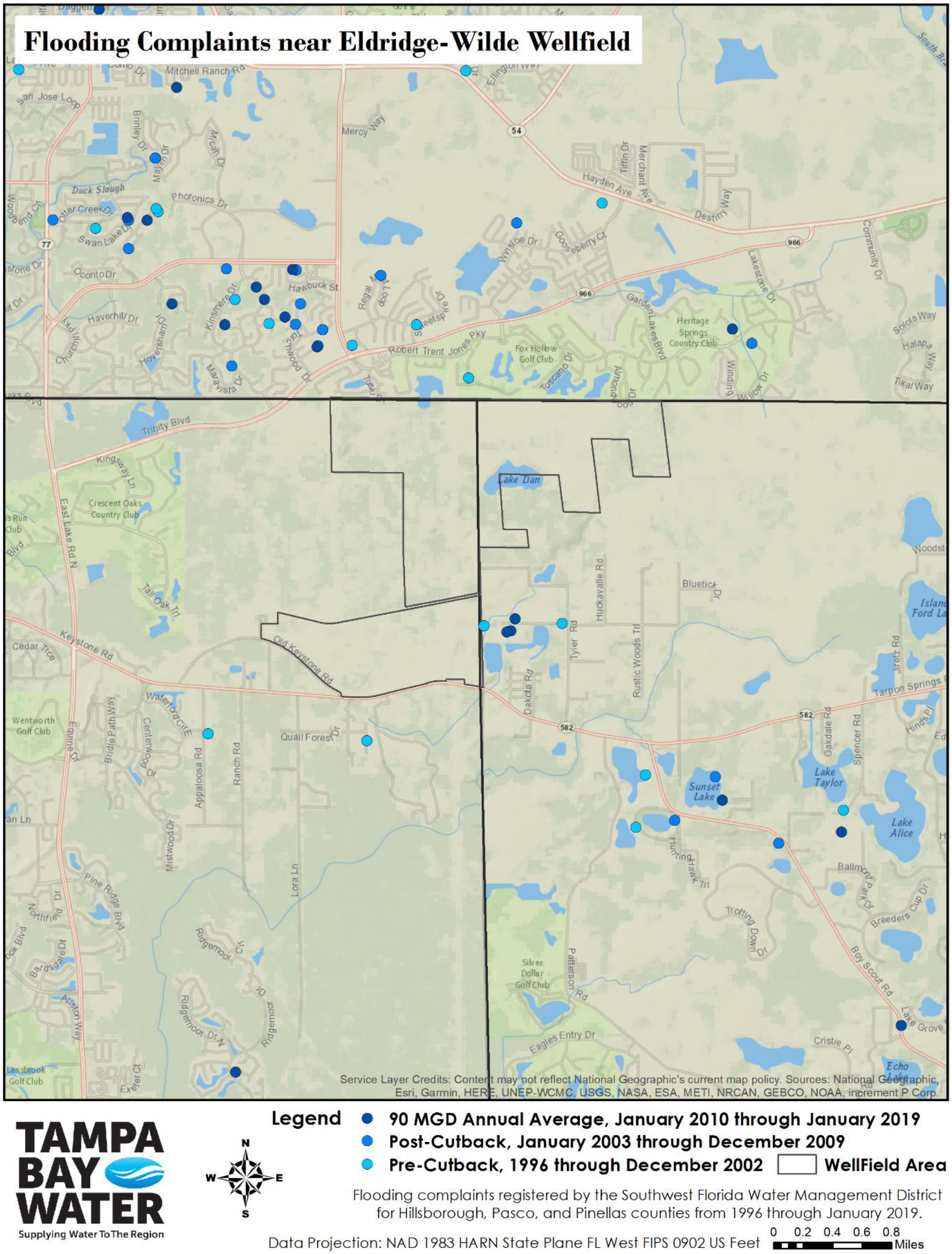


Figure 12.52: Location of Flooding Complaints near the Eldridge-Wilde Wellfield

Historical monitoring of wetlands on the wellfield were performed by the District in 1972/73, 1982, and 1989 as described in Section 3.3. The historic impacts on the wellfield included significant soil subsidence, treefall, and the migration of upland plants and trees into wetland perimeters (Southwest Florida Water Management District, 1989a). Evidence of historic ditching associated with previous agricultural land uses exists on the wellfield, particularly on the southwest portion of the property and the area north of Lake Dan (Figures 3.7 and 12.51). These ditches connected wetlands and lowered the water table, creating usable pastureland; however, the wetlands on the property have primarily been affected by periods of rainfall deficit and pumping-related drawdown in the surficial aquifer.

Figure 11.2 shows surficial aquifer model-predicted drawdown for two periods, before and after the reduction in wellfield pumping. At the EWWF, the median drawdown in the surficial aquifer during 1996-2002 was predicted to be 16 to 18 feet in the north-central area of the wellfield which is within the zone previously identified as having no confining layer. This degree of drawdown is illustrated at two monitored wetlands in this area (ELW-NW062717 and EWWF 3) that are deeply subsided, and possibly 10 or more feet deep, that rarely had standing water before the reduction in pumping. During the period of 2012-2018, the predicted surficial aquifer drawdown on the wellfield is between 6 and 8 feet.

The wetlands in the unconfined zone experienced more significant water deficit conditions due to drawdown than wetlands located in parts of the wellfield with a confining unit below the surficial aquifer. Extended periods with no standing water exposed the organic soils within the wetlands leading to soil subsidence and loss. The organic soils act as a seal on the bottom of the wetland, helping to hold water from vertical leakage and retaining moisture to support wetland-dependent plants during seasonal or longer-term dry periods. Soil subsidence in a wetland can consist of the loss of organic soils through oxidation or the loss of mineral soils due to karst-type collapse features. The loss of organic soils is more common but some wetlands in the wellfield area with no confining layer and high historic drawdown appear to have experienced both types of soil loss. Some of these wetlands have centers that are much deeper than expected for the type and size of the wetland (up to 10 feet or greater) and the wetland basin depressions have steep sides. These subsided wetlands do not support vegetation communities similar to other cypress or marsh systems in the region as the central portions are too deep for rooted vegetation of any type. Vegetation is limited to the fringes of the wetlands when full of water and many of the wetlands only have scattered trees, where once the canopy was continuous.

Lake Dan is located within the unconfined zone of the wellfield but did not suffer the severe impacts as did nearby wetlands. A water budget analysis found the lake to be much leakier than other lakes in the area and it also receives surface water inflows during wetter times (HSW Engineering, Inc., 2012a). The lake has experienced extreme water level fluctuations and augmentation was historically required to maintain a pool during dry periods. By preventing the lake from going completely dry, it has not lost all of its organic sediments, enabling it to retain water to some degree even at elevations above the surrounding surficial aquifer levels. The lake also has also not experienced any known sinkholes. It has lost much of its cypress fringe, but some areas of cypress have persisted. The shallow sloping shorelines support an herbaceous plant assemblage that, given time, adjusts its zonation depending on fluctuations in lake levels. This has helped the lake maintain a natural appearance even when it is apparent that water levels have been lower than historic levels.

In areas outside of the unconfined zone, impacts were not as severe. Two wetlands in particular, NW122716 (mentioned before) in the western part of the wellfield, and NW052717 in the eastern part, appear to be relatively unaffected by drawdown. Minor loss of organic soils and some lowering of the water table have occurred but in general, these wetlands have maintained their tree canopy and natural vegetation assemblage. Other wetlands such as EC112716, and NNW122716 experienced intermediate impacts, such as some loss of organic soils with subsequent subsidence and treefall, invasion into wetland zones by upland vegetation, trees and invasive species, reduced hydroperiods, and lower median water levels. Depending on the degree of subsidence, treefall, and vegetation shifts, these wetlands have retained varying degrees of their natural character.

An assessment of improved water levels in the surficial and Upper Floridan aquifer following the reduction in wellfield pumping was conducted by the Wise Consulting Group (2016d). This assessment found average water level improvement in the surficial aquifer of 5 to 6 feet in the central part of the wellfield, with other areas of the wellfield improving between 2 to 4.5 feet (Figure 12.53). The Upper Floridan Aquifer recorded average water level improvement of 9 feet in the center of the wellfield, with other wellfield areas improving between approximately 4 feet to 7 feet (Figure 12.54). The sustained recovery in the surficial and Upper Floridan aquifers is shown for monitor wells EWMW-2s and 2d on the northern border of the Eldridge-Wilde Wellfield in Figure 12.55. The water level in the surficial aquifer generally fluctuates around elevation 25 feet after 2010, less than 10 feet below land surface.

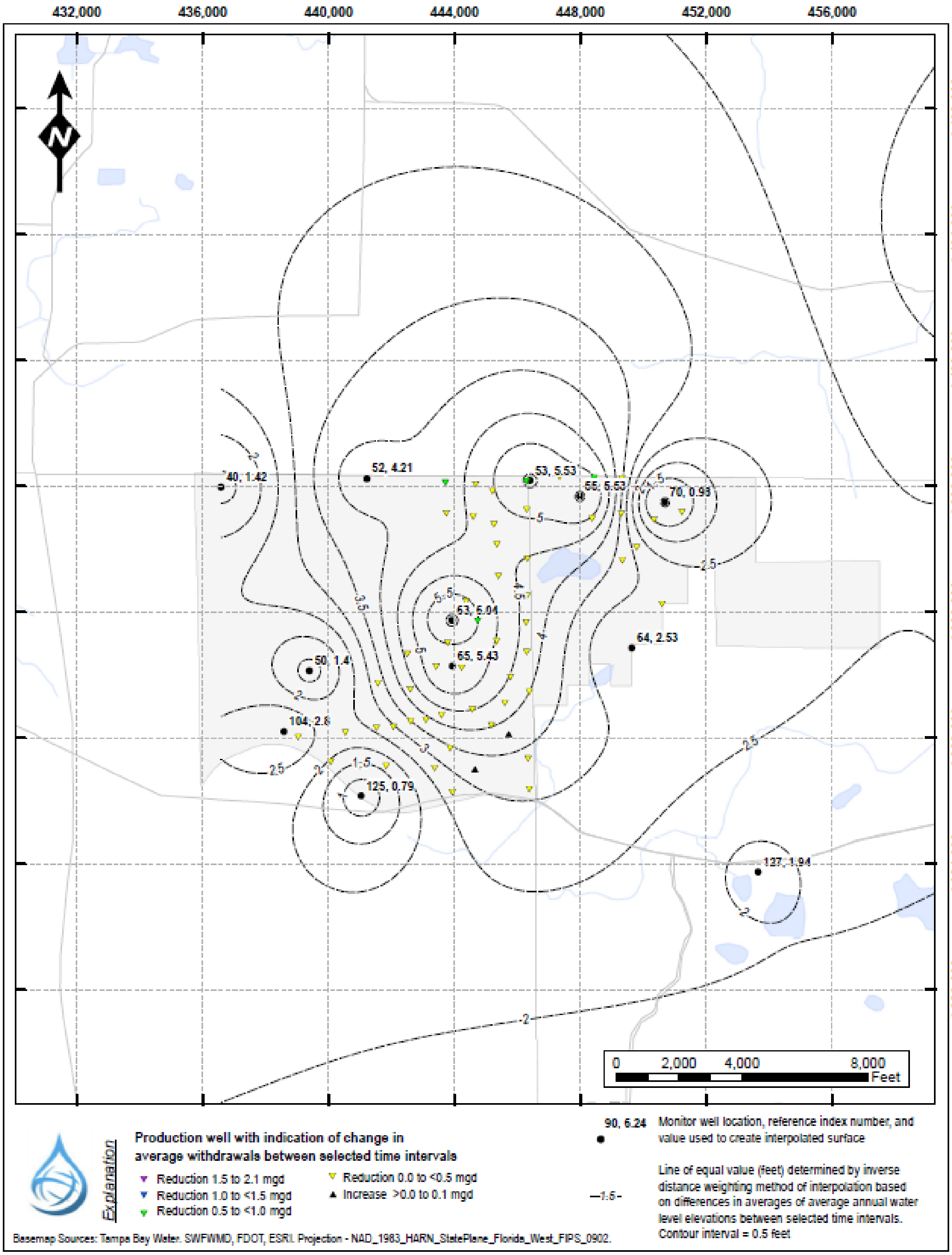


Figure 12.53: Recovery in the Surficial Aquifer at the Eldridge-Wilde Wellfield Due to Pumping Reduction (from Wise Consulting Group, 2016d)

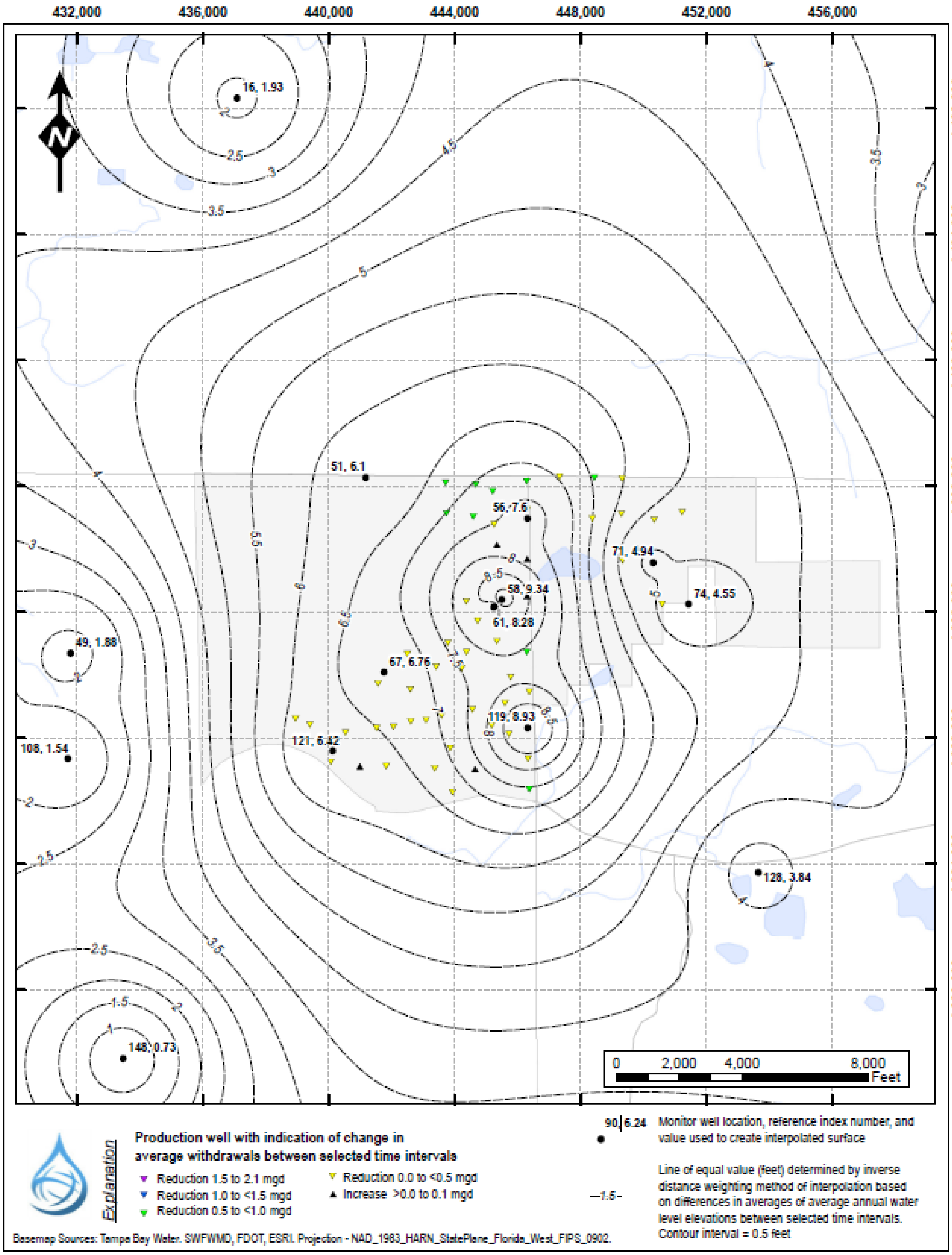


Figure 12.54: Recovery in the Upper Floridan Aquifer at the Eldridge-Wilde Wellfield Due to Pumping Reduction (from Wise Consulting Group, 2016d)

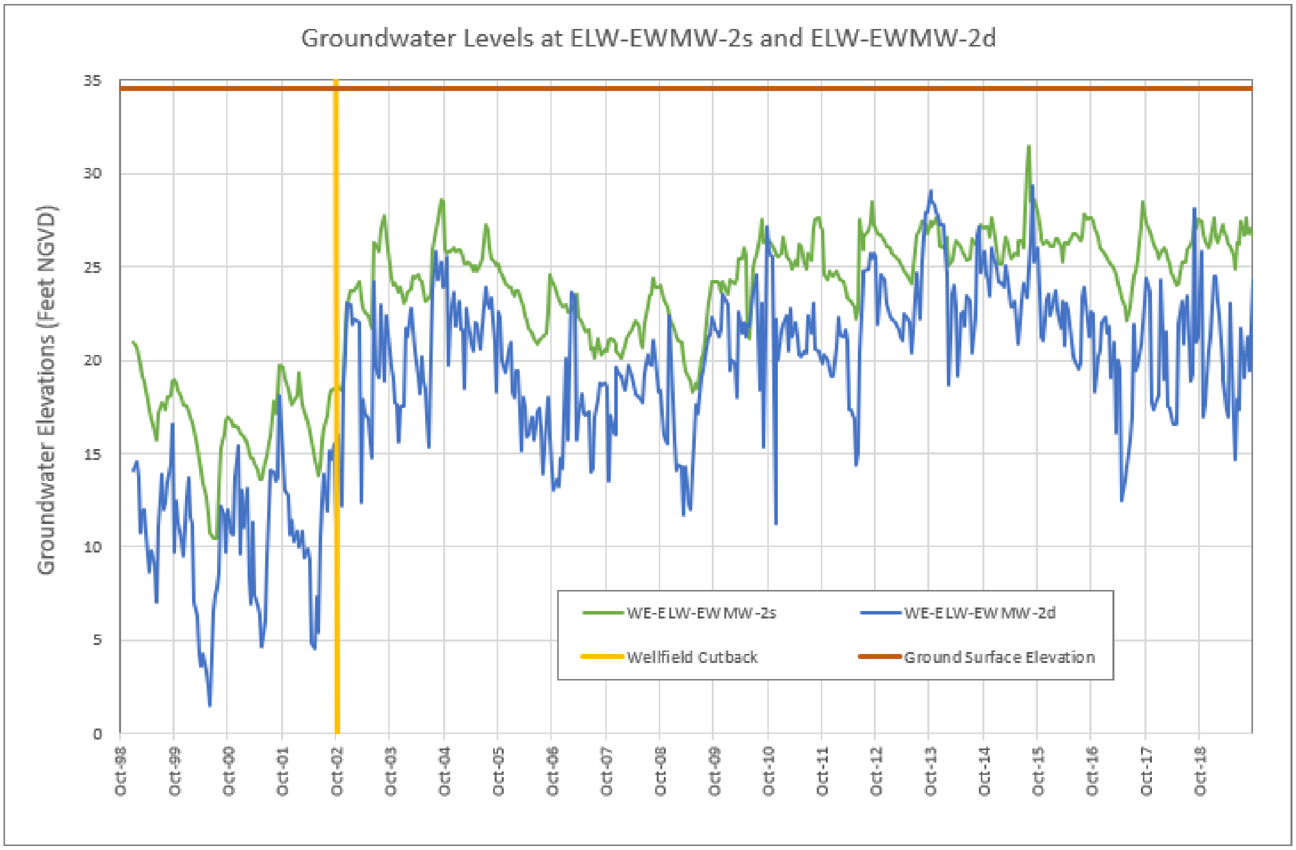


Figure 12.55: Surficial and Upper Floridan Aquifer Water Levels at Eldridge-Wilde Wellfield Monitor Wells EWMW-2s and EWMW-2d

12.8.1 Site-Specific Results

There are 14 monitored wetlands on the final recovery assessment list associated with the Eldridge-Wilde Wellfield. The final recovery assessment classifications for these wetlands are presented in Section 9.2.8 and the final assessment bin for each of these wetlands is included in Table 9.8. The final recovery assessment results for these wetlands are summarized as:

- Recovered – 11 wetlands
- Improved – 2 wetlands
- Impacted Due to Other Causes – 1 wetland

Ten of the 14 monitored sites are isolated mesic cypress wetlands, one is an isolated xeric cypress wetlands, two are connected wetlands, and one is classified as Other. The wetlands at the EWWF were assessed as described in Chapter 9 and the location and final status of these 14 wetlands are shown in Figure 9.27. Monitoring of wetland SW082717 has been discontinued but sufficient information was available to make a final quantitative assessment of recovery.

Eight of the 10 isolated mesic cypress wetlands met the recovery metric and are classified as Recovered. Mesic cypress wetlands NW062717 and SW062717 are classified as Improved as they did not meet their hydrologic offset metric. These wetlands are located north and south of Lake Dan, respectively. Wetland SW062717 is located adjacent to Lake Dan and missed its recovery metric by 0.4 foot for the Water Year 2008 – 2019 period of final evaluation. The one xeric-associated cypress wetland, EWWF3, was analyzed using the updated xeric wetland metric and is classified as Recovered. Both of the connected wetlands are classified as Recovered. Isolated mesic cypress wetland SW272717 (Lansbrook Golf Course) did not meet its hydrologic recovery metric and was further reviewed. Aerial photography and a site visit including the District staff showed that the site water levels, located adjacent to the golf course parking lot, are drained by a ditch and likely suppressed by the adjacent stormwater pond. The site is located more than three miles south of the wellfield in an area of little to no surficial aquifer drawdown. Due to the associated ditch and stormwater pond, the site is prevented from achieving its hydrologic recovery metric and is classified as Impacted Due to Other Causes.

Five lakes are associated with the EWWF and Lake Dan is the only lake on the wellfield property. As previously discussed, Lake Dan is located in the area with little to no confining layer beneath the surficial aquifer and lake water levels were historically low, exposing part of the lake bottom sediments. It is a very leaky lake system; however, the water levels in Lake Dan have significantly recovered, meeting many of the metrics used for the weight-of-evidence lake recovery analysis described in Chapter 8. The lake median (P50) and P10 water levels met the Minimum Level for the last 6-year and 10-year periods and passed the rate-of-decline analysis and the post-cutback water level trend slope analysis. The lake has achieved these levels without any groundwater augmentation since 2010. The lake median water level was 0.74 foot below the established Minimum Level for the full post-cutback period of 2003 – 2019 and was not classified as meeting the Minimum Level by District staff in 2018. The lake is classified as Improved for this recovery assessment; however, the improvement in water levels at Lake Dan is significant and shown in Figure 12.56.

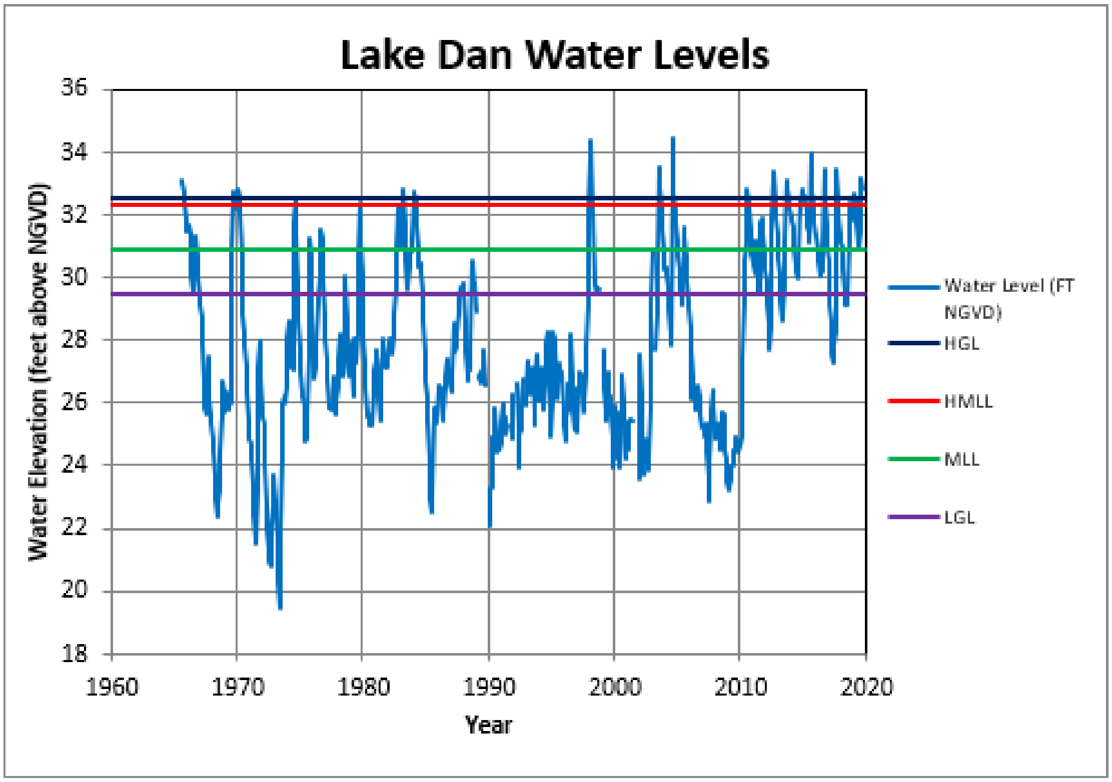


Figure 12.56: Period of Record Water Levels at Lake Dan

The other four lakes associated with the EWWF are located just south of Keystone Road to the southeast of the wellfield: all four are classified as Recovered. These results are presented in Table 14.1, and the lakes with their recovery status indicated are included in Figure 8.8. This figure also includes the results for lakes at nearby the nearby Cosme-Odessa Wellfield.

The Area of Investigation for the Eldridge-Wilde Wellfield is described in Section 5.3 and the 286 unmonitored wetlands and lakes within this defined area were qualitatively assessed as described in Chapter 10. The qualitative recovery assessment of these unmonitored sites is shown in Figure 10.18 and 263 sites (92%) were predicted to have a High Degree of Certainty of Wetland Health. Only 23 sites (8%) are predicted to have a Low Degree of Certainty of Wetland Health. The final assessment results for all monitored and unmonitored sites on and near the wellfield is presented in Figure 14.6.

12.8.2 Discussion of Recovery

Historic environmental impacts on the EWWF were observed in the years with higher annual average pumping rates that predated regulations on water withdrawals or the regulatory changes that prohibited impacts to wetlands on property owned or controlled by the permittee. Documented soil subsidence and soil loss due to karst features occurred during this historic period and changed the soil substrate under some of the wetland systems on the wellfield. After the reduction in pumping, environmental recovery has occurred on the wellfield property and water levels have returned to wetland systems that had been dry for many years.

The water level recovery in the aquifers beneath the EWWF following the reduction in wellfield pumping has been characterized by Wise (2016) as 4 to 9 feet in the Upper Floridan Aquifer and 2 to 6 feet in the surficial aquifer within the wellfield property. The hydrograph of monitor wells EWMW2s and EWMW2d on the north-central boundary of the wellfield shows that the surficial aquifer in this area has recovered by approximately 8 feet and the Upper Floridan Aquifer potentiometric surface has improved by approximately 10 feet since October 2002 (Figure 12.55). In response to these improvements in the surficial and Upper Floridan aquifers, lakes and wetlands across the wellfield have also improved and the majority of monitored wetlands in the wellfield meet their recovery metrics. Lake Dan has maintained median water levels above its recovery target for the latest 6- and 10-year periods without augmentation since 2010 despite being in the area without a continuous confining layer beneath the surficial aquifer.

Figure 14.6 shows the location of all monitored wetlands, monitored lakes, and unmonitored sites associated with the EWWF and their final Recovery Assessment classifications. The two wetlands and Lake Dan that are classified as Improved are located in the center of the wellfield, the area shown to have little or no confining layer beneath the surficial aquifer. The recovery of the potentiometric surface beneath wetlands across the wellfield is shown in the four hydrographs of Figure 12.57. Wetlands NW022716, SW062717, and NW052717 are located along the northern part of the wellfield, closest to the Trinity community. These hydrographs show that the potentiometric surface has increased in elevation beneath these wetlands following the reduction in wellfield pumping, to generally less than 10 feet below land surface. This higher potentiometric surface increases the potential for flooding in areas surrounding the EWWF. As previously discussed, residential and commercial development around the wellfield primarily occurred during the time of higher pumping and lower water levels. The Trinity community and Duck Slough areas to the northwest of the wellfield have experienced repeated flooding conditions since the reduction in wellfield pumping and the District and Pasco County are working on measures to move high water from these areas to alleviate flooding. Further reduction in the wellfield pumping rate would exacerbate these conditions, and so the recovery that can be achieved in the center of the wellfield is limited.

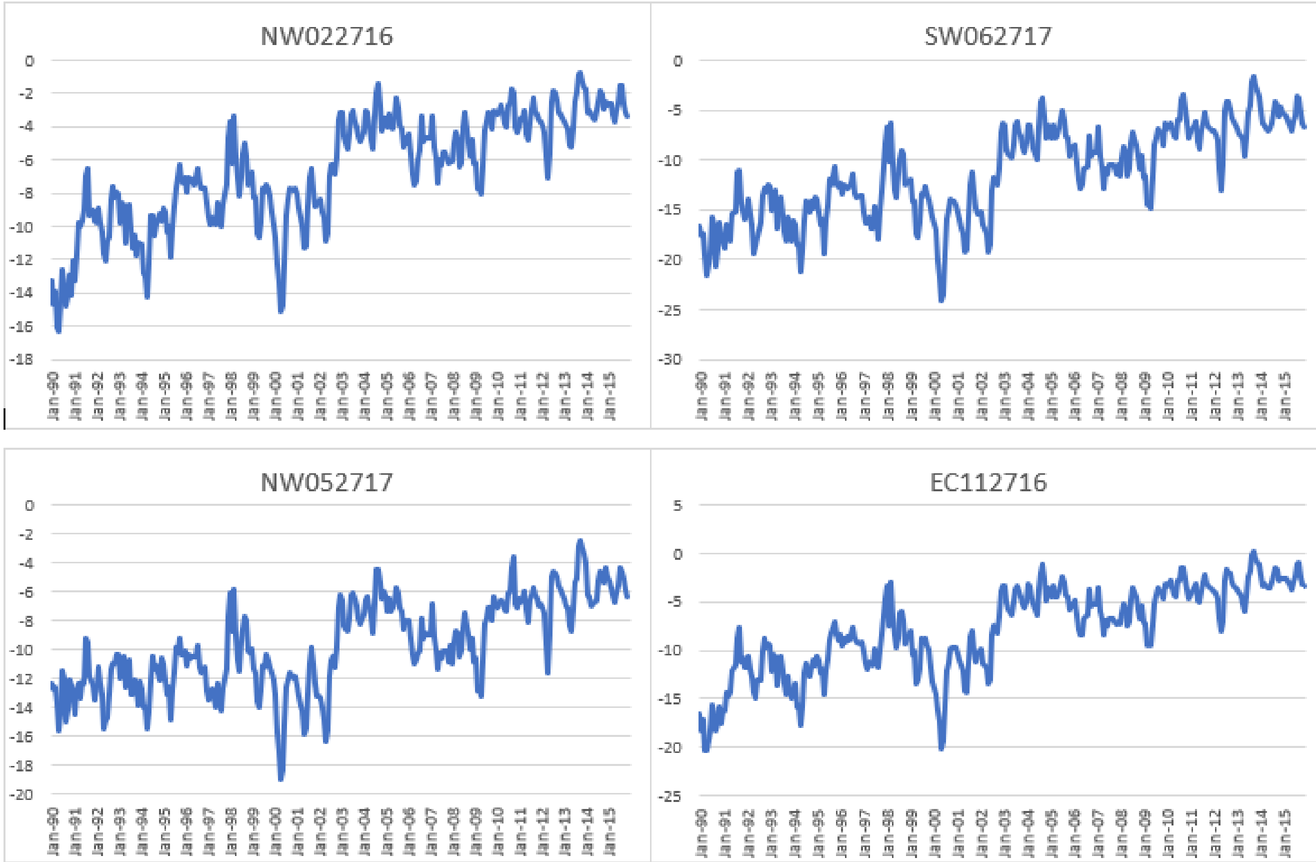


Figure 12.57: Depth to the Upper Floridan Aquifer Potentiometric Surface Beneath Four Wetlands at the Eldridge-Wilde Wellfield

In summary, all wetlands and lakes at the Eldridge-Wilde Wellfield have achieved significant levels of recovery. The majority of the monitored sites meet their recovery metrics or are prevented from meeting their metric by drainage alterations. The three sites that are classified as Improved show significant hydrologic improvements and alterations within the surrounding drainage basins have limited the degree of recovery that can be achieved. The current condition of the monitored lakes and wetlands on the wellfield is the new baseline condition for the EWWF.

12.9 Cosme Odessa Wellfield

The Cosme-Odessa Wellfield (COWF) was developed by the City of St. Petersburg beginning in 1930. The wellfield was expanded in phases to meet the City's potable water needs with the last production wells drilled in 1957. The wellfield consists of three separate parcels with the original and largest parcel bounded on the east by Gunn Highway and on the south by Race Track Road. The middle and northern segments of the wellfield stretch north along the former Seaboard Airline Railroad right-of-way toward Odessa with the northern production wells located along the east side of Gunn Highway approximately 1.5 miles north of the main wellfield (Figure 12.58). A more comprehensive discussion of the history of the wellfield is included in Section 3.3.

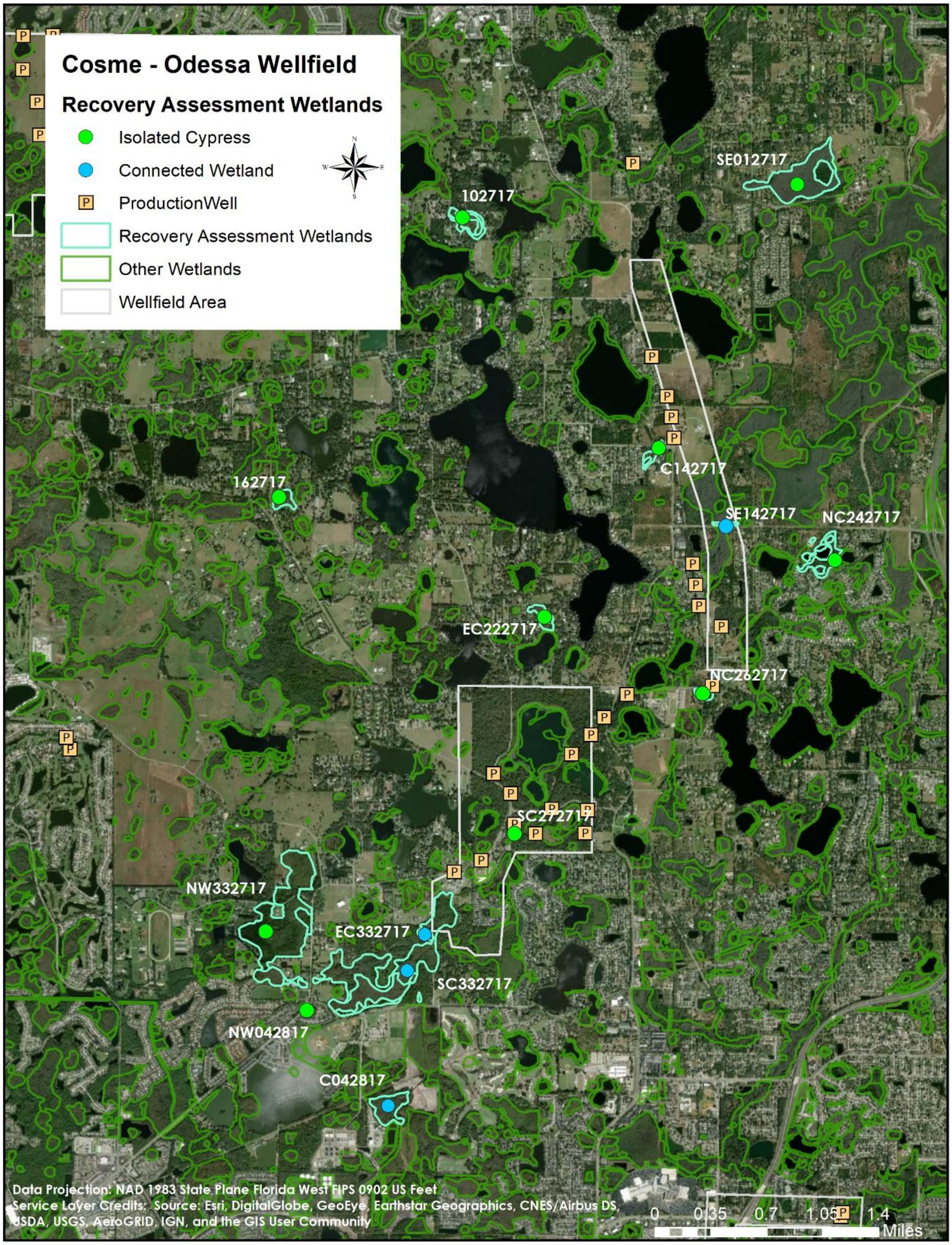


Figure 12.58: Cosme-Odessa Wellfield, Wetland Monitoring Sites and Production Wells

The generalized geology in the wellfield area is typical of the northern Tampa Bay region with a clay semi-confining layer between the surficial aquifer and the underlying limestone strata of the Upper Floridan Aquifer. The semi-confining layer in the area of the COWF is described as varying between 5 and 40 feet thick (Corral and Thompson, 1988). In areas with less confinement between the aquifers, water in the surficial aquifer leaks downward more readily than in areas with greater confinement. The topography of the COWF area is generally flat, with elevations dropping in the proximity of the many lakes and wetlands present in this area. Prevalent natural communities in the wellfield area include cypress wetlands (strands, sloughs, and domes), pine flatwoods and oak hammocks. Some of the lakes and wetlands are internally drained and are only connected under unusually high water conditions while other wetlands are connected creating sloughs and strands. Rocky and Brushy Creeks are located in COWF area, both of which flow through a series of lakes before reaching Old Tampa Bay and Lake Tarpon, respectively.

Aerial photography from 1938 shows that the COWF area was relatively undeveloped with prevalent natural communities and some agricultural uses, primarily citrus, on significant tracts of land (Figure 3.3). By 1967, pasture and citrus land uses are more prevalent than natural communities and numerous homes can be seen surrounding most of the lakes in the area (Figure 3.4). The 2018 aerial photograph shows that the area has remained mostly rural although much of the former agricultural land has transitioned to residential use. Homes have been constructed surrounding most of the lakes in the region with small residential developments along county roads. Citrus production has largely left the area; some tracts of pasture and other undeveloped areas remain (Figure 3.5).

The COWF is the oldest of the Consolidated Permit wellfields, coming online in September 1930. The annual average pumping rate during Water Year 1931 was 1.7 mgd and steadily increased to a maximum of 19.6 mgd in Water Year 1962, the highest annual pumping rate in the period of record. During the late 1950s and early 1960s, water production was greater than 15 mgd and concerns grew about the effects of wellfield-related drawdown in area lakes. The Section 21 Wellfield came online in 1963 allowing the pumping rate to be reduced at the COWF. The average annual wellfield production rate generally fluctuated between 7 and 12 mgd until regional alternative water supplies were available and wellfield pumping decreased in Water Year 2003. Since that time, annual average production from the COWF has fluctuated between 2 and 9 mgd (Figure 3.37). The annual average pumping rate for the wellfield was 9.7 mgd during Water Years 1986 through 2002 and declined to an average of 6 mgd during Water Years 2003 through 2019, a reduction of 38%.

Rain gages at the nearby Northwest Hillsborough Regional and Eldridge-Wilde Wellfields were used to assess environmental conditions on the COWF. The average Water Year total rainfall at the long-term rainfall gage in nearby St. Leo, Florida is 54.05 inches and is considered representative of the area. At the COWF, Water Year total rainfall has fluctuated from approximately 32 inches during drought years to 80 inches in years with significant storm or hurricane activity (Figure 12.42). Notable periods of drought at the COWF occurred during 1992 through 1997, 1999 through 2002, and 2005 through 2009. Most of the years during the period of 1989 through 2009 had rainfall totals below the long-term average. These periods were punctuated by periods of extreme rainfall in 1998 and 2003 to 2004. These extreme events were sufficient to reset wetland, lake, and groundwater levels to normal levels. The 2003 rainfall coincided with the reduction in wellfield production, resulting in rapid water level recovery. Since Water Year 2009, rainfall typically has been near or above the long-term average with high rainfall recorded in Water Years 2012, 2015, and 2019.

Most wetlands and lakes associated with the COWF are within relatively undeveloped areas, either on the wellfield or other government-owned land, or adjacent to semi-rural low to medium density residential areas common in the area. In the late 1950s and early 1960s, lowered lake levels were noted by the City and area residents. This was the time of highest wellfield pumping and the effects of any agricultural ditching associated with pasture or citrus land uses would have been realized. Citrus was prevalent in the area during this time and groves are usually well-drained to maintain the drier soils that citrus requires. Wetlands in the wellfield area likely experienced the same low water level conditions; however, historical references from this time only discuss the low water level conditions observed in area lakes.

Figure 11.2 shows model-predicted drawdown in the surficial aquifer for two periods, before and after the reduction in wellfield pumping. At the COWF, the median drawdown in the surficial aquifer during 1996 - 2002 was predicted to be four feet or less, with some areas of the middle and northern portions of the wellfield with less than two feet of predicted drawdown. The average wellfield pumping in 1996 – 2002 was 10.8 mgd. During the period of 2012 - 2018, the predicted surficial aquifer drawdown on the wellfield is less than two feet in all areas. The predicted drawdown in the Upper Floridan Aquifer during 1996 - 2002 was much greater with median drawdown of 12 to 15 feet in the southern wellfield area (Figure 11.4). The median predicted drawdown in the Upper Floridan Aquifer during 2012 - 2018 at the COWF was reduced to 4 to 6 feet with less than 4 feet at the north end of the wellfield.

The drawdown in the surficial and Upper Floridan aquifers was higher during the late 1950's and early 1960's when the COWF average pumping rate was between 15 and 20 mgd. It was during this period that low lake water levels were observed in the wellfield area and in some cases, lake and wetland bottom organic sediments became exposed to air. When this occurs for prolonged periods of time, the organic soils desiccate and decomposition may occur. The organic soils are important to the hydrologic health of lakes and wetlands as they act as a confining layer at the bottom of the wetland or lake slowing the leakage of water into the underlying surficial aquifer. Organic soils also retain moisture to support wetland-dependent plants during seasonal or longer-term dry periods. Soil subsidence can occur due to oxidation, loss of mineral soils through karst-type collapse features, or both processes.

The change in leakance properties within the lake basins of Lakes Raleigh and Rogers, both located on the southern part of the COWF, are documented in the reports establishing Minimum Levels for these two systems (Southwest Florida Water Management District, 2013a and 2013b). These reports state that a shift in water regime or levels occurred within these two lakes sometime during the late 1950's to mid-1960's. The District stated in the reports that it is possible that the physical stress associated with increasing pumping rates and additional surface storage at flood elevations (Hurricane Donna event) altered leakance properties between Lakes Raleigh and Rogers and the Upper Floridan Aquifer System, perhaps through sinkhole activity. There were no known drainage alterations during this period of time that could be associated with the precipitous shift in lake stage. Because of this structural alteration of the lake basins associated with the change in leakance properties, the two systems are classified as structurally-altered lakes.

Historic structural alterations to monitored wetland SC272717 (also known as Cosme WF Wetland) was documented in the District report reevaluating wetland Minimum Levels in the northern Tampa Bay area (Southwest Florida Water Management District, 2019b). This wetland is located on the southern part of the wellfield just south of Lakes Raleigh and Rogers. The report cites significant soil subsidence observed around cypress roots and that the entire center of the wetland appears to have collapsed. The District observed indicators of wetland normal pool at two distinctly different elevations leading to the conclusion that this wetland experienced significant soil subsidence and collapse many years ago. As a result, the wetland was removed from the Minimum Level Wetland list. While this is the only monitored wetland at the COWF with this level of documented subsidence, other wetlands and lakes in the area also experienced the same historic dry conditions and may also have some level of historic soil subsidence.

An assessment of improved water levels in the surficial and Upper Floridan aquifer was conducted by the Wise Consulting Group (2016d). Water level data was compared from 1994 to 2002 and from 2005 to 2013 to represent the COWF-area water levels before and after the reduction in wellfield pumping. This assessment found average water level improvement in the surficial aquifer of about 1 to 1.5 feet across the COWF area, with some higher values at specific monitor wells adjacent to production wells (Figure 12.59). The Upper Floridan Aquifer recorded average water level improvement of 3.5 to 5 feet in and around the wellfield (Figure 12.60). Note that the time periods used did not include the years of peak production (and drawdown) in the 1950s and 1960s, which would identify greater levels of aquifer recovery. The sustained recovery in the surficial and Upper Floridan aquifers is shown for monitor wells COS-10s and COS-James 11 in the center of the wellfield in Figure 12.61. Following the reduction in wellfield pumping, water levels improved by 1.8 feet in the surficial aquifer and 3.9 feet in the Upper Floridan Aquifer following the reduction in wellfield pumping.

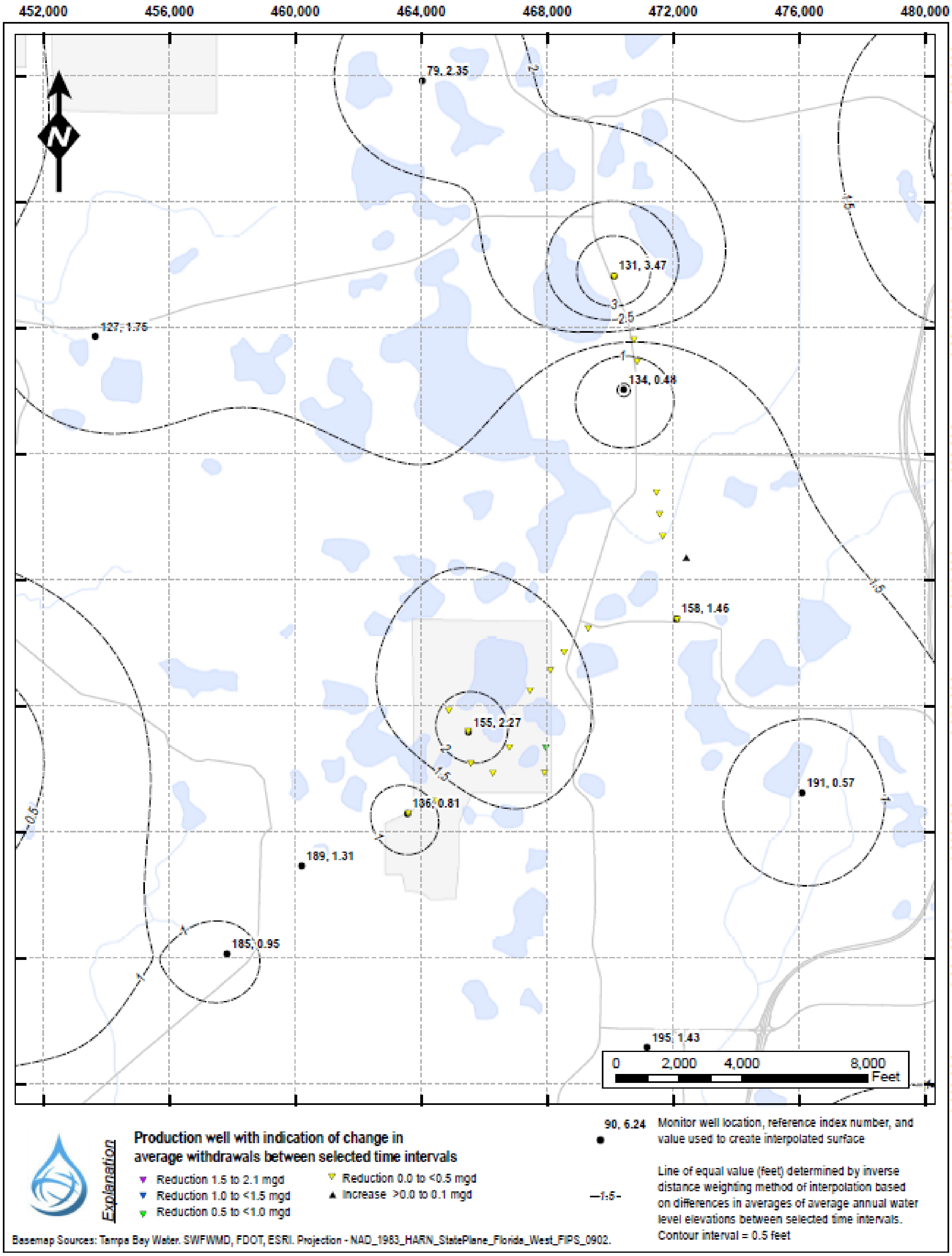


Figure 12.59: Recovery in the Surficial Aquifer System at the COWF due to Pumping Reduction
(from Wise Consulting Group, 2016d)

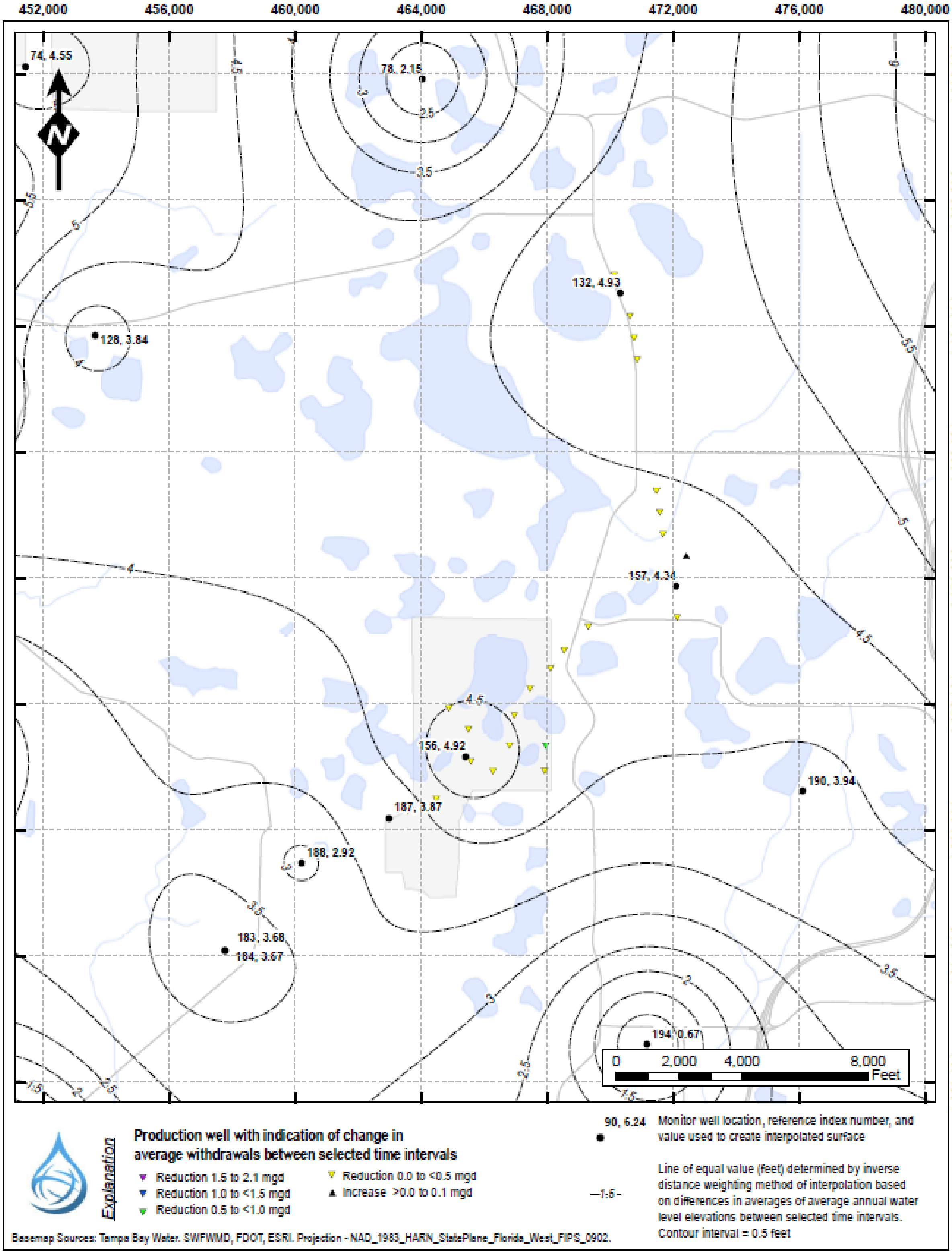


Figure 12.60: Recovery in the Upper Floridan Aquifer System at the COWF due to Pumping Reduction (from Wise Consulting Group, 2016d)

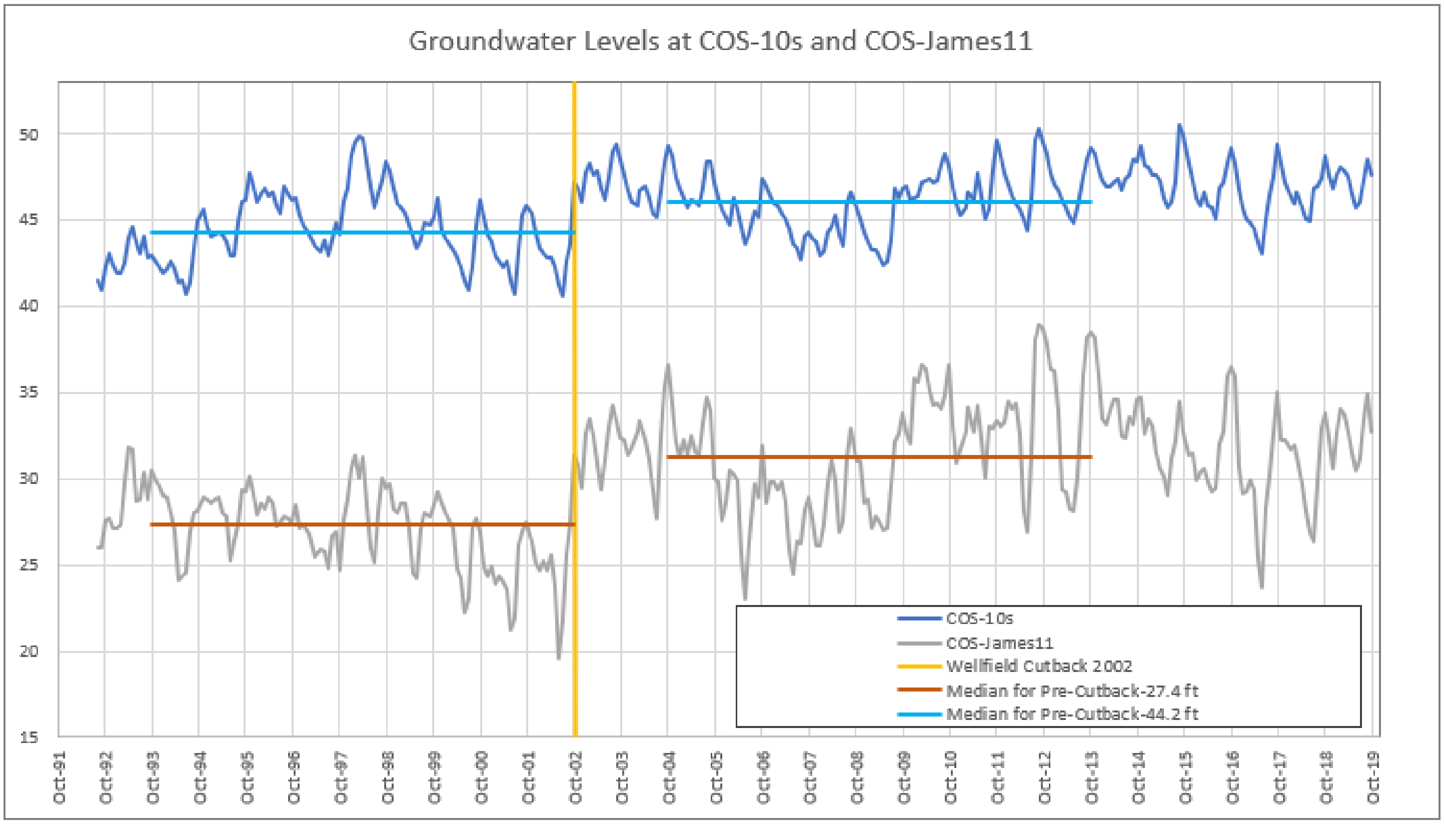


Figure 12.61: Surficial and Upper Floridan Aquifer Water Levels at COWF Monitor Wells COS-10s and COS-James 11

12.9.1 Site-Specific Results

There are 14 monitored wetlands on the final recovery assessment list associated with the Cosme-Odessa Wellfield. The final recovery assessment classifications for these wetlands are presented in Section 9.2.7 and the final assessment bin for each of these wetlands is included in Table 9.8. The final recovery assessment results for these wetlands are summarized as:

- Recovered – 11 wetlands
- Improved – 2 wetlands
- Impacted Due to Other Causes – 1 wetland

Five of the 14 monitored sites are isolated mesic cypress wetlands, four are isolated xeric cypress wetlands, four are connected wetlands, and one is classified as Other. The wetlands at the COWF were assessed as described in Chapter 9 and the location and final status of these 14 wetlands are shown in Figure 9.28. Monitoring has been discontinued at three of these sites but all had sufficient information to make a final quantitative assessment of recovery.

Site NC242717 is an isolated mesic cypress wetland and monitoring was discontinued in 2013 due to loss of access. The available water level data through 2013 indicated that the site was not meeting its recovery metric and was investigated further. Aerial photography of various time periods was examined and evidence of ditching was found in the area; however, it could not be determined that any of the ditches directly affect the site. The site shows improvement after the reduction in wellfield pumping, but without sufficient evidence of non-wellfield impacts, the site is classified as Improved.

Site SC272717 is an isolated xeric cypress wetland located in the southern portion of the COWF and was until recently one of the District Minimum Level wetlands (Cosme WF Wetland) as described above. The site experienced severe historic subsidence due to a combination of loss of organic soils and karst activity. The wetland is now structurally altered and is too deep to support rooted plants when full of water, although cypress trees and other wetland vegetation exist along the littoral zone and fringes. The wetland missed meeting its xeric recovery metric by 0.27 foot for the final assessment period of 2008 through 2019 and is classified as Improved.

Site NW042817 is a small isolated mesic wetland located to the southwest of the COWF. The wetland is bisected by Race Track Road and is drained by the associated roadside ditches. Monitoring of this wetland was discontinued in 2005 due to road-widening work which destroyed all monitoring devices. The transitional and outer deep monitoring zones of this wetland were also destroyed when the road was widened. Since the wetland water levels are controlled by the roadside ditches, this wetland is classified as Impacted Due to Other Causes as described in Appendix 9.12.

There are many lakes in the COWF area and 38 lakes are associated with the wellfield in the Recovery Assessment Plan. The lakes are shown in Figure 8.8 and extend from Black Lake south of State Road 54 to Fairy (Maureen) Lake south of the wellfield. The lakes at the northern end of the map are also close to the Eldridge-Wilde Wellfield. Several of these lakes are controlled by fixed or operable outfall structures in order to control the flow of water and prevent flooding conditions at the surrounding homes and roads. The recovery of monitored lakes was assessed using a weight-of-evidence approach that emphasized statistical analyses of water levels, as described in Chapter 8. The final status for all Recovery Assessment lakes is presented in Tables 8.2 and 8.5 and all lakes in this area are classified as Recovered based on the Recovery Assessment weight-of-evidence analyses with two exceptions. Buck Lake is classified as Not Impacted by Wellfield Pumping and Fern Lake is classified as Improved as described in Chapter 8. With the reduction in pumping at the COWF to a post-cutback average of 6 mgd for Water Years 2003 to 2019 and a return to more normal rainfall conditions, these lakes have Recovered and are expected to maintain this status.

Since the reduction of wellfield pumping in 2003, water levels in lakes near the COWF with established Minimum Levels (Calm, Horse, Juanita, Little Moon, Rainbow, Raleigh, and Rogers Lakes) have met their Minimum Levels for the past 6 and 10 years. and since the reduction of wellfield pumping. This includes meeting both the established Minimum and High Minimum Levels for all three time periods. The period of time since the pumping was reduced at the COWF and other regional wellfields has included periods of both above and below-average rainfall and the recent period is characterized as approximately average with only five years since 2003 with greater than 60 inches of rainfall recorded at the nearby Eldridge Wilde Wellfield and Northwest Hillsborough gages (Figure 12.42).

The Area of Investigation described in Section 5.3 does not include the COWF due to less than 2 feet of predicted drawdown in the surficial aquifer. Therefore, there are no unmonitored wetlands associated with the wellfield. The median predicted drawdown map for 2012 – 2018 shown in Figure 11.2 also shows that there is less than two feet of median predicted drawdown in the surficial aquifer based on actual pumping levels during this recent time period. The final assessment results for all monitored and unmonitored sites on and near the wellfield is presented in Figure 14.7.

12.9.2 Discussion of Recovery

The COWF is the oldest wellfield governed by the Consolidated Permit. Historic impacts in the wellfield area were observed in the years with higher annual average pumping rates that predated regulations on water withdrawals or the regulatory changes that prohibited impacts to wetlands on property owned or controlled by the permittee. Documented soil subsidence, possible karst features, and the reduction in leakage rates in the confining layer beneath some lakes and wetlands occurred during this historic time period reducing the ability of some area lakes and wetlands to retain water. Environmental recovery has occurred throughout the wellfield area after the reduction in pumping that began in Water Year 2003. The degree of recovery achieved at the COWF eliminated the need for the Rocky Creek Lake Enhancement Project evaluated under the Phase 1 Mitigation Plan. This project was intended to divert flow from Lake Pretty during times of high flow into lakes Horse, Raleigh, and Rogers to restore lake water levels. Due to water level recovery, the Minimum Levels established for these lakes and public opposition, this project was not pursued.

The water level recovery in the aquifers beneath the COWF following the reduction in wellfield pumping has been characterized by Wise (2016d) as 3.5 to 5 feet in the Upper Floridan Aquifer and 1 to 1.5 feet in the surficial aquifer within the wellfield property. These estimations of recovery were based on available water level data from the period of 1994 to 2002, not the higher pumping period of the late 1950's and early 1960's. In response to these improvements in the surficial and Upper Floridan aquifers, lakes and wetlands across the wellfield have also improved and the majority of monitored wetlands in the wellfield meet their recovery metrics. A small number of flooding complaints have been received by the District following the reduction in wellfield pumping near the COWF as shown in Figure 3.79 and most of them occurred after January 2010.

Figure 14.7 shows the location of all monitored wetlands, monitored lakes, and unmonitored sites associated with the COWF and their final Recovery Assessment classifications. There are 14 monitored wetlands at this wellfield and 86% are classified as Recovered or Impacted Due to Other Causes, and two sites (14% of the total) are classified as Improved. One of the Improved sites experienced historic soil subsidence and collapse and is structurally altered. The other Improved site is no longer monitored due to the loss of site access and the final recovery classification could only be inferred. Within the COWF area, 37 of the 38 monitored lakes are classified as Recovered or Never Impacted and only Lake Fern located north of the wellfield is classified as Improved.

In summary, all wetlands and lakes at the Cosme-Odessa Wellfield have achieved significant levels of recovery. The majority met their recovery metrics, except for those sites prevented from doing so by manmade or structural alterations. The current condition of the monitored lakes and wetlands on the wellfield is the new baseline condition for the COWF.

12.10 Section 21 Wellfield

The Section 21 Wellfield was developed by the City of St. Petersburg on a 600-acre parcel in northwest Hillsborough County, southwest of the intersection of Dale Mabry Highway and Van Dyke Road (Figure 12.62). The City drilled ten production wells on the property and six of the wells began producing water in 1963. While the City still owns the property, Hillsborough County leases the land and manages most of the property as Lake Park, a public-access park. A more comprehensive discussion of the history of the wellfield is included in Section 3.3.

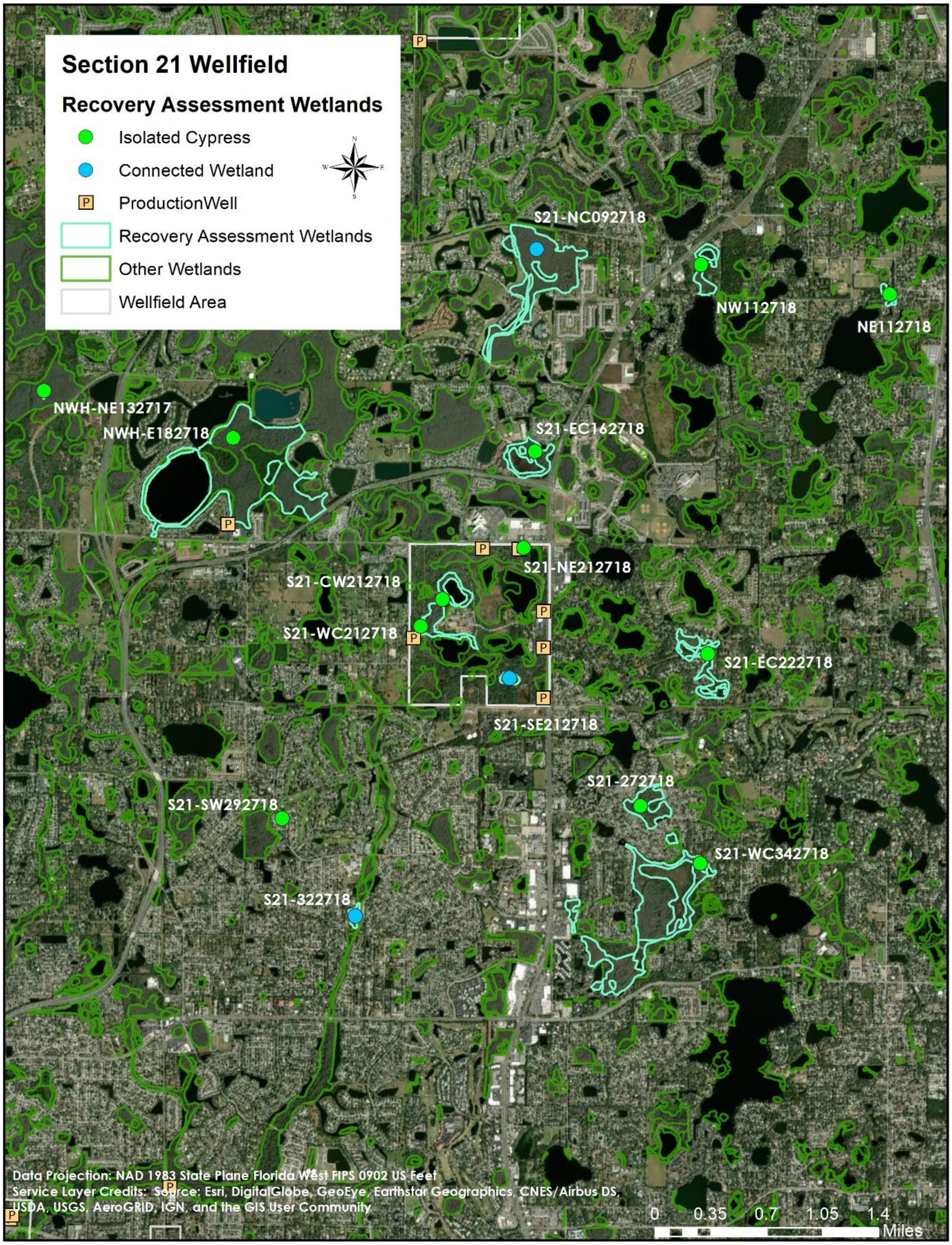


Figure 12.62: Section 21 Wellfield, Wetland Monitoring Sites and Production Wells

The generalized geology in the wellfield area is typical of the northern Tampa Bay region with a clay semi-confining layer between the surficial aquifer and the underlying limestone strata of the Upper Floridan Aquifer. Soon after the Section 21 Wellfield began pumping in 1963, 64 sinkholes were documented on and within one mile of the wellfield Sinclair, 1982). Several sinkholes were reported near production well 10 (Sinclair, 1982) which was pumped at nearly double the rate of the other wellfield production wells at the time. According to Sinclair, the clay layer between the surficial and Upper Floridan aquifers has been shown to be fairly sporadic throughout the southeastern portion of the wellfield, which could explain the formation of sinkholes in that area. Sediment borings performed by Ardaman & Associates, Inc. (2016) as part of an investigation of a possible sinkhole feature on wellfield, found that the clay confining layer ranges from 10 feet to less than 5 feet on the property. This possible sinkhole feature was in the southern half of the wellfield, an area known for having more severe drawdown and subsidence impacts to lakes and wetlands in the past. In areas with less confinement between the aquifers or within sinkhole features, water in the surficial aquifer leaks downward more readily than in areas with greater confinement. The northwestern area of the wellfield appears to have a thicker or more continuous clay layer than other areas.

The topography of the Section 21 Wellfield area is generally flat with the water table historically close to land surface. The result is that many lakes and wetlands in this area flow from one to another, creating sloughs, strands, and stream systems that convey surface flows to progressively larger streams. Most of the surface flows near the wellfield discharge into Brushy Creek either directly or via the Interceptor Canal. Prevalent natural communities in the wellfield area include lakes, cypress wetlands (strands, sloughs, and domes), pine flatwoods and oak hammocks.

Aerial photography from 1938 shows that the Section 21 Wellfield area was relatively undeveloped and much of the area around the wellfield had been converted to pasture (Figure 3.9). By 1967, agricultural uses of pasture and citrus were more prevalent and homes had been constructed around the lakes east of the wellfield (Figure 3.10). Dale Mabry Highway had been constructed on the east border of the wellfield and the large, excavated Interceptor Canal had been completed just south of the wellfield. This canal drains areas to the east and north of the wellfield through a system of natural and excavated flow-ways. By 1988, large areas of pasture remained, but large residential subdivisions had been constructed south of the wellfield on former agricultural areas (Figure 3.11). Low-density residential land use had increased around area lakes and the drainage connections between wetlands in residential areas had been improved. The 2018 aerial photograph shows that almost all of the remaining open areas have been developed with a few small tracts of pasture and low-to-mid-density residential areas (Figure 3.12). For the most part, the only undeveloped areas now are wetlands, which comprise a large proportion of the area.

The Section 21 Wellfield came online in 1963 and produced an average of 3.3 mgd that year. Production from the wellfield quickly increased to an annual average rate of 16.4 mgd between 1966 and 1973, with the period-of-record maximum Water Year average production occurring in 1970 (17.8 mgd). Pumping from the wellfield was reduced in 1974 when the South Pasco Wellfield came online. Between Water Years 1974 and 2004, the annual pumping rate from the wellfield averaged 9.1 mgd. This represented a 45% reduction in pumping from the 1966 to 1973 high production period. The Section 21 Wellfield was connected to the Regional System in Water Year 2005 allowing further a further reduction in pumping. The annual average wellfield pumping rate between Water Years 2005 and 2019 was 3.1 mgd, a further reduction of 66% compared to the average pumping rate during Water Years 1974 to 2004 (Figure 3.39).

Tampa Bay Water modified the active production wells at the Section 21 Wellfield in 2003 and 2004 by deepening the total depth of the wells, extending the production well casings to depths of approximately 200 feet below land surface, or both. The casings in production wells S21-8 and S21-10 could not be deepened due to physical issues with the wells. These measures were taken to reduce the amount of water from shallower zones entering the production wells and reduce impacts to lakes and wetlands. All of the production wells were returned to service in Water Year 2005 when the wellfield was connected to the Regional System. Lake and wetland water levels in and around the wellfield improved at that time, likely due to both the well modifications and the reduction in wellfield pumping rate.

Rainfall data from gages at the nearby Northwest Hillsborough Regional and Eldridge-Wilde Wellfields are presented to describe rainfall trends at the Section 21 Wellfield. The long-term average rainfall at the St. Leo, Florida gage is 54.05 inches and is considered representative of the area. In the northwest Hillsborough County area, Water Year total rainfall has fluctuated from approximately 32 inches during drought years to 80 inches in years with significant storm or hurricane activity (Figure 12.42). Notable periods of drought in the northwest Hillsborough area occurred during 1992 through 1997, 1999 through 2002, and 2005 through 2009. Most of the years during the period of 1989 through 2009 had rainfall totals below the long-term average. These periods were punctuated by periods of extreme rainfall in 1998 and 2003 to 2004. These extreme events were sufficient to reset wetland, lake, and groundwater levels to normal levels. The 2003 rainfall coincided with the reduction in wellfield production, resulting in rapid water level recovery. Since Water Year 2009, rainfall typically has been near or above the long-term average with high rainfall recorded in Water Years 2012, 2015, and 2019.

Lower water levels in lakes on and near the Section 21 Wellfield became a significant concern as pumping continued through the 1960's. These lower lake levels were generally attributed to wellfield drawdown and lower rainfall (Southwest Florida Water Management District, 1984b). Wetlands on the wellfield property also experienced lower water levels after the wellfield production began although there was no formal wetland monitoring program until much later. Lower water levels eventually led to soil desiccation and subsidence, tree fall, and the migration of upland plant species into some wellfield wetlands. The sinkholes observed on the wellfield and surrounding properties also affected water levels in nearby lakes and wetlands. Low wetland and lake water levels on the wellfield property are visible in the 1967 – 1969 aerial photograph with Starvation Lake having separated into two pools due to low water levels (Figure 3.10). Lake Simmons and other unmonitored lakes in the southern half of the wellfield were completely dry during the drought of 1999 to 2002.

Figure 11.2 shows model-predicted drawdown in the surficial aquifer for two periods, before and after the reduction in wellfield pumping. At the Section 21 Wellfield, the median drawdown in the surficial aquifer during 1996 to 2002 was predicted to be six to ten feet on the south half of the property and between two and six feet on the north half of the property. The average wellfield pumping in 1996 to 2002 was 9.5 mgd. During the period of 2012 to 2018, the predicted surficial aquifer drawdown on the wellfield is between two and four feet in the south and less than two feet in the north half of the wellfield. The predicted drawdown in the Upper Floridan Aquifer during 1996 to 2002 was much greater with median drawdown of 12 to 15 feet across the wellfield property (Figure 11.4). The median predicted drawdown in the Upper Floridan Aquifer during 2012 - 2018 at the Section 21 Wellfield was reduced to 4 to 6 feet.

Drawdown in both aquifers was greater during the higher pumping period of 1966 to 1973. During this period, particularly in those areas where the geologic confinement is less, the organic sediments of some lake or wetland bottoms can become dry and exposed to air. When this occurs for prolonged periods of time, the organic soils desiccate and decomposition may occur. The organic soils are important to the hydrologic health of lakes and wetlands as they act as a confining layer at the bottom of the wetland or lake to slow the leakage of water into the underlying surficial aquifer. Organic soils also retain moisture to support wetland-dependent plants during seasonal or longer-term dry periods. Soil subsidence can occur due to oxidation, loss of mineral soils through karst-type collapse features, or both processes. All of the monitored wetlands and lakes within this wellfield have experienced historic loss of organic soils, treefall, and changes in plant communities to varying degrees depending on their location. Monitored wetlands WC212718 and SE212718 on the wellfield property have experienced the loss of organic soils and more severe karst-type structural subsidence.

Wetlands and lakes located further from the wellfield were also historically affected by wellfield pumping but to a lesser degree. Lakes and wetlands off of the wellfield property have been impacted by a combination of drawdown, periods of deficit rainfall, and drainage alterations. The initial drainage changes occurred in the area for cattle pasture and citrus development. The Interceptor Canal was built in the mid-1960s to collect runoff from large areas to the north and east of the wellfield, making the land suitable for residential development. The planned developments that followed have stormwater management systems to prevent flooding in these communities. The outfall structures of lakes have been modified or improved to prevent flooding of adjacent homes and roads have been constructed and widened in the area, changing the direction and magnitude of stormwater flow. As a result of these various influences, the water levels in some lakes and wetlands located off of the wellfield property are prevented from reaching their historic high-water levels.

12.10.1 Site-Specific Results

An assessment of improved water levels in the surficial and Upper Floridan aquifer was conducted by the Wise Consulting Group (2016d). Data was compared from 1994 to 2002 and from 2005 to 2013 to assess the degree of water level improvement at the Section 21 Wellfield before and after the reduction in wellfield pumping. This assessment found water level recovery in the surficial aquifer of approximately 8 feet in the southern half of the wellfield and approximately 1.5 feet in the northwest corner of the wellfield where the semi-confining layer is thicker (Figure 12.63). The Upper Floridan Aquifer recorded average water level improvement of 7 to 8 feet within the wellfield (Figure 12.64) after the reduction in wellfield pumping. Note that the time periods used did not include the years of peak production (and drawdown) between 1966 and 1973, which would result in larger values of aquifer recovery.

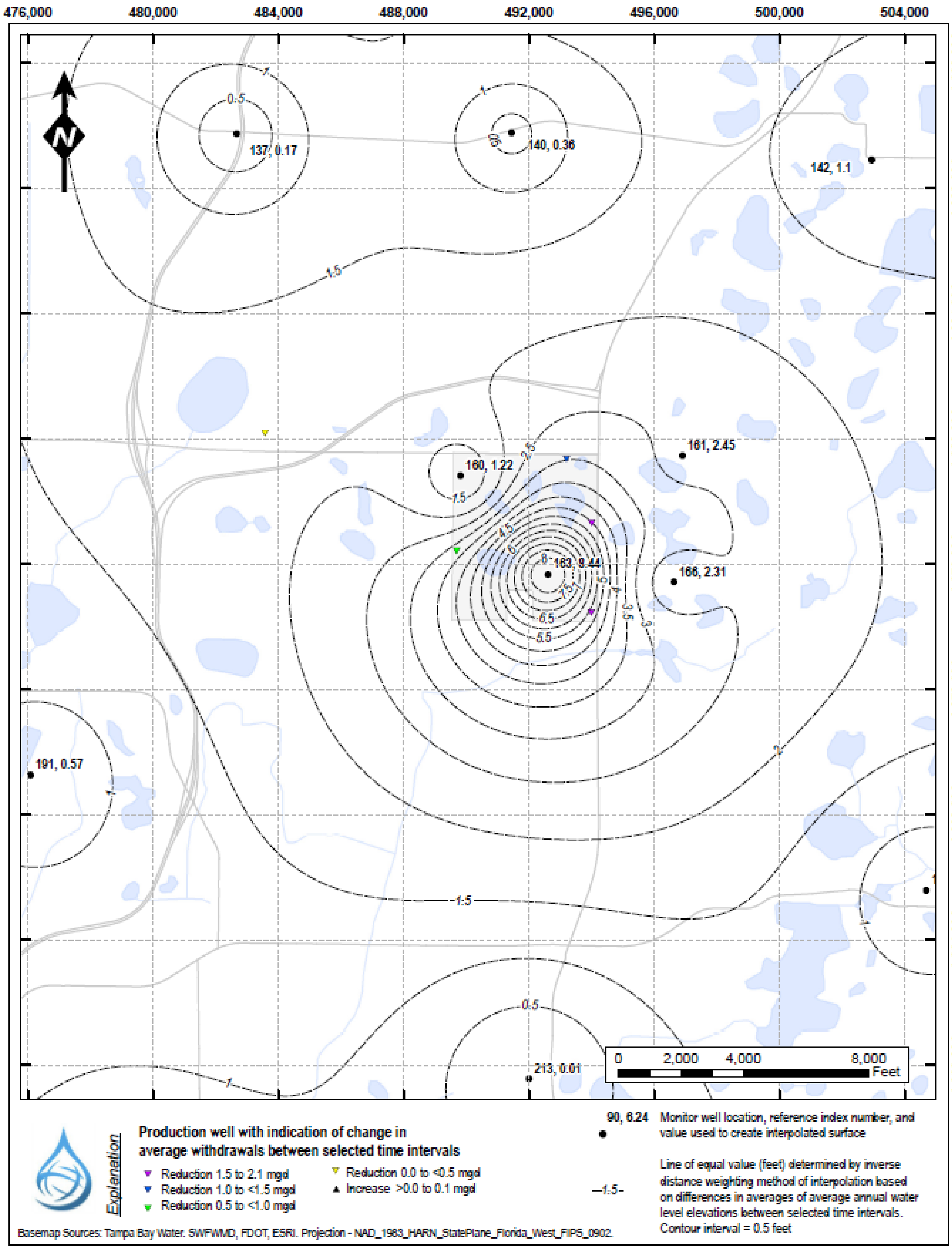


Figure 12.63: Recovery in the Surficial Aquifer at the Section 21 Wellfield due to Pumping Reduction (from Wise Consulting Group, 2016d)

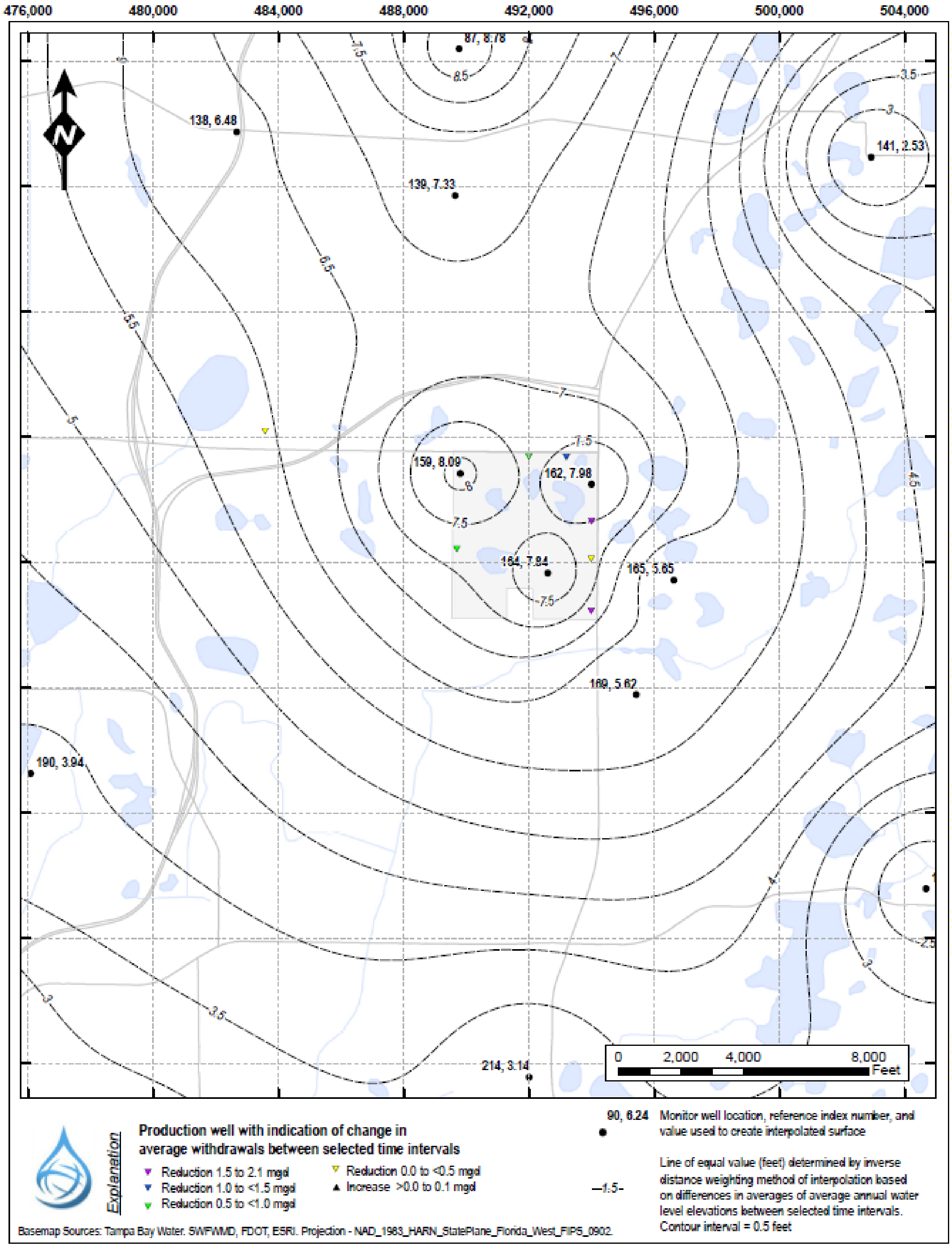


Figure 12.64: Recovery in the Upper Floridan Aquifer at the Section 21 Wellfield due to Pumping Reduction (from Wise Consulting Group, 2016d)

The sustained recovery in the surficial and Upper Floridan aquifers is shown for monitor wells Hillsborough-13s and 13d that are located in the southeast part of the wellfield (Figure 12.65). This area of the wellfield is known to contain sinkholes and has a high degree of leakance between the surficial and Upper Floridan aquifers. Following the reduction in wellfield pumping, median water levels at this site improved by 9.1 feet in the surficial aquifer and 7 feet in the Upper Floridan Aquifer. The water level in surficial aquifer monitor well Jackson-26As is also included in the hydrograph to demonstrate the difference in water level response in different areas of the wellfield. Monitor well Jackson 26-As is located in the northwest corner of the wellfield in an area with an effective semi-confining layer. There was only 1.3 feet of median water level recovery at this well after the reduction in wellfield pumping. Lake Jackson, located near this monitor well, has also shown little effect from historic levels of pumping.

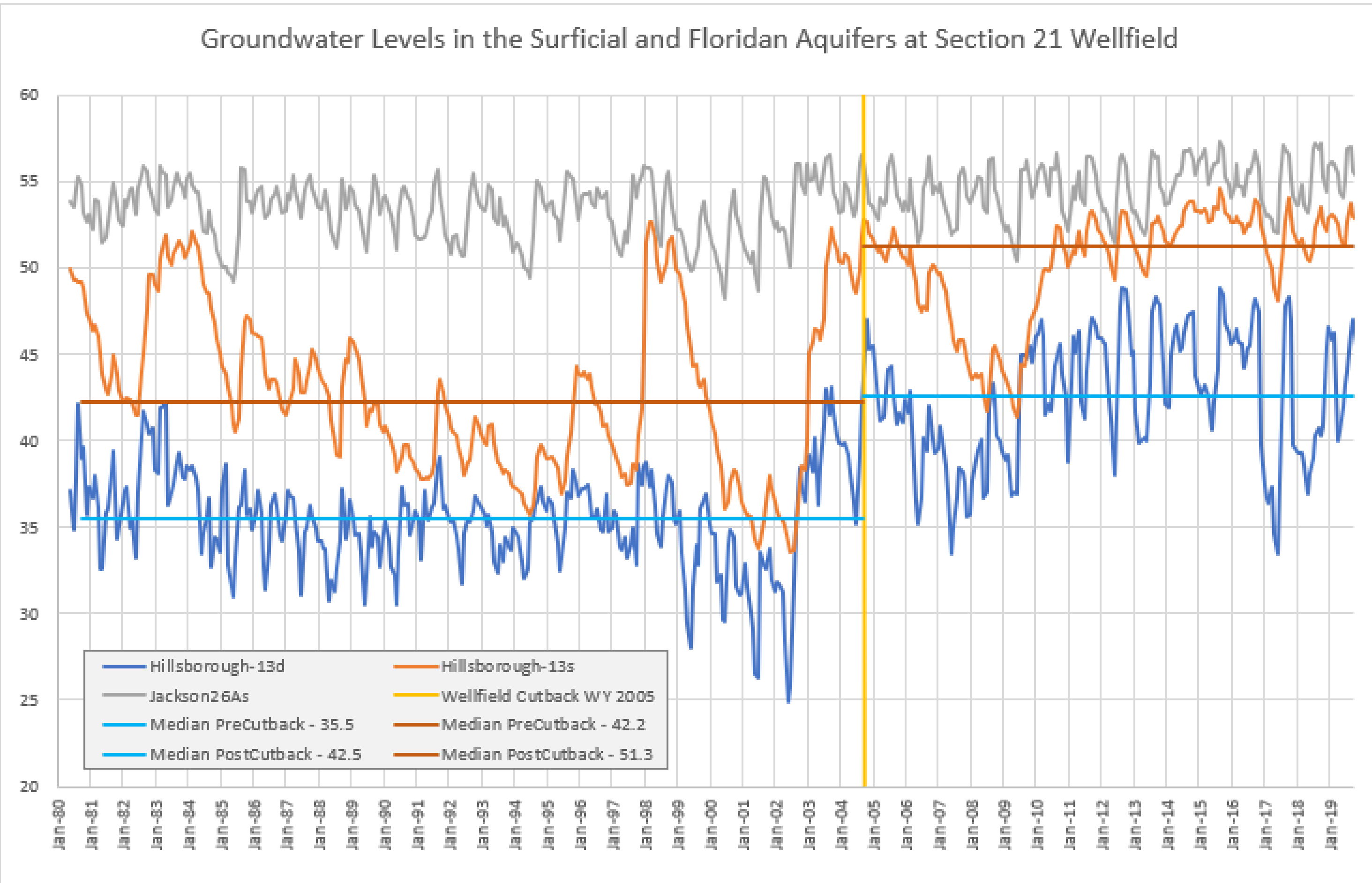


Figure 12.65: Surficial and Upper Floridan Aquifer Water Levels at Section 21 Wellfield Monitor Wells Hillsborough-13s, Jackson-26As, and Hillsborough-13d

There are 15 monitored wetlands on the final recovery assessment list associated with the Section 21 Wellfield. The final recovery assessment classifications for these wetlands are presented in Section 9.2.10

and the final assessment bin for each of these wetlands is included in Table 9.8. The final recovery assessment results for these wetlands are summarized as:

- Never Impacted – 1 wetland
- Recovered – 11 wetlands
- Improved – 3 wetlands

Eight of the 15 monitored sites are isolated mesic cypress wetlands, one is an isolated xeric cypress wetland, three are connected wetlands, and three are classified as Other. The wetlands at the Section 21 Wellfield were assessed as described in Chapter 9 and the location and final status of these 15 wetlands are shown in Figure 9.30. Monitoring has been discontinued at two of these sites but all had sufficient information to make a final quantitative assessment of recovery.

Site EC162718 is an isolated mesic cypress wetland but the metric and assessment method for this wetland type could not be applied since this site does not have a normal pool elevation; Tampa Bay Water has never had access to the interior of the wetland. All historic monitoring has been performed along the Dale Mabry Highway right-of-way. This wetland shows evidence of ditching and excavation in the aerial photographs from the late 1960’s and late 1980’s (Figures 3.10 and 3.11). Due to the lack of water level response to changes in wellfield pumping, it is classified as Never Impacted as described in Appendices 9.4 and 9.16.

Site NE212718 is an isolated mesic cypress wetland located in the northeast corner of the wellfield. This wetland missed its hydrologic recovery metric by 0.12 foot for the final assessment period of 2008 – 2019. A ditch connects this wetland to Starvation Lake and the outfall elevation of the wetland appears to prevent the wetland water level from regularly achieving the site normal pool elevation. A detailed survey of this drainage feature has not been completed at the time of this report and wetland NE212718 is classified as Improved.

Two remaining isolated mesic cypress wetlands are classified as Improved: sites NW112718 and 272718. Both of these sites are in locations impacted to some degree by local drainage. Site NW112718 is located approximately 2 miles northeast of the wellfield, adjacent to Dale Mabry Highway. This wetland drains into Lake Thomas through an outfall ditch as described in Appendix 9.16 and monitoring ceased in 2010. Wetland 272718 is located approximately one mile southeast of the wellfield and is surrounded by a subdivision also described in this appendix. The wetland is heavily ditched and appears to be part of the neighborhood stormwater management system. A detailed survey of this drainage system has not been completed at the time of this report and the wetland missed its hydrologic recovery metric by 1.9 feet for the final assessment period of 2008 – 2019. Both sites have improved water levels following the reduction in wellfield pumping. It is likely that the drainage features at the wetlands have been improved to prevent flooding or high water tables from affecting the nearby roads and residences thus hindering the ability of these wetlands to reach higher stages.

There are 32 lakes in the Section 21 Wellfield area that are associated with the wellfield in the Recovery Assessment Plan. The lakes are shown in Figure 8.10 and extend from Lakes Thomas and Commiston northeast of the wellfield to Lakes Platt and Burrell southeast of the wellfield. The lakes also extend west of the wellfield to Lakes Turkey Ford and LeClare. Other lakes associated with the Northwest

Hillsborough Regional and Cosme-Odessa Wellfields are also visible in the figure but are discussed in those sections of this report. Several of these lakes have control structures to prevent flooding conditions in the homes and roads surrounding the lakes. The recovery of monitored lakes was assessed using a weight-of-evidence approach that emphasized statistical analyses of water levels, as described in Chapter 8. The final status for all Recovery Assessment lakes is presented in Tables 8.2 and 8.5 and all lakes in this area are classified as Recovered based on the Recovery Assessment weight-of-evidence analyses. With the reduction in pumping at the Section 21 Wellfield and a return to more normal rainfall conditions, lakes in this area have Recovered and are expected to maintain this status.

Water levels in the majority of lakes on or near the Section 21 Wellfield with established Minimum Levels (Brandt, Bird, Charles, Crenshaw, Crystal, Dosson, Merrywater, Reinheimer, Round, Saddleback, Starvation, and Sunshine Lakes) meet their Minimum Levels for the past 6 and 10 years and since the reduction of wellfield pumping in Water Year 2005. This includes meeting both the established Minimum and High Minimum Levels for all three time periods. The two exceptions are Lakes Charles and Saddleback where the P10 water levels since Water Year 2005 were 0.1 foot or less below the High Minimum Levels for these lakes. Both lakes have been historically augmented; however, augmentation has been typically unnecessary since the reduction in wellfield pumping. The District report reevaluating the Minimum Levels for Lake Charles summarizes the pumping of water out of the lake by Hillsborough County in response to flooding concerns in 2015 and 2016 (Southwest Florida Water Management District, 2019c). The period of time since the reduction in pumping at the Section 21 Wellfield and other regional wellfields has included periods of both above and below-average rainfall. The recent period is characterized as approximately average with only three years since Water Year 2005 where the annual rainfall at the Eldridge Wilde and Northwest Hillsborough Wellfields were both above 60 inches (Figure 12.42).

The Area of Investigation for the Section 21 Wellfield is described in Section 5.3 and the 47 unmonitored wetlands and lakes within this defined area were qualitatively assessed as described in Chapter 10. The qualitative recovery assessment of these unmonitored sites is shown in Figure 10.21 and all 47 sites (100%) were predicted to have a High Degree of Certainty of Wetland Health. The final assessment results for all monitored and unmonitored sites on and near the wellfield is presented in Figure 14.8.

12.10.2 Discussion of Recovery

Historic impacts at the Section 21 Wellfield were observed in the years with higher annual average pumping rates that predated regulations on water withdrawals. Documented soil subsidence, sinkholes, and the associated reduction in leakage rates in the confining layer beneath some lakes and wetlands occurred during this historic time period reducing the ability of some area lakes and wetlands to retain water. Environmental recovery has occurred throughout the wellfield area after the reduction in pumping that began in Water Year 2005 and the deepening of the casings in most of the production wells at the wellfield. The degree of recovery achieved at the wellfield eliminated the need for the Section 21 Wellfield Restoration Project that was evaluated under the Phase 1 Mitigation Plan. This project was intended to use stormwater from the Interceptor Canal or reclaimed water from Hillsborough County to restore water levels in wetlands and lakes on the wellfield. Due to water level recovery across the wellfield property, this project was not pursued.

The water level recovery in the aquifers beneath the Section 21 Wellfield following the reduction in wellfield pumping has been characterized by Wise (2016d) as approximately 7 to 8 feet in the Upper Floridan Aquifer and up to 8 feet in the surficial aquifer on the south half of the wellfield. These estimations of recovery were based on available water level data from the period of 1994 to 2002, not the higher pumping period of the late 1966 to 1973. In response to these improvements in the surficial and Upper Floridan aquifers, lakes and wetlands across the wellfield have also improved and the majority of monitored wetlands in the wellfield meet their recovery metrics.

A small number of flooding complaints have been received by the District following the reduction in wellfield pumping near the Section 21 Wellfield as shown in Figure 3.79: most have occurred after January 2010. Residents on the east and west sides of the wellfield live in neighborhoods where the homes have individual septic tank systems for sanitation purposes. It has been reported to Tampa Bay Water staff that septic tank systems have been very slow to drain during recent summer rainy seasons when the water table elevations are very high. Annual flooding on the wellfield property has been so extensive in the past 10 years that public access to Lake Park (the wellfield property) has been severely restricted. The hydrograph of Starvation Lake in Figure 3.49 shows the annual high water levels in the lake after 2010. When the lake levels exceed the High Guidance Level (HGL) established for this lake, water sheet-flows across the property from one wetland and lake to another and most of the wellfield access roads are impassible, rendering the public recreation spaces inaccessible.

Figure 14.8 shows the location of all monitored wetlands, monitored lakes, and unmonitored sites associated with the Section 21 Wellfield and the final Recovery Assessment classifications. There are 15 monitored wetlands associated with this wellfield and 12 are classified as Recovered or Never Impacted by wellfield pumping. The three improved sites show hydrologic recovery but have unquantified impacts associated with ditches or stormwater management systems. All of the 32 monitored lakes associated with this wellfield are classified as Recovered based on the weight-of-evidence assessment and all unmonitored sites are predicted to have a High Degree of Certainty of Wetland Health. Annual high water table elevations in the neighborhoods adjacent to the wellfield and flooding on the wellfield property are issues associated with the lower pumping rate from the wellfield during the recent period of approximately normal rainfall. A coordinated response to continued high water levels in this urbanized area may be required in the future.

12.11 Northwest Hillsborough Wellfield

The Northwest Hillsborough Regional Wellfield (NWHRWF) is a dispersed wellfield located in northwestern Hillsborough County approximately six miles north of Old Tampa Bay. The West Coast Regional Water Supply Authority constructed six production wells along Gunn Highway between 1983 and 1985 and one production well west of the Section 21 Wellfield on Van Dyke Road. This wellfield was developed to replace a network of community production wells drilled to serve individual developments in this area; these wells were plugged and abandoned after the NWHRWF came online. This wellfield was connected to Tampa Bay Water's Regional system in late 2011 with the completion of the Northwest Hillsborough Transmission Main. The locations of the six southern production wells are shown in Figure 12.66 and a more comprehensive discussion of the history of the wellfield is included in Section 3.6.

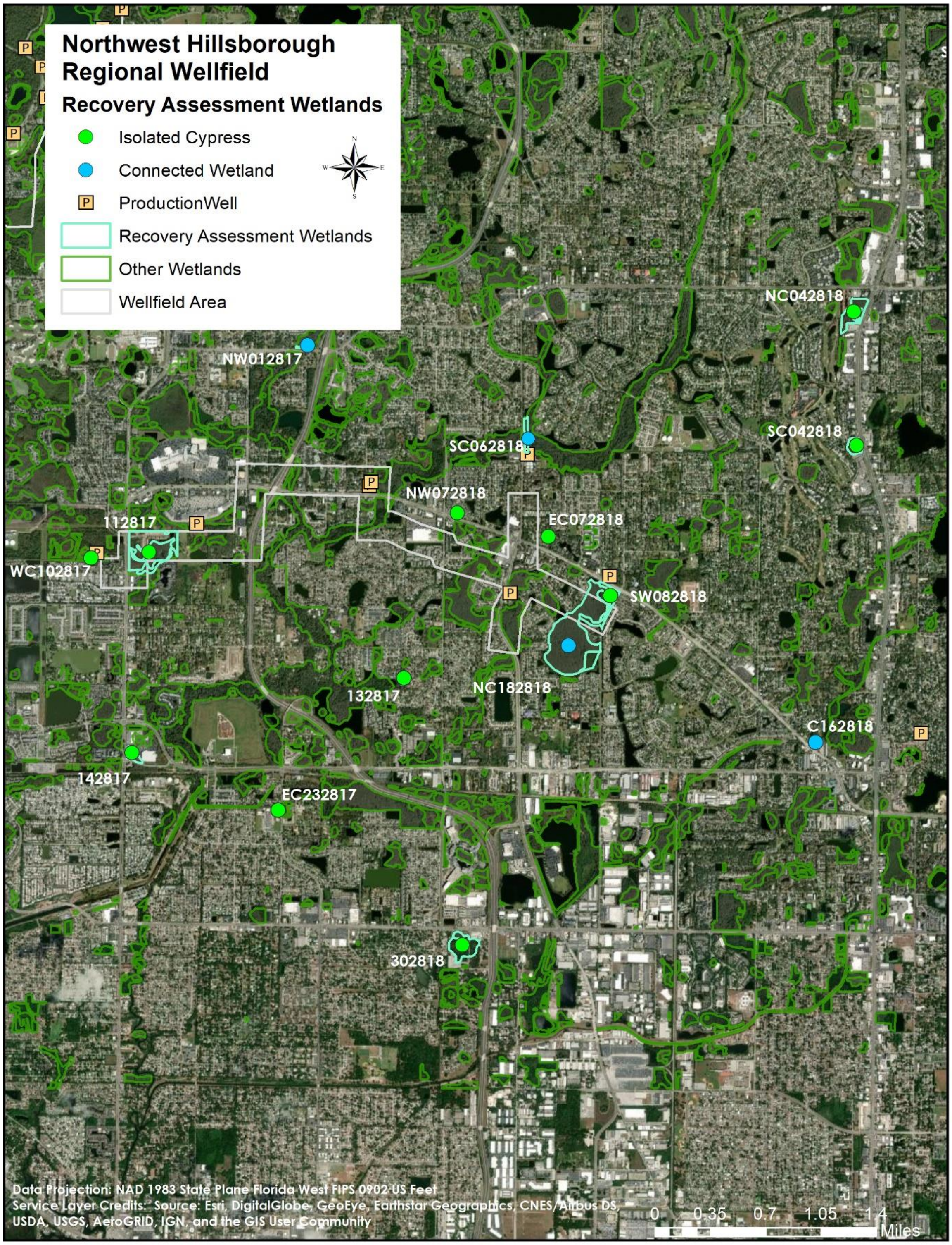


Figure 12.66: Northwest Hillsborough Regional Wellfield, Wetland Monitoring Sites and Production Wells

The average production rate from the northwest Hillsborough area increased gradually as the dispersed neighborhood production wells were placed into service. The pumping record from these wells begins in mid-1977 but several of the dispersed wells existed before that time. The annual pumping rate from the dispersed wells first exceeded 6 mgd in Water Year 1984 and the seven regional production wells began pumping as they were developed with the first placed into service during Water Year 1985. The annual average pumping rate from the NWHRWF production wells gradually increased to a maximum of 11.2 mgd in 2001. Pumping from the wellfield was first reduced in Water Year 2012 when the connection to the Regional System was completed. The annual average pumping rate for Water Years 2002 through 2011 was 8.3 mgd. Since Water Year 2012, production at the NWHRWF has averaged 2.3 mgd, a reduction of approximately 72% (Figure 3.44).

Rainfall data from the Northwest Hillsborough Regional gage is shown in Figure 12.42 compared to the long-term annual average rainfall of 54.05 inches recorded at the St. Leo, Florida gage. Rainfall at the Northwest Hillsborough Regional gage has fluctuated from approximately 32 inches during drought years to 80 inches in years with significant storm or hurricane activity. Periods of drought in this wellfield area occurred during 1989 through 1993, 1999 through 2002, and 2005 through 2009. Extremely high rainfall occurred in 1998 and 2003 and was sufficient to reset area wetland, lake, and groundwater levels to normal levels. Since Water Year 2010, rainfall has been near or above the long-term average with high rainfall recorded in Water Years 2012, 2013, 2015, and 2019.

The generalized geology in the wellfield area is typical of the northern Tampa Bay region with a clay semi-confining layer between the surficial aquifer and the underlying limestone of the Upper Floridan Aquifer. The semi-confining layer is generally continuous in this area as shown in the geologic cross-section Figure 2.3 with a leakance rate between the surficial aquifer and the Upper Floridan Aquifer that is less than in the northern wellfields. The surficial aquifer and wetlands in the wellfield are less influenced by pumping from the Upper Floridan Aquifer and sinkhole occurrence is low in the wellfield area. The topography of the land around the NWHRWF is generally flat containing streams and wetlands; the water table was often at or near land surface prior to development. Prevalent natural communities include cypress wetlands (strands and domes), streams, pine flatwoods and oak hammocks. Rocky, Brushy, and Sweetwater Creeks flow generally north to south through the wellfield area and discharge into Old Tampa Bay north of the Courtney Campbell Causeway. The downstream reaches and other sections of these streams have been channelized extensively to promote drainage.

Aerial photography from 1938 shows that the NWHRWF area was almost completely undeveloped at that time and natural communities were prevalent (Figure 3.22). By 1967, more agricultural and some residential land uses were present, and the excavation of Channel A to promote drainage from Rocky Creek is visible in the aerial photograph shown in Figure 3.23. Other small streams and cypress strands were channelized or deepened at that time to maintain drainage of pastures and expanding residential areas. By 1988, extensive development had occurred but some open and agricultural areas remained (Figure 12.67). As this area began to transition from agriculture to residential and commercial land uses, flooding became a major concern. To alleviate these flooding issues, the U.S. Soil Conservation Service constructed two main channels, Channels A and G in the Rocky Creek and Sweetwater Creek watersheds (Figure 3.23). Other channels connected to these main channels and dredging activities were largely completed between 1967 and 1972.

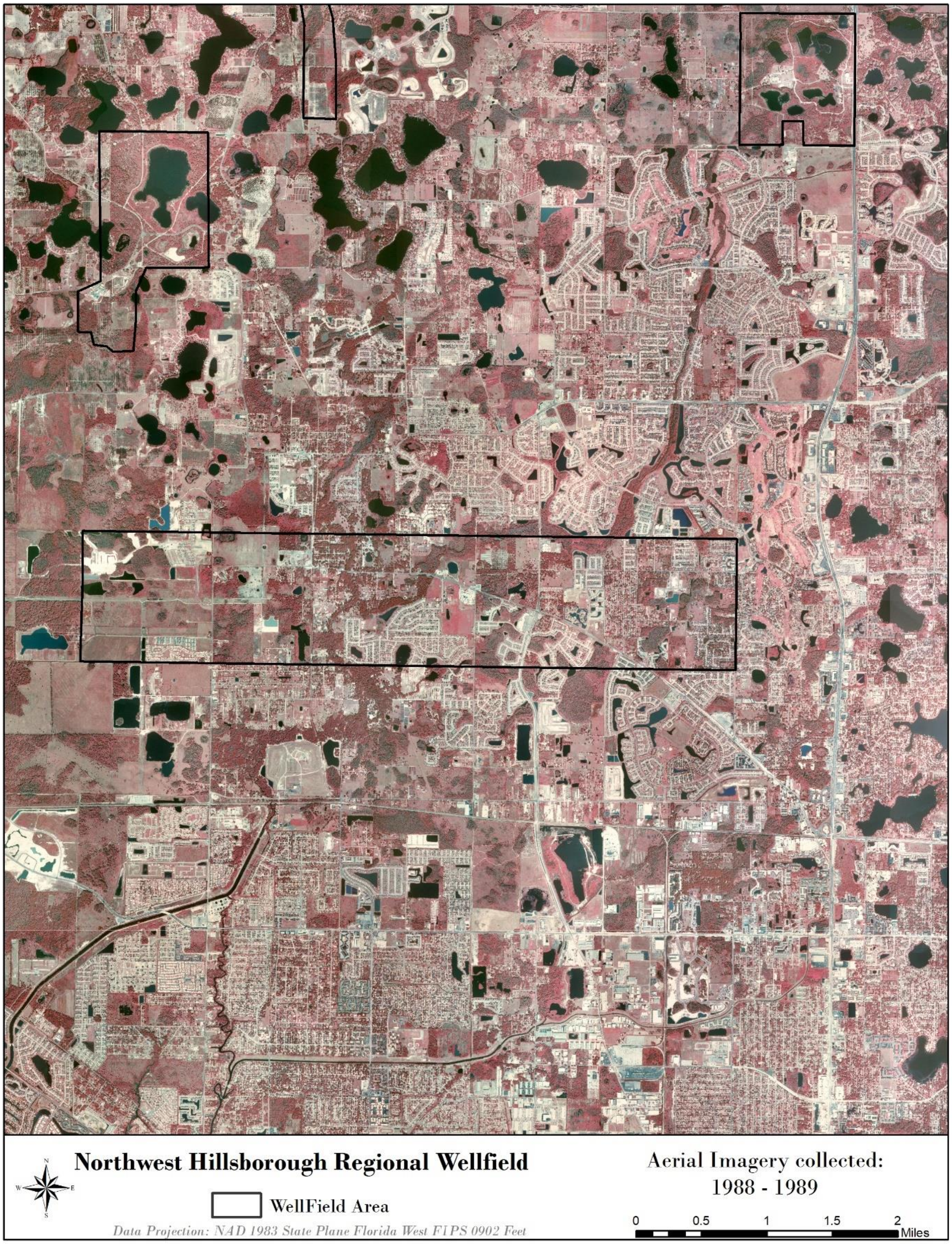


Figure 12.67: Aerial Photograph of the Northwest Hillsborough Regional Wellfield Area from 1988

It has been estimated that urbanization and the construction of interconnected surface water drainage systems in northwest Hillsborough County have lowered the water table in the area by approximately 5 feet as compared to the pre-development period (HSW Engineering, Inc., 2018b). A change in the surface water management gate operation in Channels A and G in 2014 resulted in a surface water decrease in the main channels of 2 to 3 feet which may have further lowered the local water table in those watersheds. The lower water table elevation across the area has allowed land development at the historic edges of wetland and stream systems. The 2018 aerial photograph shows that almost all open areas have been developed and the Veteran's Expressway now passes through the area (Figure 3.24). Smaller surface water flow-ways that were visible in earlier aerial photographs are now difficult to see in the landscape and many are routed through pipes.

The area around the NWHRWF is now fully developed with residential and commercial land uses. Land use maps show that the natural communities that were present in the 1970's (Figure 12.68) have been almost completely replaced with urban land uses (Figure 12.69). Currently, the only remaining natural or open lands are wetlands. In most cases, these wetlands have been considerably altered by encroachment of urban land uses or incorporation into stormwater management systems. The water levels of these wetlands are generally controlled by structures with the purpose of stormwater treatment, retention, and flood control.

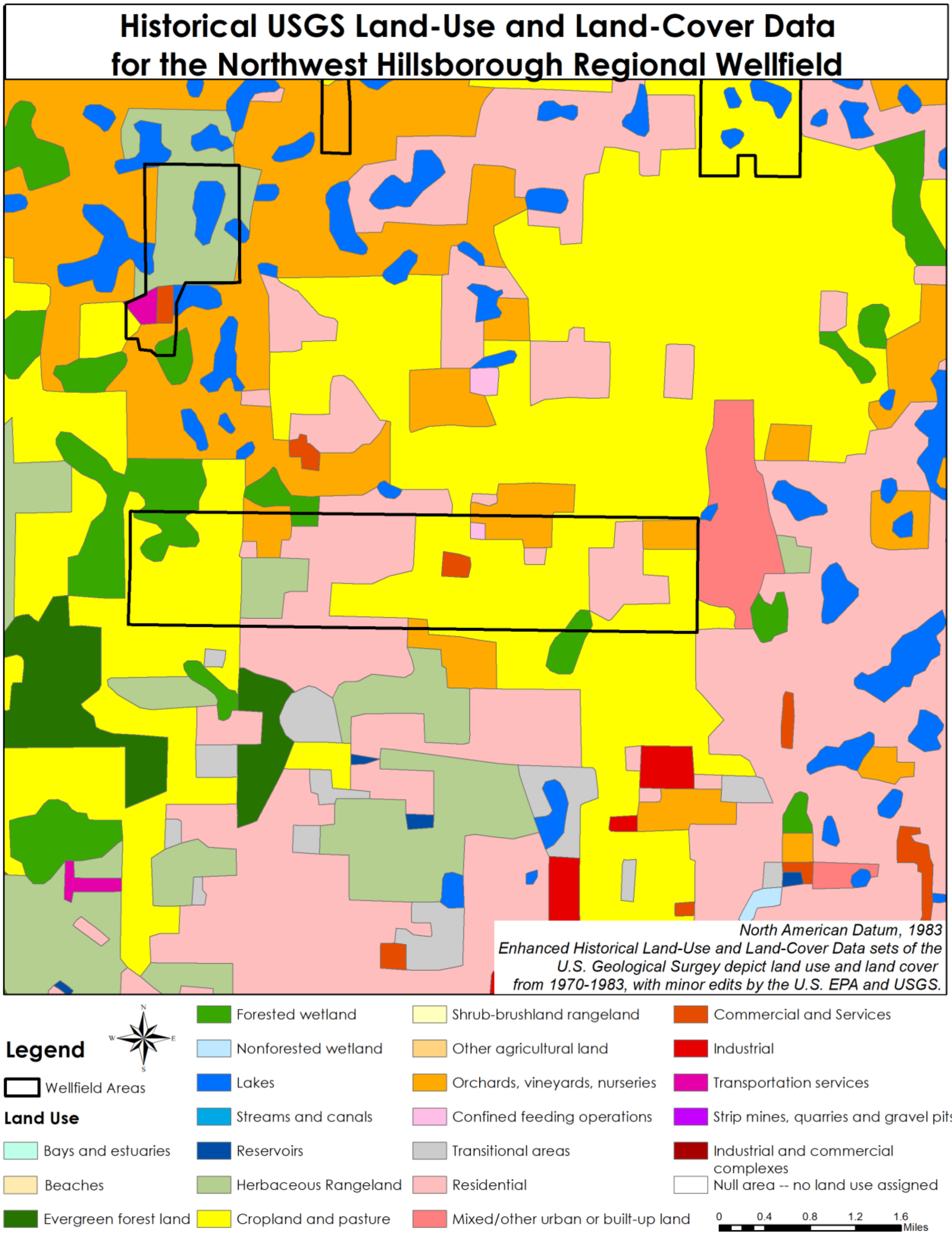


Figure 12.68: Land Use Map of Northwest Hillsborough Regional Wellfield Area Prior to Urbanization (1970s-1980s)

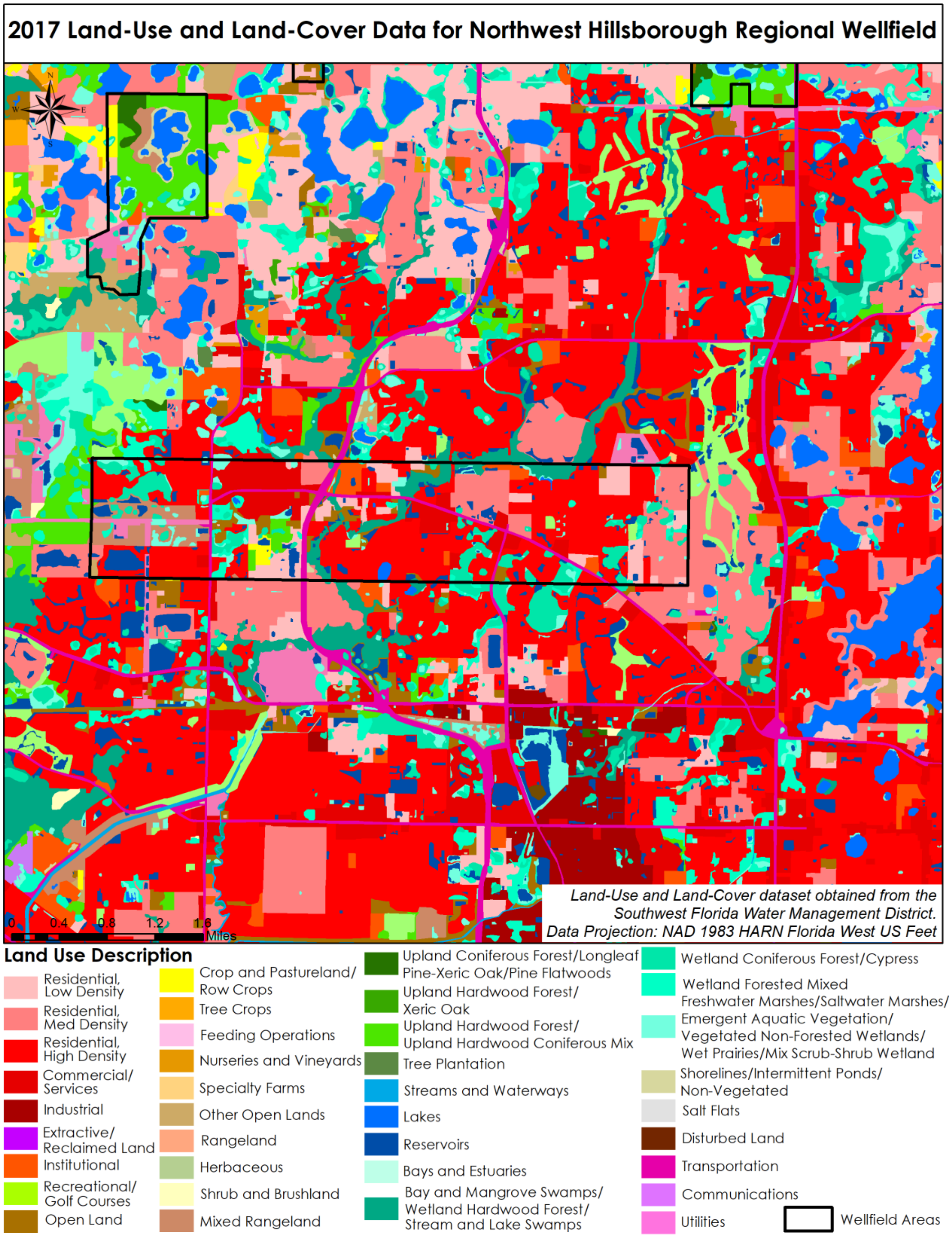


Figure 12.69: Land Use Map of Northwest Hillsborough Regional Wellfield Area, 2017

Tampa Bay Water has conducted monitoring and assessment of wetlands in the NWHRWF area since the mid-1980's. Determining wellfield-related impacts for monitored wetlands associated with the wellfield has been challenging due to the multiple influences on wetland water levels in the area. As described above, wetland water levels have been influenced by drainage and development activities beginning in the 1950s and the area was heavily developed and altered by the time the wellfield came online in 1985. Much of this development preceded modern wetland protection regulations: many wetlands were intentionally drained while others were incorporated into drainage systems, thus adding excess inflows to some wetlands and diverting flow out of others. Cypress systems that were incorporated into drainage systems and used as stormwater storage for flood control often have chronic high water levels. This negatively affects cypress trees and other wetland plants that require either seasonal or extended drying of the wetland to allow for germination and growth of seedlings. Persistent high water can also cause an invasion of aquatic species such as cattail which can grow in a thick monoculture, crowding out typical wetland species.

As a result of these development activities, there are few wetlands in the NWHRWF area that have retained their typical or pre-development characteristics. Some are chronically dry or wet and most have lost edge areas and natural drainage connections. While water level recovery may restore the hydrology of a site back to a normal condition, the vegetation species assemblages and zonation, and other ecological characteristics, do not appear normal or natural at most of the monitored wetlands in this area.

An assessment of improved water levels in the surficial and Upper Floridan aquifers was conducted by the Wise Consulting Group (2016d). Since the NWHRWF did not reduce pumping until Water Year 2012, the region had already experienced a reduction in pumping at the nearby Cosme-Odessa and more distant Eldridge-Wilde Wellfields in 2003 and the Section 21 Wellfield in 2005. The study found that groundwater level increases due to the pumping reduction at the NWHRWF were less than the groundwater recovery observed in response to the reductions at these other wellfields. The surficial aquifer recovery after the reduction in NWHRWF pumping was less than 0.5 foot across most of the study area (Figure 12.70), while the surficial aquifer recovery after the 2003 – 2005 regional pumping reduction was approximately 0.5 to 1.5 feet (Figure 12.71).

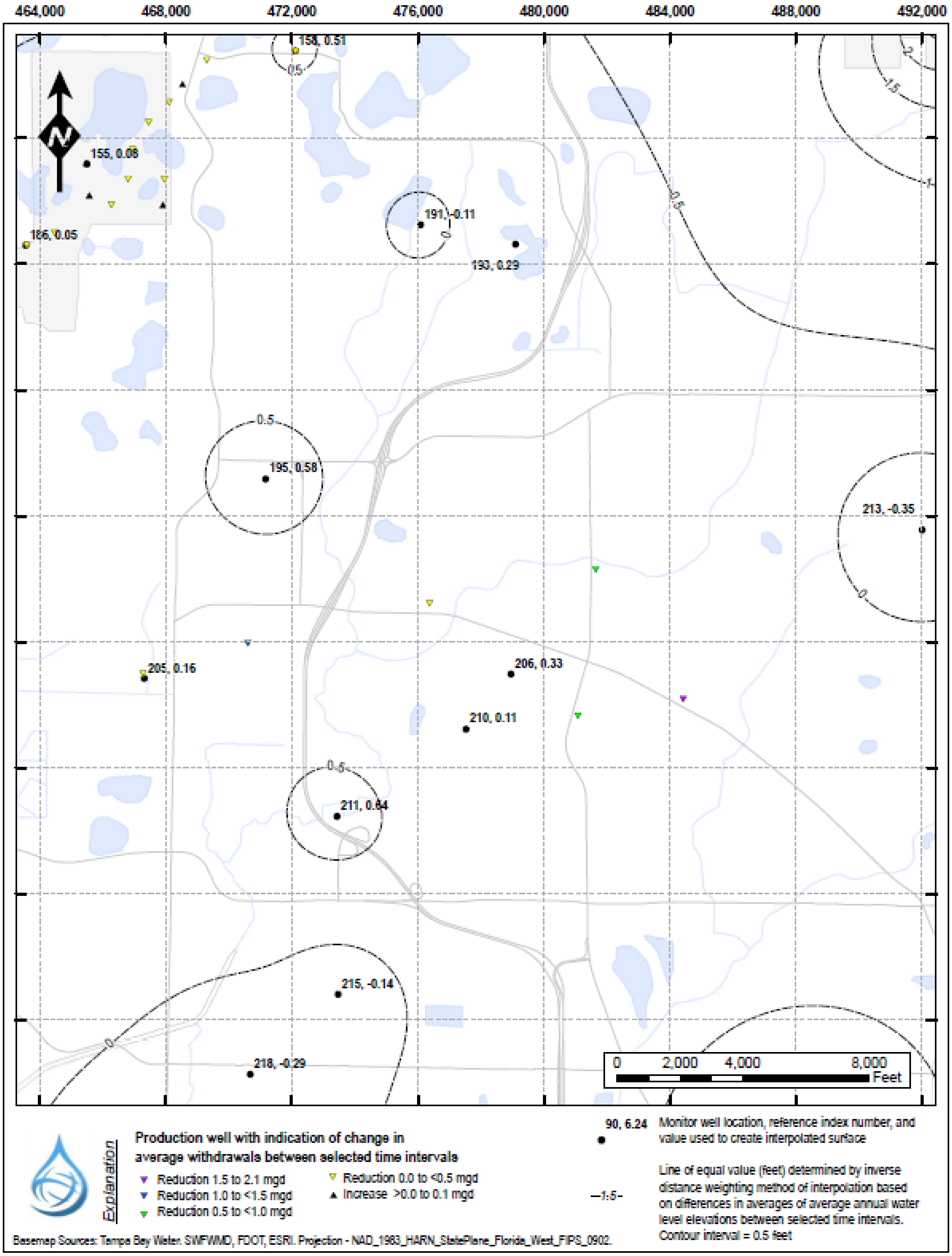


Figure 12.70: Recovery in the Surficial Aquifer at the NWHRWF due to Water Year 2012 Pumping Reduction (from Wise Consulting Group, 2016d)

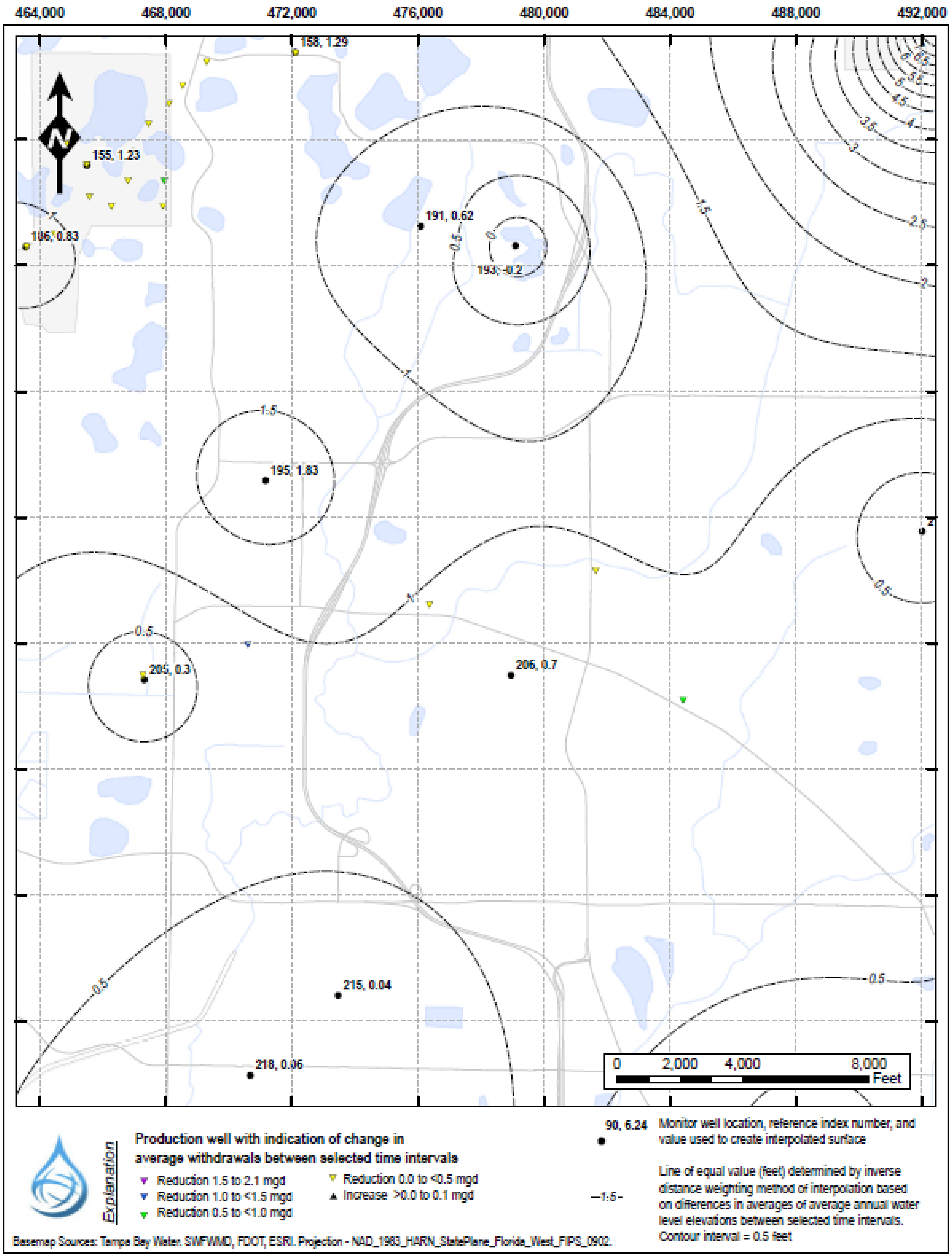


Figure 12.71: Recovery in the Surficial Aquifer at the NWHRWF due to Water Year 2003 Pumping Reduction (from Wise Consulting Group, 2016d)

The sustained recovery in the surficial and Upper Floridan aquifers is shown for monitor wells RMP-8s and RMP-8d that are located in the center of the wellfield production wells (Figure 12.72). Following the reduction in pumping at the NWHRWF, median water levels at this site improved by 0.9 foot in the surficial aquifer and 3 feet in the Upper Floridan Aquifer. Approximately 0.2 foot of this recovery in the surficial aquifer and 0.6 foot of Upper Floridan Aquifer recovery at this site occurred after the regional wellfield pumping reduction in 2003. These water level recovery data agree with the observation that lakes and wetlands in the NWHRWF area are not strongly influenced by wellfield pumping.

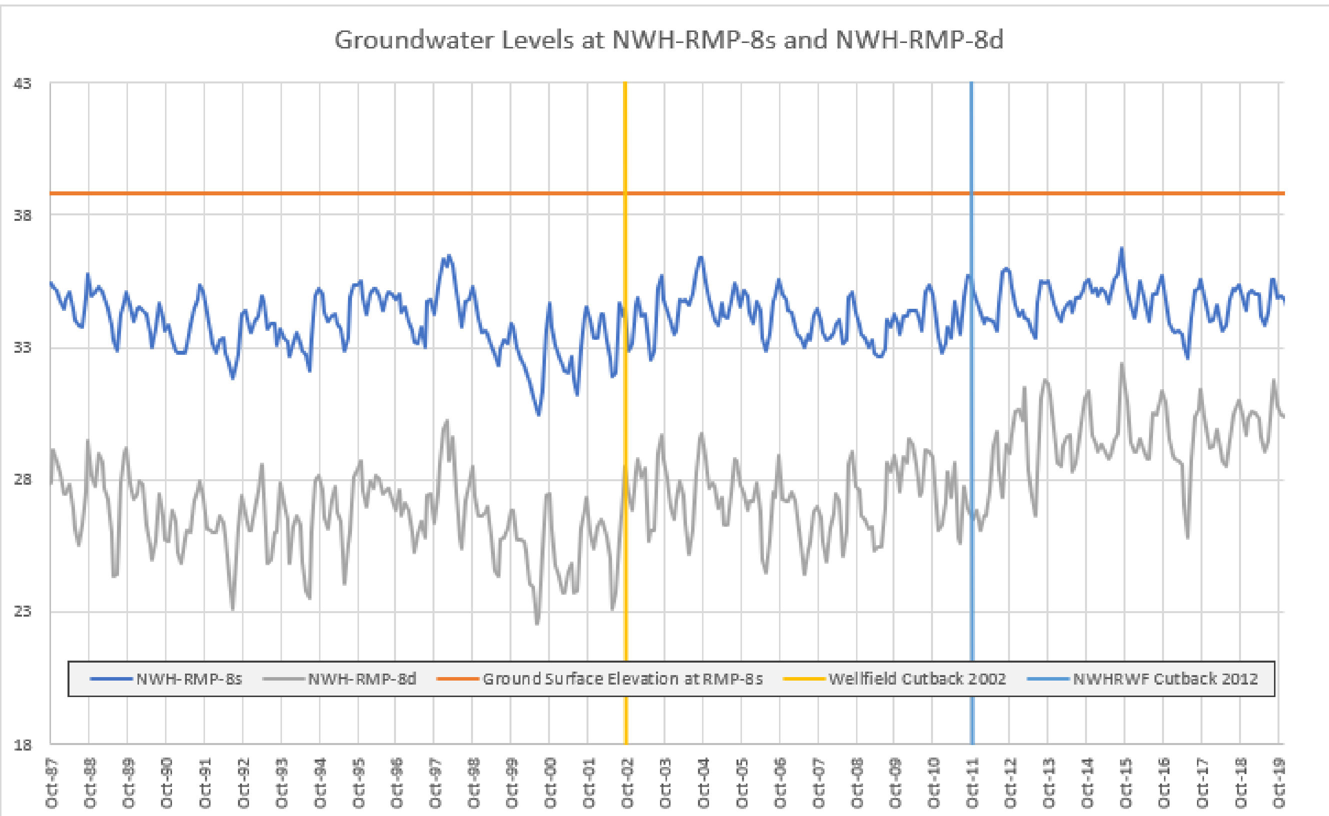


Figure 12.72: Surficial and Upper Floridan Aquifer Water Levels at NWHRWF Monitor Wells RMP-8s and RMP-8d

12.11.1 Site-Specific Results

There are 15 monitored wetlands on the final recovery assessment list associated with the NWHRWF. The final recovery assessment classifications for these wetlands are presented in Section 9.2.11 and the final assessment bin for each of these wetlands is included in Table 9.8. The final recovery assessment results for these wetlands are summarized as:

- Recovered – 11 wetlands
- Impacted Due to Other Causes – 4 wetlands

Eight of the 15 monitored sites are isolated mesic cypress wetlands, three are isolated xeric cypress wetlands, and four are connected wetlands. The wetlands at the NWHRWF were assessed as described in Chapter 9 and the location and final status of these 15 wetlands are shown in Figure 9.29. Monitoring has been discontinued at four of these sites but all had sufficient information to make a final quantitative assessment of recovery. Eleven of the 15 sites met their hydrologic metrics and are classified as Recovered.

Four monitored wetlands are classified as Impacted Due to Other Causes as they are prevented from reaching their recovery metrics by drainage ditches within or adjacent to the wetlands as discussed in the assessment report included as Appendix 9.17. Wetland 132817 is located adjacent to Airview Drive and the site water levels are controlled at a low elevation by a ditch draining the wetland to the south. Wetland 302818 is located on the south side of Waters Avenue just west of the Veterans Expressway and monitoring was discontinued in 2004 because of no site access since that time. This wetland is drained by a ditch along Waters Avenue that discharges to Sweetwater Creek and Channel G. Wetland EC232817 is bisected by Wilsky Blvd. and is surrounded by single-family homes and Bellamy Elementary School; this wetland is drained by a ditch that exits the site to the west. Wetland NC042818 is on the southwest corner of Dale Mabry Highway and Ehrlich Road and drains east to Bay Lake through culverts under Dale Mabry Highway. The results of the final bin assignments for all monitored wetlands at the NWHRWF are presented in Figure 9.29.

There are 16 lakes associated with the NWHRWF in the Recovery Assessment Plan. The lakes are shown in Figures 8.9 and 8.10 and most are located to the east of the wellfield, away from the immediate vicinity of the production wells. Most of these lakes are in an urbanized landscape, are interconnected by culverts, and have discharge structures that control their water levels to prevent flooding conditions in the surrounding homes and roads. The recovery of monitored lakes was assessed using a weight-of-evidence approach that emphasized statistical analyses of water levels, as described in Chapter 8. The final status for all Recovery Assessment lakes is presented in Tables 8.2 and 8.5 and all lakes in this area are classified as Recovered based on the Recovery Assessment weight-of-evidence analyses and are expected to maintain this status.

The Area of Investigation for the NWHRWF is described in Section 5.3 and the 31 unmonitored wetlands and lakes within this defined area were qualitatively assessed as described in Chapter 10. The qualitative recovery assessment of these unmonitored sites is shown in Figure 10.20 and all 31 sites (100%) are predicted to have a High Degree of Certainty of Wetland Health. The final assessment results for all monitored and unmonitored sites on and near the wellfield is presented in Figure 14.10.

12.11.2 Discussion of Recovery

The area surrounding the NWHRWF has experienced significant land use development and drainage alterations in past decades: many of the landscape features that influence water levels were in place prior to the development of the wellfield. Many of the lakes and wetlands within this area have been incorporated into managed drainage systems that control surface water levels to prevent local flooding. The analysis of surficial and Upper Floridan aquifer water levels following the reduction in wellfield pumping show that this area was relatively unaffected by the reduction in groundwater pumping and surficial aquifer levels remain stable. The median predicted drawdown in the surficial aquifer is less than two feet based on a modeling analysis of the recent wellfield pumping rate during 2012 – 2018 (Figure 11.2).

The final recovery classification of all monitored wetlands, monitored lakes, and unmonitored sites in the NWHRWF area is shown in Figure 14.10. All of the monitored wetlands either met their hydrologic recovery metrics or are prevented from meeting these levels by ditch systems that control water levels in those wetlands. All 16 monitored lakes near the wellfield are classified as Recovered and all unmonitored sites within the defined Area of Investigation are predicted to have a High Degree of Certainty of Health. The reduced level of wellfield pumping has resulted in recovery of the NWHRWF area wetlands and lakes which are expected to remain in their current state.

13: Regional Assessment Discussion and Conclusions

13. Regional Assessment Discussion and Conclusions

Special Condition No. 11 of the 2011 Consolidated Permit requires Tampa Bay Water to complete a Permit Recovery Assessment Plan that includes an evaluation of the recovery of water resource and environmental systems attributable to the reduction of groundwater withdrawals from the Central System to a long-term average of 90 mgd, identify any remaining unacceptable adverse impacts caused by the Central System withdrawals at a long-term average rate of 90 mgd, and identify and evaluate potential options to address any remaining unacceptable adverse impacts at the time of the Consolidated Permit renewal in 2020. This chapter describes how Tampa Bay Water has successfully met these conditions of the 2011 Consolidated Permit, draws conclusions from the information and analyses presented in the preceding chapters, and discusses the environmental recovery achieved from a regional perspective.

13.1 Assessment of Empirical Data Using a Weight of Evidence Approach

There are three operable requirements within Special Condition 11 of the 2011 Consolidated Permit that direct the completion of the Recovery Assessment Plan. The first two requirements specify what Tampa Bay Water is to address and what the final assessment should include. Tampa Bay Water is required to:

1. evaluate the recovery that is attributable to the reduction in pumping from the 11 wellfields to an annual average quantity of 90 mgd; and

2. identify any remaining adverse impacts existing at the time the analyses are complete (the present condition).

Evaluating the recovery that is attributable to the reduction in pumping from the wellfields required the agency to evaluate the actual reduction in pumping and what recovery has been achieved based on the actual pumping rate in recent years. To assess the environmental recovery achieved at the 90 mgd annual average production quantity, an Area of Investigation was created based on annual average pumping at 90 mgd. The current hydrologic state and environmental health of all lakes and wetlands within this defined area was evaluated. Identifying possible present-day adverse impacts requires the evaluation of actual conditions that exist now based on analysis of empirical data and field assessments of current environmental conditions.

These two permit requirements for the Recovery Assessment Plan led to a weight-of-evidence approach that focused on the decades of empirical data collected by Tampa Bay Water and the District. The reduction in pumping from the Consolidated Permit wellfields began in late 2002 and the 12-month running average pumping rate from these wellfields has been below the 90 mgd permit limit since December 2009. There are now many years of water level and other environmental data in the time periods before and after the reduction in wellfield pumping. These data sets from two distinctly different pumping regimes allow the analysis of actual data from specific lakes and wetlands instead of having to rely solely on predictive models as in the Candidate Sites Evaluation Study/Phase 1 Mitigation Plan (Section 3.13). The 50 percent reduction in the actual wellfield pumping rate since 2002 (Section 3.15) is significant enough to detect a recognizable response in the environmental data and assess environmental recovery. Tampa Bay Water's January 23, 2014 submittal of the original Recovery Assessment Area of Investigation included the proposal to assess the empirical data from monitored lakes and wetlands against agreed-upon hydrologic standards. This submittal letter and the District's May 22, 2014 acceptance of this approach are contained in Appendix 5.3.

Tampa Bay Water has focused the analyses of empirical water level and environmental data throughout the Recovery Assessment Plan to meet the requirements of the 2011 Consolidated Permit. These assessments account for the actual rate of wellfield pumping and the effects of recent wellfield pumping rates. This approach allowed Tampa Bay Water to assess what actual adverse impacts remain on the wellfields given the reduced rate of pumping. Predictive modeling approaches have been used to help understand system responses to different stressors and provide supplemental analyses but were not used as the main lines of evidence. Models cannot make a determination of actual environmental conditions or if an adverse impact is present at a specific lake or wetland. Modeling approaches are often employed in the absence of long-term data but because of the wealth of environmental data available, Tampa Bay Water has primarily focused these evaluations on long-term water level and environmental data from hundreds of sites as the most direct assessment of lake and wetland recovery.

Assessing environmental recovery and determining if there are remaining adverse impacts due to wellfield pumping is a complex process because of the multiple factors that influence water levels and environmental health. Many of these factors, such as the alteration of natural drainage patterns, cannot be directly assessed due to the lack of data. Analyzing environmental data using a single type of data or single approach rarely provides a high degree of confidence when evaluating cause-and-effect relationships such as recovery due to a reduction in wellfield pumping. To address these issues, Tampa Bay Water developed a weight-of-evidence approach to assess the recovery and environmental health of lakes and wetlands. This approach takes into account the multiple factors that influence water levels and environmental health through the examination of all available lake and wetland data and multiple assessment techniques. While a weight-of-evidence analysis does not demonstrate cause and effect relationships, this assessment method weighs all available lines of information and examines the current environmental condition in light of actual pumping, rainfall and the drainage alterations that have occurred on and near the wellfields. This approach also acknowledges the uncertainty present in ecological data and the establishment of recovery metrics using this data by relying on multiple analyses and data types. Multiple lines of available evidence, including field assessments, were evaluated for lakes and wetlands during the preliminary and final technical analyses before making the final determination of recovery and environmental health for each site.

This weight-of-evidence approach, developed as the agency began to assess recovery at the Starkey Wellfield, is described in Section 9.1. The assessment process is documented in Appendix 9.1 which includes the December 9, 2016 letter from the District concurring with the approach and the initial results for a subset of the Starkey Wellfield wetlands. This weight-of-evidence approach for assessing recovery at monitored wetlands was subsequently applied to all monitored lakes and unmonitored sites. Tampa Bay Water consistently applied this approach for all recovery analyses that were included in the Preliminary Report of Findings (Tampa Bay Water, 2019b) and this final assessment report. This balanced approach is based on long-term compliance with established water level metrics of lake and wetland health and accounts for the lag time between hydrologic recovery and ecological/vegetative change. Many of the sites that do not fully meet their recovery metrics were reviewed in the field to determine the actual condition of these lakes and wetlands. This final step in the process was to confirm if adverse impacts remain on or near the Consolidated Permit wellfields.

13.2 Assessment of Recovery at MFL Lakes and Wetlands

Some of the earliest Recovery Assessment Plan discussions between Tampa Bay Water and the District focused on what environmental features to include in this assessment. The staff of both agencies agreed that it was important to assess all monitored lakes and wetlands on and near the wellfields and comprehensive lists of lakes and wetlands were compiled and approved for evaluation. These lists of monitored lakes and wetlands included lakes for which the District had adopted Minimum Levels in Chapter 40D-8, F.A.C and these Minimum Level sites were noted in the tables of lakes and wetlands to be assessed. There are presently 61 lakes and 29 wetlands with established Minimum Levels in the Recovery Assessment plan which make up 17.5% of the total monitored sites within the plan. Tampa Bay Water consistently applied the agreed-upon technical assessments of recovery to all monitored lakes and wetlands within the Recovery Assessment Plan; no separate analyses were proposed or performed for Minimum Level lakes or wetlands in the preliminary or final assessment reports.

Tampa Bay Water has made extensive use of the Minimum Level work of the District and used the adopted Minimum Levels for the 61 lakes included in Chapter 40D-8, F.A.C. as the numeric metrics of recovery for these Recovery Assessment Plan lakes (Section 6.4.2). Staff also incorporated the normal pool offset methodology for isolated wetlands in a mesic landscape in the Recovery Assessment Plan as described in Section 6.3.2 as the numeric recovery metric for this type of wetland. The analyses in the Recovery Assessment Plan used the adopted Minimum Levels for the 29 wetlands listed in Chapter 40D-8, F.A.C. that are also included in the list of wetlands for assessment. The results of the annual status assessments performed by District staff for Minimum Level lakes have also been included in the weight-of-evidence analysis of Recovery Assessment lakes as described in Chapter 8.

Tampa Bay Water's assessment of recovery at monitored lakes and wetlands, including sites with established Minimum Levels, was a weight-of-evidence approach that focused on the long-term water level data as compared to a numeric metric. These numeric metrics were developed using environmental data and classifications of ecological health with respect to different levels of pumping stress. These analyses assume that if the long-term water level in a lake or wetland is above the applicable metric, that site should not exhibit signs of adverse impact. If the long-term water level for a site is below the numeric metric for that site, a field assessment is required to determine if adverse impacts are present based on the standards provided in Chapter 40D-2, F.A.C. District staff independently performed these field assessments for many of the lakes and wetlands with a recommended assessment bin of Improved as described in Sections 8.6 and 9.6.2.

The final assessment of monitored wetlands presented in Section 9.7 includes a discussion of the five Minimum Level wetlands that are currently below their recovery metrics in this final analysis. Two of the sites (CBR Q-01 and MBR-88) were reviewed in the field by District staff who determined that no signs of adverse impacts are present in these wetlands. Two of the wetlands (CYC W-12 and CYC W-56) were not assessed in the field by District staff but are within 0.26 foot of their recovery metrics on a long-term basis. These are wetlands at the Cypress Creek Wellfield where surrounding landscape changes have limited the amount of recovery that can be achieved through reduced wellfield pumping as discussed in Section 13.5. The remaining wetland (CYB-A) was not assessed for adverse impact in the field and is discussed in Chapter 15.

The weight-of-evidence method applied to assess recovery at the monitored lakes is described in detail in Section 8.5 which includes a discussion of the technical justifications for analyzing all available data and lines of evidence instead of relying on a single type of assessment. Of the 61 lakes with established Minimum Levels assessed under this Recovery Assessment Plan, 17 lakes were noted as not meeting their Minimum Levels by District staff in their 2018 MFL status assessment. Table 8.2 presents all lines of evidence for each monitored lake. As described above in the assessment of wetlands, a field review is required to determine if adverse impacts are present at a site based on the standards provided in Chapter 40D-2, F.A.C. Data analyses alone cannot make this regulatory determination. The District field assessment of monitored lakes (Section 8.6) included 14 of the 17 lakes that were reported as not meeting their Minimum Levels in 2018. District staff determined that nine of these lakes did not show signs of adverse impact, three lakes were determined to be impacted by factors other than wellfield pumping, and two lakes were assessed as having adverse impacts. These two sites, Lakes Raleigh and Rogers, are discussed in Section 8.7 and were assessed further as presented in Chapter 15.

The three lakes that were not assessed in the field were Lakes Bird (Hillsborough), Dan, and Pasco. District staff have determined that the Minimum Levels for Pasco Lake should be removed from Chapter 40D-8, F.A.C. pending a reevaluation of the lake and establishment of potential Minimum Levels at a future date. This action is anticipated in late 2020 or early 2021. All lines of evidence except for the District's 2018 status assessment indicate that Bird Lake (Hillsborough) meets the Minimum Levels based on the weight-of-evidence assessment (Table 8.2) including a statistically significant increasing water level trend following the reduction in wellfield pumping. The weight-of-evidence evaluation of Lake Dan classified the lake as improved with two lines of evidence not supporting a classification of Recovery; the District 2018 status assessment and the post-cutback P50 water level. All other indicators passed the screening assessment including a statistically significant increase in water levels following the reduction in wellfield pumping. This is a lake that was historically augmented by Pinellas County and Tampa Bay Water; however, no augmentation has been needed since 2010 (Section 3.13.2.4).

In the application of the agreed-upon assessment methods for the monitored lakes and wetlands in this Recovery Assessment Plan, Tampa Bay Water has considered the District's established lake and wetland Minimum Levels. The final assessment of recovery at the Minimum Level lakes and wetlands includes the District's field determination of adverse impact so that these assessment results can be applied to the renewal of the Consolidated Permit.

13.3 Regional Discussion of the Monitored Sites Assessment Results

The recovery assessment results for monitored lakes and wetlands are the primary focus of the Recovery Assessment Plan. These are the sites where data has been collected for many years and this data spans the time periods before and after the reduction in wellfield pumping. These lakes and wetlands provide the best available data upon which to conclude if recovery has been achieved or if any adverse impacts remain due to wellfield pumping. This assessment of long-term water level and environmental data provides the necessary certainty in the decision to move forward and determine mitigation requirements for sites with continued adverse impact.

Staff assessed water levels at monitored lakes and different types of wetlands against the applicable numeric metrics of recovery developed during this study. The recovery metrics were developed using ecological data to establish thresholds of environmental health which were expressed as specific water level elevations or offsets. Uncertainty in the recovery metric for isolated wetlands in mesic and xeric landscapes was considered in the application of these metrics and is described in Section 6.3. The water level screening method allowed many sites to be assessed quickly so that sites below their respective metrics could be further studied. These analyses focused on if the water levels at a site met the applicable recovery metric and was not designed to determine the ecological health of an individual wetland or lake which can only be assessed in the field.

The initial monitored wetland evaluations compared two long-term periods before and after the reduction of wellfield pumping with similar average rainfall. The assessment of wetland water levels during these two periods allowed Tampa Bay Water to characterize the hydrologic improvement due to reduced wellfield pumping for sites that did not achieve their numeric metric of recovery. The water level data from monitored lakes was also assessed before and after the reduction in pumping using multiple trend tests and time periods. Staff evaluated subsequent years of water level data through 2019. Extending the period of study to the present recognizes the lag time between water level improvement and ecological change. The final assessment results through 2019 were evaluated in the field for many of the Improved sites to determine the current ecological conditions at these sites. These field assessments identified if adverse impact conditions were present and the final assessment results reflect these field reviews.

The final wetland assessment period of 2008-2019 corresponds to the period of time when ten of the eleven Consolidated Permit wellfields were fully interconnected to the Regional System. The Northwest Hillsborough Regional Wellfield was the last wellfield to be connected - in late 2011. The first two to four years of this 12-year period were characterized by low rainfall across the wellfields as the region emerged from a protracted drought (Figure 3.48). The recent eight years of this time period have been characterized by mostly average rainfall conditions except for Water Years 2015 and 2018 which recorded above-average rainfall in all wellfield areas. This final period of analysis for wetland recovery contains years of below and above-average rainfall and constitutes an appropriate period of time for the evaluation of environmental recovery due to the reduction in pumping at the Consolidated Permit wellfields.

The combined assessment results for monitored lakes and wetlands demonstrates that a remarkable level of environmental recovery has been achieved with sustained wellfield pumping at or below 90 mgd and a return to normal rainfall conditions. A total of 85% of the 515 monitored lakes and wetlands included in this study meet their numeric metrics of recovery. This includes lakes and wetlands that were assessed as:

1. not impacted by wellfield pumping,
2. recovered or meets metric,
3. a high degree of certainty of wetland health,
4. or impacted by some factor other than wellfield pumping (i.e., sinkholes or significant drainage alterations).

Of the remaining lakes and wetlands, 13.5% (70 sites) were characterized as improved or a low degree of certainty of wetland health and only 1.5% (8 sites) were characterized as having a continued impact likely due to wellfield pumping. The qualitative bins used to characterize the state of unmonitored or formerly-monitored sites are discussed in Chapter 10.

There are a total of 70 monitored wetlands and lakes that are classified as Improved or having a low degree of predicted wetland health in the final assessment results. Four of these 70 Improved sites are monitored lakes that show considerable improvement in the post-pumping reduction period. Monitoring ceased at 13 of these 70 wetland sites in the past and their degree of improvement following the reduction in pumping cannot be characterized. The remaining 53 monitored wetlands that are classified as Improved have sufficient water level data records before and after the reduction in wellfield pumping to assess the degree of improvement. Most of these wetlands missed their numeric metric of recovery by less than one foot over the 12-year period of assessment as reported in Section 9.7. The median value by which these sites missed their recovery metrics ranged from 0.5 to 0.8 foot, depending on the type of wetland system. Field inspection of most of these 53 wetlands classified as Improved revealed that no evidence of adverse impact was observed, further demonstrating that significant environmental recovery has been achieved across the wellfields. Field inspections were not possible for the remaining wetlands categorized as Improved at the conclusion of the study due to site access issues including flooded wetlands and access roads.

13.4 Regional Discussion of the Unmonitored Sites Assessment Results

Chapter 40D-2.301, F.A.C. outlines the Criteria for Issuance of a Water Use Permit and requires that an applicant demonstrate that their withdrawals do not cause harm to the water resources of the area including wetlands and other surface waters. Tampa Bay Water committed in the Recovery Assessment Work Plan and Schedule (Section 5.2) to identify an area of potential impact resulting from the wellfield pumping at an average of 90 mgd. An Area of Investigation was developed based on the predicted drawdown of wellfield pumping at an annual average rate of 90 mgd based on conservative assumptions (Section 5.3). Tampa Bay Water also committed to attempt to assess the environmental recovery or degree of health of all monitored and unmonitored wetlands within the Area of Investigation to address this permitting requirement.

The unmonitored sites within the defined Area of Investigation have little or no historical or current monitoring data. Statistically-interpolated data sets were generated based on monitoring data from nearby lakes and wetlands and the Upper Floridan Aquifer. These spatial datasets were used to predict the health of the unmonitored sites for this final report using multiple lines of evidence. Based on an analysis of uncertainty associated with analyzing the statistically-generated data, Tampa Bay Water applied a weight-of-evidence approach to the final assessment of unmonitored lakes and wetlands as described in Chapter 10. The degree of uncertainty associated with the analysis of the unmonitored sites resulted in qualitative predictions of wetland health as discussed at the June 13, 2019 technical coordination meeting. Tampa Bay Water and District staff agreed at this June 2019 meeting that this weight-of-evidence approach and qualitative final assessment were appropriate for the unmonitored sites. This method and two qualitative assessment categories provide the best possible means to assess these sites with little or no data.

The final analysis of unmonitored sites presented in Chapter 10 includes the qualitative assessment of 845 individual lakes and wetlands. Of this total, 73% of the sites are predicted to have a high degree of certainty of wetland health and the remaining 27% are predicted to have a low degree of certainty of wetland health. The percentage of unmonitored sites with a high degree of certainty in their health assessment is relatively close to the 85% of monitored sites that have either recovered or are not affected by wellfield pumping. There were conservative assumptions built into the assessment of unmonitored sites, so the slightly lower percentage was expected. The results of the monitored and unmonitored sites have been combined in the discussions of wellfield-scale recovery in Chapter 12 and the final presentation of results in Chapter 14; however, no mitigation action will be required for any of the unmonitored sites based on the lack of monitoring data and the uncertainty contained in the qualitative assessment of recovery as described at the end of Chapter 10.

13.5 Assessment of Recovery Given Changes Surrounding the Wellfields

Tampa Bay Water has assessed the recovery of 1,360 individual lakes and wetlands (both monitored and unmonitored) located on or near the Consolidated Permit wellfields. It was important to assess each individual site against the applicable recovery metric with historic and current data, and where available, characterize the health or recovery of each lake and wetland. Remarkably, the vast majority of monitored sites have recovered. However, in many cases, focusing only on individual site results does not account for the changes that have occurred to the landscape surrounding the wellfields. Residential developments and individual homes have been constructed immediately adjacent to the wellfields as shown in the historical aerial photography included in Chapter 3. In some cases, these new residential areas have limited the degree of recovery that can be achieved.

The wellfield-scale discussions of recovery presented in Chapter 12 consider the limitations that adjacent development has placed on environmental recovery. For example, the homes in Quail Hollow and Saddlewood Estates were constructed immediately adjacent to the boundary of the Cypress Creek Wellfield prior to the reduction in pumping. The annual average pumping rate from this wellfield has been reduced by almost 50% (Figure 3.41) and the water table and potentiometric surface of the Upper Floridan Aquifer have increased under the wellfield property and the surrounding developments. The hydrologic recovery in the aquifers presented in Chapter 11 shows that at the Cypress Creek Wellfield property boundary adjacent to Saddlewood Estates, the water table and potentiometric surface of the Upper Floridan Aquifer are often within 2 to 3 feet below land surface following the reduction in wellfield pumping. The water level difference between these two aquifers following the reduction in pumping generally fluctuates between zero and two feet meaning that the water table in this area does not quickly percolate into the underlying Upper Floridan Aquifer. Surface water in this area must exit through surface water drainage features or evaporate; much less percolation into the underlying aquifers occurs now as compared to the period before the pumping reduction.

Residents from these neighborhoods have filed flooding complaints with the District and/or Pasco County in the years following the reduction in wellfield pumping (Figure 3.79). In four of the last five years, the Saddlewood Estates Homeowners Association requested that Tampa Bay Water pump water out of the floodplain north of Dye's Crossing on the wellfield property to alleviate flooding conditions in their community (Section 3.13.2.3). The District directed Tampa Bay Water to pump water out of the Dye's Crossing floodplain during the summer of 2015 and 2017 which resulted in 287 million gallons of water removed from wetlands that are part of the recovery assessment study; this pumped quantity is in addition to the water that flowed through the structure at Dye's Crossing during those years. The maps presented in Section 11.1 show the predicted median drawdown from the Cypress Creek Wellfield following the pumping reduction and water level improvement has occurred within and outside of the wellfield. The wellfield pumping has averaged approximately 15 mgd in the post-cutback period and the water level improvement is greatest on the wellfield property. A lesser degree of predicted drawdown is expected in the water table under the Saddlewood Estates and Quail Hollow subdivisions. Pumping the Cypress Creek Wellfield at a lesser quantity on a long-term basis would increase water levels on the wellfield but would also further increase the water table levels underneath the residential areas where the residents complain of flooding and the homes rely on septic tank systems.

There are 78 monitored wetlands associated with the Cypress Creek Wellfield and 26 of them have been assessed as Improved or Not Fully Recovered. The assessments of recovery demonstrate that all have improved following the pumping reduction and the long-term water level at most of these wetlands are less than two feet from their recovery metrics. Figure 9.23 shows that the vast majority of wetlands that do not currently meet their metrics of recovery are located in the central and eastern part of the wellfield, closer to the residential developments discussed above. Focusing only on the individual site results can lead to the conclusion that recovery has not been achieved at this wellfield. However, when the changes to the adjacent landscape are taken into account, the information presented demonstrates that the wetlands at the Cypress Creek Wellfield have reached the degree of recovery that can be achieved given the changes to the property adjacent to the wellfield. Additional hydrologic improvements on the wellfield property would exacerbate high water table conditions in the residential developments adjacent to the wellfield property boundary.

The Cypress Creek Wellfield is one example where changes to the landscape adjacent to a wellfield have influenced the degree of recovery that can be achieved. Persistent flooding concerns have been documented in residential developments adjacent to the Cross Bar Ranch, Cypress Creek, South Pasco, Eldridge Wilde, and Section 21 Wellfields following the reduction in wellfield pumping. The wellfield-scale discussions of recovery in Chapter 12 provide additional information related to landscape changes that limit the degree of recovery that can be achieved.

13.6 Assessment of Recovery with Respect to Baseline Conditions and Protocol

The third operable requirement within Special Condition 11 of the 2011 Consolidated Permit is for Tampa Bay Water to identify and evaluate potential options to address any remaining unacceptable adverse impacts at the time of the Consolidated Permit renewal in 2020. This condition created the requirement to develop a method of assessing Tampa Bay Water’s mitigation responsibility at the conclusion of the Recovery Assessment Plan process. The Recovery Assessment Work Plan identified the need for this mitigation assessment process and the development of a temporal baseline that would consider the timing of historic impacts, any past structural changes within lakes and wetlands, and changes in wetland function or health between the temporal baseline and the present.

The landscape on and around the Consolidated Permit wellfields has been altered by human activity, affecting all lakes and wetlands. These alterations include impacts to lakes and wetlands due to high wellfield pumping rates in the past when no regulations existed or when on-site impacts were not prohibited. Therefore, it is inappropriate to use an unimpacted or pre-development condition as a starting point for the assessment of mitigation. The baseline protocol and temporal baseline dates developed by Tampa Bay Water are discussed in Section 6.9 and presented in Appendix 6.15, including the District concurrence with this approach. This protocol provides the individual site assessment steps and subsequent actions that Tampa Bay Water has taken to assess recovery and determine if mitigation is required at the time of permit renewal. The protocol provides a starting point for evaluating recovery and potential mitigation that accounts for the higher wellfield pumping rates in the past and the regulatory changes that have occurred since the Consolidated Permit wellfields began operating. The baseline protocol and reference dates resolve the multiple complexities associated with calculating a mitigation requirement based on environmental improvement from a past, impacted condition.

Tampa Bay Water and the District agreed that only those lakes and wetlands in the final assessment classification bin of Not Fully Recovered, Continued Wellfield Impact would be candidates for potential mitigation (see Section 6.9). The sites that are classified as Improved in the final assessment demonstrate an environmental condition in the present time that is better than the condition that existed prior to the reduction in wellfield pumping. Since the environmental condition has improved at these sites, there is no need to assess them for mitigation requirement; a quantitative assessment would demonstrate that mitigation is not required for a site that has improved as compared to an impacted baseline condition.

Tampa Bay Water staff developed the mitigation assessment methodology for the Not Fully Recovered, Continued Wellfield Impact wetlands with input from the District as described in Chapter 15. The mitigation assessment methodology was developed prior to the final assessment of wetland recovery to avoid any potential bias in the development of the quantitative process. The baseline protocol also requires Tampa Bay Water to submit specific mitigation actions for any residual wellfield-related adverse impacts to the District for review and approval prior to the expiration of the 2011 Consolidated Permit. The final quantification of remaining adverse impacts and specific mitigation proposals are detailed in Chapter 15. The final mitigation assessment and development of mitigation actions successfully completes the requirements of the Recovery Assessment Plan and recognizes the recovery that has already been achieved due to the reduction in pumping to an annual average quantity of 90 mgd and any needed mitigation.

13.7 New Environmental Baseline Conditions at the Consolidated Permit Wellfields

One of the primary objectives in the creation of Tampa Bay Water was to reduce the pumping rate from the 11 wellfields in the northern Tampa Bay area to promote environmental recovery on and surrounding these critical water supply facilities. The first alternative water supplies came online in late 2002 allowing Tampa Bay Water to reduce wellfield pumping; the 12-month running average pumping rate from the Consolidated Permit wellfields has remained below 90 mgd since late 2009. With this sustained reduction in groundwater pumping, Tampa Bay Water has been able to assess the resulting improvement in the environment through the completion of this Recovery Assessment Plan. Based on the results of the technical analyses completed under this plan, the environment on and around the Consolidated Permit wellfields has recovered.

This environmental recovery is directly attributable to the regional cooperation that created Tampa Bay Water, the cooperative agreements that funded the construction of multiple alternative water supply projects, and the significant $1.7 billion financial investment in the fully-interconnected regional water supply system. Tampa Bay Water operates the regional supply system by balancing the water used from the three source water types so that there are no adverse environmental impacts at any of the water supply facilities. The Optimized Regional Operations Plan (OROP) guides the wellfield pumping distribution within and between wellfields based on current environmental conditions to minimize the drawdown in the water table across all wellfields. This weekly optimized pumping distribution has played a significant role in achieving environmental recovery at the Consolidated Permit wellfields.

The goal of reducing wellfield pumping was to minimize the drawdown influence on lake and wetland water levels so that these levels can fluctuate naturally with rainfall. Recovery is broadly described as lakes and wetlands that are full when they are supposed to be (after the wet season or in years with above-average rainfall) and have low water levels during the dry season and droughts. Based on the analyses completed in this Recovery Assessment Plan, this is the condition that now exists at the Consolidated Permit wellfields. Although 85% of the monitored wetlands and lakes in this study have recovered, changes to the landscape adjacent to the wellfields has limited the amount of environmental recovery that can be achieved at some wellfields as described in Chapter 12 and Section 13.5 above. The current environmental condition of the monitored lakes and wetlands represents the highest level of recovery that can be achieved given the changes that have occurred within the local drainage basins.

Several of the environmental restoration projects that were originally investigated in the Tampa Bay Water Phase 1 Mitigation Plan have been eliminated due to the recovery achieved at the wellfields. Water levels in the project lakes and wetlands were restored through the wellfield pumping reduction and a return to normal rainfall conditions. Staff will continue to operate the surface water management systems at the Cypress Creek and Cross Bar Ranch Wellfields to continue to promote environmental health and minimize flooding in adjacent developments to the degree possible with these systems.

The current condition of the wetlands on and surrounding the wellfields reflects both the recovery resulting from reduced groundwater pumping and landscape alterations that have occurred adjacent to the wellfields. This balanced condition can be brought into the renewed Consolidated Permit as a new environmental baseline for the wellfields authorized under this permit. Through continued wellfield pumping at or below the 90 mgd annual average limit as guided by the OROP based on current environmental conditions, the lakes and wetlands at the wellfields should fluctuate within their natural ranges based on climatic conditions. The monitored sites that have recovered should remain in this state as assessed by long-term monitoring data and those sites that have significantly improved since the reduction in pumping should also maintain their level of environmental improvement. The new environmental baseline condition preserves the recovery achieved and incorporates past regulatory changes and adjacent developments.

14: Final Assessment

14. Final Assessment

The preceding chapters presented the results of the Recovery Assessment Plan in different groupings. Chapters 8 through 10 discussed how the final Recovery Assessment status or bin was determined for each monitored lake, monitored wetland, or unmonitored site, respectively. Chapter 12 presented the results for all types of systems for each wellfield so the results could be presented and interpreted with respect to the history, operation, and changes near each wellfield. Chapter 13 discussed the results on a regional basis without specific information about any particular site. The following is a summary of the final assessment results.

14.1 Assessment of Environmental Recovery – Summary of Results

The 11 wellfields assessed under the Recovery Assessment Plan cover a large geographic area north of Tampa Bay, making it difficult to visually present the results for all wellfields on one map that is readable and useful. In order to spatially present the final assessment results, the final bins for all monitored lakes, monitored wetlands, and unmonitored sites are presented for each wellfield area in Figures 14.1 through 14.10. The recovery status or bins are shown in consistent colors on each map and the final assessment results for the unmonitored sites are shown in light green and pink to be easily distinguished from the final results for monitored sites. The site name for all monitored lakes and wetlands are shown on the figures but the Site ID for each unmonitored site is not included on the maps. Many of the unmonitored sites are small and the labels would overlap and be unreadable at the scale of the figures.

Assessing the combined results for all wetland types on a wellfield-scale was an important part of the weight-of-evidence approach within the Recovery Assessment Plan. By presenting the final results for all types of wetlands on these figures, the degree of recovery achieved can be interpreted for entire wellfield areas as described in Chapter 12. Due to the uncertainty in the final assessment results for the sites with no monitoring data, the results for these sites are shown as general information on the maps and this data was used to inform or confirm the final results of the monitored lakes and wetlands for each wellfield area. Additional information on the uncertainty in the unmonitored site results and how these sites may be addressed in the next permit term can be found in Chapters 10 and 13. A summary of the final results for each type of wetland are presented in tables in the following sections.

14.1.1 Monitored Lakes

The weight-of-evidence approach that Tampa Bay Water used to assign a recovery classification or bin to each of the 137 monitored lakes is described in Chapter 8. Based on the weight-of-evidence approach, 97% of the lakes were assigned a bin of Recovered or Not Impacted by Wellfield Pumping. Only four of the monitored lakes were assigned to the bin of Improved, Not Fully Recovered (3% of the total). No lakes were assigned to the bin of Not Fully Recovered, Continuing Wellfield Impact. Table 14.1 presents the final Recovery Assessment status or bin for each of the monitored lakes. These results are illustrated in Figures 14.1 through 14.10.

Table 14.1: Final Recovery Assessment Findings for Monitored Lakes

Wetland ID	Lake Name	MFL Lake	County	Final Recovery Assessment Bin
601	Alice Lake	Yes	Hillsborough	Recovered
602	Allen Lake	Yes	Hillsborough	Recovered
28	Alligator Pond	No	Pasco	Recovered
118	Amelia Lake	No	Hillsborough	Recovered
603	Ann-Parker Lake	Yes	Pasco	Recovered
120	Armistead Lake	No	Hillsborough	Recovered
604	Artillery Lake	No	Hillsborough	Recovered
600	Avis Lake	No	Hillsborough	Recovered
605	Bass (Holiday) Lake	No	Pasco	Recovered
606	Bell Lake	Yes	Pasco	Recovered
15	Big Fish Lake	Yes	Pasco	Improved, Not Fully Recovered
607	Big Lake Vienna	No	Pasco	Recovered
608	Bird Lake (Hillsborough)	Yes	Hillsborough	Recovered
609	Bird Lake (Pasco)	Yes	Pasco	Recovered
610	Black Lake	No	Pasco	Recovered
611	Boat Lake	No	Hillsborough	Recovered
414	Bonnet Lake	No	Pasco	Recovered
612	Brant Lake	Yes	Hillsborough	Recovered
613	Brooker Lake	No	Hillsborough	Recovered
615	Browns Lake	No	Hillsborough	Recovered
616	Buck Lake	No	Hillsborough	Not Impacted by Wellfield Pumpage
617	Burrell Lake	No	Hillsborough	Recovered
618	Calm Lake	Yes	Hillsborough	Recovered
620	Camp Lake	Yes	Pasco	Recovered
621	Carroll Lake	Yes	Hillsborough	Recovered
622	Catfish Lake	No	Pasco	Recovered
623	Cedar Lake East	No	Hillsborough	Recovered
	Cedar Lake West	No	Hillsborough	Recovered
624	Chapman Lake	No	Hillsborough	Recovered
625	Charles Lake	Yes	Hillsborough	Recovered
626	Church Lake	Yes	Hillsborough	Recovered
3	Clear Lake	No	Pasco	Recovered
627	Commiston Lake	No	Hillsborough	Recovered
629	Cooper Lake	No	Hillsborough	Recovered
630	Cow (East) Lake	No	Pasco	Recovered
631	Crenshaw Lake	Yes	Hillsborough	Recovered
632	Crescent Lake	Yes	Hillsborough	Recovered

Wetland ID	Lake Name	MFL Lake	County	Final Recovery Assessment Bin
25	Crews Lake	Yes	Pasco	Recovered
633	Crystal Lake	Yes	Hillsborough	Recovered
634	Curve Lake	No	Pasco	Recovered
636	Cypress Lake	Yes	Hillsborough	Recovered
252	Dan Lake	Yes	Hillsborough	Improved, Not Fully Recovered
368	Darby Lake	No	Hillsborough	Recovered
637	Deer Lake	Yes	Hillsborough	Recovered
638	Dosson Lake	Yes	Hillsborough	Recovered
639	Echo Lake	Yes	Hillsborough	Recovered
640	Eckles Lake	No	Hillsborough	Recovered
642	Elaine Lake	No	Hillsborough	Recovered
643	Elizabeth Lake	No	Hillsborough	Recovered
644	Ellen Lake	No	Hillsborough	Recovered
645	Fairy (Maureen) Lake	Yes	Hillsborough	Recovered
646	Fern Lake	No	Hillsborough	Improved, Not Fully Recovered
647	Floyd Lake	No	Pasco	Recovered
648	Flynn Lake	No	Hillsborough	Recovered
649	Garden (Thomas) Lake	Yes	Hillsborough	Recovered
651	Gass Lake	No	Hillsborough	Recovered
653	George (Hillsborough) Lake	No	Hillsborough	Recovered
37	Goose Lake	No	Pasco	Recovered
655	Gooseneck Lake	No	Pasco	Recovered
657	Green Lake	Yes	Pasco	Recovered
658	Halfmoon Lake	Yes	Hillsborough	Recovered
659	Halls Lake	No	Hillsborough	Recovered
660	Hanna Lake	Yes	Hillsborough	Recovered
661	Harvey Lake	Yes	Hillsborough	Recovered
662	Helen Lake	Yes	Hillsborough	Recovered
663	Hiawatha Lake	No	Hillsborough	Recovered
665	Hobbs Lake	Yes	Hillsborough	Recovered
666	Hog Island Lake	No	Hillsborough	Recovered
119	Horse Lake	Yes	Hillsborough	Recovered
667	Island Ford Lake	No	Hillsborough	Recovered
392	Jackson Lake	Yes	Hillsborough	Recovered
669	James Lake	No	Hillsborough	Recovered
670	Jo Ann Lake	No	Pasco	Recovered
671	Josephine Lake	No	Hillsborough	Recovered
672	Joyce (Hog) Lake	No	Pasco	Recovered
673	Juanita Lake	Yes	Hillsborough	Recovered

Wetland ID	Lake Name	MFL Lake	County	Final Recovery Assessment Bin
674	Keene Lake	Yes	Hillsborough	Recovered
675	Kell Lake	Yes	Hillsborough	Recovered
676	Keystone Lake	No	Hillsborough	Recovered
678	King Lake (West) at Drexel	Yes	Pasco	Recovered
679	LeClare Lake	No	Hillsborough	Recovered
680	Linda Lake	Yes	Pasco	Recovered
681	Lipsey Lake NR Sulphur Springs	No	Hillsborough	Recovered
683	Little Lake	No	Hillsborough	Recovered
684	Little Moon Lake	Yes	Hillsborough	Recovered
685	Little Moss (Como) Lake	No	Pasco	Recovered
686	Long Lake	No	Hillsborough	Recovered
687	Magdalene Lake	No	Hillsborough	Recovered
688	Marlee Lake	No	Hillsborough	Recovered
689	Merrywater Lake	Yes	Hillsborough	Recovered
472	Moon Lake (Pasco)	Yes	Pasco	Recovered
692	Moss Lake	No	Pasco	Recovered
693	Mound Lake	Yes	Hillsborough	Recovered
695	Mud Lake (Geneva Lake)	No	Pasco	Recovered
696	Myrtle Lake	No	Pasco	Recovered
697	Noreast Lake	No	Hillsborough	Recovered
698	Osceola Lake	No	Hillsborough	Recovered
699	Padgett Lake	Yes	Pasco	Recovered
32	Pasco Lake	Yes	Pasco	Improved, Not Fully Recovered
701	Pierce Lake	Yes	Pasco	Recovered
702	Platt Lake	Yes	Hillsborough	Recovered
703	Pretty Lake	Yes	Hillsborough	Recovered
24	Raft Lake	No	Pasco	Recovered
704	Rainbow Lake	Yes	Hillsborough	Recovered
705	Raleigh Lake	Yes	Hillsborough	Recovered
706	Reinheimer Lake	Yes	Hillsborough	Recovered
709	Rogers Lake	Yes	Hillsborough	Recovered
710	Round Lake	Yes	Hillsborough	Recovered
364	Ryals Lake	No	Pasco	Recovered
711	Saddleback Lake	Yes	Hillsborough	Recovered
712	Sapphire Lake	Yes	Hillsborough	Recovered
714	Saxon Lake	No	Pasco	Recovered
741	Seminole Lake	No	Pasco	Recovered
715	Simmons Lake	No	Hillsborough	Recovered

Wetland ID	Lake Name	MFL Lake	County	Final Recovery Assessment Bin
161	Stanford Lake	No	Pasco	Recovered
717	Starvation Lake	Yes	Hillsborough	Recovered
718	Stemper Lake	Yes	Hillsborough	Recovered
719	Strawberry Lake	Yes	Hillsborough	Recovered
720	Sunset Lake	Yes	Hillsborough	Recovered
721	Sunshine (Sunrise) Lake	Yes	Hillsborough	Recovered
722	Tampa (Turtle) Lake	No	Pasco	Recovered
723	Taylor Lake	Yes	Hillsborough	Recovered
724	Thomas Lake	No	Hillsborough	Recovered
725	Thorpe Lake	No	Hillsborough	Recovered
726	Toni Lake	No	Pasco	Recovered
727	Turkey Ford Lake	No	Hillsborough	Recovered
729	Twin Lake (Pasco)	No	Pasco	Recovered
730	Unnamed Lake 1B14	No	Hillsborough	Recovered
731	Unnamed Lake 2B14	No	Hillsborough	Recovered
732	Unnamed Lake 22 (Loyce)	Yes	Pasco	Recovered
157	Unnamed Lake 26	No	Pasco	Recovered
734	Van Dyke Lake	No	Hillsborough	Recovered
736	Virginia Lake	Yes	Hillsborough	Recovered
737	Wastena Lake	No	Hillsborough	Recovered
738	White Trout Lake	No	Hillsborough	Recovered
739	Wistaria Lake	No	Pasco	Recovered
740	Wood Lake	No	Hillsborough	Recovered

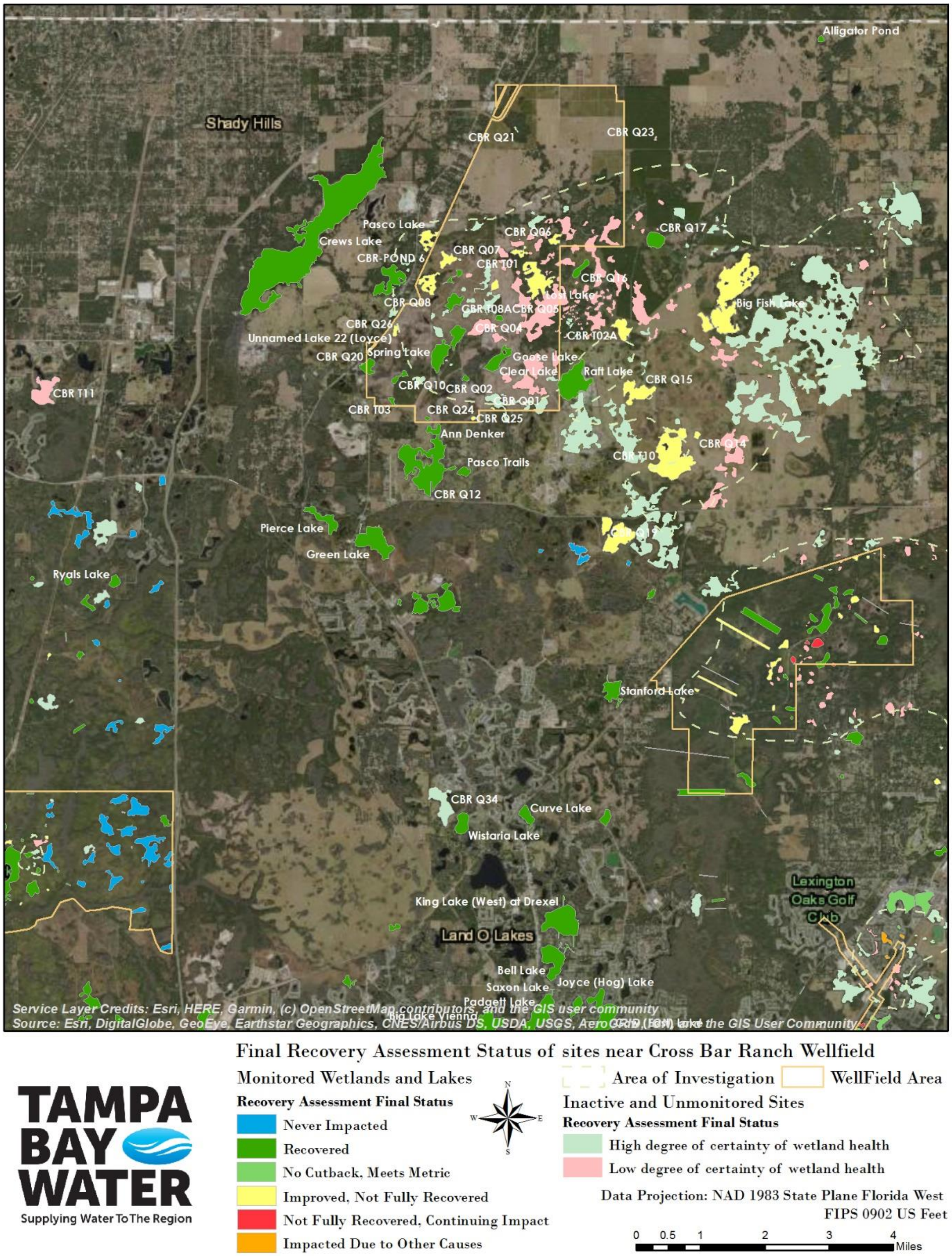


Figure 14.1: Final Recovery Assessment Site Results for the Cross Bar Ranch Wellfield Area

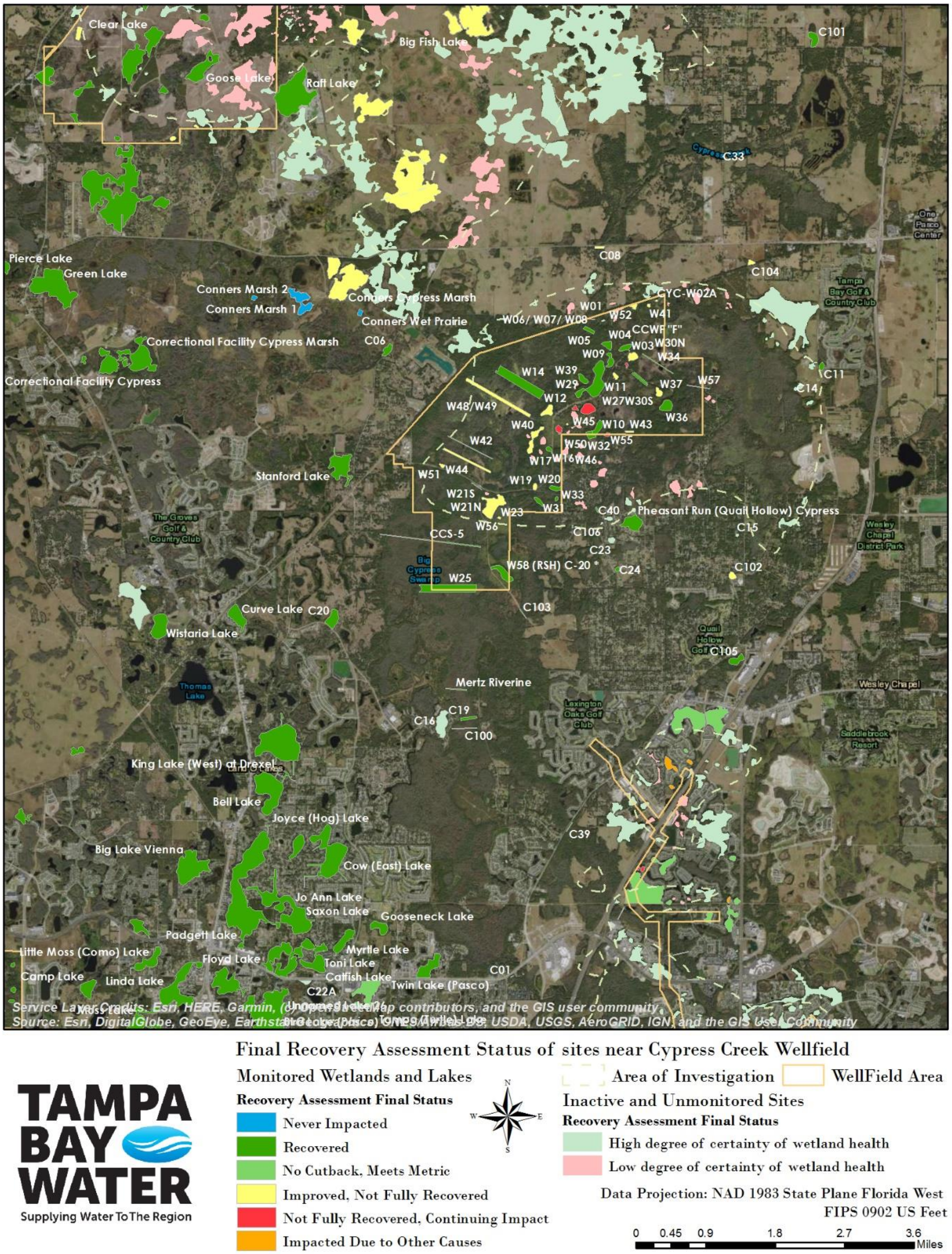


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Figure 14.2: Final Recovery Assessment Site Results for the Cypress Creek Wellfield Area

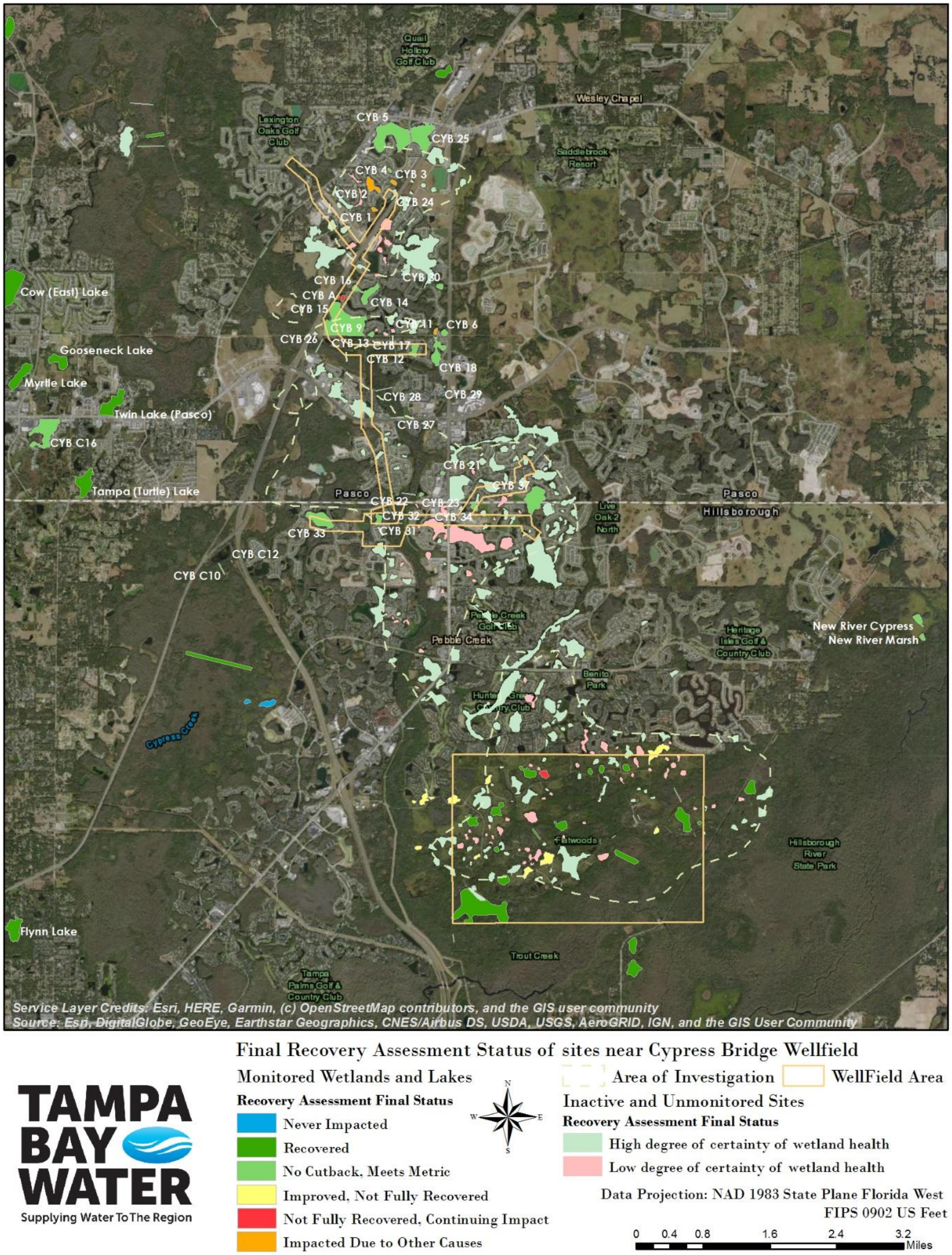

Figure 14.3: Final Recovery Assessment Site Results for the Cypress Bridge Wellfield Area

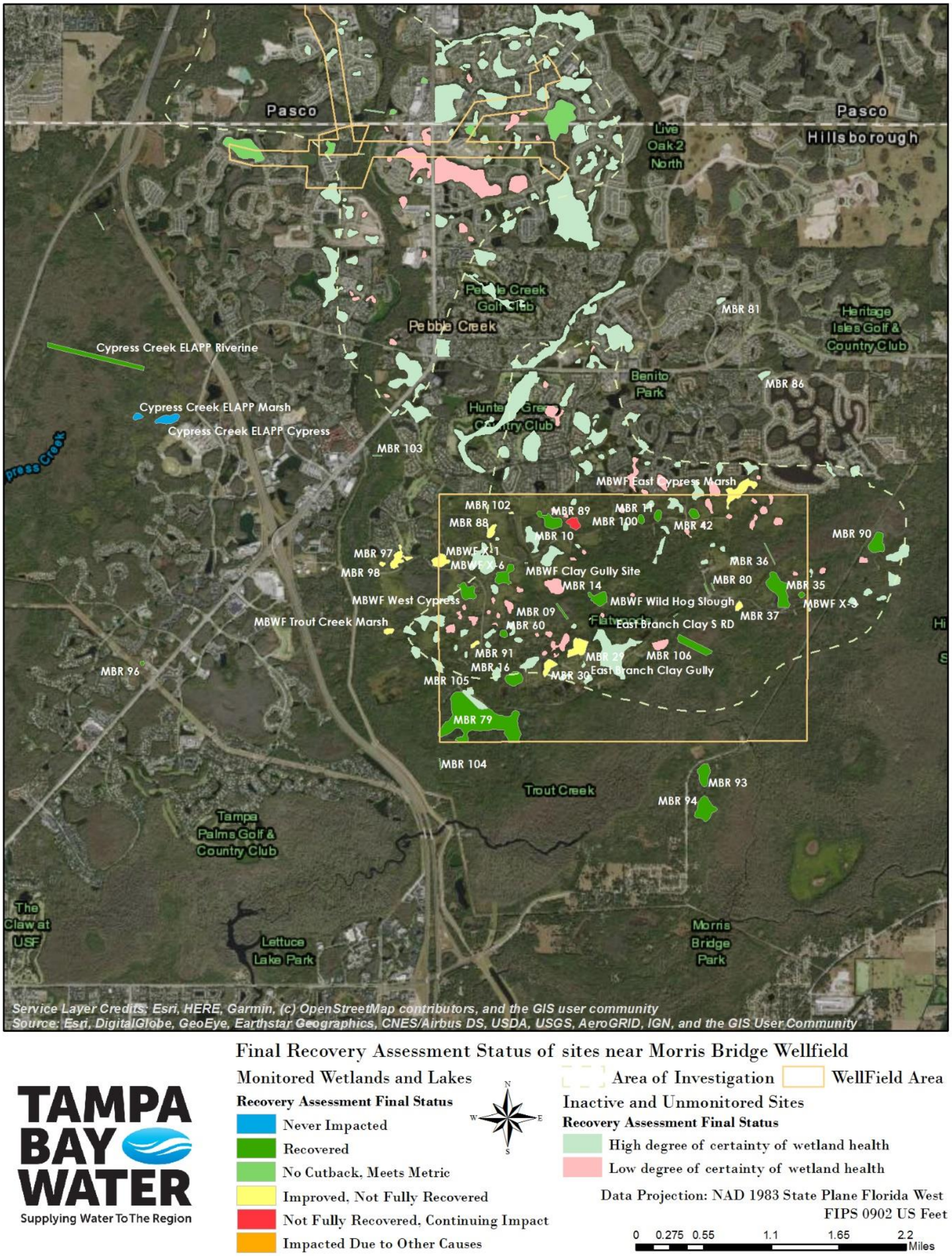

Figure 14.4: Final Recovery Assessment Site Results for the Morris Bridge Wellfield Area

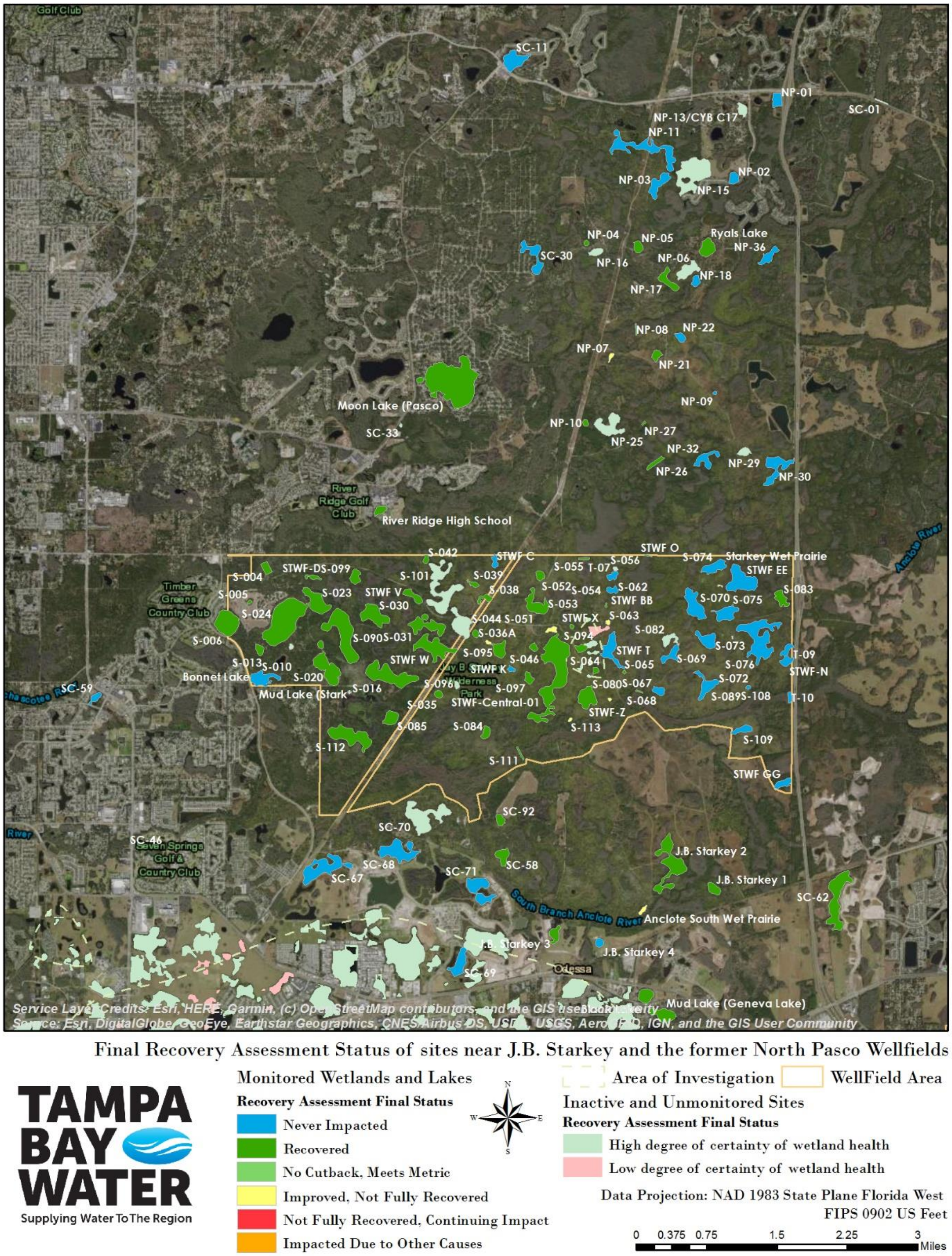

Figure 14.5: Final Recovery Assessment Site Results for the Starkey and North Pasco Wellfield Areas

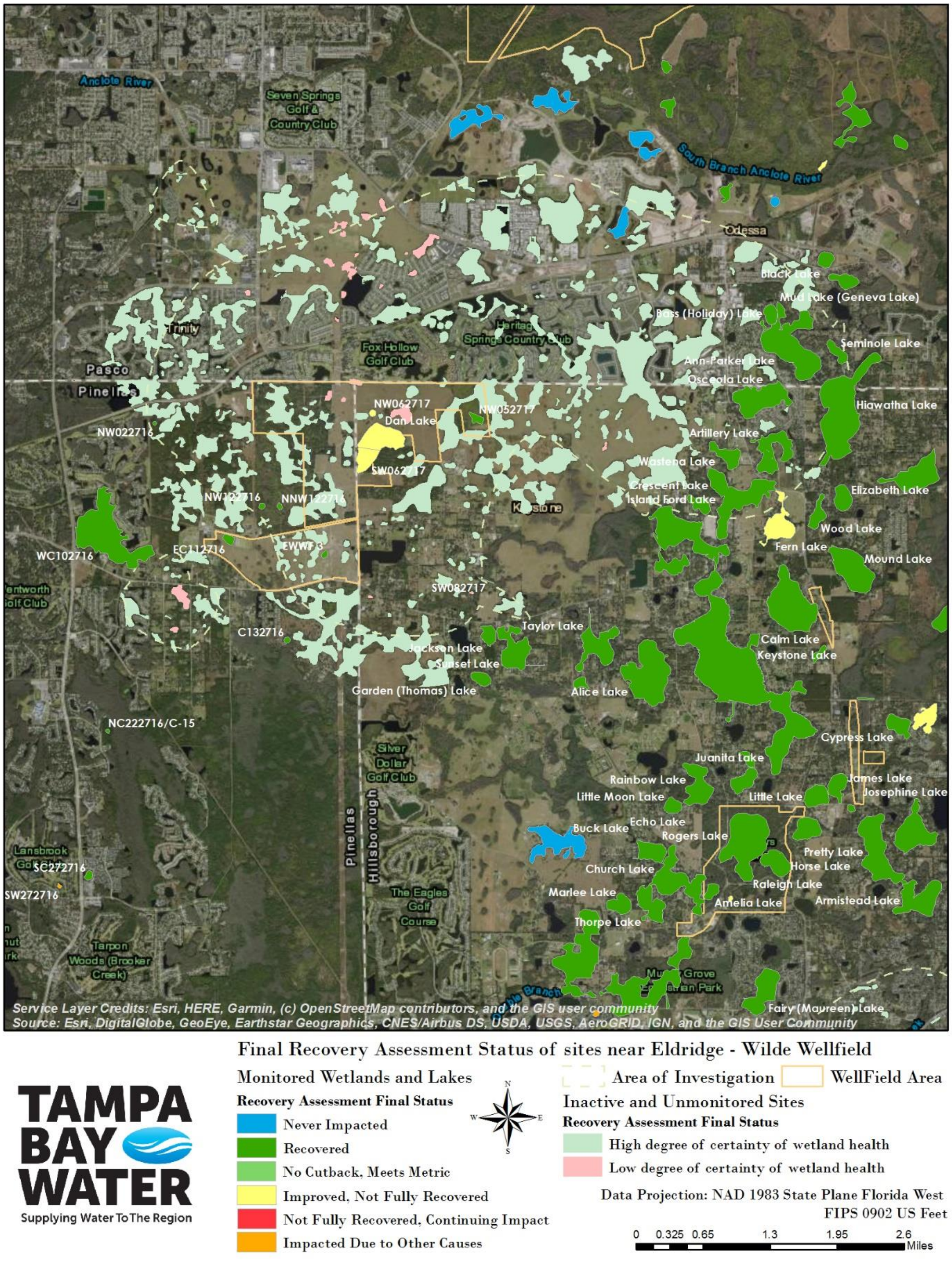

Figure 14.6: Final Recovery Assessment Site Results for the Eldridge-Wilde Wellfield Area

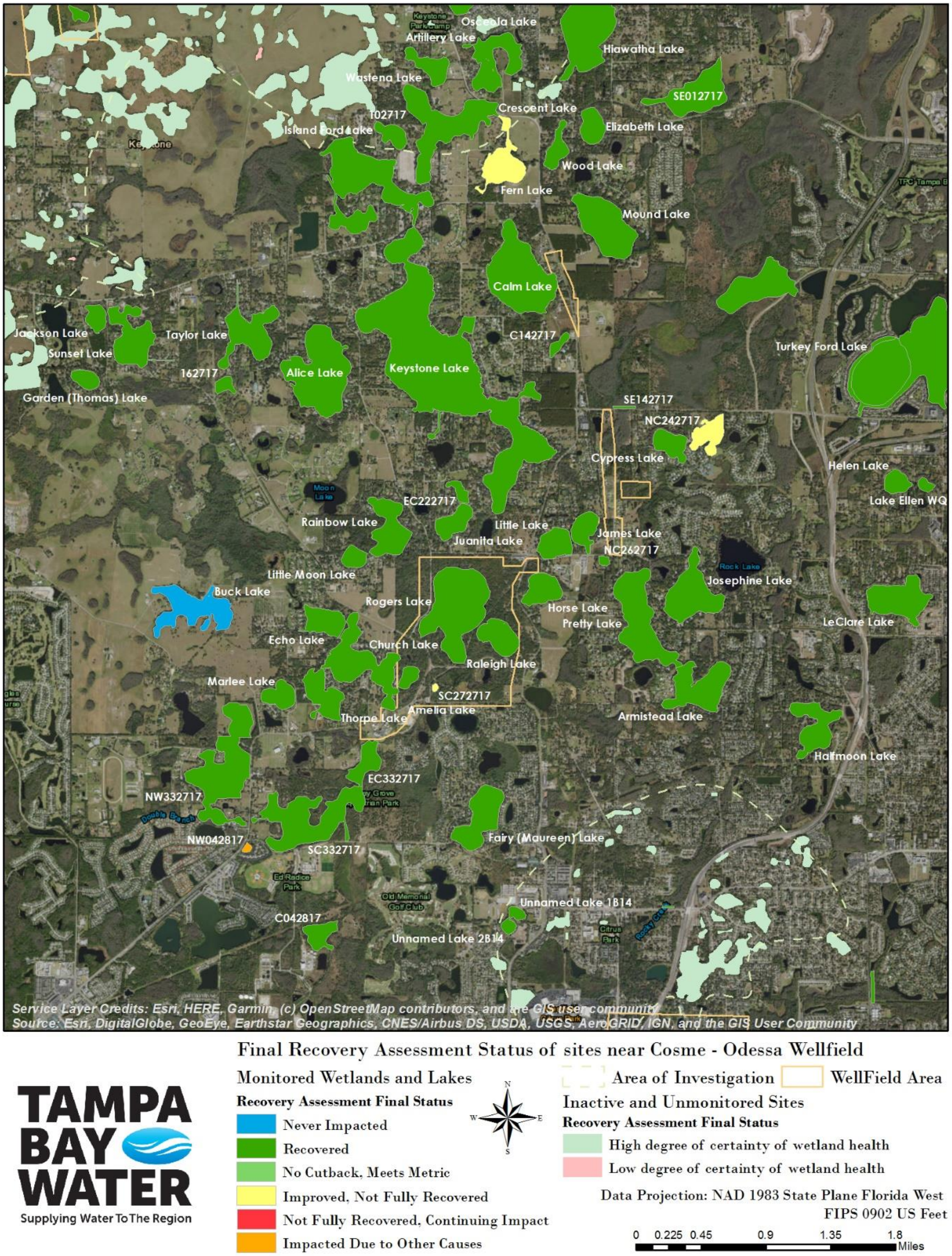

Figure 14.7: Final Recovery Assessment Site Results for the Cosme-Odessa Wellfield Area

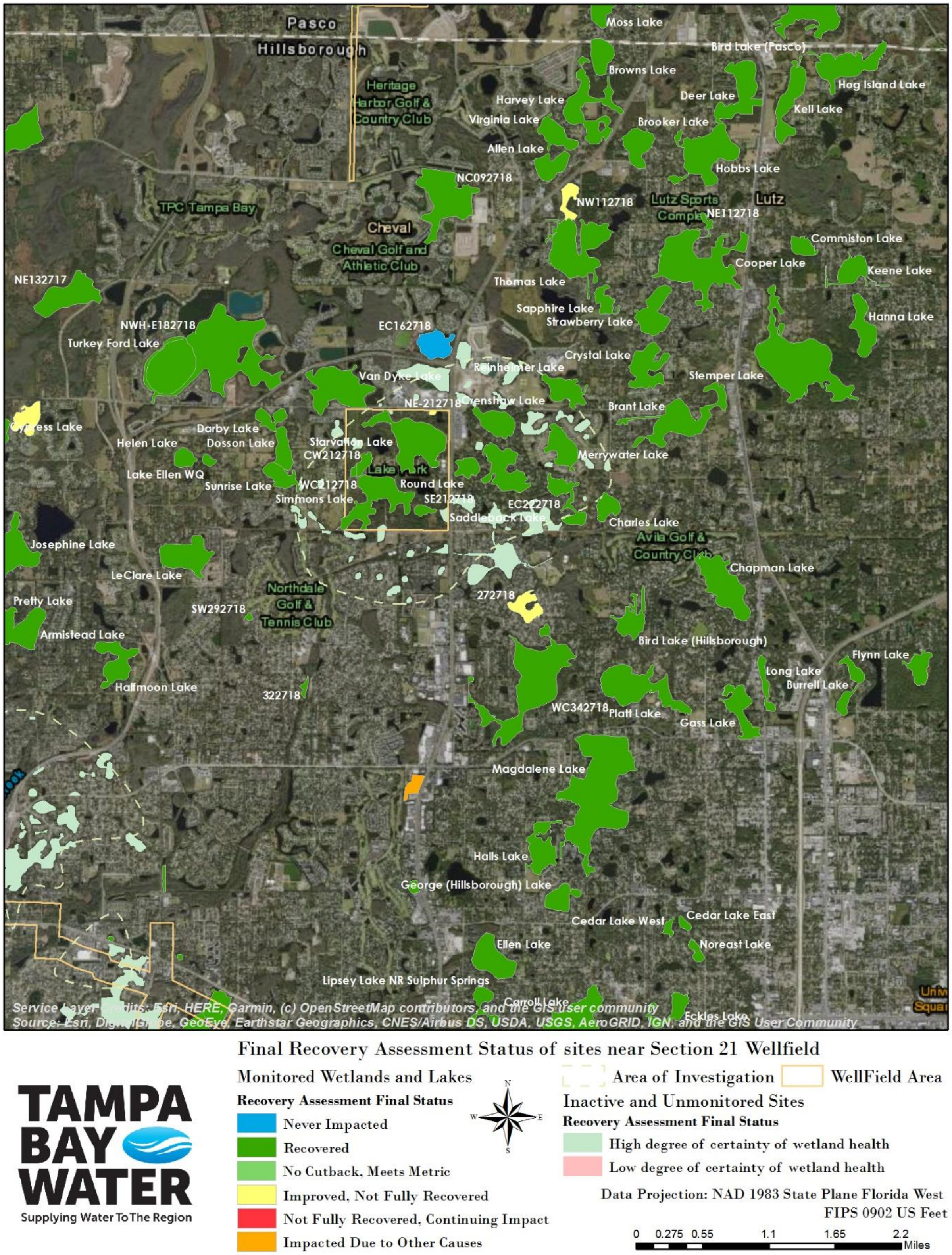

Figure 14.8: Final Recovery Assessment Site Results for the Section 21 Wellfield Area

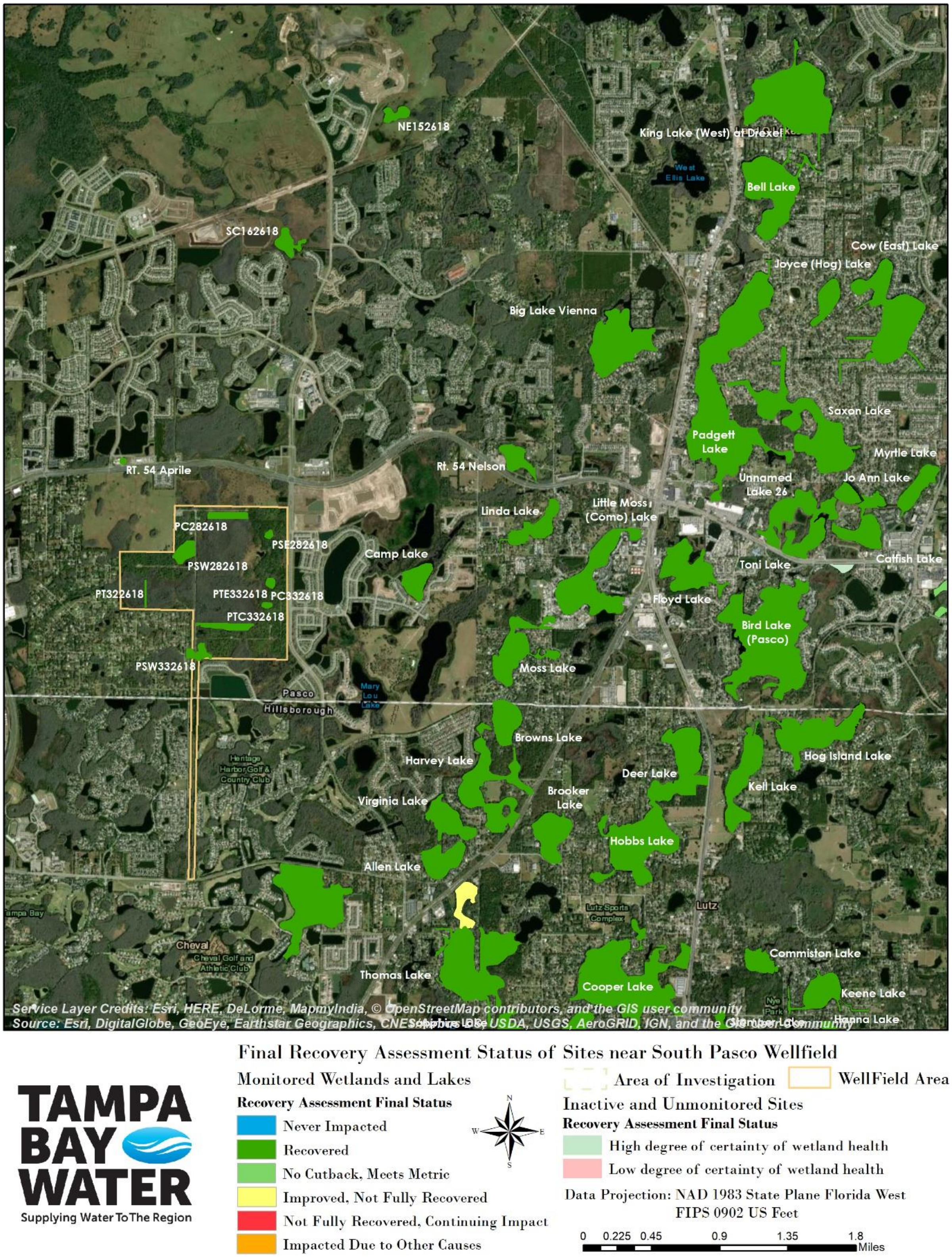

Figure 14.9: Final Recovery Assessment Site Results for the South Pasco Wellfield Area

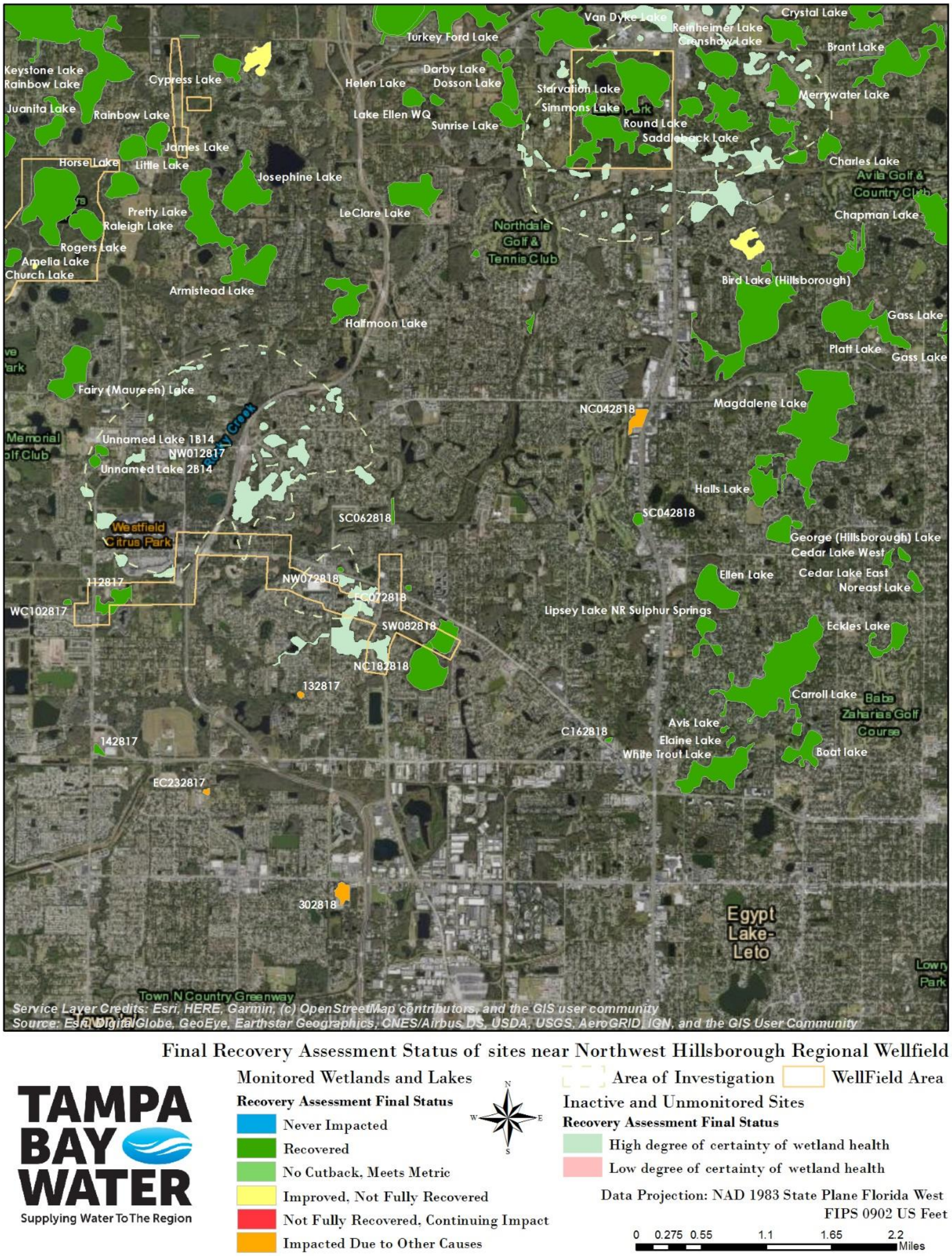

Figure 14.10: Final Recovery Assessment Site Results for the Northwest Hillsborough Regional Wellfield Area

14.1.2 Monitored Wetlands

Chapter 9 discusses the multiple types of data, the assessment procedures developed to evaluate the degree of wetland recovery that can be attributed to the reduction in wellfield pumping, and the weight-of-evidence approach used to assess the monitored wetlands at each wellfield. The individual wellfield assessments of monitored wetlands are included in Chapter 9 as well as the annual updates to the water level data analyses and the assignment of each of the 378 monitored wetland to a final Recovery Assessment status or bin. The final assessment showed that 78% of the monitored wetlands are classified as Never Impacted, Recovered/Meets Metric, or having a High Degree of Certainty of Wetland Health and another 3% of the monitored wetlands were classified as Impacted Due to Other Causes. There are 66 monitored wetlands (17% of the total) assigned to the bin of Improved, Not Fully Recovered and the degree of this environmental improvement was further characterized in Section 9.7. For the Improved wetlands with current water level data, the median long-term water level was between 0.5 to 0.8 foot below the metric of wetland health or recovery for the three different wetland types. This characterization demonstrates significant environmental recovery, even in the wetlands that did not quite meet the standard for a Recovered wetland. Only eight wetlands (2% of the total) are assigned to the bin of Not Fully Recovered, Continuing Wellfield Impact. Table 14.2 presents the final Recovery Assessment status or bin for each of the monitored wetlands. These results are shown in Figures 14.1 through 14.10.

Table 14.2: Final Recovery Assessment Findings for Monitored Wetlands

SWFWMD ID	Site Name	Wellfield Code	Final Recovery Assessment Bin
1	**CBR-Q01**	**CBR**	Improved, Not Fully Recovered
2	CBR-Q02	CBR	Recovered
4	CBR-Q04	CBR	Recovered
5	CBR-Q05	CBR	Improved, Not Fully Recovered
6	CBR-Q06	CBR	Improved, Not Fully Recovered
7	CBR-Q07	CBR	Improved, Not Fully Recovered
8	CBR-Q08	CBR	Improved, Not Fully Recovered
9	CBR-Q10	CBR	Recovered
10	CBR-Q12	CBR	Recovered
11	CBR-Q14	CBR	Improved, Not Fully Recovered
12	CBR-Q15	CBR	Improved, Not Fully Recovered
13	CBR-Q16	CBR	Recovered
14	CBR-Q17	CBR	Recovered
17	CBR-Q20	CBR	Recovered
18	CBR-Q21	CBR	Improved, Not Fully Recovered
20	CBR-Q23	CBR	Low Degree of Certainty of Wetland Health
21	CBR-Q24	CBR	Recovered
22	**CBR-Q25**	**CBR**	Improved, Not Fully Recovered
23	CBR-Q26	CBR	Improved, Not Fully Recovered
31	CBR Q34	CBR	High Degree of Certainty of Wetland Health
34	CBR-T01	CBR	Improved, Not Fully Recovered
35	CBR-T02A	CBR	Improved, Not Fully Recovered
36	**CBR-T03**	**CBR**	Recovered
38	CBR-T08A	CBR	Recovered
39	CBR-T10	CBR	Improved, Not Fully Recovered
40	CBR T11	CBR	Low Degree of Certainty of Wetland Health
41	Ann Denker	CBR	Recovered
42	Pasco Trails	CBR	Recovered
542	Lost Lake	CBR	Improved, Not Fully Recovered
543	Spring Lake	CBR	Recovered
544	Cross Bar 6	CBR	Recovered
103	COS-102717	COS	Recovered
104	COS-162717	COS	Recovered
105	COS-C042817	COS	Recovered
106	COS-C142717	COS	Recovered
107	COS-EC222717	COS	Recovered
108	COS-EC332717	COS	Recovered

SWFWMD ID	Site Name	Wellfield Code	Final Recovery Assessment Bin
109	COS-NC242717	COS	Improved, Not Fully Recovered
110	COS-NC262717	COS	Recovered
111	COS-NW042817	COS	Impacted Due to Other Causes
112	COS-NW332717	COS	Recovered
113	COS-SC272717	COS	Improved, Not Fully Recovered
114	COS-SC332717	COS	Recovered
115	COS-SE012717	COS	Recovered
116	COS-SE142717	COS	Recovered
121	CYB-01	CYB	Impacted Due to Other Causes
122	CYB-02	CYB	Impacted Due to Other Causes
123	CYB-03	CYB	Impacted Due to Other Causes
124	**CYB-04**	**CYB**	No cutback, meets metric
125	CYB-05	CYB	No cutback, meets metric
126	CYB-06	CYB	No cutback, meets metric
127	CYB-09	CYB	No cutback, meets metric
128	CYB-11	CYB	Impacted Due to Other Causes
129	CYB 12	CYB	Low Degree of Certainty of Wetland Health
130	CYB-13	CYB	No cutback, meets metric
131	CYB-14	CYB	No cutback, meets metric
132	CYB-15	CYB	Not Fully Recovered, Continuing Wellfield Impact
133	**CYB-16**	**CYB**	No cutback, meets metric
134	CYB-17	CYB	No cutback, meets metric
135	CYB-18	CYB	No cutback, meets metric
138	CYB-21	CYB	No cutback, meets metric
139	CYB-22	CYB	No cutback, meets metric
140	CYB-23	CYB	No cutback, meets metric
141	CYB 24	CYB	High Degree of Certainty of Wetland Health
142	**CYB-25**	**CYB**	No cutback, meets metric
143	CYB-26	CYB	No cutback, meets metric
144	CYB-27	CYB	No cutback, meets metric
145	CYB-28	CYB	No cutback, meets metric
146	CYB-29	CYB	No cutback, meets metric
147	CYB-30	CYB	No cutback, meets metric
148	CYB-31	CYB	No cutback, meets metric
149	**CYB-32**	**CYB**	No cutback, meets metric
150	CYB-33	CYB	No cutback, meets metric
151	CYB-34	CYB	No cutback, meets metric
152	CYB-37	CYB	No cutback, meets metric
153	**CYB-A**	**CYB**	Not Fully Recovered, Continuing Wellfield Impact

SWFWMD ID	Site Name	Wellfield Code	Final Recovery Assessment Bin
154	CYB-C10	CYB	No cutback, meets metric
155	CYB-C12	CYB	No cutback, meets metric
156	CYB-C16	CYB	No cutback, meets metric
158	New River Cypress	CYB	No cutback, meets metric
159	New River Marsh	CYB	No cutback, meets metric
16	CYC C25/ CBR Q19	CYC	Improved, Not Fully Recovered
160	C01	CYC	Recovered
162	CYC-C06	CYC	Recovered
163	C08	CYC	Improved, Not Fully Recovered
164	CYC-C11	CYC	Recovered
166	CYC-C14	CYC	Recovered
167	C15	CYC	High Degree of Certainty of Wetland Health
168	C16	CYC	High Degree of Certainty of Wetland Health
169	CYC-C19	CYC	Recovered
170	CYC-C20	CYC	Recovered
172	C22A	CYC	High Degree of Certainty of Wetland Health
173	C23	CYC	High Degree of Certainty of Wetland Health
174	CYC-C24	CYC	Recovered
176	CYC-C33	CYC	Recovered
177	CYC-C39	CYC	Recovered
178	CYC-C40	CYC	Recovered
179	CYC-C100	CYC	Recovered
180	CYC-W25	CYC	Recovered
181	CYC-C101	CYC	Recovered
182	CYC-C102	CYC	Improved, Not Fully Recovered
183	CYC-C103	CYC	Recovered
184	CYC-C104	CYC	Improved, Not Fully Recovered
185	CYC-C105	CYC	Recovered
186	C106	CYC	Recovered
187	CYC-W01	CYC	Recovered
188	W02A	CYC	Improved, Not Fully Recovered
189	CYC-W03	CYC	Improved, Not Fully Recovered
190	CYC-W04	CYC	Recovered
191	CYC-W05	CYC	Recovered
192	W06/ W07/ W08	CYC	Recovered
193	CYC-W09	CYC	Recovered
194	CYC-W10	CYC	Recovered
195	**CYC-W11**	**CYC**	Recovered
196	**CYC-W12**	**CYC**	Improved, Not Fully Recovered

SWFWMD ID	Site Name	Wellfield Code	Final Recovery Assessment Bin
197	CYC-W14	CYC	Recovered
198	CYC-W16	CYC	Not Fully Recovered, Continuing Wellfield Impact
199	**CYC-W17**	**CYC**	Recovered
200	CYC-W19	CYC	Improved, Not Fully Recovered
201	CYC-W20	CYC	Recovered
202	CYC-W21N	CYC	Recovered
203	CYC-W21S	CYC	Recovered
204	CYC-W23	CYC	Improved, Not Fully Recovered
205	CYC-W27	CYC	Improved, Not Fully Recovered
206	CYC-W29	CYC	Recovered
207	CYC-W30N	CYC	Recovered
208	W30S	CYC	Recovered
209	CYC-W31	CYC	Recovered
210	CYC-W32	CYC	Not Fully Recovered, Continuing Wellfield Impact
211	CYC-W33	CYC	Recovered
212	W34	CYC	Recovered
213	CYC-W36	CYC	Recovered
214	CYC-W37	CYC	Improved, Not Fully Recovered
215	CYC-W39	CYC	Recovered
216	CYC-W40	CYC	Improved, Not Fully Recovered
217	CYC-W41	CYC	Improved, Not Fully Recovered
218	W42	CYC	Recovered
220	CYC-W43	CYC	Improved, Not Fully Recovered
221	CYC-W44	CYC	Improved, Not Fully Recovered
222	CYC-W45	CYC	Not Fully Recovered, Continuing Wellfield Impact
223	CYC-W46	CYC	Improved, Not Fully Recovered
225	CYC-W49	CYC	Improved, Not Fully Recovered
226	CYC-W50	CYC	Recovered
227	CYC-W51	CYC	Improved, Not Fully Recovered
228	CYC-W52	CYC	Improved, Not Fully Recovered
229	CYC-W55	CYC	Not Fully Recovered, Continuing Wellfield Impact
230	**CYC-W56**	**CYC**	Improved, Not Fully Recovered
231	CYC-W57	CYC	Recovered
232	CYC-W58	CYC	Recovered
233	CCS-5	CYC	Recovered
234	CCWF "F"	CYC	Not Fully Recovered, Continuing Wellfield Impact
235	Conners Cypress Marsh	CYC	Improved, Not Fully Recovered
236	Conners Marsh 1	CYC	Never Impacted

SWFWMD ID	Site Name	Wellfield Code	Final Recovery Assessment Bin
237	Conners Marsh 2	CYC	Never Impacted
238	Conners Wet Prairie	CYC	Never Impacted
239	Correctional Facility Cypress	CYC	Recovered
240	Correctional Facility Cypress Marsh	CYC	Recovered
241	Mertz Riverine	CYC	Recovered
242	Pheasant Run (Quail Hollow) Cypress	CYC	Recovered
243	ELW-C132716	ELW	Recovered
244	ELW-EC112716	ELW	Recovered
245	ELW-NC222716	ELW	Recovered
246	**ELW-NNW122716**	**ELW**	Recovered
247	ELW-NW022716	ELW	Recovered
248	**ELW-NW052717**	**ELW**	Recovered
249	ELW-NW062717	ELW	Improved, Not Fully Recovered
250	ELW-NW122716	ELW	Recovered
251	ELW-SC272716	ELW	Recovered
252	ELW-SW062717	ELW	Improved, Not Fully Recovered
253	SW082717	ELW	Recovered
254	ELW-SW272716	ELW	Impacted Due to Other Causes
255	ELW-WC102716	ELW	Recovered
256	EWWF3	ELW	Recovered
257	MBR-09	MBR	Recovered
258	MBR-10	MBR	Not Fully Recovered, Continuing Wellfield Impact
259	MBR-11	MBR	Recovered
260	MBR-14	MBR	Recovered
261	**MBR-16**	**MBR**	Recovered
262	MBR-29	MBR	Improved, Not Fully Recovered
263	MBR-30	MBR	Improved, Not Fully Recovered
264	**MBR-35**	**MBR**	Recovered
265	MBR-36	MBR	Recovered
266	MBR-37	MBR	Improved, Not Fully Recovered
267	MBR-42	MBR	Recovered
268	MBR-60	MBR	Recovered
269	MBR-79	MBR	Recovered
270	MBR-80	MBR	Recovered
271	MBR 81	MBR	High Degree of Certainty of Wetland Health
272	MBR 86	MBR	High Degree of Certainty of Wetland Health

SWFWMD ID	Site Name	Wellfield Code	Final Recovery Assessment Bin
273	**MBR-88**	**MBR**	Improved, Not Fully Recovered
274	**MBR-89**	**MBR**	Recovered
275	MBR-90	MBR	Recovered
276	MBR-91	MBR	Improved, Not Fully Recovered
277	MBR-93	MBR	Recovered
278	MBR-94	MBR	Recovered
279	MBR-96	MBR	Recovered
280	MBR-97	MBR	Improved, Not Fully Recovered
281	MBR-98	MBR	Improved, Not Fully Recovered
282	MBR 100	MBR	Recovered
283	MBR-102	MBR	Improved, Not Fully Recovered
284	MBR-103	MBR	Recovered
285	MBR-104	MBR	Recovered
286	MBR-105	MBR	Improved, Not Fully Recovered
287	MBR-106	MBR	Recovered
288	MBWF Clay Gully Site	MBR	Recovered
289	East Branch Clay S RD	MBR	Recovered
290	East Branch Clay Gully	MBR	Improved, Not Fully Recovered
291	MBWF East Cypress Marsh	MBR	Improved, Not Fully Recovered
292	MBWF Trout Creek Marsh	MBR	Improved, Not Fully Recovered
293	MBWF West Cypress	MBR	Recovered
294	MBWF Wild Hog Slough	MBR	Recovered
295	MBWF X-1	MBR	Improved, Not Fully Recovered
296	MBWF X-3	MBR	Recovered
297	MBWF X-6	MBR	Recovered
312	Cypress Creek ELAPP Cypress	None	Never Impacted
313	Cypress Creek ELAPP Marsh	None	Never Impacted
314	Cypress Creek ELAPP Riverine	None	Recovered
336	NOP-01	NOP	Never Impacted
337	NOP-02	NOP	Never Impacted
338	**NOP-03**	**NOP**	**Never Impacted**
339	NOP-04	NOP	Recovered
340	NOP-05	NOP	Recovered
341	NP-06	NOP	High Degree of Certainty of Wetland Health
342	NOP-07	NOP	Improved, Not Fully Recovered

SWFWMD ID	Site Name	Wellfield Code	Final Recovery Assessment Bin
343	NP-08	NOP	Recovered
344	NOP-09	NOP	Never Impacted
345	NOP-10	NOP	Recovered
346	NOP-11	NOP	Never Impacted
347	NP-13/CYB C17	NOP	High Degree of Certainty of Wetland Health
348	NP-15	NOP	High Degree of Certainty of Wetland Health
349	NP-16	NOP	High Degree of Certainty of Wetland Health
350	NOP-17	NOP	Recovered
351	NOP-18	NOP	Never Impacted
352	**NOP-21**	**NOP**	**Recovered**
353	NOP-22	NOP	Never Impacted
354	NP-25	NOP	High Degree of Certainty of Wetland Health
355	NP-26	NOP	Recovered
356	NP-27	NOP	Recovered
357	NP-29	NOP	High Degree of Certainty of Wetland Health
358	NOP-30	NOP	Never Impacted
360	NP-32	NOP	Never Impacted
362	NOP-36	NOP	Never Impacted
365	112817	NWH	Recovered
366	NWH-132817	NWH	Impacted Due to Other Causes
367	NWH-142817	NWH	Recovered
369	302818	NWH	Impacted Due to Other Causes
370	C162818	NWH	Recovered
372	NWH-EC072818	NWH	Recovered
373	NWH-EC232817	NWH	Impacted Due to Other Causes
374	NWH-NC042818	NWH	Impacted Due to Other Causes
375	NC182818	NWH	Recovered
377	NWH-NW012817	NWH	Recovered
378	NWH-NW072818	NWH	Recovered
379	NWH-SC042818	NWH	Recovered
380	NWH-SC062818	NWH	Recovered
381	NWH-SW082818	NWH	Recovered
382	NWH-WC102817	NWH	Recovered
371	NWH-E182718	S21	Recovered
376	NWH-NE132717	S21	Recovered
383	S21-272718	S21	Improved, Not Fully Recovered
384	S21-322718	S21	Recovered
385	S21-CW212718	S21	Recovered
386	S21-EC162718	S21	Never Impacted

SWFWMD ID	Site Name	Wellfield Code	Final Recovery Assessment Bin
387	S21-EC222718	S21	Recovered
388	S21-NC092718	S21	Recovered
389	NE112718	S21	Recovered
390	S21-NE212718	S21	Improved, Not Fully Recovered
391	NW112718	S21	Improved, Not Fully Recovered
393	S21-SE212718	S21	Recovered
394	S21-SW292718	S21	Recovered
395	S21-WC212718	S21	Recovered
396	S21-WC342718	S21	Recovered
397	SOP-NE152618	SOP	Recovered
398	SOP-PC282618	SOP	Recovered
399	SOP-PT322618	SOP	Recovered
400	SOP-PTC332618	SOP	Recovered
401	SOP-PSW282618	SOP	Recovered
402	**SOP-PC332618**	**SOP**	Recovered
403	**SOP-PSE282618**	**SOP**	Recovered
404	SOP-PSW332618	SOP	Recovered
405	**SOP-PTE332618**	**SOP**	Recovered
406	SOP-SC162618	SOP	Recovered
407	Rt. 54 Aprile	SOP	Recovered
408	Rt. 54 Nelson	SOP	Recovered
409	J.B. Starkey 1	STK	Recovered
410	S-004	STK	Recovered
411	STK-S-005	STK	Recovered
412	STK-S-006	STK	Recovered
415	STK-S-010	STK	Never Impacted
417	S-013	STK	High Degree of Certainty of Wetland Health
418	STK-S-016	STK	Recovered
419	STK-S-018	STK	Recovered
420	STK-S-020	STK	Recovered
421	STK-S-023	STK	Recovered
422	STK-S-024	STK	Recovered
423	STK-S-030	STK	Recovered
424	STK-S-031	STK	Recovered
425	STK-S-035	STK	Recovered
426	S-036A	STK	High Degree of Certainty of Wetland Health
427	STK-S-038	STK	Recovered
428	STK-S-039	STK	Recovered
429	STK-S-042	STK	Recovered

SWFWMD ID	Site Name	Wellfield Code	Final Recovery Assessment Bin
430	STK-S-044	STK	Recovered
431	STK-S-046	STK	Improved, Not Fully Recovered
432	S-051	STK	Recovered
433	STK-S-052	STK	Recovered
434	STK-S-053	STK	Improved, Not Fully Recovered
435	STK-S-054	STK	Recovered
436	STK-S-055	STK	Recovered
437	S-056	STK	High Degree of Certainty of Wetland Health
438	STK-S-062	STK	Recovered
439	STK-S-063	STK	Improved, Not Fully Recovered
440	STK-S-064	STK	Recovered
441	STK-S-065	STK	Recovered
442	STK-S-067	STK	Recovered
443	STK-S-068	STK	Never Impacted
444	**STK-S-069**	**STK**	**Never Impacted**
445	STK-S-070	STK	Never Impacted
446	STK-S-072	STK	High Degree of Certainty of Wetland Health
447	**STK-S-073**	**STK**	**Never Impacted**
448	STK-S-074	STK	Never Impacted
449	**STK-S-075**	**STK**	**Never Impacted**
450	STK-S-076	STK	Never Impacted
451	STK-S-080	STK	Improved, Not Fully Recovered
452	S-082	STK	High Degree of Certainty of Wetland Health
453	S-083	STK	Recovered
454	STK-S-084	STK	Recovered
455	STK-S-085	STK	Recovered
456	STK-S-089	STK	Never Impacted
457	STK-S-090	STK	Recovered
458	S-094	STK	Recovered
459	STK-S-095	STK	Recovered
460	S-096	STK	High Degree of Certainty of Wetland Health
461	STK-S-097	STK	Recovered
462	**STK-S-099**	**STK**	Recovered
463	S-101	STK	High Degree of Certainty of Wetland Health
464	STK-S-108	STK	Never Impacted
465	STK-S-109	STK	Never Impacted
466	S-111	STK	Recovered
467	STK-S-112	STK	Recovered
468	STK-S-113	STK	Improved, Not Fully Recovered

SWFWMD ID	Site Name	Wellfield Code	Final Recovery Assessment Bin
469	SC-01	STK	High Degree of Certainty of Wetland Health
470	STK-SC-11	STK	Never Impacted
471	STK-SC-30	STK	Never Impacted
473	SC-33	STK	High Degree of Certainty of Wetland Health
474	SC-46	STK	Recovered
475	STK-SC-58	STK	Recovered
476	STK-SC-59	STK	Never Impacted
477	SC-62	STK	Recovered
478	STK-SC-67	STK	Never Impacted
479	STK-SC-68	STK	Never Impacted
480	SC-69	STK	Never Impacted
481	SC-70	STK	High Degree of Certainty of Wetland Health
482	STK-SC-71	STK	Never Impacted
483	STK-SC-92	STK	Recovered
484	**STK-Central-01**	**STK**	Recovered
485	STK-D	STK	Recovered
486	**STK-N**	**STK**	Never Impacted
487	**STK-Z**	**STK**	Recovered
488	STK-T-07	STK	Never Impacted
489	STK-T-09	STK	Never Impacted
490	STK-T-10	STK	Never Impacted
491	Anclote South Wet Prairie	STK	Improved, Not Fully Recovered
492	J.B. Starkey 2	STK	Recovered
493	J.B. Starkey 3	STK	Recovered
494	J.B. Starkey 4	STK	Never Impacted
495	River Ridge High School	STK	Recovered
496	Starkey Wet Prairie	STK	Improved, Not Fully Recovered
497	STWF BB	STK	Never Impacted
498	STWF C	STK	Never Impacted
499	STWF EE	STK	Never Impacted
500	STWF GG	STK	Never Impacted
501	STWF K	STK	Never Impacted
502	STWF O	STK	Recovered
503	STWF T	STK	Never Impacted
504	STWF V	STK	Recovered
505	STWF W	STK	Recovered
506	STWF X	STK	Recovered

Bold = MFL Wetland

14.1.3 Unmonitored Sites

The final assessment of recovery included 845 unmonitored wetlands and lakes that are located on or near the wellfields in areas where a potential impact may exist from wellfield pumping at an average annual quantity of 90 mgd. These unmonitored sites were assessed in addition to the monitored wetlands and lakes to provide a full assessment of recovery and potential remaining impacts as required by the Consolidated Permit. The data used to assess the status of the unmonitored sites was interpolated from sites with measured water level or ecological data and several geospatial datasets were created to predict the health at the unmonitored sites. All of the data used to assess the unmonitored sites contained errors and there was considerable uncertainty in the predicted results. Uncertainty in the results was expected due to the fact that little or no data exists for these 845 sites. The final assessment of the unmonitored sites is discussed in detail in Chapter 10 and concluded that 73% of the unmonitored sites had a High Degree of Certainty of Wetland Health based on the multiple datasets used in the assessment. This percentage is close to the percent of monitored wetlands and lakes that were classified as Never Impacted or Recovered giving validation to the assessment results. Table 14.3 presents the final Recovery Assessment status or bin for each of the unmonitored sites and the wellfield associated with each site. These results are illustrated in Figures 14.1 through 14.10 but the Site ID numbers do not appear on the figures as explained above.

Table 14.3: Final Recovery Assessment Findings for Unmonitored Sites

Site ID	Associated Wellfield	Final Assessment Status
1121	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1133	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1145	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1166	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1186	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1201	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1217	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1218	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1221	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1222	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1226	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1228	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1229	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1235	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1246	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1248	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1254	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1259	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1262	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1264	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1270	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1274	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1283	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1291	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1292	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1304	Northwest Hillsborough	High Degree of Certainty of Wetland Health
1416	Section 21	High Degree of Certainty of Wetland Health
1436	Section 21	High Degree of Certainty of Wetland Health
1437	Section 21	High Degree of Certainty of Wetland Health
1438	Section 21	High Degree of Certainty of Wetland Health
1444	Section 21	High Degree of Certainty of Wetland Health
1452	Section 21	High Degree of Certainty of Wetland Health
1455	Section 21	High Degree of Certainty of Wetland Health
1459	Section 21	High Degree of Certainty of Wetland Health
1474	Section 21	High Degree of Certainty of Wetland Health
1477	Section 21	High Degree of Certainty of Wetland Health
1481	Section 21	High Degree of Certainty of Wetland Health

1491	Section 21	High Degree of Certainty of Wetland Health
1494	Section 21	High Degree of Certainty of Wetland Health
1498	Section 21	High Degree of Certainty of Wetland Health
1506	Section 21	High Degree of Certainty of Wetland Health
1512	Section 21	High Degree of Certainty of Wetland Health
1513	Section 21	High Degree of Certainty of Wetland Health
1523	Section 21	High Degree of Certainty of Wetland Health
1532	Section 21	High Degree of Certainty of Wetland Health
1551	Section 21	High Degree of Certainty of Wetland Health
1556	Section 21	High Degree of Certainty of Wetland Health
1574	Section 21	High Degree of Certainty of Wetland Health
1575	Section 21	High Degree of Certainty of Wetland Health
1579	Section 21	High Degree of Certainty of Wetland Health
1591	Section 21	High Degree of Certainty of Wetland Health
1593	Section 21	High Degree of Certainty of Wetland Health
1605	Section 21	High Degree of Certainty of Wetland Health
1606	Section 21	High Degree of Certainty of Wetland Health
1607	Section 21	High Degree of Certainty of Wetland Health
1627	Section 21	High Degree of Certainty of Wetland Health
1640	Section 21	High Degree of Certainty of Wetland Health
1642	Section 21	High Degree of Certainty of Wetland Health
1657	Section 21	High Degree of Certainty of Wetland Health
1680	Section 21	High Degree of Certainty of Wetland Health
1683	Section 21	High Degree of Certainty of Wetland Health
1707	Section 21	High Degree of Certainty of Wetland Health
1738	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1746	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1749	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
1756	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1767	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1768	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1775	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1776	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1800	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1805	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
1806	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1817	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1821	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1822	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
1825	Eldridge-Wilde	High Degree of Certainty of Wetland Health

1832	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1838	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
1841	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1853	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1859	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1860	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1879	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1890	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1891	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1900	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1904	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1910	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1923	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1925	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1927	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1937	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1940	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1945	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1946	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1952	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1955	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1959	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1962	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1963	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1965	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1966	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1969	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1979	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1989	Eldridge-Wilde	High Degree of Certainty of Wetland Health
1993	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2003	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2008	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2016	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2022	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2026	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2033	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2044	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2059	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2063	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2064	Eldridge-Wilde	High Degree of Certainty of Wetland Health

2069	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2070	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2072	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2073	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2074	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2075	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2077	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2080	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2083	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2086	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2095	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2098	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2099	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2100	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2105	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2106	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2109	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2115	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2118	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
2126	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2130	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2133	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2135	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2136	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2137	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2139	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2140	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2141	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2146	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2149	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2150	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2153	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2157	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2158	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2161	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2162	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2163	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2165	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2168	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2170	Eldridge-Wilde	High Degree of Certainty of Wetland Health

2172	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2174	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2176	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2177	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2182	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
2185	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2186	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2190	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2191	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2193	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2195	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
2203	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2210	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
2216	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2218	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2221	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2223	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2225	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2229	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2239	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2242	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2245	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2249	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2254	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2255	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2256	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2263	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2270	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2271	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2277	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2278	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2279	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2285	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2312	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2315	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2317	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2321	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2326	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2328	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2330	Eldridge-Wilde	High Degree of Certainty of Wetland Health

2332	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2334	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2336	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
2341	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2351	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2352	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2356	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2357	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2360	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2362	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2365	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2367	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2369	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2373	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2374	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2375	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2377	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2380	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2381	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2382	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2386	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2391	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2395	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2397	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2399	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2400	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2404	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2418	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2425	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2439	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2440	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2448	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2457	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
2458	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
2463	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2473	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2488	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2491	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2492	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
2505	Eldridge-Wilde	High Degree of Certainty of Wetland Health

2506	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2510	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2511	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2516	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2522	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
2523	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2531	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2535	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2536	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2541	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2548	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2549	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2550	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
2551	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2567	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2569	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2570	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2571	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2578	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2583	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2593	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2604	Eldridge-Wilde	High Degree of Certainty of Wetland Health
2636	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3039	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3044	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3046	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3047	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3048	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3049	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3050	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3051	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3052	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3053	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3054	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3059	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3060	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3061	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3065	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3066	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3067	Eldridge-Wilde	High Degree of Certainty of Wetland Health

3070	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3071	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3075	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3077	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3080	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3081	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3082	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3085	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3087	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3088	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3089	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3091	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3092	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3094	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3095	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3096	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3100	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3101	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3102	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3103	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3104	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3105	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3106	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3107	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3108	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
3109	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3110	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3111	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3112	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3113	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3114	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
3115	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
3116	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
3117	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3118	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
3119	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
3120	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
3121	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3122	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3123	Eldridge-Wilde	High Degree of Certainty of Wetland Health

3124	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3125	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3126	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3127	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
3128	Eldridge-Wilde	Low Degree of Certainty of Wetland Health
3130	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3131	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3133	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3134	Eldridge-Wilde	High Degree of Certainty of Wetland Health
3136	Section 21	High Degree of Certainty of Wetland Health
3140	Northwest Hillsborough	High Degree of Certainty of Wetland Health
3143	Northwest Hillsborough	High Degree of Certainty of Wetland Health
3144	Northwest Hillsborough	High Degree of Certainty of Wetland Health
3145	Northwest Hillsborough	High Degree of Certainty of Wetland Health
3331	Starkey	High Degree of Certainty of Wetland Health
3361	Starkey	High Degree of Certainty of Wetland Health
3390	Starkey	High Degree of Certainty of Wetland Health
3399	Starkey	High Degree of Certainty of Wetland Health
3420	Starkey	High Degree of Certainty of Wetland Health
3461	Starkey	Low Degree of Certainty of Wetland Health
3489	Starkey	High Degree of Certainty of Wetland Health
3881	Cypress Creek	High Degree of Certainty of Wetland Health
3898	Cypress Creek	High Degree of Certainty of Wetland Health
3903	Cypress Creek	High Degree of Certainty of Wetland Health
3939	Cypress Creek	High Degree of Certainty of Wetland Health
3955	Cypress Creek	High Degree of Certainty of Wetland Health
3961	Cypress Creek	High Degree of Certainty of Wetland Health
3962	Cypress Creek	High Degree of Certainty of Wetland Health
3975	Cypress Creek	Low Degree of Certainty of Wetland Health
3991	Cypress Creek	Low Degree of Certainty of Wetland Health
4008	Cypress Creek	Low Degree of Certainty of Wetland Health
4009	Cypress Creek	Low Degree of Certainty of Wetland Health
4043	Cypress Creek	Low Degree of Certainty of Wetland Health
4064	Cypress Creek	Low Degree of Certainty of Wetland Health
4079	Cypress Creek	Low Degree of Certainty of Wetland Health
4081	Cypress Creek	Low Degree of Certainty of Wetland Health
4086	Cypress Creek	High Degree of Certainty of Wetland Health
4087	Cypress Creek	Low Degree of Certainty of Wetland Health
4097	Cypress Creek	Low Degree of Certainty of Wetland Health
4102	Cypress Creek	Low Degree of Certainty of Wetland Health

4112	Cypress Creek	Low Degree of Certainty of Wetland Health
4123	Cypress Creek	Low Degree of Certainty of Wetland Health
4128	Cypress Creek	Low Degree of Certainty of Wetland Health
4148	Cypress Creek	Low Degree of Certainty of Wetland Health
4236	Cypress Creek	High Degree of Certainty of Wetland Health
4271	Cypress Creek	Low Degree of Certainty of Wetland Health
4283	Cypress Creek	High Degree of Certainty of Wetland Health
4286	Cypress Creek	Low Degree of Certainty of Wetland Health
4336	Cypress Creek	High Degree of Certainty of Wetland Health
4355	Cypress Creek	High Degree of Certainty of Wetland Health
4392	Cypress Creek	High Degree of Certainty of Wetland Health
4405	Cypress Creek	High Degree of Certainty of Wetland Health
4423	Cypress Creek	High Degree of Certainty of Wetland Health
4439	Cypress Creek	High Degree of Certainty of Wetland Health
4442	Cypress Creek	High Degree of Certainty of Wetland Health
4465	Cypress Creek	High Degree of Certainty of Wetland Health
4468	Cypress Creek	High Degree of Certainty of Wetland Health
4474	Cypress Creek	Low Degree of Certainty of Wetland Health
4489	Cypress Creek	Low Degree of Certainty of Wetland Health
4491	Cypress Creek	Low Degree of Certainty of Wetland Health
4501	Cypress Creek	Low Degree of Certainty of Wetland Health
4503	Cypress Creek	Low Degree of Certainty of Wetland Health
4504	Cypress Creek	Low Degree of Certainty of Wetland Health
4512	Cypress Creek	High Degree of Certainty of Wetland Health
4514	Cypress Creek	Low Degree of Certainty of Wetland Health
4538	Cypress Creek	Low Degree of Certainty of Wetland Health
4543	Cypress Creek	Low Degree of Certainty of Wetland Health
4558	Cypress Creek	Low Degree of Certainty of Wetland Health
4562	Cypress Creek	High Degree of Certainty of Wetland Health
4574	Cypress Creek	High Degree of Certainty of Wetland Health
4578	Cypress Creek	Low Degree of Certainty of Wetland Health
4613	Cypress Creek	High Degree of Certainty of Wetland Health
4682	Cross Bar Ranch	High Degree of Certainty of Wetland Health
4802	Cross Bar Ranch	High Degree of Certainty of Wetland Health
4822	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
4832	Cross Bar Ranch	High Degree of Certainty of Wetland Health
4848	Cross Bar Ranch	High Degree of Certainty of Wetland Health
4871	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
4884	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
4893	Cross Bar Ranch	Low Degree of Certainty of Wetland Health

4924	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
4959	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
4963	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
4977	Cross Bar Ranch	High Degree of Certainty of Wetland Health
4985	Cross Bar Ranch	High Degree of Certainty of Wetland Health
4990	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5003	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5004	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5006	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5010	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5011	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5012	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5019	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5021	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5025	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5027	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5031	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5032	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5036	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5038	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5040	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5041	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5043	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5046	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5049	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5051	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5054	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5057	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5058	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5059	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5060	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5061	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5063	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5064	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5065	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5066	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5067	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5068	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5070	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5071	Cross Bar Ranch	Low Degree of Certainty of Wetland Health

5073	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5074	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5075	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5076	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5077	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5078	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5080	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5081	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5082	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5083	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5084	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5086	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5087	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5088	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5090	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5091	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5092	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5093	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5094	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5095	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5099	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5100	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5101	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5102	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5103	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5104	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5105	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5106	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5107	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5108	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5109	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5110	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5111	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5114	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5115	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5116	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5117	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5118	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5119	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5120	Cross Bar Ranch	Low Degree of Certainty of Wetland Health

5123	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5124	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5125	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5126	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5129	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5131	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5133	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5134	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5136	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5137	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5138	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5139	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5140	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5141	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5143	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5144	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5148	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5149	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5150	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5151	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5152	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5153	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5155	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5156	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5157	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5158	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5159	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5160	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5161	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5162	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5163	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5166	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5168	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5169	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5170	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5171	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5172	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5174	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5177	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5178	Cross Bar Ranch	Low Degree of Certainty of Wetland Health

5179	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5182	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5194	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5195	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5196	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5198	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5203	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5208	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5210	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5214	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5215	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5217	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5218	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5221	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5222	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5236	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5237	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5238	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5239	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5245	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5246	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5247	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5248	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5259	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5270	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5271	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5279	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5286	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
5308	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5309	Cross Bar Ranch	High Degree of Certainty of Wetland Health
5320	Cypress Creek	Low Degree of Certainty of Wetland Health
5323	Cypress Creek	Low Degree of Certainty of Wetland Health
5347	Cypress Creek	Low Degree of Certainty of Wetland Health
5348	Cypress Creek	Low Degree of Certainty of Wetland Health
5357	Cypress Creek	Low Degree of Certainty of Wetland Health
5366	Cypress Creek	Low Degree of Certainty of Wetland Health
5367	Cypress Creek	Low Degree of Certainty of Wetland Health
5488	Morris Bridge	High Degree of Certainty of Wetland Health
5493	Morris Bridge	High Degree of Certainty of Wetland Health
5496	Morris Bridge	High Degree of Certainty of Wetland Health

5497	Morris Bridge	High Degree of Certainty of Wetland Health
5499	Morris Bridge	High Degree of Certainty of Wetland Health
5501	Morris Bridge	High Degree of Certainty of Wetland Health
5506	Morris Bridge	High Degree of Certainty of Wetland Health
5508	Morris Bridge	High Degree of Certainty of Wetland Health
5513	Morris Bridge	High Degree of Certainty of Wetland Health
5515	Morris Bridge	Low Degree of Certainty of Wetland Health
5516	Morris Bridge	High Degree of Certainty of Wetland Health
5518	Morris Bridge	Low Degree of Certainty of Wetland Health
5521	Morris Bridge	Low Degree of Certainty of Wetland Health
5522	Morris Bridge	High Degree of Certainty of Wetland Health
5523	Morris Bridge	High Degree of Certainty of Wetland Health
5524	Morris Bridge	High Degree of Certainty of Wetland Health
5527	Morris Bridge	High Degree of Certainty of Wetland Health
5528	Morris Bridge	Low Degree of Certainty of Wetland Health
5529	Morris Bridge	High Degree of Certainty of Wetland Health
5530	Morris Bridge	Low Degree of Certainty of Wetland Health
5531	Morris Bridge	High Degree of Certainty of Wetland Health
5535	Morris Bridge	Low Degree of Certainty of Wetland Health
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5538	Morris Bridge	Low Degree of Certainty of Wetland Health
5539	Morris Bridge	Low Degree of Certainty of Wetland Health
5540	Morris Bridge	Low Degree of Certainty of Wetland Health
5543	Morris Bridge	High Degree of Certainty of Wetland Health
5545	Morris Bridge	Low Degree of Certainty of Wetland Health
5546	Morris Bridge	Low Degree of Certainty of Wetland Health
5549	Morris Bridge	Low Degree of Certainty of Wetland Health
5550	Morris Bridge	High Degree of Certainty of Wetland Health
5551	Morris Bridge	High Degree of Certainty of Wetland Health
5554	Morris Bridge	High Degree of Certainty of Wetland Health
5557	Morris Bridge	Low Degree of Certainty of Wetland Health
5559	Morris Bridge	High Degree of Certainty of Wetland Health
5560	Morris Bridge	Low Degree of Certainty of Wetland Health
5563	Morris Bridge	Low Degree of Certainty of Wetland Health
5567	Morris Bridge	High Degree of Certainty of Wetland Health
5568	Morris Bridge	Low Degree of Certainty of Wetland Health
5572	Morris Bridge	High Degree of Certainty of Wetland Health
5573	Morris Bridge	Low Degree of Certainty of Wetland Health
5578	Morris Bridge	High Degree of Certainty of Wetland Health
5580	Morris Bridge	Low Degree of Certainty of Wetland Health

5581	Morris Bridge	High Degree of Certainty of Wetland Health
5583	Morris Bridge	Low Degree of Certainty of Wetland Health
5584	Morris Bridge	High Degree of Certainty of Wetland Health
5587	Morris Bridge	High Degree of Certainty of Wetland Health
5589	Morris Bridge	High Degree of Certainty of Wetland Health
5593	Morris Bridge	High Degree of Certainty of Wetland Health
5594	Morris Bridge	High Degree of Certainty of Wetland Health
5595	Morris Bridge	High Degree of Certainty of Wetland Health
5599	Morris Bridge	High Degree of Certainty of Wetland Health
5605	Morris Bridge	Low Degree of Certainty of Wetland Health
5608	Morris Bridge	High Degree of Certainty of Wetland Health
5610	Morris Bridge	High Degree of Certainty of Wetland Health
5612	Morris Bridge	Low Degree of Certainty of Wetland Health
5613	Morris Bridge	High Degree of Certainty of Wetland Health
5614	Morris Bridge	Low Degree of Certainty of Wetland Health
5617	Morris Bridge	Low Degree of Certainty of Wetland Health
5618	Morris Bridge	Low Degree of Certainty of Wetland Health
5619	Morris Bridge	Low Degree of Certainty of Wetland Health
5623	Morris Bridge	Low Degree of Certainty of Wetland Health
5624	Morris Bridge	Low Degree of Certainty of Wetland Health
5626	Morris Bridge	Low Degree of Certainty of Wetland Health
5629	Morris Bridge	High Degree of Certainty of Wetland Health
5634	Morris Bridge	High Degree of Certainty of Wetland Health
5635	Morris Bridge	Low Degree of Certainty of Wetland Health
5636	Morris Bridge	High Degree of Certainty of Wetland Health
5640	Morris Bridge	Low Degree of Certainty of Wetland Health
5643	Morris Bridge	Low Degree of Certainty of Wetland Health
5646	Morris Bridge	Low Degree of Certainty of Wetland Health
5648	Morris Bridge	Low Degree of Certainty of Wetland Health
5649	Morris Bridge	High Degree of Certainty of Wetland Health
5653	Morris Bridge	Low Degree of Certainty of Wetland Health
5654	Morris Bridge	Low Degree of Certainty of Wetland Health
5657	Morris Bridge	High Degree of Certainty of Wetland Health
5662	Morris Bridge	High Degree of Certainty of Wetland Health
5664	Morris Bridge	High Degree of Certainty of Wetland Health
5667	Morris Bridge	High Degree of Certainty of Wetland Health
5669	Morris Bridge	High Degree of Certainty of Wetland Health
5670	Morris Bridge	High Degree of Certainty of Wetland Health
5671	Morris Bridge	High Degree of Certainty of Wetland Health
5672	Morris Bridge	High Degree of Certainty of Wetland Health

5673	Morris Bridge	High Degree of Certainty of Wetland Health
5674	Morris Bridge	High Degree of Certainty of Wetland Health
5683	Morris Bridge	High Degree of Certainty of Wetland Health
5684	Morris Bridge	High Degree of Certainty of Wetland Health
5685	Morris Bridge	High Degree of Certainty of Wetland Health
5692	Morris Bridge	High Degree of Certainty of Wetland Health
5701	Morris Bridge	High Degree of Certainty of Wetland Health
5710	Morris Bridge	High Degree of Certainty of Wetland Health
5713	Morris Bridge	High Degree of Certainty of Wetland Health
5720	Morris Bridge	High Degree of Certainty of Wetland Health
5728	Morris Bridge	High Degree of Certainty of Wetland Health
5731	Morris Bridge	High Degree of Certainty of Wetland Health
5733	Morris Bridge	High Degree of Certainty of Wetland Health
5739	Cypress Bridge	High Degree of Certainty of Wetland Health
5744	Morris Bridge	Low Degree of Certainty of Wetland Health
5749	Cypress Bridge	High Degree of Certainty of Wetland Health
5757	Cypress Bridge	Low Degree of Certainty of Wetland Health
5768	Cypress Bridge	High Degree of Certainty of Wetland Health
5771	Morris Bridge	High Degree of Certainty of Wetland Health
5772	Morris Bridge	Low Degree of Certainty of Wetland Health
5813	Morris Bridge	High Degree of Certainty of Wetland Health
5819	Morris Bridge	High Degree of Certainty of Wetland Health
5826	Cypress Bridge	High Degree of Certainty of Wetland Health
5827	Cypress Bridge	High Degree of Certainty of Wetland Health
5833	Morris Bridge	Low Degree of Certainty of Wetland Health
5844	Morris Bridge	High Degree of Certainty of Wetland Health
5850	Cypress Bridge	Low Degree of Certainty of Wetland Health
5865	Morris Bridge	High Degree of Certainty of Wetland Health
5866	Morris Bridge	High Degree of Certainty of Wetland Health
5890	Cypress Bridge	High Degree of Certainty of Wetland Health
5908	Cypress Bridge	Low Degree of Certainty of Wetland Health
5909	Cypress Bridge	Low Degree of Certainty of Wetland Health
5918	Cypress Bridge	Low Degree of Certainty of Wetland Health
5958	Cypress Bridge	High Degree of Certainty of Wetland Health
6000	Cypress Bridge	High Degree of Certainty of Wetland Health
6010	Cypress Bridge	Low Degree of Certainty of Wetland Health
6014	Cypress Bridge	High Degree of Certainty of Wetland Health
6033	Cypress Bridge	High Degree of Certainty of Wetland Health
6036	Cypress Bridge	High Degree of Certainty of Wetland Health
6037	Cypress Bridge	High Degree of Certainty of Wetland Health

6041	Cypress Bridge	Low Degree of Certainty of Wetland Health
6043	Cypress Bridge	High Degree of Certainty of Wetland Health
6046	Cypress Bridge	High Degree of Certainty of Wetland Health
6047	Cypress Bridge	High Degree of Certainty of Wetland Health
6048	Cypress Bridge	Low Degree of Certainty of Wetland Health
6049	Cypress Bridge	High Degree of Certainty of Wetland Health
6050	Cypress Bridge	High Degree of Certainty of Wetland Health
6051	Cypress Bridge	High Degree of Certainty of Wetland Health
6054	Cypress Bridge	High Degree of Certainty of Wetland Health
6055	Cypress Bridge	Low Degree of Certainty of Wetland Health
6056	Cypress Bridge	High Degree of Certainty of Wetland Health
6059	Cypress Bridge	High Degree of Certainty of Wetland Health
6060	Cypress Bridge	High Degree of Certainty of Wetland Health
6061	Cypress Bridge	Low Degree of Certainty of Wetland Health
6062	Cypress Bridge	High Degree of Certainty of Wetland Health
6064	Cypress Bridge	High Degree of Certainty of Wetland Health
6069	Cypress Bridge	High Degree of Certainty of Wetland Health
6072	Cypress Bridge	Low Degree of Certainty of Wetland Health
6073	Cypress Bridge	Low Degree of Certainty of Wetland Health
6074	Cypress Bridge	High Degree of Certainty of Wetland Health
6075	Cypress Bridge	Low Degree of Certainty of Wetland Health
6076	Cypress Bridge	Low Degree of Certainty of Wetland Health
6077	Cypress Bridge	High Degree of Certainty of Wetland Health
6079	Cypress Bridge	High Degree of Certainty of Wetland Health
6080	Cypress Bridge	Low Degree of Certainty of Wetland Health
6083	Cypress Bridge	High Degree of Certainty of Wetland Health
6084	Cypress Bridge	High Degree of Certainty of Wetland Health
6085	Cypress Bridge	Low Degree of Certainty of Wetland Health
6086	Cypress Bridge	Low Degree of Certainty of Wetland Health
6087	Cypress Bridge	Low Degree of Certainty of Wetland Health
6088	Cypress Bridge	Low Degree of Certainty of Wetland Health
6089	Cypress Bridge	High Degree of Certainty of Wetland Health
6090	Cypress Bridge	High Degree of Certainty of Wetland Health
6091	Cypress Bridge	High Degree of Certainty of Wetland Health
6092	Cypress Bridge	High Degree of Certainty of Wetland Health
6093	Cypress Bridge	High Degree of Certainty of Wetland Health
6094	Cypress Bridge	Low Degree of Certainty of Wetland Health
6095	Cypress Bridge	High Degree of Certainty of Wetland Health
6097	Cypress Bridge	High Degree of Certainty of Wetland Health
6098	Cypress Bridge	High Degree of Certainty of Wetland Health

6099	Cypress Bridge	High Degree of Certainty of Wetland Health
6100	Cypress Bridge	High Degree of Certainty of Wetland Health
6101	Cypress Bridge	High Degree of Certainty of Wetland Health
6102	Cypress Bridge	High Degree of Certainty of Wetland Health
6103	Cypress Bridge	High Degree of Certainty of Wetland Health
6104	Cypress Bridge	High Degree of Certainty of Wetland Health
6106	Cypress Bridge	High Degree of Certainty of Wetland Health
6107	Cypress Bridge	High Degree of Certainty of Wetland Health
6108	Cypress Bridge	High Degree of Certainty of Wetland Health
6109	Cypress Bridge	High Degree of Certainty of Wetland Health
6110	Cypress Bridge	High Degree of Certainty of Wetland Health
6111	Cypress Bridge	High Degree of Certainty of Wetland Health
6112	Cypress Bridge	High Degree of Certainty of Wetland Health
6115	Cypress Bridge	High Degree of Certainty of Wetland Health
6121	Cypress Bridge	High Degree of Certainty of Wetland Health
6123	Cypress Bridge	High Degree of Certainty of Wetland Health
6124	Cypress Bridge	Low Degree of Certainty of Wetland Health
6125	Cypress Bridge	High Degree of Certainty of Wetland Health
6137	Cypress Bridge	Low Degree of Certainty of Wetland Health
6139	Cypress Bridge	Low Degree of Certainty of Wetland Health
6143	Cypress Bridge	High Degree of Certainty of Wetland Health
6147	Cypress Bridge	High Degree of Certainty of Wetland Health
6149	Cypress Bridge	Low Degree of Certainty of Wetland Health
6153	Cypress Bridge	High Degree of Certainty of Wetland Health
6154	Cypress Bridge	High Degree of Certainty of Wetland Health
6157	Cypress Bridge	High Degree of Certainty of Wetland Health
6159	Cypress Bridge	High Degree of Certainty of Wetland Health
6160	Cypress Bridge	Low Degree of Certainty of Wetland Health
6163	Cypress Bridge	High Degree of Certainty of Wetland Health
6165	Cypress Bridge	High Degree of Certainty of Wetland Health
6168	Cypress Bridge	Low Degree of Certainty of Wetland Health
6169	Cypress Bridge	High Degree of Certainty of Wetland Health
6172	Cypress Bridge	High Degree of Certainty of Wetland Health
6200	Cypress Bridge	High Degree of Certainty of Wetland Health
6202	Cypress Bridge	High Degree of Certainty of Wetland Health
6203	Cypress Bridge	Low Degree of Certainty of Wetland Health
6204	Cypress Bridge	Low Degree of Certainty of Wetland Health
6205	Cypress Bridge	Low Degree of Certainty of Wetland Health
6206	Cypress Bridge	Low Degree of Certainty of Wetland Health
6207	Cypress Bridge	High Degree of Certainty of Wetland Health

6214	Cypress Bridge	High Degree of Certainty of Wetland Health
6217	Cypress Bridge	Low Degree of Certainty of Wetland Health
6225	Cypress Bridge	High Degree of Certainty of Wetland Health
6232	Cypress Bridge	High Degree of Certainty of Wetland Health
6246	Cypress Bridge	High Degree of Certainty of Wetland Health
6247	Cypress Bridge	High Degree of Certainty of Wetland Health
6251	Cypress Bridge	High Degree of Certainty of Wetland Health
6252	Cypress Bridge	High Degree of Certainty of Wetland Health
6253	Cypress Bridge	High Degree of Certainty of Wetland Health
6254	Morris Bridge	Low Degree of Certainty of Wetland Health
6258	Morris Bridge	Low Degree of Certainty of Wetland Health
6259	Morris Bridge	Low Degree of Certainty of Wetland Health
6260	Morris Bridge	Low Degree of Certainty of Wetland Health
6262	Morris Bridge	High Degree of Certainty of Wetland Health
6266	Morris Bridge	High Degree of Certainty of Wetland Health
6268	Morris Bridge	High Degree of Certainty of Wetland Health
6280	Morris Bridge	High Degree of Certainty of Wetland Health
6281	Morris Bridge	Low Degree of Certainty of Wetland Health
6282	Morris Bridge	High Degree of Certainty of Wetland Health
6296	Morris Bridge	High Degree of Certainty of Wetland Health
6298	Cypress Bridge	High Degree of Certainty of Wetland Health
6299	Morris Bridge	Low Degree of Certainty of Wetland Health
6304	Cypress Bridge	High Degree of Certainty of Wetland Health
6305	Cypress Bridge	High Degree of Certainty of Wetland Health
6309	Cypress Bridge	High Degree of Certainty of Wetland Health
6310	Cypress Bridge	High Degree of Certainty of Wetland Health
6311	Cypress Bridge	High Degree of Certainty of Wetland Health
6312	Cypress Bridge	High Degree of Certainty of Wetland Health
6313	Cypress Bridge	High Degree of Certainty of Wetland Health
6314	Cypress Bridge	High Degree of Certainty of Wetland Health
6315	Cypress Bridge	High Degree of Certainty of Wetland Health
6316	Cypress Bridge	High Degree of Certainty of Wetland Health
6317	Cypress Bridge	High Degree of Certainty of Wetland Health
6318	Cypress Bridge	High Degree of Certainty of Wetland Health
6320	Cypress Bridge	High Degree of Certainty of Wetland Health
6322	Cypress Bridge	High Degree of Certainty of Wetland Health
6325	Cypress Bridge	High Degree of Certainty of Wetland Health
6328	Cypress Bridge	High Degree of Certainty of Wetland Health
6331	Cypress Bridge	Low Degree of Certainty of Wetland Health
6333	Cypress Bridge	High Degree of Certainty of Wetland Health

6334	Cypress Bridge	High Degree of Certainty of Wetland Health
6336	Cypress Bridge	High Degree of Certainty of Wetland Health
6339	Section 21	High Degree of Certainty of Wetland Health
6358	Cross Bar Ranch	High Degree of Certainty of Wetland Health
6410	Eldridge-Wilde	High Degree of Certainty of Wetland Health
6411	Eldridge-Wilde	High Degree of Certainty of Wetland Health
6413	Eldridge-Wilde	High Degree of Certainty of Wetland Health
6415	Eldridge-Wilde	High Degree of Certainty of Wetland Health
6480	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
6481	Cross Bar Ranch	High Degree of Certainty of Wetland Health
6489	Cross Bar Ranch	High Degree of Certainty of Wetland Health
6494	Cross Bar Ranch	Low Degree of Certainty of Wetland Health
6498	Cross Bar Ranch	High Degree of Certainty of Wetland Health
6499	Cross Bar Ranch	High Degree of Certainty of Wetland Health
6500	Cypress Creek	Low Degree of Certainty of Wetland Health
6579	Eldridge-Wilde	High Degree of Certainty of Wetland Health
6670	Section 21	High Degree of Certainty of Wetland Health
6671	Section 21	High Degree of Certainty of Wetland Health
6673	Section 21	High Degree of Certainty of Wetland Health
6675	Section 21	High Degree of Certainty of Wetland Health
6676	Section 21	High Degree of Certainty of Wetland Health
6681	Section 21	High Degree of Certainty of Wetland Health
6683	Section 21	High Degree of Certainty of Wetland Health
6774	Eldridge-Wilde	High Degree of Certainty of Wetland Health
6776	Eldridge-Wilde	High Degree of Certainty of Wetland Health
6777	Eldridge-Wilde	High Degree of Certainty of Wetland Health
6780	Eldridge-Wilde	High Degree of Certainty of Wetland Health
6783	Eldridge-Wilde	High Degree of Certainty of Wetland Health
6804	Eldridge-Wilde	High Degree of Certainty of Wetland Health
6805	Eldridge-Wilde	High Degree of Certainty of Wetland Health
6806	Eldridge-Wilde	High Degree of Certainty of Wetland Health
6988	Northwest Hillsborough	High Degree of Certainty of Wetland Health
7007	Cross Bar Ranch	High Degree of Certainty of Wetland Health
7012	Cypress Bridge	High Degree of Certainty of Wetland Health
7013	Morris Bridge	High Degree of Certainty of Wetland Health
7044	Eldridge-Wilde	High Degree of Certainty of Wetland Health
7102	Morris Bridge	High Degree of Certainty of Wetland Health
8121	Eldridge-Wilde	High Degree of Certainty of Wetland Health
10045	Eldridge-Wilde	High Degree of Certainty of Wetland Health
11000	Cypress Creek	Low Degree of Certainty of Wetland Health

11001	Eldridge-Wilde	High Degree of Certainty of Wetland Health
11002	Eldridge-Wilde	High Degree of Certainty of Wetland Health
12001	Section 21	High Degree of Certainty of Wetland Health
12002	Section 21	High Degree of Certainty of Wetland Health
12003	Eldridge-Wilde	High Degree of Certainty of Wetland Health
12004	Eldridge-Wilde	High Degree of Certainty of Wetland Health
12005	Eldridge-Wilde	High Degree of Certainty of Wetland Health
12006	Eldridge-Wilde	High Degree of Certainty of Wetland Health

14.2 Identification of Remaining Adverse Impacts

The Consolidated Permit requires Tampa Bay Water to assess environmental recovery at the 11 wellfields and determine if there are any remaining adverse impacts attributed to continued wellfield pumping at the permitted annual average rate of 90 mgd. The permit further states that if there are any remaining adverse environmental impacts, Tampa Bay Water is to propose options to address those impacts at the time of the Consolidated Permit renewal.

The requirement for potential wetland mitigation created the need to establish a baseline condition, based on the creation of and modification of District Water Use Permit Rules and the timing of historic wetland impacts. Tampa Bay Water developed and the District approved a baseline protocol that defines the baseline years that would be used to assess the need for wetland mitigation under the Consolidated Permit. This Baseline Protocol is described in Section 6.9 of this report. Tampa Bay Water and the District determined that only those wetlands that are assigned to the bin of Not Fully Recovered, Continuing Wellfield Impact in the final Recovery Assessment analysis would be evaluated for potential mitigation action.

Based on the final Recovery Assessment results summarized above, there are eight monitored wetlands and no monitored lakes that are assigned to the bin of Not Fully Recovered, Continuing Wellfield Impact. Tampa Bay Water and the District agreed that, due to the uncertainty in the results for the unmonitored sites, mitigation will not be required for a site with no monitoring data. The eight monitored wetlands in the bin of Not Fully Recovered, Continuing Wellfield Impact are:

Cypress Creek Wellfield

- CYC W-16
- CYC W-32
- CYC W-45
- CYC W-55
- CCWF “F”

Cypress Bridge Wellfield

- CYB-15
- CYB-A

Morris Bridge Wellfield

- MBR-10

These eight wetlands have been assessed for potential mitigation action. The method of assessing wetland impact with respect to the Baseline Protocol is described in detail in Chapter 15.

15. Development of Mitigation Options and Plans

The preceding chapters of this report have documented the development of the Recovery Assessment Plan processes, identification of the specific sites to be evaluated, development of recovery/health metrics for multiple types of systems, and the application of a weight-of-evidence approach to assign a recovery status or bin to each of the identified lakes and wetlands. The final requirement for the completion of the Recovery Assessment Plan is to identify and evaluate potential options to address any remaining unacceptable adverse impacts at the time of the Consolidated Permit renewal in 2020. In this last step, Tampa Bay Water has assessed the need for mitigation at the eight sites that have been assigned to the final recovery bin of Not Fully Recovered, Continuing Wellfield Impact. The following sections detail the process used to complete this final requirement.

15.1 Baseline Protocol

The Recovery Assessment Plan Initial Work Plan included two regulatory issues that identified the need to establish a temporal baseline (Section 5.2.2). The first issue addressed how to determine wetland and lake recovery with respect to the timing, nature, and extent of past adverse impacts. The second issue addressed the potential need to mitigate remaining adverse impacts at the conclusion of the Recovery Assessment Plan. This requirement to mitigate adverse impacts created the need to establish a baseline condition on which to make an assessment of wetland function change for any wetlands that continue to exhibit adverse impacts due to wellfield pumping at an annual average quantity of 90 mgd. In order to assess wetland function change, the starting point (historic time period) had to be identified for comparison to the current condition. Resolution of these two issues allowed Tampa Bay Water to assess the recovery of individual lakes and wetlands in light of changes that have occurred to the landscape on and surrounding the Consolidated Permit wellfields, assess historic wetland impacts with respect to changes in water use regulations, and develop a process to quantify any wetland function loss at sites with continued adverse impacts related to wellfield pumping.

Tampa Bay Water and District staffs began the discussion to define a temporal baseline condition in the technical coordination meetings between late 2012 and mid-2014. Those early discussions were general in nature as staffs began developing specific work processes for the multiple regulatory and technical issues identified in the Initial Work Plan. A focused series of meetings was held in 2015 to discuss the framework and implementation details of a baseline protocol that would guide the assessments and quantify any mitigation responsibility at the time of the Consolidated Permit renewal in 2020. To address the two regulatory issues identified in the Initial Work Plan, staffs agreed that physical alterations to wetlands and lakes caused by high levels of historical pumping from the wellfields should be considered in the evaluation of the recovery status of each site if those impacts likely occurred before key dates. Tampa Bay Water and District staff also agreed that these key dates are critical in the evaluation of any mitigation requirement for wetlands or lakes that have not fully recovered at the time of permit renewal and evidence exists that the adverse impacts related to wellfield pumping may continue.

The baseline protocol is discussed in Section 6.9 and is included as Appendix 6.15 to this report. The baseline protocol includes specific actions for wetlands and lakes within different recovery classification bins that were developed for this Recovery Assessment Plan. The initial recovery classification bins were included in the baseline protocol document and updated in 2017 as discussed in Section 6.2 and presented in Appendix 6.2. These classification bins are important to the process of evaluating wetlands with respect to past impacts and quantifying any mitigation for loss of wetland function.

15.1.1 Baseline Periods

The key dates contained in the baseline protocol define the historical condition against which to compare the current environmental condition to determine if a wetland or lake condition has improved or deteriorated. The two key dates are 1974 when the first water use regulations were adopted and 1989 when the water use regulations were fundamentally changed to prohibit adverse impacts to wetlands, whether or not they exist on or off the property controlled by a permittee. As these two baseline dates were developed, it became apparent that the dates when pumping was initiated at each wellfield also would be important during the implementation of the baseline protocol assessments. The year in which each of the 11 wellfields began pumping is contained in the baseline protocol document as well as the year in which pumping significantly increased to the point where adverse impacts to lakes and wetlands were more likely to have occurred. The pumping history of each wellfield is presented in Figures 3.37 through 3.47.

The earliest wellfields were constructed and operating prior to the first baseline date of 1974 when water use regulations began in Florida. The Cosme-Odessa, Eldridge-Wilde, Section 21, and South Pasco Wellfields were all pumping prior to this date but the rate of pumping at the South Pasco Wellfield did not increase to a relatively high level until 1974. Therefore, this initial baseline year is applicable only for the Cosme-Odessa, Eldridge-Wilde, and Section 21 Wellfields. The second baseline year of 1989 covers the wellfields that were developed and pumping at relatively high rates between the two baseline years; the South Pasco, Starkey, Cypress Creek, Morris Bridge, and Cross Bar Ranch Wellfields. The three remaining wellfields were either developed after the 1989 baseline year (North Pasco Wellfield) or did not reach a relatively high rate of pumping until after 1989 (Northwest Hillsborough Regional and Cypress Bridge Wellfields). These baseline years and initial dates of higher wellfield pumping have been considered in the assessment of historical impacts and recovery at the 11 wellfields and in the quantification of mitigation requirements as described in the baseline protocol document (Appendix 6.15).

15.1.2 Assessment Protocol

Tampa Bay Water staff completed a Recovery Assessment analysis for each monitored lake and wetland using the applicable wetland type and recovery metric and each site has been assigned to a specific recovery bin (Chapters 8 and 9). Under the initial process, unmonitored sites included in the Recovery Assessment Plan followed the same process. Due to the uncertainty in the assessment results for the unmonitored sites, they have been assigned to one of two qualitative assessment bins and no further action is required under the Recovery Assessment Plan (Chapter 10). During the final analysis of monitored lakes and wetlands, structural alterations to wetlands and lakes (e. g., land subsidence, sinkholes, oxidation) were considered in the evaluation of recovery if these changes occurred prior to 1974 for the older wellfields or prior to 1989 for on-site wetlands and lakes at wellfields where the initiation of high pumping occurred prior to this date. All wetlands and lakes assigned to the final Recovery Assessment bin of Not Fully Recovered, Continuing Wellfield Impact were then further assessed to determine if mitigation is required at the conclusion of the Recovery Assessment Plan.

As Tampa Bay Water evaluated these remaining wetlands for potential mitigation, the baseline years were again necessary to define the environmental conditions that existed during a specific past year as the starting point for the mitigation assessment. It is also important to note whether a wetland or lake is located on or off a wellfield property because of the implications of changing water use regulations over time. The baseline protocol defines the three baseline periods as:

- 1974 is the environmental baseline year for assessing change in off-site wetlands and lakes on and near the wellfields where the initiation of high pumping occurred before this date (Cosme-Odessa, Eldridge-Wilde, and Section 21 Wellfields). Prior to this year, there were no regulations addressing adverse impacts to any wetland systems.
- 1989 is the environmental baseline year for assessing change in on-site wetlands and lakes at the wellfields where the initiation of high pumping occurred before this date (Cosme-Odessa, Eldridge-Wilde, Section 21, South Pasco, Starkey, Cypress Creek, Morris Bridge, and Cross Bar Ranch Wellfields). Prior to this year and after 1974, the existing water use regulations did not prohibit adverse impacts to wetlands on property owned or controlled by a permittee.
- The remaining three wellfields (Northwest Hillsborough, Cypress Bridge, and North Pasco) use the environmental baseline condition that was present prior to the onset of high pumping from those wellfields. Since these wellfields began their higher pumping periods after the 1989 change in water use regulations, adverse impacts were prohibited for both on-site and off-site wetlands and lakes.

The environmental baseline conditions for these years were defined using historical environmental data and environmental monitoring reports prepared by or for Tampa Bay Water or the District prior to the applicable years. The available time series of historical aerial photography was also important data as the past environmental conditions were characterized. Tampa Bay Water performed individual wetland mitigation assessments using the methodology developed specifically for the Recovery Assessment Plan which is described in the following section. This methodology was applied at each wetland assigned to the bin of Not Fully Recovered, Continuing Wellfield Impact to compare the current and baseline conditions and assess the degree of change between the two environmental conditions. According to the baseline protocol, if the current environmental condition of a lake or wetland is the same or better than during the applicable baseline condition, no mitigation is required – these wetlands have remained the same or improved since the time when adverse impacts at that lake or wetland were not prohibited. If it was determined that the current environmental condition is worse than the applicable baseline condition, the methodology was used to calculate the functional loss that has occurred at that lake or wetland. The wetland functional loss applied to the acreage of the assessed wetland is the mitigation requirement that Tampa Bay Water must address under the current Consolidated Permit. This assessment protocol is presented in greater detail in Appendix 6.15 and the assessment steps are visually presented in process diagrams shown in Figures 6.3 and 6.4.

15.1.3 Functional Assessment of Wetland Recovery (FAWR)

Tampa Bay Water and the District began discussing the development of a process to assess and define the Recovery Assessment Plan mitigation requirement in early 2016. Both staffs understood that it would take time to develop and test a new mitigation assessment method and that it should be completed before the final Recovery Assessment results were known to avoid potential bias in the process development.

The Functional Assessment of Wetland Recovery (FAWR) method is based on the Uniform Mitigation Assessment Method (UMAM) used in Environmental Resource Permitting (ERP) in Florida; the first version was developed by Atkins in 2017 (Atkins, 2017). The method was field tested in 2017 and 2018 with the participation of District staff and District input has been incorporated throughout the process. Recommendations for revising the initial FAWR method were incorporated into a report called "Functional Assessment of Wetland Recovery: Field Testing and Peer Review" (VHB, 2019). The recommendations in that report were considered and implemented in the final FAWR guidance document, "Functional Assessment of Wetland Recovery: Impact and Mitigation Guide for the Recovery Assessment Plan" (VHB and Atkins, 2020). This final FAWR method document is included in this report as Appendix 15.1 and contains a full description of the method, field procedures, and the information required to complete these assessments.

Testing of the FAWR method identified the need for extensive data compilation and analyses prior to evaluating a wetland in the field. The data and information sources necessary for a FAWR evaluation include rainfall, wetland water level, pumping data, vegetative data (e.g. WAPs, qualitative descriptions or quantitative data in wellfield monitoring reports), and historical aerial imagery. In order to put historic data or imagery in the context of antecedent rainfall and whether the data or image represent a time of near-average, wet or dry conditions, Tampa Bay Water completed a study of historic rainfall by wellfield. This study (Ormiston, 2020) provides graphs and other tools that put rainfall conditions into context and allows for the comparison of the antecedent rainfall for any particular data parameter or image to long-term average conditions. This report is included as Appendix 15.2.

15.2 Final Quantification of Mitigation Requirement

Eight wetlands are binned as "not fully recovered, continued wellfield impact" in this report:

- CCWF F (Wetland ID 234)
- CYC W-16 (Ted's Marsh; Wetland ID 198)
- CYC W-32 (Wetland ID 210)
- CYC W-45 (Wetland ID 222)
- CYC W-55 (Wetland ID 229)
- MBR-10 (Wetland ID 258)
- CYB-A (Wetland ID 153)
- CYB-15 (Wetland ID 132)

The two Cypress Bridge wetlands (CYB-A and CYB-15) were addressed in the 2020 OROP Biennial Report (Tampa Bay Water 2020l). A new OROP control point, SAS well CYB-5-1950, is recommended in this report, with a target level based on a correlation with water levels in wetland CYB-15. Monitor well CYB-5-1950 was also correlated with adjacent wetland CYB-A. The calculated target level from that regression was a little lower than that from the regression with wetland CYB-15. Because the CYB-15-based target level (57.26 ft. NGVD) is more protective of the two wetlands, it is recommended in the 2020 OROP Biennial Report to use that level.

Following District approval, the new OROP control point for the Cypress Bridge Wellfield will be implemented. Hydrologic conditions in wetlands CYB-A and CYB-15 will be tracked routinely as part of the EMP semi-annual analysis and in annual reports. If the new OROP control point does not result in improved hydrologic conditions in these wetlands, a new recovery analysis, and possibly a FAWR mitigation assessment, will be performed during the next permit term.

A FAWR assessment of baseline and current conditions (VHB, and Water and Air Research 2020a; included in this report as Appendix 15.3) was performed on the remaining six wetlands – five at the Cypress Creek Wellfield and one at the Morris Bridge Wellfield. Three of the Cypress Creek wetlands (CCWF F, CYC W-16 and CYC W-45) were found to have current conditions that were slightly better than those in the baseline year of 1989. One wetland, CYC W-32, had a "delta" of 0 – meaning that from an overall perspective, the current ecological condition of the wetland was equivalent to that in the baseline year. For all four of these wetlands, hydrologic conditions were determined to be better in the current condition presumably due to the pumping reduction at the Cypress Creek Wellfield. For two wetlands, CYC W-16 and CYC W-32, there was a decrease in the vegetation score in the current condition that is believed to be due to a lag in vegetative response to both historic pumping impacts and water level recovery. Tampa Bay Water will continue environmental monitoring at these wetlands.

Wetland CYC W-55 is on the southern border of the Cypress Creek Wellfield and approximately half of the wetland is off-site on private property. Therefore, a baseline year of 1974 was chosen for the FAWR analysis of this wetland. This resulted in a considerable decline in both hydrologic and vegetative parameters in the current condition since the Cypress Creek Wellfield was not yet constructed and pumping in 1974. Based on the mitigation calculation employed (identical to that used in UMAM), 0.73 mitigation credits will be required for this wetland.

Wetland MBR-10 is a marsh on the northern part of the Morris Bridge Wellfield. It has had low hydroperiods and water levels throughout the monitored period of record, which began in 1991. There are a number of sinkhole-like features in this wetland, which may help explain the abnormally low hydrology. There are documents that indicate that sinkholes in this area were present prior to the baseline year of 1989. Comparison of wetland MBR-10 to other surrogate marshes on the Morris Bridge Wellfield indicate it has had generally lower water levels. In the FAWR analysis, the current and baseline hydrologic and vegetative conditions were judged to be equivalent (all with a score of 5, indicating moderate departure from expected unimpacted conditions). Therefore, no mitigation is required for wetland MBR-10 but environmental monitoring will continue.

Lakes Raleigh and Rogers, both located on the Cosme-Odessa Wellfield, were binned as Recovered in the final Recovery Assessment analysis of monitored lakes. A FAWR analysis was also performed for the littoral zones for these lakes (Water and Air Research and VHB, 2020b and are included in this report as Appendix 15.4) because they were identified by District Regulatory Staff as having adverse impacts (Sections 8.6 and 8.7). In both lakes, current environmental conditions were considered to be better, on an overall basis, than those in the baseline year of 1989. In the case of Lake Rogers, both the hydrologic and vegetative FAWR parameters were scored higher in the current condition. For Lake Raleigh, there was a considerable improvement in the hydrologic parameter in the current condition as compared to 1989, while there was a slight decline in the vegetative parameter due to the invasion of punk trees (*Melaleuca quinquenervia*) in the littoral region of the lake. No mitigation is required for either lake as detailed in the FAWR analysis (Appendix 15.4).

15.3 Plan to Address Remaining Adverse Impacts

In the mid-1990s, Tampa Bay Water constructed the Model Dairy Wetland Mitigation Project in order to provide the anticipated mitigation required for a number of regional system pipelines which were then under design. More mitigation acreage was created at this site than was ultimately required for the pipeline permits. In 2012, Tampa Bay Water performed a UMAM analysis on the remaining wetland mitigation acreage and submitted an ERP modification request to the District to convert the remaining mitigation acreage to UMAM credits. ERP 43010993.011 was issued in January 2013. The remaining unallocated mitigation acreage at the Model Dairy Wetland Mitigation Site was converted to "10.01 excess freshwater herbaceous functional gain units and 3.47 excess freshwater forested functional gain units."

The FAWR assessment methodology was based on the UMAM, has the same parameters and "delta" calculation, and the required FAWR mitigation is equivalent to UMAM functional units. Both Model Dairy and wetland CYC W-55 are in the Hillsborough River basin, satisfying the regulatory preference for mitigation in the same basin as the impact. District Regulatory staff have confirmed that the Model Dairy UMAM credits are available for use as mitigation in the Consolidated Permit renewal (John Emery, personal communication). Wetland CYC W-55 is a forested wetland. Therefore, as the required mitigation determined under the Consolidated Permit Recovery Assessment, Tampa Bay Water intends to withdraw the required 0.73 functional units from the available 3.47 freshwater forested units at the Model Dairy Wetland Mitigation Site, leaving an available balance of 2.74 freshwater forested units for future consideration.

16: Consolidated Permit Renewal Discussion

16. Consolidated Permit Renewal Discussion

The development and completion of a Permit Recovery Assessment Plan is required by Special Condition 11 of the 2011 Consolidated Permit. The last requirement of this permit condition is to submit the final results of this assessment with the application to renew the Consolidated Permit in 2020. This comprehensive evaluation of lake and wetland recovery on and surrounding the Consolidated Permit wellfields is a significant component of the technical assessments submitted with the permit renewal application to satisfy the Conditions for Issuance of Permits found in Chapter 40D-2.301, F.A.C.

Tampa Bay Water staff worked cooperatively with the District staff throughout the 10-year term of the 2011 Consolidated Permit to develop the framework for this study, the metrics of recovery for different wetland types and the assessment methods as described in Chapters 5 and 6. All of the preliminary and final assessments of recovery for monitored lakes and wetlands (Chapters 8, 9, and 10) were discussed with District staff during technical coordination meetings and suggested improvements have been incorporated into the final results. The implementation of the Recovery Assessment Plan contained many sequential, complex analyses. Tampa Bay Water submitted each process, recovery metric, and preliminary analysis to the District in writing as they were developed and requested review and written approval/concurrence from the District. This process has ensured that the District staff was fully informed and has avoided disputes and substantial analytical changes at the end of the process. It also allowed District staff to review voluminous technical material as it was developed, which will facilitate their review of these documents during the 30-day statutory review period following the submittal of the Consolidated Permit renewal application.

16.1 Demonstration of Environmental Recovery

Tampa Bay Water has assessed the environmental recovery and health of 1,360 individual lakes and wetlands as part of this Recovery Assessment Plan. Staff completed rigorous analyses for the 515 monitored lakes and wetlands and quantitively analyzed recovery and completed qualitative assessments of health for the 845 unmonitored lakes and wetlands near the 11 wellfields. Only qualitative assessments of the unmonitored sites were possible because no direct data is available for those sites and due to the uncertainty in statistically-interpolated datasets (Chapter 10). The final determination of environmental recovery on and near the wellfields has been made for 515 lakes and wetlands that Tampa Bay Water and the District have monitored for many years. The analyses presented in Chapters 8 and 9 and summarized in Chapters 13 and 14 demonstrate that 85% of these monitored sites meet their numeric metrics of recovery based on analysis of long-term datasets that include the most recent 12 years of data. This period of time captures years of above and below-average rainfall. During this period, the 12 month running average pumping rate from the Consolidated Permit wellfields was reduced to below 90 mgd, and these wellfields were fully interconnected to the regional system.

An additional 13.5% of these sites (70 lakes and wetlands) did not meet their numeric recovery metric but did exhibit significant improvement since Tampa Bay Water reduced the wellfield pumping rates. Most of the improved wetlands missed their specific numeric water level target by less than one foot on a long-term basis as described in Section 9.7. Field review of many of these improved sites revealed that these sites do not show signs of adverse environmental impact. The information discussed in Chapters 12 and 13 document physical limitations that prevent these sites from reaching their specific recovery targets. Only eight wetlands across the 11 wellfields were identified as not fully recovered with a continued impact related to wellfield pumping. Environmental conditions at two of these wetlands, both associated with the Cypress Bridge Wellfield, were addressed by a change in the OROP (Tampa Bay Water, 2020l). The other six wetlands were assessed to determine if mitigation is required by Tampa Bay Water. As described in Chapter 15, only one wetland requires mitigation in accordance with the baseline protocol developed by Tampa Bay Water and approved by the District (Section 6.9 and Appendix 6.15).

Lakes Raleigh and Rogers were classified as Recovered using the final weight-of-evidence analysis for monitored lakes but were assessed for potential mitigation due to a District staff field assessment that indicated adverse impacts to vegetation on the edge of these two lakes (Section 8.6). The mitigation assessment concluded that both lakes have current environmental conditions that were better, on an overall basis, than those in the baseline year and no mitigation is required for either lake (Section 15.2 and Appendix 15.4).

Through the completion of this Recovery Assessment Plan, Tampa Bay Water has demonstrated that environmental recovery has been achieved at the Consolidated Permit wellfields following the reduction of annual average pumping below 90 mgd.

16.2 Regulatory Requirements and Objectives Satisfied

Tampa Bay Water and District staff stated a common goal at the onset of the Recovery Assessment Plan to renew the Consolidated Permit in the year 2020 under the District's Water Use Permitting Rules (Chapter 40D-2, F.A.C.) without the need for a third phase of the Recovery Strategy for the Northern Tampa Bay Water Use Caution Area (Chapter 40D-80.073, F.A.C.). This goal was also stated in the Recovery Assessment Work Plan and Schedule (Appendix 5.1) that Tampa Bay Water submitted to the District in January 2012.

It is demonstrated in this final Recovery Assessment Plan report that the monitored lakes and wetlands at the 11 wellfields have fully recovered or have recovered to the greatest degree that can be achieved given the landscape alterations adjacent to the wellfields. At the conclusion of the assessment of mitigation requirement in Chapter 15, only wetland W-55 at the Cypress Creek Wellfield will require mitigation based on the Recovery Assessment Plan baseline protocol and mitigation assessment method. This wetland is located on the southeast boundary of the wellfield with half of the wetland on the wellfield property and the other half on private residential property in the Quail Hollow Subdivision. The house on this property was constructed in 1988 according to the Pasco County Property Appraiser's website, the time when the Cypress Creek Wellfield was consistently pumping at an annual average rate of 30 mgd and increased drawdown was present in the water table and Upper Floridan Aquifer. Tampa Bay Water will resolve the mitigation obligation for this wetland at another location as described in Section 15.3 because directly mitigating wetland W-55 by increasing the wetland water level would impact the private home and septic tank system located on this and surrounding parcels of land.

Tampa Bay Water has completed all permit requirements for the Recovery Assessment Plan by assessing and documenting environmental recovery, identifying any remaining adverse impacts caused by wellfield pumping and providing mitigation for the single wetland for which mitigation is required. The Chapter 40D-8, F.A.C. Minimum Level lakes and wetlands analyzed through the Recovery Assessment Plan show that all of these lakes and wetlands meet their Minimum Levels based on the weight-of-evidence analyses developed for this Recovery Assessment Plan, do not exhibit signs of adverse environmental impact, or cannot meet their levels for reasons summarized in Chapters 12 and 13. Since all of these conditions have been met, Tampa Bay Water asserts that the Consolidated Permit should be issued under the Water Use Permitting Rules contained in Chapter 40D-2, F.A.C. without the need for the provisions of a third phase of the Recovery Strategy Rules in Chapter 40D-80, F.A.C.

16.3 Criteria for Issuance for a Water Use Permit

District Rule 40D-2.301 lists the Criteria for Issuance for a Water Use Permit. An applicant must provide reasonable assurance that the proposed consumptive use of water meets numerous criteria in order to obtain a new or renewed permit. Criteria 40D-2.301(2)(g)4 and 5 specify that the consumptive use “Will not cause harmful hydrologic alterations to natural systems, including wetlands or other surface water; and will not otherwise cause harmful hydrologic alterations to the water resources of the area.”

The technical assessments contained in this report and the summary of findings contained in Section 16.1 demonstrate that environmental recovery across the 11 wellfields has been achieved following the reduction in wellfield pumping to an annual average quantity of 90 mgd. There are no adverse impacts remaining related to the continued wellfield pumping at this long-term average rate. Additional documentation of environmental recovery at the wellfields is contained in the data and hydrographs found in the 2019 Annual Reports for each of these water supply facilities (Tampa Bay Water, 2020a-j). The successful completion of the Recovery Assessment Plan and resolution of the one wetland for which mitigation was required provide reasonable assurance that an annual average pumping rate of 90 mgd from the ten remaining wellfields does not cause harmful hydrologic alterations to the lakes, wetlands, and surface water resources on and near the wellfields.

16.4 Maintaining the Condition of Environmental Recovery Achieved

Tampa Bay Water provides further reasonable assurances to the District that the continued operation of the Consolidated Permit wellfields at an annual average rate of 90 mgd will not cause adverse environmental impacts. These assurances are provided in Tampa Bay Water’s commitments to continue environmental data collection and analysis, operate these ten remaining wellfields under the guidance of the OROP, and continue the balanced operation of the multiple source water types in the regional supply system in a manner that avoids and minimizes impacts to environmental features. These three commitments are discussed further in the sections that follow.

16.4.1 Continued Environmental Data Collection and Analysis

Tampa Bay Water will continue to collect water level and environmental data for the ten remaining wellfields authorized under the Consolidated Permit during the term of the renewed permit. This data collection program will be conducted according to the revised Environmental Management Plan (EMP) that will be included in the renewed Consolidated Permit at the specific sites listed in the renewed permit. The data will be assessed semi-annually and for the completion of wellfield compliance reports to determine if adverse impacts are detected related to pumping from the wellfields. These data and analyses will be submitted to the District at the frequency specified in the renewed permit.

16.4.2 Continue EMP/OROP Protocol to Preserve Recovery

Tampa Bay Water will continue to use the Optimized Regional Operations Plan (OROP) to guide the production from the Consolidated Permit wellfields based on current hydrologic conditions during the term of the renewed permit. Continued use of this optimization tool during the next permit term further provides reasonable assurance that pumping at an annual average rate of 90 mgd does not and will not cause harmful alterations to natural systems or the water resources of the area.

Tampa Bay Water will continue to perform semi-annual analyses for lakes and wetlands as specified in the revised EMP to determine if any of the sites have anomalously low hydrologic conditions. If these conditions are detected and it is determined that the distribution of pumping from the production wells of the Consolidated Permit wellfields has caused the adverse site conditions, Tampa Bay Water will follow the process in the revised EMP to remedy the adverse condition. The lake and wetland conditions documented in this final Recovery Assessment Plan report reflect the significant reduction in groundwater pumping from the wellfields, changes in water use regulations over time, and changes that have occurred within the drainage basins surrounding many of the wellfields. These current conditions reflect a new environmental baseline condition that now exists on and around these ten wellfields. Tampa Bay Water’s commitment to continue using the OROP to guide production and the environmental assessment and response protocol outlined in the revised EMP provides reasonable assurance that continued operation of the wellfields at an annual average quantity of 90 mgd will not cause adverse environmental conditions below this new environmental baseline condition.

16.4.3 Regional System Operations

Tampa Bay Water will continue to operate the regional supply system during the term of the renewed permit in accordance with the Operations Plan. The balancing of three different source water types as described in Section 4.7 has allowed Tampa Bay Water to reduce pumping at the Consolidated Permit wellfields and operate all water supply facilities without causing adverse environmental impacts. The regional balancing of source water types based on availability and system constraints allows Tampa Bay Water to reduce the wellfield pumping rate during the summer rainy season allowing the lakes, wetlands, and aquifer water levels to quickly increase, sustaining the wetland systems through the fall and winter seasons. This operational scenario allows water levels in lakes and wetlands on and near the Consolidated Permit wellfield to fluctuate in a normal pattern where water levels are low at the end of the spring dry season and high at the end of the summer rainy season. The continued annual average wellfield pumping rate of 90 mgd and this seasonal pumping pattern provides additional reasonable assurance that the recovery of lakes and wetlands on and near the wellfields will be sustained and that adverse impacts related to wellfield pumping will not occur.

As described in Section 4.7, Tampa Bay Water's goal, for budgetary and operational purposes, is to maintain production from the Consolidated Permit wellfields at or below 85 mgd on an annual average basis, even though the annual average permitted rate is 90 mgd. This provides the Agency with flexibility so that the wellfields can be pumped at a higher monthly rate when needed to account for emergency conditions within the regional system or manage the supply sources during drought conditions without exceeding the permit limit. The Water Shortage Mitigation Plan will be implemented during water shortage and drought conditions as described in Section 4.6 and 4.7 to manage the water supply sources and minimize any environmental impacts associated with the level of pumping necessary to meet the necessary public water demand and avoid a public health and safety emergency. Tampa Bay Water will plan for long-term growth in population and demand using the Master Water Plan process to develop new supplies as they are needed, ensuring that the Tampa Bay region has a safe and sustainable water supply into the future.

17: References

17. References

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