Water Supply Facilities Work Plan 2020 Update

June 16, 2020

Hazen

CITY OF FORT LAUDERDALE

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Executive Summary

Introduction

This executive summary provides a brief summary of the key findings in the City of Fort Lauderdale Water Supply Facilities Work Plan 2020 Update.

Background

Chapter 163, Part II, Florida Statutes (F.S.), requires local governments to prepare and adopt 10-Year Water Supply Facilities Work Plans into their comprehensive plans within 18 months after the South Florida Water Management District (SFWMD) approves a regional water supply plan or its update. The 2018 Lower East Coast Water Supply Plan Update (2018 LECWSP Update) was adopted by the District's Governing Board on November 8, 2018. Therefore, local governments within the Lower East Coast Region are required to amend their comprehensive plans and include an updated 10-year Water Supply Facilities Work Plan and related planning elements by May 8, 2020.

The State of Florida requires that the 10-year Water Supply Facilities Work Plan 2020 Update address the development of traditional and alternative water supplies and management strategies, including conservation and reuse. The data and analyses, including population projections and water demands must span at least a 10-year planning period and be consistent with the 2018 LECWSP Update. The data presented herein are for the planning period through the year 2040.

Water Service Area

The City of Fort Lauderdale is the single largest purveyor of potable water in Broward County. This includes retail customers residing in the Roosevelt Gardens, Franklin Park, Washington Park, and Boulevard Gardens communities of unincorporated Broward County. These communities are expected to become incorporated by the end of the planning period. The utility's service area encompasses a total area of 43 square miles, approximately one-tenth the total area of urban Broward County. Other retail customers include residential, commercial, and industrial properties within the City of Fort Lauderdale, Lazy Lake, and a portion of Lauderdale-by-the-Sea. The utility also maintains wholesale agreements for potable water supply with Broward County Water and Wastewater Services; Cities of Oakland Park, Wilton Manors, and Tamarac; Town of Davie and Port Everglades. Figure ES-1 depicts the water service area (inclusive of all retail and wholesale customers).

Figure ES-1 also depicts the location of key City water supply assets including the following: 1) Dixie Wellfield; 2) Prospect Wellfield; 3) Peele-Dixie Water Treatment Plant; 4) Fiveash Water Treatment Plant; 5) 2nd Avenue Water Tank and Pump Station; 6) Poinciana Park Water Tank and Pump Station; and 7) George T. Lohmeyer Wastewater Treatment Plant.

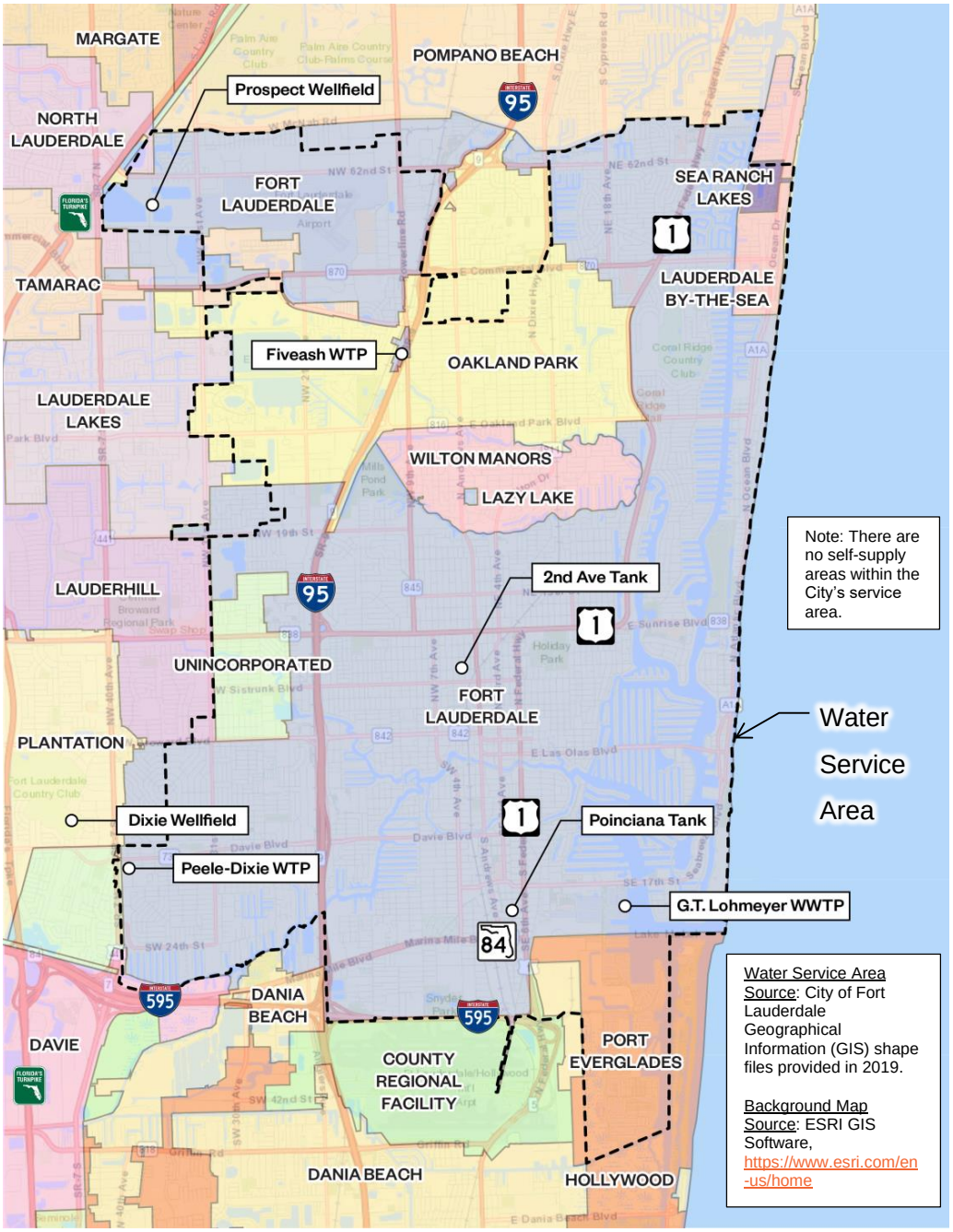

Figure ES-1: Water Service Area

Population Forecast

The population forecast was based on University of Florida's Bureau of Economic and Business Research (BEBR) data. Figure ES-1 presents the population forecast for the City of Fort Lauderdale's water service area through the year 2040. It is noted that the year 2040 population data presented herein is 1.3 percent higher than the year 2040 population presented in the SFWMD's 2018 LECWSP Update.

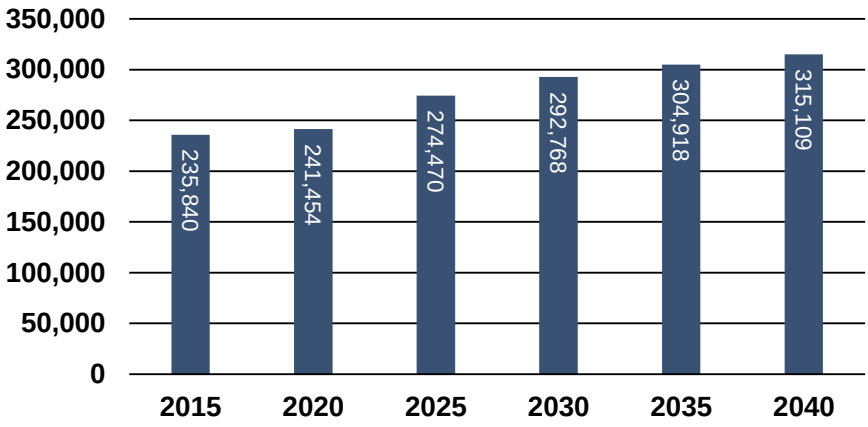

Figure ES-2: Population Forecast

Source: Population data are based on University of Florida's Bureau of Economic and Business Research (BEBR) as processed by The Corradino Group and provided to Hazen on May 24, 2019.

Water Supply

The City's traditional source of water has been the Biscayne Aquifer. The Biscayne Aquifer is a shallow, surficial aquifer that is highly porous, and transmissive. It is the traditional supply in Southeast Florida. The City's existing Fiveash and Peele-Dixie water treatment plants are designed to treat the Biscayne Aquifer. Peele-Dixie has space and power supply for the installation of additional infrastructure to treat water from the Floridan Aquifer System (FAS).

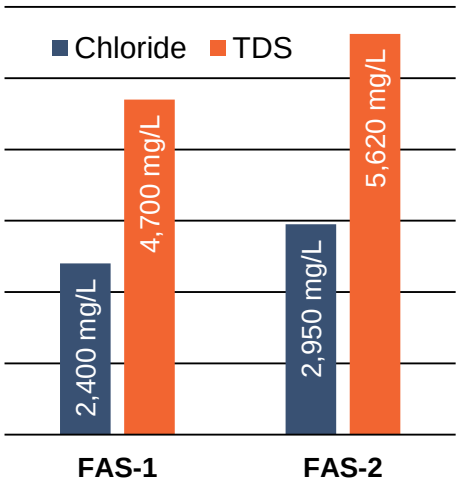

Figure ES-3: Floridan Aquifer Well Data

Source: (Hazen and Sawyer, 2008a).

The City has also drilled two full-size FAS wells to collect data needed for planning purposes. Chloride and total dissolved solids (TDS) data from these wells are presented in Figure ES-3 (Hazen and Sawyer, 2008a). Based on modeling presented in the 2018 LECWSP Update, the TDS is estimated to increase to 8,000 mg/L by the year 2040 (South Florida Water Management District, 2018a). The Peele-Dixie WTP was designed with space available to add reverse osmosis (RO) to treat water from the FAS. Space is available for 6-mgd of finished water capacity RO and electrical capacity to treat water with a TDS up to approximately 8,000-mg/L and chloride concentration of 4,300 mg/L (Hazen and Sawyer, 2008b).

The SFWMD issued the City's Water Use Permit (No. 06-00123-W) on September 11, 2008; the permit expires on September 11, 2028. The permit limits withdrawal from the Biscayne Aquifer and the FAS as follows, on Annual Average Day (AAD) basis:

- Biscayne Aquifer Withdrawal Limit: 52.55 mgd (AAD)
- FAS Withdrawal Limit: 8.64 mgd (AAD)

Raw Water Demand Forecast

Figure ES-4 graphically illustrates the raw water demand forecast on an annual average day (AAD) basis for the City's water service area. A water supply deficit is forecasted begin in the year 2035. Figure ES-4 is based upon the City operating the Peele-Dixie WTP to produce approximately 6-mgd of finished water indefinitely. Furthermore, this figure assumes that lime softening is continued at the Fiveash WTP indefinitely. If the City increases finished water produced at the Peele-Dixie WTP or decides to change the treatment technology at the Fiveash WTP to a lower efficiency technology, then the demand curve would increase – resulting in a water supply deficit earlier than currently forecasted.

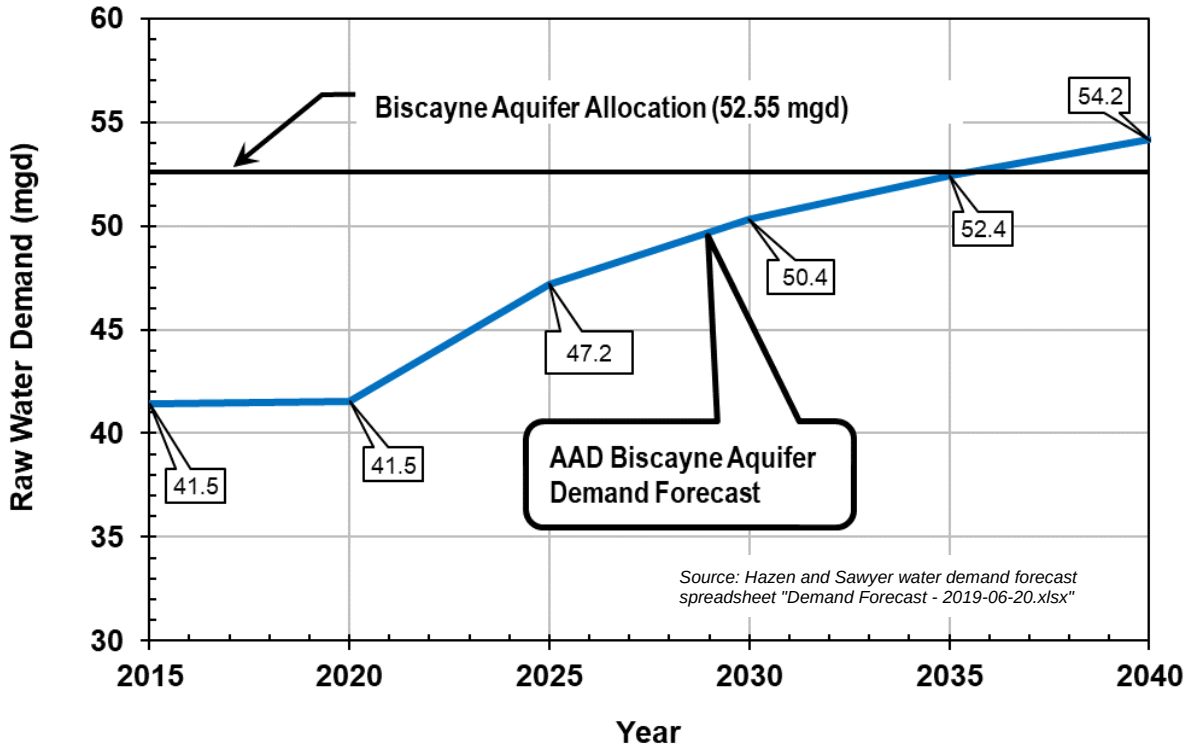

Figure ES-4: Biscayne Aquifer Raw Water Demand Forecast Annual Average Day (mgd)

Finished Water Demand Forecast

Figure ES-5 graphically illustrates the finished water demand forecast on an annual average day basis for the City's water service area.

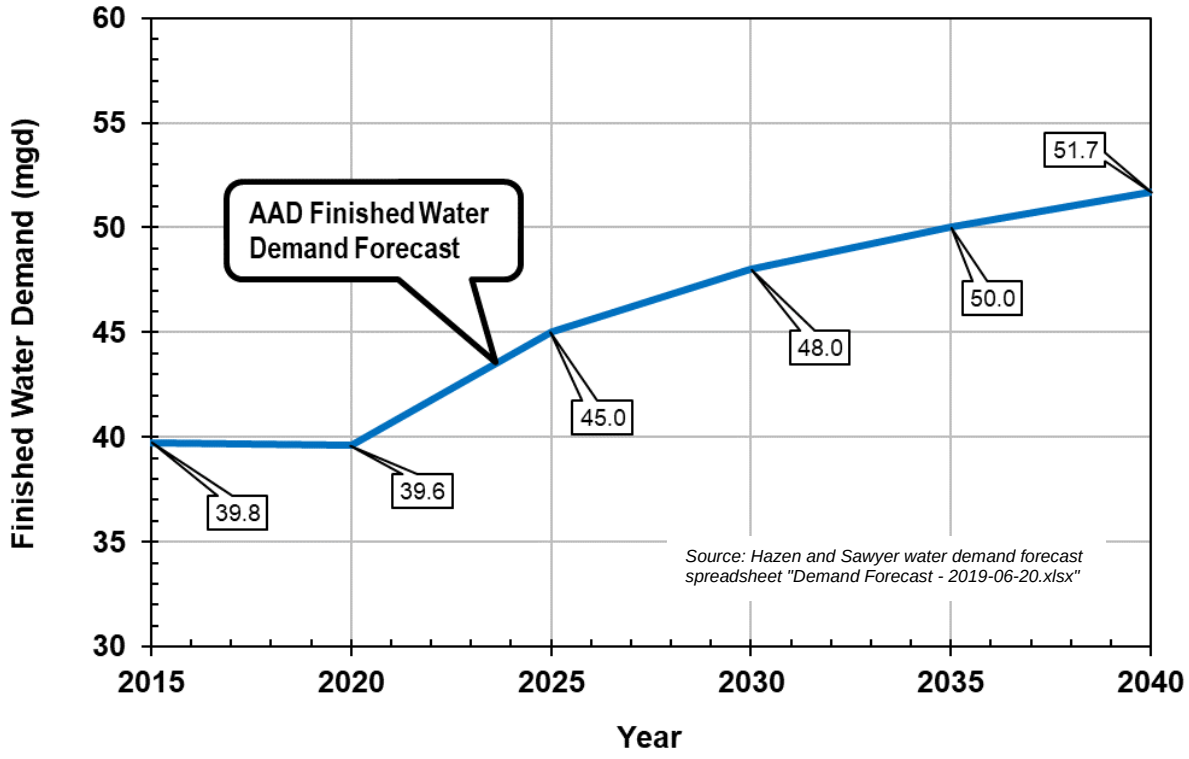

Figure ES-5: Finished Water Demand Forecast Annual Average Day (mgd)

Comprehensive Utility Strategic Master Plan (CUSMP)

The City's Comprehensive Utility Strategic Master Plan (CUSMP), completed by Reiss Engineering, Inc., in 2017 is a planning document that evaluated the City's water and wastewater systems and recommends improvements to maintain or improve levels of service over a 20-year period ending in 2035. The CUSMP aligned its recommendations with the City's long-term goals identified in the City's Fast Forward Fort Lauderdale 2035 Strategic Plan and the Southeast Florida Regional Climate Action Plan.

As indicated in the CUSMP, the City's existing water supply, treatment and distribution infrastructure is aging. The City recognizes that significant investment is necessary to sustain the reliability of its infrastructure. The City is actively planning the necessary investment decisions to ensure maintaining its level-of-service. For example, the City has begun a project titled "Granular Activated Carbon Pilot and Plant Evaluation at the Fiveash Water Plant". This project includes evaluation of treatment technologies

to achieve the City's color goal at the Fiveash WTP. The project is ongoing and is expected to be completed in late 2019. This study will recommend to either replace all or part of the Fiveash WTP and includes evaluation of alternative water supply technologies. The City will use this report to inform future CIP scheduling decisions.

Alternative Water Supply Plan

The data in Figure ES-4 indicate that demand is projected to exceed the Biscayne Aquifer supply in the year 2035. The City plans that this supply deficit will be addressed via RO treatment of the FAS. The City reserves the right to alter this plan based on the findings of ongoing City studies and future CUSMP updates. Additionally, this plan may be altered as additional data becomes available regarding the risks presented by unexpected changes to water quality in the FAS.

In 2008, the City completed conceptual plans for implementing 6-mgd of finished water capacity RO at the Peele-Dixie WTP. Five FAS wells were also conceptually planned. The planning documents (illustrated in Figure ES-6) are titled "Floridan Aquifer Conceptual Plan for the Dixie Wellfield" and "Peele-Dixie Reverse Osmosis Basis of Design Report".

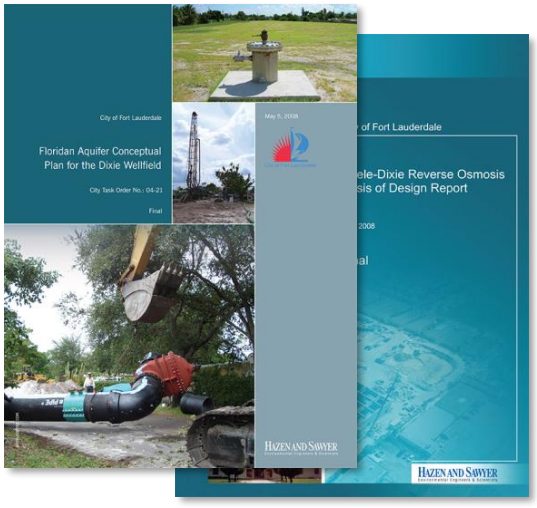

Figure ES-6: Alternative Water Supply Planning Documents

These plans provide the City with a roadmap to quickly implement this alternative water supply in advance of demand exceeding its traditional Biscayne Aquifer supply. It is estimated that it would require approximately five years to implement FAS wells and RO treatment at the Peele-Dixie WTP.

The costs for implementing 6-mgd of finished water capacity RO at the Peele-Dixie WTP along with five FAS wells are presented in the reports titled "Floridan Aquifer Conceptual Plan for the Dixie Wellfield" and "Peele-Dixie Reverse Osmosis Basis of Design Report". The cost total from these reports is $36.7 in 2008 dollars. Escalating the cost to 2019 dollars amounts to $49.1 million using Engineering News-Record Construction Cost Indexes of 8,310 for 2008 and 11,118 for 2019. This cost includes construction cost plus contingency along with engineering services (Engineering News-Record, 2019). This is a Class 5 estimate as defined by Association for the Advancement of Cost Engineering (AACE) International. The expected accuracy of this estimate is +50% to -30%.

1. Introduction

1.1 Scope of This Report

The City of Fort Lauderdale's Water Supply Facilities Work Plan 2020 Update identifies water supply sources, availability and facilities needed to serve existing and new development within the local government's jurisdiction. Chapter 163, Part II, Florida Statutes (F.S.), requires local governments to prepare and adopt 10-Year Water Supply Facilities Work Plans into their comprehensive plans within 18 months after the South Florida Water Management District (District) approves a regional water supply plan or its update.

The 2018 Lower East Coast Water Supply Plan Update (2018 LECWSP Update) was adopted by the District's Governing Board on November 8, 2018. Therefore, local governments within the Lower East Coast Region are required to amend their comprehensive plans and include an updated 10-year Water Supply Facilities Work Plan and related planning elements by May 8, 2020.

The State of Florida requires that the 10-year Water Supply Facilities Work Plan 2020 Update address the development of traditional and alternative water supplies and management strategies, including conservation and reuse. The data and analyses, including population projections, water demands and service areas must cover at least a 10-year planning period and be consistent to the LECWSP and the updated comprehensive plan amendment.

The City of Fort Lauderdale's 10-year Water Supply Facilities Work Plan 2020 Update is divided into five sections:

1.0 – Introduction

2.0 – Background Information

3.0 – Data and Analysis

4.0 – Capital Improvements

5.0 – Goals, Objectives, and Policies.

1.2 Location Map

The City of Fort Lauderdale is located on the southeastern coast of Florida within Broward County. Figure 1-1 illustrates a location map of the City.

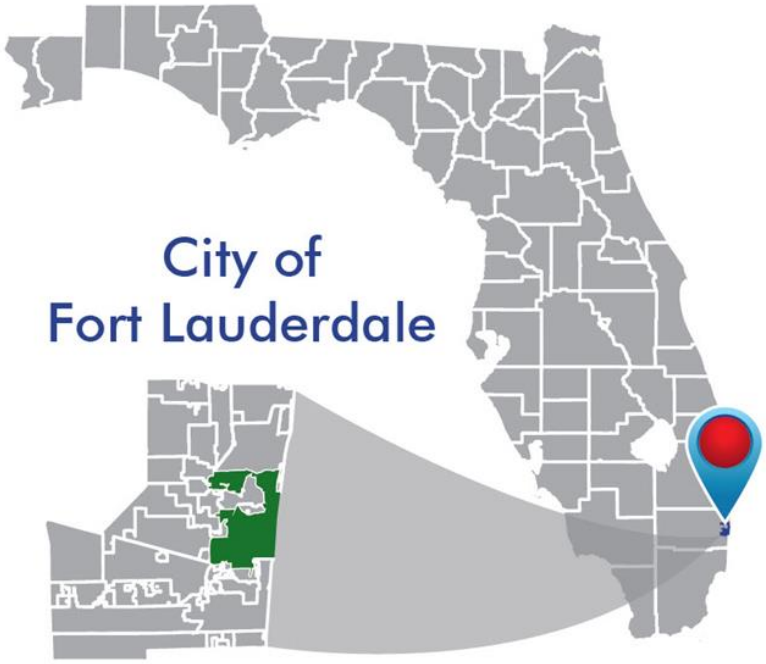

Figure 1-1: Fort Lauderdale Location Map

Source: City of Fort Lauderdale

1.3 Statutory History

The Florida Legislature enacted bills during the 2002, 2004, 2005, 2011, 2012, 2015, and 2016 sessions to address the state's water supply needs. These bills, particularly Senate Bills 360 and 444 enacted during the 2005 legislative session, strengthened the statutory links between the regional water supply plans (RWSPs) prepared by water management districts and the Comprehensive Plans prepared by local governments through changes to Chapters 163 and 373, F.S. These changes improved coordination between local land use planning and regional water supply planning.

1.4 Statutory Requirements

The City of Fort Lauderdale has considered the following statutory provisions in updates to this Water Supply Facilities Work Plan.

1. Coordinate appropriate aspects of its comprehensive plan with the 2018 LECWSP [163.3177(4) (a), F.S.].

2. Ensure the future land use plan is based upon availability of adequate water supplies and public facilities and services [s.163.3177 (6) (a), F.S.]. Data and analysis demonstrating that adequate water supplies and associated public facilities will be available to meet projected growth demands must accompany all proposed Future Land Use Map amendments submitted for review.

3. Ensure that adequate water supplies and potable water facilities are available to serve new development no later than the issuance by the local government of a certificate of occupancy or its functional equivalent and consult with the applicable water supplier to determine whether adequate water supplies will be available to serve the development by the anticipated issuance date of the certificate of occupancy [s.163.3180 (2), F.S.].

4. Revision of the related comprehensive planning elements within 18 months after the water management district approves an updated regional water supply plan, to:

    a. Identify and incorporate the alternative water supply project(s) selected by the local government from projects identified in the 2013 LECWSP, or alternative project(s) proposed by the local government under s. 373.709(8)(b), F.S. [s. 163.3177(6)(c), F.S.];

    b. Identify the traditional and alternative water supply projects and the conservation and reuse programs necessary to meet water needs identified in the 2013 LECWSP [s. 163.3177(6)(c)3, F.S.]; and

    c. Update the 10-year Water Supply Facilities Work Plan for at least a 10-year planning period for constructing the public, private, and regional water supply facilities identified in the element as necessary to serve existing and new development [s. 163.3177(6)(c)3, F.S.].

5. Revise the Five-Year Schedule of Capital Improvements to include water supply, reuse, and conservation projects and programs to be implemented during the five-year period [s. 163.3177(3)(a)4, F.S.].

6. To the extent necessary to maintain internal consistency after making changes described in Paragraph 1 through 5 above, revise the Conservation Element to assess projected water needs and sources for at least a 10-year planning period, considering the 2018 LECWSP, as well as applicable consumptive use permit(s) [s.163.3177 (6) (d), F.S.]. The plan must address the water supply sources necessary to meet and achieve the existing and projected water use demand for the established planning period, considering the applicable regional water supply plan [s.163.3167(9), F.S.].

7. To the extent necessary to maintain internal consistency after making changes described in Paragraphs 1 through 5 above, revise the Intergovernmental Coordination Element to ensure coordination of the comprehensive plan with the 2018 LECWSP [s.163.3177 (6) (h) 1., F.S.].

8. Evaluation and Appraisal Report are required once every 7 years. Local governments are encouraged to comprehensively evaluate, and as necessary, update comprehensive plans to reflect changes in local conditions. The evaluation could address the extent to which the local government has implemented the need to update their 10-year Water Supply Facilities Work Plan, including the development of alternative water supplies, and determine whether the identified alternative water supply projects, traditional water supply projects, and conservation and reuse programs are meeting local water use demands [s.163.3191 (3), F.S.].

2. Background Information

2.1 Introduction

This section includes the following:

- An overview of the City of Fort Lauderdale's water service area; and
- A description of regional water supply planning issues that impact the City of Fort Lauderdale, including the following:
    - Climate Change
    - Regional Water Availability Rule
    - Participation in the C-51 Reservoir Project
    - Regional Climate Action Plan
    - Lake Okeechobee Surface Water Allocation Limitations
    - Lowering Lake Okeechobee Level
    - Infrastructure Planned to Attenuate Damaging Peak Flow Events from Lake Okeechobee
    - Expanded Use of Reclaimed Water to Meet Future Water Supply Demands
    - Wellfield Management to Prevent Undesirable Changes in Floridan Aquifer Water Quality

2.2 Service Area

2.2.1 Introduction

The City of Fort Lauderdale is the single largest purveyor of potable water in Broward County. This includes retail customers residing in the Roosevelt Gardens, Franklin Park, Washington Park, and Boulevard Gardens communities of unincorporated Broward County. These communities are expected to become incorporated by the end of the planning period. The utility's service area encompasses a total area of 43 square miles, approximately one-tenth the total area of urban Broward County. Other retail customers include residential, commercial, and industrial properties within the City of Fort Lauderdale, Lazy Lake, and a portion of Lauderdale-by-the-Sea. The utility also maintains wholesale agreements for potable water supply with Broward County Water and Wastewater Services; Cities of Oakland Park, Wilton Manors, and Tamarac; Town of Davie and Port Everglades.

2.2.2 Water Service Area Map

Figure 2-1 depicts the water service area (inclusive of all retail and wholesale customers). Figure 2-1 also depicts the location of key City assets including the following: 1) Dixie Wellfield; 2) Prospect Wellfield; 3) Peele-Dixie Water Treatment Plant; 4) Fiveash Water Treatment Plant; 5) 2nd Avenue Water Tank and Pump Station; 6) Poinciana Park Water Tank and Pump Station; and 7) George T. Lohmeyer Wastewater Treatment Plant.

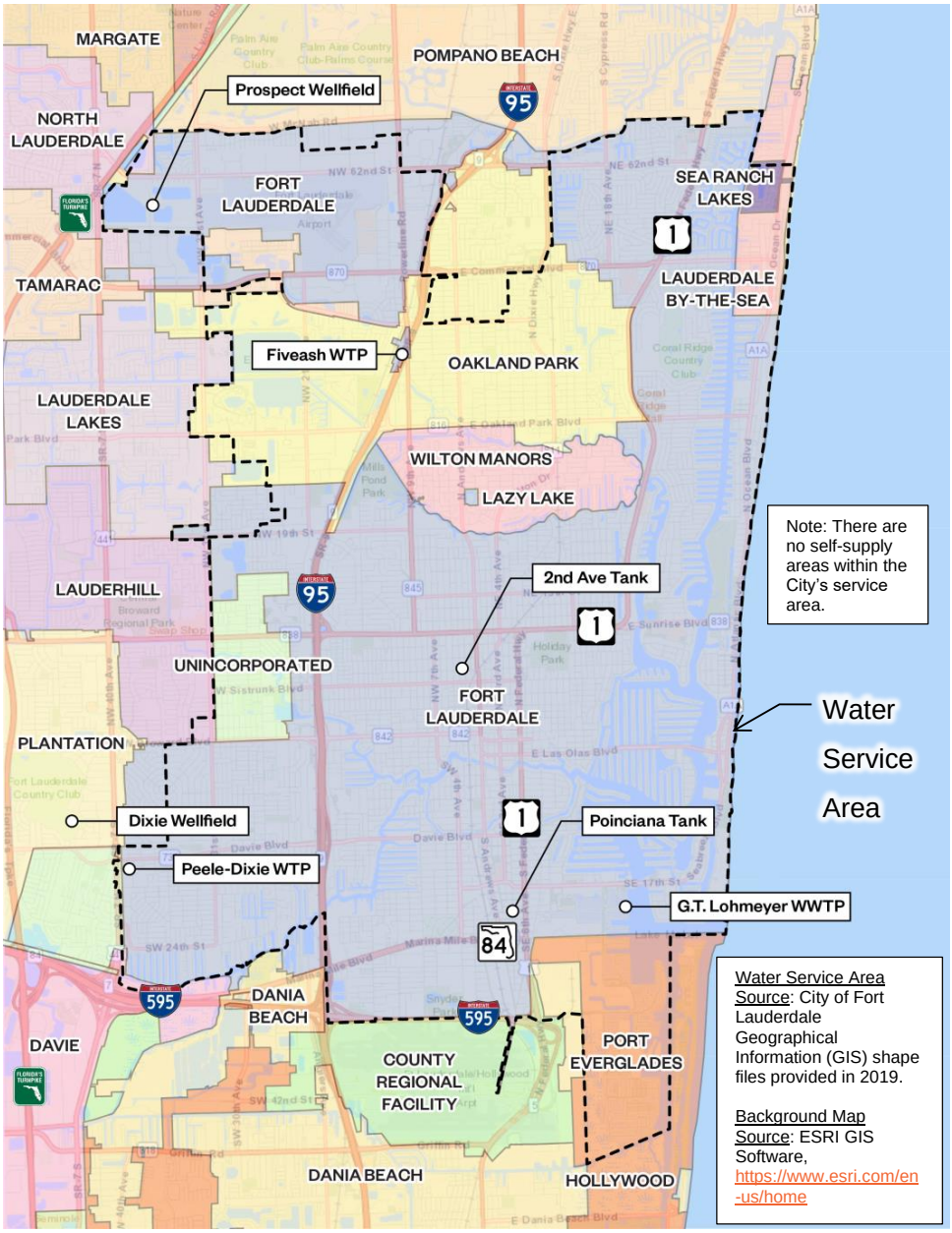

Figure 2-1: Water Service Area

2.2.3 Areas of Self-Supply

There are no existing areas within the City of Fort Lauderdale's water service area that self-supply potable water. There are no plans for future domestic self-supplied systems.

2.3 Climate Change

Investigations and evaluations conducted at the national, regional, and local levels have reinforced the need to plan for the predicted impacts of more frequent and severe drought, increases in tidal and storm-related flooding, and ensuring that future planning efforts are flexible to adapt to changes to ensure a sustainable water supply infrastructure.

The City of Fort Lauderdale, together with its municipal and regional partners, understands that it is imperative that local governments and water utilities begin to formalize the integration of water supply and climate change considerations as part of coordinated planning efforts and work to provide relevant updates to the 10-year Water Supply Facilities Work Plan and enhance Goals, Objectives and Policies (GOPs) of its comprehensive plan.

The City is a leader in developing planning tools and identifying achievable and cost-effective goals that meet the needs of its community. The City has recently signed a resolution endorsing the Mayor's Climate Action Pledge; affirming support for the Southeast Florida Regional Climate Change Compact; and agreeing to consider implementation of the Regional Climate Action Plan (2012) in whole or in part as appropriate for the City.

Key considerations relative to climate change include: 1) Sea level rise and 2) saltwater intrusion. These topics are presented in the following subsections.

2.3.1 Sea Level Rise

The City of Fort Lauderdale is a participant in the Southeast Florida Regional Climate Change Compact. The Compact is an ongoing collaborative effort among the participants (local communities, regulatory agencies, along with Broward, Miami-Dade, Monroe and Palm Beach Counties) to foster sustainability and climate resilience on a regional scale.

Development of cost-effective sea level rise adaptation strategies to ensure the sustainability of the City's water supply is critical to all ongoing planning efforts. To facilitate planning, the Southeast Florida Regional Climate Change Compact developed the sea level rise graphic illustrated in Figure 2-2. This sea level rise projection is now being used as the basis for planning throughout the region.

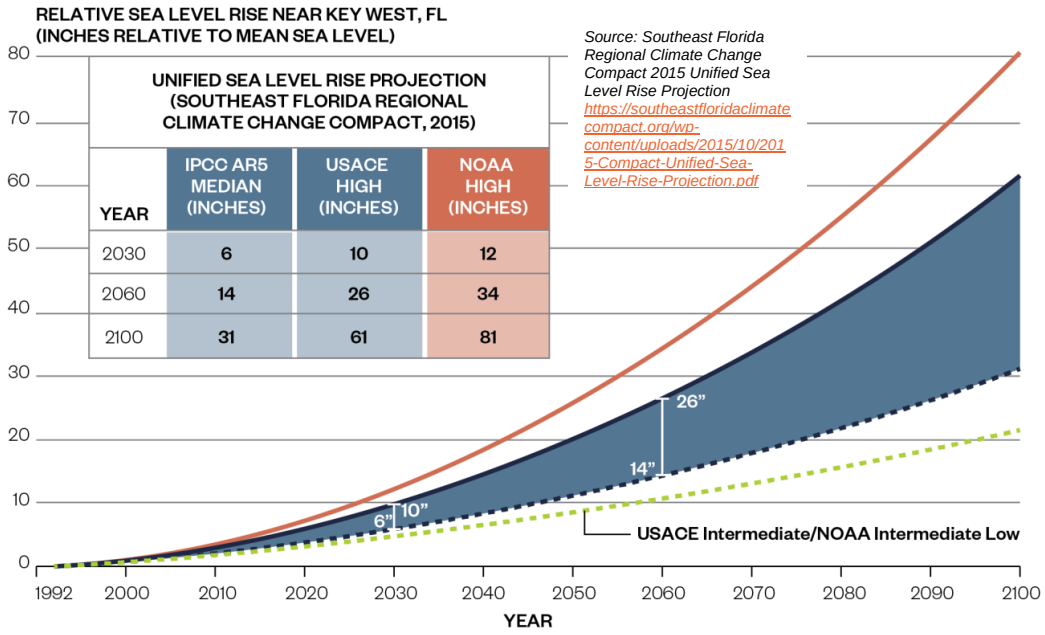

Figure 2-2: Sea Level Rise

The City contributed funding for Broward County and the United States Geological Survey (USGS) to develop a SEAWAT Saltwater Intrusion Model to evaluate various sea level rise scenarios. According to USGS Report titled "*Potential Effects of Alterations to the Hydrologic System on the Distribution of Salinity in the Biscayne Aquifer in Broward County"* under the high sea level rise scenario, the Dixie Wellfield will experience a slight increase in salinity to 50 milligrams per liter (mg/L) in 2060 (Hughes, 2016). However, as explained in the following subsection, high levels of chloride (greater than 1,000-mg/L) have been measured at the Dixie wellfield. No impact to the Prospect Wellfield is expected (Hughes, 2016).

The City is cautioned that model accuracy and use are limited by uncertainty in the physical properties and boundary conditions of the system, uncertainty in historical and future conditions, and generalizations made in the mathematical relationships used to describe the physical processes of groundwater flow and transport. Because of these limitations, model results should be considered in relative rather than absolute terms. Nonetheless, model results do provide useful information on the relative scale of response of the system to changes in pumping distribution, sea-level rise, and mitigation activities (Hughes, 2016).

The City collects data from 10 saltwater monitoring wells (MWs). The data from the saltwater MWs is presented in the follow subsection.

2.3.2 Saltwater Intrusion

The Biscayne Aquifer which serves as the City's primary water supply is a shallow, surficial aquifer characterized by limestone karst geology which is highly porous and transmissive. Coastal saltwater intrusion of the aquifer has occurred in eastern parts of Broward County. The mapping of the saltwater intrusion front (i.e., the depth and location of the 250 mg/L chloride concentration toe) is supported by local governments throughout the region, USGS, and the South Florida Water Management District (SFWMD). The current Saltwater Intrusion Line for Broward County is illustrated in Figure 2-3 (South Florida Water Management District, 2018b).

At the toe of the saltwater front, chloride concentrations exceed drinking water standards of 250 mg/l and thus restrict and/or require abandonment of wellheads located east of the saltwater intrusion line. The City has been proactively managing saltwater intrusion risk through a combination of managing wellfield pumpage and the collection of data from 10 saltwater monitoring wells constructed in 2002.

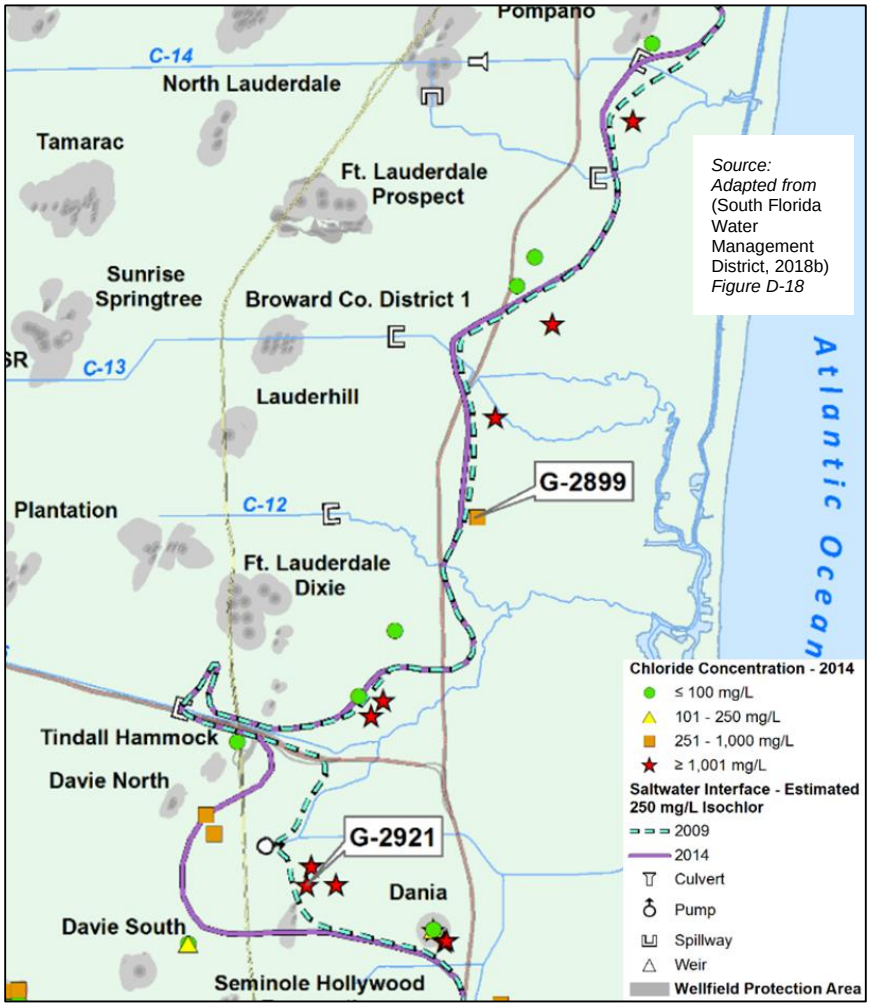

Figure 2-3: 250 mg/L Isochlor

The City operates a Saline Intrusion Monitoring Program (the "SALT Program"). The goal of the SALT Program is to locate and monitor the saltwater interface in and around the City's wellfields. The purpose of the Program is to provide an early warning monitoring system to assist wellfield managers in tracking the location and to manage withdrawals to limit the inland movement of the salt front. The City currently has 10 saltwater monitoring wells (MWs).

The City measures conductivity at its saltwater MWs on a monthly basis. The latest data available are presented in the City's report titled "2018 Annual Saltwater Intrusion Monitoring Report". The data indicate no evidence of saltwater instruction at the Prospect Wellfield. Additionally, the report documents evidence of high chlorides at the Dixie Wellfield, as presented below.

MW-10 is located at the Dixie Wellfield. The 2018 conductivity data (the latest available) for MW-10 is presented in Figure 2-4 (City of Fort Lauderdale, 2018).

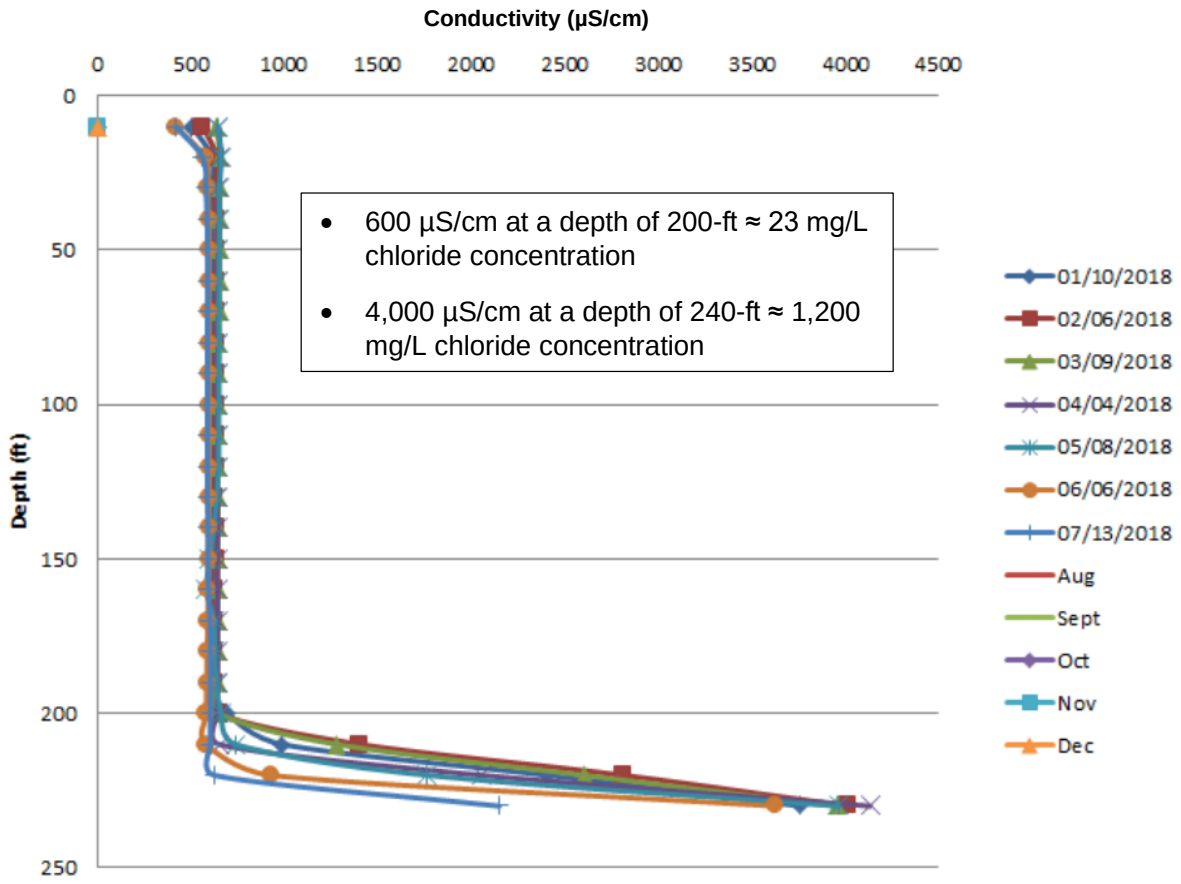

Figure 2-4: Conductivity (µS/cm) Measured at Saltwater Monitor Well 10

The City's 2018 data for MW-10 indicates conductivity of approximately 600 µS/cm at a depth of 200-feet below land surface and approximately 4,000 µS/cm at a depth of 240-feet below land surface (City of Fort Lauderdale, 2018). These conductivity value correlates to a calculated chloride level of

approximately 23 mg/L at a depth of 200-feet below land surface and 1,200 mg/L at a depth of 240-feet below land surface. The 1,200 mg/L chloride concentration is at a depth much lower than the water production zone of 80-feet to 125-feet below-land-surface. Given the depth of the high chloride concentration below the production depth, upconing is not likely to be a concern currently. It is recommended that the City collect temperature, conductivity and chloride concentrations once per week at each Dixie well for one year to assess if upconing is occurring.

The City reports that in late July of 2018, saltwater MW-10 (located within the Dixie Wellfield) was accidentally abandoned as part of a larger remediation project occurring on Fort Lauderdale Country Club (FLCC) property (City of Fort Lauderdale, 2018). The Dixie wellfield is located within the FLCC property. The City roughly estimates that saltwater MW-10 would be replaced by the end of August 2020.

The Comprehensive Utility Strategic Master Plan (CUSMP) (Reiss Engineering, 2017) recommended continued monitoring of salinity along with development of variable density model in the short term. Section 5.A.9 of the CUSMP indicated that it may be appropriate to add saline monitoring wells based on the findings of the variable density model; the number and location of the wells would be determined based on the model findings (Reiss Engineering, 2017). The City continues to monitor its wells for saltwater intrusion.

2.4 Regional Water Availability Rule

The Regional Water Availability (RWA) rule was passed by the SFWMD on February 16, 2007. The RWA limits water withdrawals from the Biscayne Aquifer to the maximum quantity during any consecutive five years preceding April 2006. Water utilities needing additional water supplies are required to seek sources that are not dependent upon the Everglades for recharge. These alternative water supply solutions include recycling water, using reclaimed water to recharge the Biscayne Aquifer, or drawing water from the deeper Floridan Aquifer (which requires high energy consumption treatment methods). The RWA and the approval of the City's Water Use permit limited the City's Biscayne Aquifer withdrawal to the following (South Florida Water Management District, 2008):

- Peele-Dixie is 5,475 MGY (15 MGD)
- Prospect is 15,851 MGY (43.43 MGD)
- Total from both wellfields is limited to 19,181 MGY (52.55 MGD)

Demands in excess of the above amount would be met via conservation and alternative water supplies.

2.5 C-51 Reservoir Project

The capture of excess stormwater is considered an alternative water supply project as defined in Section 373.707, F.S. One such project, the proposed C-51 reservoir, was evaluated in 2009 by a group of seven utilities located in Broward and Palm Beach Counties (including the City of Fort Lauderdale). The location of this proposed reservoir is adjacent to the SFWMD's existing L-8 Reservoir in Palm Beach County and is expected to share the same impermeable geologic formation that facilitates storage.

The C-51 reservoir would capture stormwater in the wet season and release it during the dry season to recharge the Biscayne Aquifer. To benefit from this recharge, a utility must execute an agreement with the owner of the C-51 reservoir to pay for the capital cost and operations and maintenance costs of the reservoir and conveyance infrastructure. Upon execution of a C-51 capacity allocation agreement, the utility's Biscayne Aquifer allocation could be increased through issuance of a water use permit by the SFWMD (with allocation dependent upon groundwater modeling results).

The C-51 reservoir, owned and operated by Palm Beach Aggregates (PBA), is planned for development in two phases. Phase 1 would consist of 14,000 acre-feet of storage capacity; equivalent to approximately 35-mgd. Phase 2, if developed, would consist of an additional 46,000 acre-feet of storage capacity. Media reports indicate environmental group opposition to utilizing Phase 2 for water supply benefit.

Phase 1 been designed and permitted. PBA has executed agreements with the following utilities:

- Broward County: 6-mgd
- Sunrise: 5-mgd
- Dania Beach: 1-mgd
- Hallandale Beach: 1-mgd
- Fort Lauderdale: 3-mgd

As of the date of this report, construction of C-51 reservoir Phase 1 has not begun. It is currently scheduled to start September 2020 and with a two year construction window, it should be operational by September 2022.

The City executed a Capacity Allocation Agreement (CAA) with PBA on December 23, 2019 for 3 MGD. The one time capital cost is $13,800,000 and the annul O&M cost is $109,654.

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2.6 Regional Climate Action Plan

Southeast Florida is widely considered one of the most vulnerable regions with respect to the impacts of climate change and sea level rise. This is largely the result of several unique geographic characteristics which include low land elevations, flat topography, a porous geology, and dense coastal development. In combination, climate change and sea level rise are expected to present significant challenges relating to water resource planning, management and infrastructure for communities throughout the region, which includes Palm Beach, Broward, Miami-Dade and Monroe Counties. These communities have agreed to partner in regionally-coordinated climate mitigation and adaptation strategies as part of the Southeast Florida Regional Climate Change Compact (Compact) and have jointly developed and adopted a Regional Climate Action Plan (RCAP) including 110 recommendations in seven primary focal areas, with 18 specific to the focal area of "Water Supply, Management, and Infrastructure". Table 2-1 presents the water supply related recommendations from the Regional Climate Action Plan (Southeast Florida Climate Compact, 2019).

Table 2-1: Water Supply Recommendations from the Regional Climate Action Plan

Item	Recommendations
WS-1	Develop local and, where appropriate, regional inventories of existing potable water supply delivery and collection systems, vulnerable wellfields, wastewater collection and/or treatment infrastructure, septic tanks/drainfields, and stormwater drainage and treatment facilities; assess the potential impact from climate change of each component; and develop different climate change scenarios and adaptation strategies for high-risk utilities and/or infrastructure which may require replacement, reinforcement, or relocation to ensure the long-term viability of the system (e.g., modified site, depth, elevation, materials, or connection requirements).
WS-2	Develop a regional saltwater intrusion baseline and utilize saltwater intrusion models to identify wellfields and underground infrastructure at risk of contamination/ infiltration by saltwater with increases in sea level.
WS-3	Utilize existing and refined inundation maps and stormwater management models to identify areas and infrastructure at increased risk of flooding and tidal inundation with increases in sea level, to be used as a basis for identifying and prioritizing adaptation needs and strategies.
WS-4	Evaluate the impacts of rising sea and groundwater levels on soil storage, infiltration rates and inflow to stormwater and wastewater collection and conveyance systems; consider longer-term influences on water quality; and develop strategies for implementing reclaimed water and stormwater reuse projects that account for current and future conditions.
WS-5	Develop and apply appropriate hydrologic and hydraulic models to further evaluate the efficacy of existing water management systems and flood control/ drainage infrastructure under variable climate conditions. Quantify the capacity and interconnectivity of the surface water control network and develop feasible adaptation strategies.

Table 2-1: Water Supply Recommendations from the Regional Climate Action Plan

Item	Recommendations
WS-6	Coordinate with the South Florida Water Management District, Drainage/Water Control Districts, and utilities/public works officials to identify flood control and stormwater management infrastructure already operating below the design capacity. Further examine water control structures to ensure that they can provide for inland or upstream migration of riparian species as freshwater habitats become more saline.
WS-7	Develop Integrated Water Management Plans that present a joint assessment and planning strategy involving local water utilities, wastewater service providers, water managers, and partners to the Southeast Florida Regional Climate Change Compact, for coordinated consideration of stormwater use and disposal, traditional and alternative water supplies, wastewater disposal and reuse, and water conservation measures for use by local leadership to guide planning decisions as well as amendments to applicable codes and regulations.
WS-8	Develop and test water management and drainage system adaptation improvements needed to maintain existing levels of service relating to drainage, flood control, and water supply, and use cost-benefit analyses to prioritize potential improvements.
WS-9	Incorporate and prioritize preferred climate adaptation improvement projects in capital improvement plans and pursue funding.
WS-10	Encourage, foster, and support investigative work and scientific research that improves the understanding of local and regional climate change impacts specific to Southeast Florida, including: • Improved down-scaling of global climate models for representation of precipitation at the regional/local scales, • Identification and targeting of gaps in monitoring to improve quantification of the hydrologic system and its response to climate change, such as evapotranspiration, groundwater levels, and precipitation, and local sea level, and • Development of risk-based decision support tools and processes for application in analysis of infrastructure design, water resource management, natural systems management, and hazard mitigation alternatives. Tools should provide for consideration of potential economic costs of comparative planning scenarios, management decisions, and infrastructure investments and the evaluation of potential tradeoffs.
WS-11	Undertake efforts to fill identified data gaps through local program efforts, agency collaborations, and advocacy for additional state/federal resources, as needed.
WS-12	Foster the development and exchange of new information, methods and technical capabilities to address key questions of concern related to climate variability and sea level rise to support management decisions: • Assess impacts of observed and predicted climate variability and sea level rise on the frequency, duration, and intensity of flooding as a result of extreme tidal excursions, storm surge, and 100-year storm events, and where impacts are likely to be greatest, • Examine the effects of climate change on water availability and groundwater vulnerability due to sea level rise, and predicted changes in precipitation and evapotranspiration patterns and rates,and • Establish a venue for a periodic exchange of ideas between resource managers, policy makers, and researchers.

Table 2-1: Water Supply Recommendations from the Regional Climate Action Plan

Item	Recommendations
WS-13	Develop agency capabilities to provide rapid deployment of resources in immediate response to intense precipitation and storm events through use of Next RAD technology.
WS-14	Cultivate partnerships with federal and state agencies and professional associations with expertise in integrated water resource planning (such as the U.S. Army Corps of Engineers Institute for Water Resources, the United States Geological Survey, and Water Foundations) as sources of important research, reports, and information regarding climate change, and efforts being undertaken in other communities.
WS-15	Monitor changes in rainfall patterns, temperature means and extremes and sea level rise through coordination with NOAA and other key organizations/partners to better predict future wet-season and dry-season rainfall. Monitor emerging science in order to assess the adequacy of regional climate models. Choose an annual conference or other venue at which such trends can be reviewed at regular intervals.
WS-16	Manage water storage in the region's publicly-owned uplands and wetlands and in other land uses compatible with water storage, including wetland restoration, certain agricultural operations and certain renewable energy production facilities. This will further serve to protect high quality drinking water supply, increase aquifer recharge, and as a means for managing saltwater intrusion.
WS-17	Support complete implementation and funding for the Comprehensive Everglades Restoration Plan (CERP) and its updated versions as fundamental to Everglades restoration, to include increased freshwater flows to the Everglades system, thereby improving water quality, maximizing regional freshwater storage and aquifer recharge, and providing potential to abate saltwater intrusion, which will become increasingly important under variable climate conditions and in the face of sea level rise.
WS-18	Combine existing and develop new land acquisition priorities in a regional setting to protect high quality drinking water supply.

Source: (Southeast Florida Climate Compact, 2019)

These recommendations are intended to meet the goals of advancing water management strategies and infrastructure improvements needed to mitigate adverse impacts of climate change and sea level rise on water supplies, water and wastewater infrastructure, and water management systems. It is the City's policy to implement these recommendations.

2.7 Lake Okeechobee Surface Water Allocation Limitations

Surface water allocations from Lake Okeechobee and the Water Conservation Areas are limited in accordance with the Lake Okeechobee Service Area Restricted Allocation Area (RAA) criteria. In 2008, the SFWMD adopted RAA criteria for the Lake Okeechobee Service Area as part of the Minimum Flow and Minimum Water Level (MFL) recovery strategy for Lake Okeechobee. The criteria limit allocations from Lake Okeechobee and integrated conveyance systems hydraulically connected to the lake to base condition water uses that occurred from April 1, 2001 to January 1, 2008. After adoption of the RAA, all irrigation users in the Lake Okeechobee Service Area were required to renew their water use permits (South Florida Water Management District, 2018a).

In 2007, the SFWMD adopted the LEC Regional Water Availability criteria to prohibit increases in surface water and groundwater withdrawn from the North Palm Beach County/Loxahatchee River Watershed Waterbodies and Lower East Coast Everglades Waterbodies above base condition water uses permitted as of April 1, 2006. This also includes canals that are connected to and receive water from these water bodies. New direct surface water withdrawals are prohibited from the Everglades and Loxahatchee River watersheds and from the integrated conveyance systems. These criteria are components of the MFL recovery strategies for the Everglades and the Northwest Fork of the Loxahatchee River (South Florida Water Management District, 2018a).

While the City is not directly impacted by the Lake Okeechobee surface water allocation limitations, the City is directly impacted by the LEC Regional Water Availability criteria as it applies to the Lower East Coast Everglades Waterbodies. These criteria impact the amount of permitted water quantities available to the City from the Biscayne Aquifer. The City's Biscayne Aquifer water consumption was limited to 52.55-mgd on an annual average day basis by this rule.

2.8 Lowering Lake Okeechobee Level

In January 2019, Florida's Governor announced his promotion of a plan to lower the minimum level of the Lake Okeechobee Regulation Schedule to 10.5 feet. The current Lake Okeechobee Regulation Schedule (LORS) ranges from a minimum level of 12.5 feet to a maximum of 15.5 feet. (Elsken, 2019).

While lowering Lake levels could provide environmental benefits to the Lake and the coastal estuaries, dropping the minimum level to 10.5 feet would reduce the amount of water stored in Lake Okeechobee, potentially reducing the amount of water available to recharge the Biscayne Aquifer. Should this happen, the risk of water shortages in the LEC, including the City of Fort Lauderdale, would increase. The City continues to monitor this issue and, when appropriate, will develop a policy to address any potential impacts to its water utility.

2.9 Infrastructure Planned to Attenuate Damaging Peak Flow Events from Lake Okeechobee

Construction of additional storage systems (e.g., reservoirs, aquifer storage and recovery systems) to capture wet season flow volumes may be needed to increase water availability during dry conditions and attenuate damaging peak flow events from Lake Okeechobee. The C-51 Reservoir project located in southwestern Palm Beach County is one such project and was described in Section 2.5.

The infrastructure planned to attenuate damaging peak flows to surface water bodies and coastal ecosystems located near the City are those underway in Broward County by the SFWMD and the US Army Corps of Engineers under the Comprehensive Everglades Restoration Project (CERP) (South Florida Water Management District, 2018a).

The CERP Broward County Water Preserve Areas project was designed to perform three primary functions:

1. Reduce seepage loss from WCA-3A/3B to developed areas (i.e., the C-11 and C-9 basins).

2. Capture, store, and distribute surface water runoff from the western C-11 Basin.
3. Restore wetlands, recharge groundwater, improve hydroperiods in WCA-3A/3B, and maintain flood protection.

The following major infrastructure features will be constructed as part of the project.

- C-11 Impoundment – A 1,168-acre impoundment to capture and store runoff from the C-11 Basin, reduce pumping of surface water into the WCAs, and provide releases for other regional uses.
- WCA-3A/3B Seepage Management Area – A 4,353-acre seepage management area that would establish a buffer to reduce seepage from WCA-3A/3B, connect the C-11 and C-9 impoundments via conveyance canal, and maintain flood protection.
- C-9 Impoundment – A 1,641-acre impoundment to capture and store surface runoff from the C-9 Basin, store C-11 Impoundment overflow, manage seepage, and provide releases for regional benefit.

These infrastructure features will provide various functions such as reducing seepage from WCA-3A, reducing phosphorus loading to WCA-3A, capturing stormwater otherwise lost to tide, and providing conveyance features for urban and natural system water deliveries. The preserve areas will benefit federally listed threatened and endangered species and many wading birds. This project provides water supplies identified in the Everglades MFL recovery strategy. The project received congressional authorization in 2014. Design efforts are under way for the C-11 Impoundment, and construction began in October 2017 on a portion of the mitigation area. Construction of the C-11 Impoundment is expected to be completed in 2027. The WCA-3A/3B Seepage Management Area is anticipated to begin construction in 2027. Construction of the C-9 Impoundment is expected to begin in 2030. The City continues to monitor the status of environment restoration projects in the LEC.

2.10 Expanded Use of Reclaimed Water to Meet Future Water Supply Demands

The City's Sewer System service area is in a critical water supply area, as designated by the SFWMD. As such, FAC Section 62-40.416 requires a reasonable amount of reuse of reclaimed water unless it is not economically, environmentally, or technically feasible. Section 403.064 of the Florida Statutes also requires domestic wastewater treatment plant permit applicants in a critical water supply problem area to submit a reuse feasibility study as part of their permit applications. Reuse feasibility studies were completed in 1994, 2008, 2012 for the City. Reclaimed water projects have been deemed non-economical. The City plans to continue to assess reclaimed water opportunities that are beneficial to community.

2.11 East Coast Floridan Aquifer System Groundwater Model

The SFWMD developed the East Coast Floridan Aquifer System (FAS) Model. East Coast FAS Model is a density-dependent groundwater flow and solute transport model of the FAS covering the Upper East Coast and Lower East Coast planning areas of the SFWMD. The East Coast FAS Model simulates regional groundwater levels, flows, and quality changes (total dissolved solids) in the FAS in response to withdrawals. The model was designed with seven layers as illustrated in 2-5. The Upper Floridan Aquifer (UFA) and Avon Park Permeable Zone (APPZ) are the two layers used as water supply sources in the Lower East Coast Planning Area.

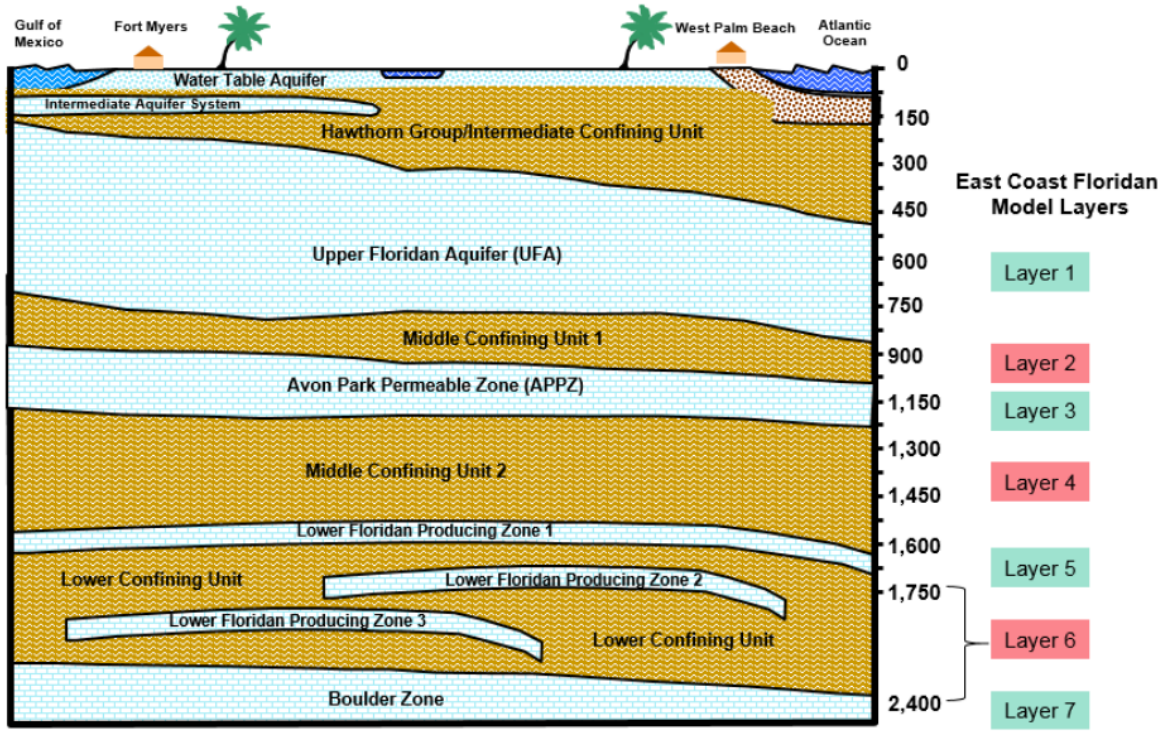


Figure 2-5: East Coast Floridan Model Layers

Adapted from South Florida Water Management District Lower East Coast Water Supply Plan 2018 Update Figure D-52

The 2018 LECWSP Update indicates that model runs were performed for years 2016 and 2040. The FAS withdrawals during those years were estimated at 65-mgd and 146-mgd. The model results are briefly summarized below (South Florida Water Management District, 2018a).

- The model predicted stable total dissolved solids (TDS) of 6,000 to 8,000-mg/L in the UFA in the vicinity of the Dixie Wellfield from 2016 through 2040.
- The model predicted that TDS in the APPZ in the vicinity of the Dixie Wellfield would increase from 8,000-mg/L to approximately 9,000-mg/L from 2016 to 2040.

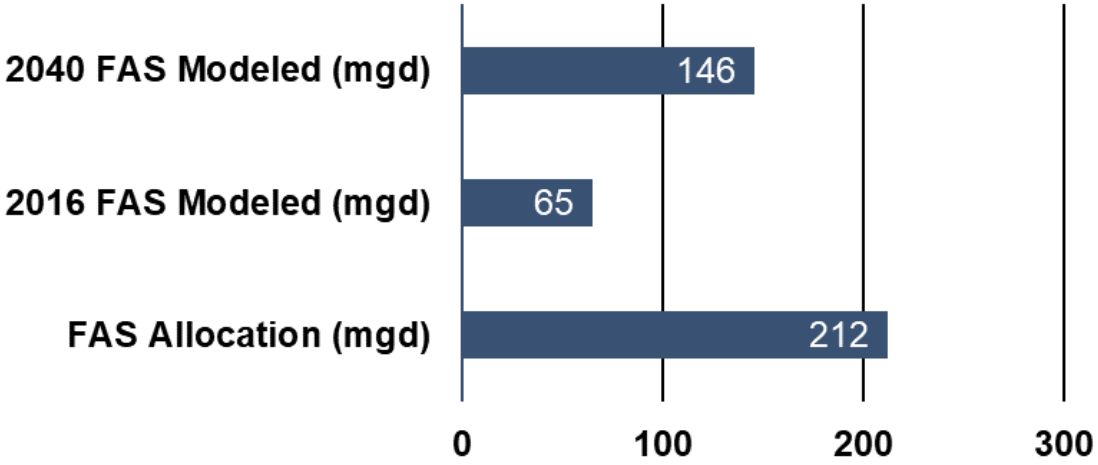
- The model predicts that the UFA ground water elevation would drop from approximately 40-ft National Geodetic Veridical Datum of 1929 (NGVD-29) to approximately 35-ft NGVD-29 in the vicinity of the Dixie Wellfield from 2016 to 2040.
- The model predicts that the APPZ ground water elevation would drop from approximately 45-ft National Geodetic Veridical Datum of 1929 (NGVD-29) to approximately 40-ft NGVD-29 in the vicinity of the Dixie Wellfield from 2016 to 2040.
- The most significant TDS increase predicted by the modeling was at the South Miami Heights wellfield in Miami-Dade; the model predicted a 2,900-mg/L increase in TDS in the UFA.

While the modeling did not predict significant water quality degradation, the regional nature of the model limits the ability to account for specific wellfield operations used by utilities. Certain utilities have experienced significant water quality degradation in its Floridan Aquifer wells. For example, the Palm Beach County Utilities Department Western Regional Floridan Aquifer wells "TP-1" and "PW-6" had chloride increase from 1,600-mg/L to nearly 5,000-mg/L over a two-year period. Construction of additional wells and subsequent reductions in individual well pumping rates reducing the interference between wells resulted in distributing aquifer stress. Within two years the chloride concentration in "PW-6" decreased to 3,500-mg/L and remained steady. The chloride concentration has continued to increase in "TP-1", exceeding 6,000-mg/L in 2018 (South Florida Water Management District, 2018a).

To avoid undesirable changes in FAS water quality, it is critical that a Floridan Aquifer wellfield be designed and operated to minimize the risk of upconing (vertical migration) of lower quality water from lower depths into the production zone. Suggested wellfield design and operating protocols to minimize the risk of upconing are described in the subsection 2.14.

2.12 Conclusions of the East Coast Floridan Aquifer System Groundwater Model May Not Represent the Actual Risk of Future Water Quality Degradation

The conclusions of the modeling prepared for the 2018 LECWSP were based on FAS withdrawals in year 2016 of 65-mgd and year 2040 of 146-mgd (South Florida Water Management District, 2018a). The SFWMD indicated that the FAS withdrawal allocation is 212-mgd as illustrated in Figure 2-6 (South Florida Water Management District, 2018c). Hence, the model results presented in the 2018 LECWSP do not include 66-mgd of potential FAS withdrawals. If the 212-mgd of FAS withdrawal allocation is fully realized it may result in increased FAS water quality degradation and reduced FAS water elevation with resultant risk of upward movement of lower quality water over the long-term. Hence, it is recommended that the City continue to support SFWMD water supply planning to produce refined modeling results going forward along with regulatory policy to restrict FAS withdrawals to protect utilities that invest in the FAS from unexpected changes in FAS water quality. Additionally, it is recommended that the City support the SFWMD in collection of additional FAS well construction, aquifer test and lithologic data from new and existing FAS wells for the SFWMD to use in future refinements of its East Coast FAS Model.



Source: August 22, 2018 presentation by the South Florida Water Management District titled "East Coast Florida Model Overview and Results Lower East Coast Planning Region"

Figure 2-6: Lower East Coast FAS Demand Summary

2.13 Other Potential Floridan Aquifer Risk Factors

The USGS has developed a seismic stratigraphic mapping technique to identify "vertical collapse features", which is a structural anomaly in the aquifer that might allow high salinity water from lower depths, such as the Boulder Zone, to migrate vertically into upper levels the aquifer, such as the UFA (United States Geological Survey, 2017). The USGS has utilized this tool on several transects within Broward County, Florida, but has not attempted comprehensive regional characterization. If present, a vertical collapse feature could result in an unexpected decline in water quality in a new FAS water supply. This risk that "vertical collapse features" represent relative to development of the FAS in South Florida remains undefined. It is recommended that the City consider this potential risk factor as it proceeds with development of alternative water supplies.

2.14 Wellfield Management to Prevent Undesirable Changes in Floridan Aquifer Water Quality

The City is planning to install 6.0-mgd of finished water RO capacity at the Peele-Dixie WTP to treat water from the FAS. This alternative water supply is projected to be needed by the year 2035, when water demand is forecast to reach the City's permitted Biscayne Aquifer withdrawal limit. Using the FAS requires careful design and wellfield management to prevent undesirable changes in water quality.

Several FAS wellfields in the LEC Planning Area have experienced some water quality degradation. The SFWMD asserts that water quality degradation risks can be managed by utilities through appropriate

wellfield design and operating protocols. The SFWMD recommended the following risk reduction strategies (South Florida Water Management District, 2018a):

1. Increasing well spacing between wells to more than 1,000 feet to minimize interference effects and to reduce stress on the FAS
2. Rotating the operation of individual wells, thereby reducing overall pumping stress on the well's production zone
3. Plugging and abandoning individual wells experiencing increases in chloride concentration and replacing them with new wells elsewhere within the wellfield area
4. Reducing pumping rates at individual wells to minimize water level declines, which increase the potential for poor-quality water to enter the well's production zone from below (i.e., upconing)
5. Installing monitor wells to provide early warning of the need for changes to wellfield operations to minimize upconing or lateral movement of poor-quality water
6. Utilities should use an incremental approach to install and test production wells due to geologic variability within the FAS. Wellfields should be designed and monitored to prevent over-stressing production zones and to minimize changes in water quality.
7. Public water supply utilities developing FAS sources are encouraged to share water quality, water level, and hydrologic data to increase understanding of the FAS and improve regional groundwater models.
8. The SFWMD should continue to use the East Coast FAS Model to address regional resource questions. Refinements to and recalibration of the model should be made as new data become available.
9. FAS users and SFWMD staff should evaluate the effects of water quality degradation and coordinate on related permitting, modeling, and planning strategies to maintain the viability of the FAS as a water supply source.

The 2018 LECWSP Update utilized the East Coast FAS Model to evaluate the impact of increasing FAS withdrawals of 65-mgd in 2016 to 146-mgd by 2040. Based on this modeling, SFWMD concluded that increased utilization of the FAS will tend to increase the risk of water quality degradation. However, the 2018 LECWSP Update noted that "water quality should remain adequate for all users with RO treatment…" (South Florida Water Management District, 2018a).

The City has long recognized the risks of changes in water quality and quantity in the FAS. The City's planning documents recommended addressing this risk through the following design features (Hazen and Sawyer, 2008b):

1. Design the RO system to treat water with a TDS up to approximately 8,000-mg/L and chloride concentration of 4,300-mg/L
2. Size the skids to allow for installation of future pressure vessels to decrease flux rate

3. Size variable frequency drives and main electrical feed for higher feed pump pressure, but only install the motor horsepower initially required
4. Size feed pump can for additional pump stage, but only add it if required later
5. Install piping and valves at higher pressure rating
6. Design the energy recovery turbine for a compromise that optimizes boost over most of the operating range at the expense of performance at the extremes of feed water salinity
7. Select wellfield pumps and size wellfield power facilities to suit the horsepower requirements of the future estimated salinity and total dissolved solids

The City will monitor the issue of FAS water quality degradation and factor this risk into its investment decision making process relative to alternative water supply opportunities.

2.15 Intergovernmental Coordination

2.15.1 Introduction

This subsection describes the City's intergovernmental coordination activities with the jurisdictions outside of the City of Fort Lauderdale that it supplies with finished water. Additionally, this subsection describes City coordination activities relative to long-range water supply planning with the SFWMD.

2.15.2 The City of Fort Lauderdale Actively Coordinates With the Agencies it Supplies With Finished Water

The City of Fort Lauderdale coordinates with the agencies it supplies with finished water on many levels. Examples of coordination between the City of Fort Lauderdale and its bulk finished water customers follows:

- The City of Fort Lauderdale monitors wholesale water use through monthly meetings with users and monthly reports.
- The City of Fort Lauderdale maintains agreements with all its customers within its service area. The agreements with certain bulk finished water customers requires periodic coordination by each party to the agreement to review issues related to water quality, quantity and technological advancements relevant to each party.
- The City's agreements with its bulk finished water customers require the bulk customers to coordinate with the City of Fort Lauderdale in advance of allowing developments to connect that are estimated to consume in excess of 100,000 gallons of water per day.
- The City coordinates with its bulk finished water customers on a monthly basis for billing for water purchases.
- The City's Utilities Division's Environmental Laboratory coordinates with its customers to provide water quality sampling and analyses for certain utilities it provides water to.

- The City's Utilities Division provides operational coordination with its bulk finished water customers on an as-needed basis to ensure effective delivery of water
- The City leads the development of financial analyses to establish water rate adjustments and coordinates the acceptance of these adjustments with its customers.
- The City temporarily switches to free chlorination and flushes its water distribution at least once per year and up to two times per year to maintain distribution water quality. The City of Fort Lauderdale coordinates this maintenance activity with all its water customers and encourages its bulk customers to flush the distribution systems that they own and operate.
- The bulk finished water customers that are supplied with water by the City of Fort Lauderdale own and operate their water distribution pipe network. The City of Fort Lauderdale assists these utilities on an as-requested basis.

2.15.3 Need for Additional Coordination Activities

Historically, there has been little need for additional coordination activities (beyond those described above) with the City's bulk finished water customers relative to planning future water supply. As the City's agreements with its bulk customers near expiration, the City may include requirements for additional coordination activities if the City determines it is needed for planning purposes.

2.15.4 Bulk Finished Water Agreements

The City maintains agreements with the following jurisdictions for sale of bulk finished water through master meters:

- Broward County Water and Wastewater Services (serving Unincorporated Broward County)
- City of Oakland Park
- City of Tamarac
- City of Wilton Manors
- Port Everglades
- Town of Davie

2.15.5 The City of Fort Lauderdale Actively Coordinates With the SFWMD During LECWSP Updates

Since 2017 the City of Fort Lauderdale's Assistant Public Works Director – Utilities, Environmental Compliance Supervisor and the Environmental Resource Supervisor have been responsible for coordinating with the SFWMD relative to the LEC Plan Update. These City personnel participated in workshops with the SFWMD during the LEC Plan Update development. Additionally, these City personnel are responsible for providing responses to the SFWMD's requests for information relative to the LEC Plan Update.

3. Data and Analyses

3.1 Introduction

This section provides the following data and analyses.

- Summary of Existing Water Treatment Facilities
- Summary of Existing Wastewater Treatment Facilities
- Population Forecast
- Historical Raw and Finished Water Demand Data
- Forecast of Raw and Finished Water Demand through the Year 2040

3.2 Summary of Existing Water Treatment Facilities

3.2.1 Water Use Permit

The City of Fort Lauderdale obtains all its raw water supply from the surficial Biscayne Aquifer system via two active wellfields. These wellfields, which are commonly known as the Dixie Wellfield and the Prospect Wellfield, operate independently of each other, the former serving the Peele-Dixie WTP and the latter serving the Fiveash WTP. Both wellfields are permitted by the South Florida Water Management District under Water Use Permit (WUP) No. 06-00123-W. The permit was issued September 11, 2008 with an expiration date of September 11, 2028.

3.2.2 Raw Water Allocation

The WUP allows withdrawal from the Biscayne Aquifer within the limitations presented in Table 3-1.

Table 3-1: Biscayne Aquifer Withdrawal Limits from WUP 06-00123-W

Category	Limitation		
	Million Gallons per Year	Million Gallons per Month	Million Gallons per Day
Biscayne Aquifer Annual Withdrawal	19,181	--	52.55
Biscayne Aquifer Maximum Month Withdrawal	--	1,857	59.90
Dixie Wellfield Biscayne Withdrawal	5,475	465.0	15.00
Prospect Wellfield Biscayne Withdrawal	15,851	1,534.5	43.43

Source: (South Florida Water Management District, 2008)

WUP Limiting Condition No. 4 indicates that the City's ground water sources are the Biscayne Aquifer and the Floridan Aquifer System (FAS). Additionally, WUP Limiting Condition No. 5 indicates an annual allocation of no more than 22,334 million gallons with a Biscayne Aquifer limitation of 19,181 million gallons per year (mgy). A reasonable interpretation of these limiting conditions is that the difference between the annual allocation and the Biscayne Aquifer Annual Withdrawal limitation would be supplied by the Floridan Aquifer, as follows:

Floridan Aquifer Allocation Limit = Annual Allocation Limit - Biscayne Aquifer Annual Withdrawal Limit

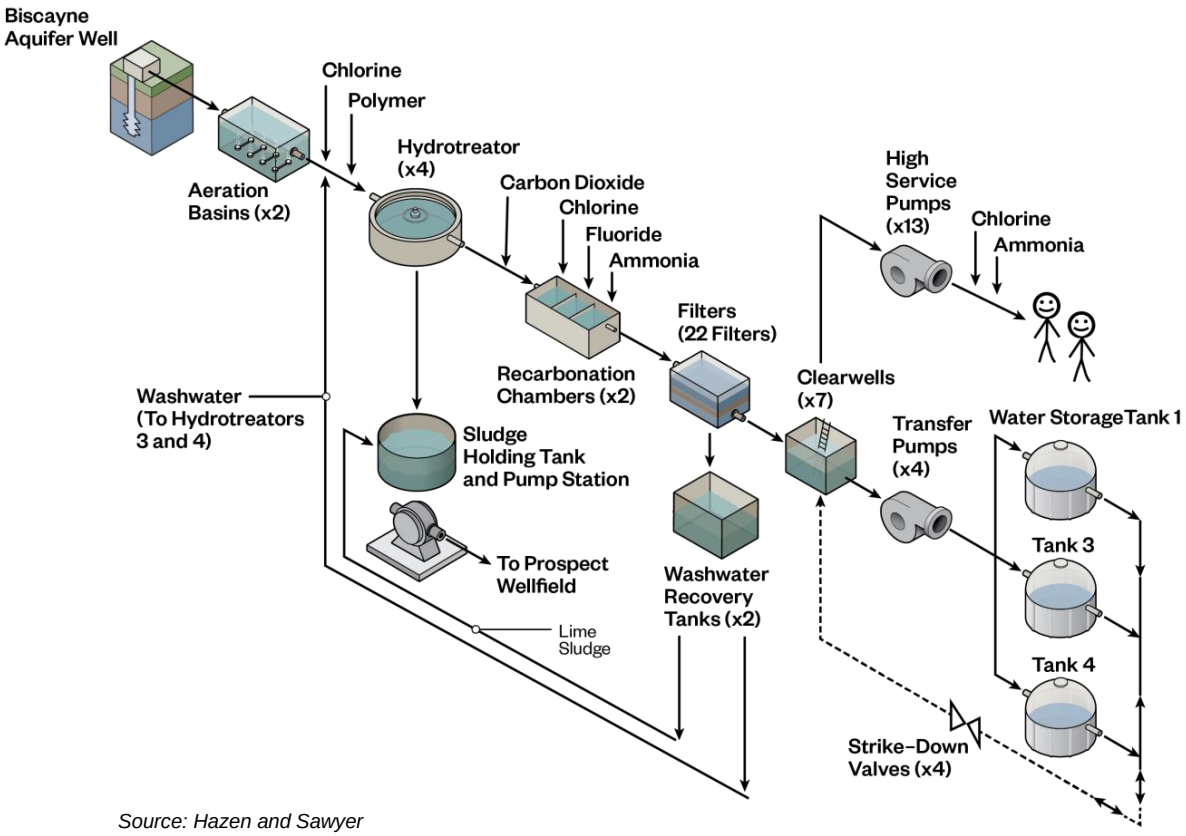
Where:

- Annual Allocation Limit = 22,334 mgy = 61.19 mgd (on an annual average day basis)
- Biscayne Aquifer Annual Withdrawal Limit = 19,181 mgy = 52.55 mgd
- Floridan Aquifer Allocation Limit = 22,334 mgy - 19,181 mgy = 3,153 mgy
- Floridan Aquifer Allocation Limit = 3,153 mgy = 8.64 mgd

In 2007, the City completed the construction of two Floridan Aquifer test wells at the Dixie Wellfield site under SFWMD Water Well Construction Permit #SF030907A issued March 30, 2007. These wells are currently idle and not equipped with pumping facilities. Based upon the permit conditions these wells are approved for testing purposes only. Withdrawals for public water supply from these wells is not currently permitted. The City would apply for a WUP modification prior to utilizing these existing wells for public water supply.

3.2.3 Fiveash Water Treatment Plant

The Fiveash WTP design capacity is permitted at 70 million gallons per day. Plant staff indicated the plant capacity may be limited to 60 million gallons per day. The plant uses conventional lime softening, followed by filtration. Polymer is added for turbidity removal and a polymer blend is added to assist in color removal. Disinfection is achieved by chloramination. The plant produces safe, reliable potable water which complies with current regulations. Figure 3-1 illustrates a simplified schematic of the Fiveash WTP.

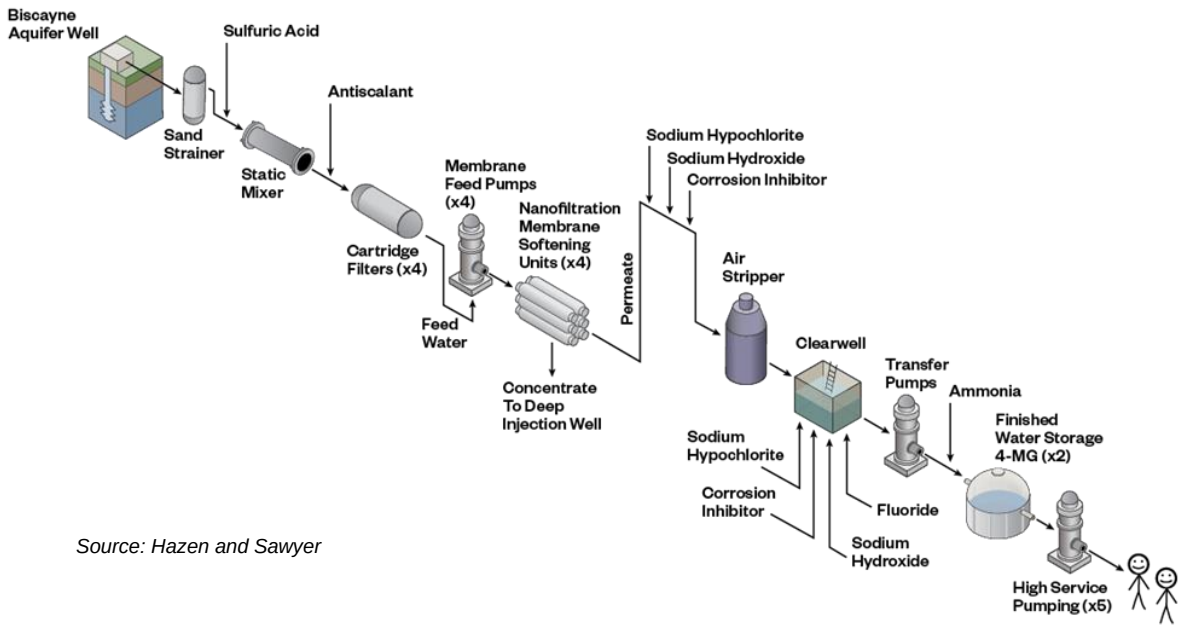


Source: Hazen and Sawyer

Figure 3-1: Fiveash WTP Schematic

3.2.4 Peele-Dixie Water Treatment Plant

The existing Peele-Dixie WTP is a nanofiltration treatment plant on the same site as the retired lime softening facilities. The nanofiltration treatment plant was placed into service the second quarter of 2008. The nanofiltration treatment plant has a maximum installed finished water treatment capacity of 12 million gallons per day with all units in service. The facility was designed to be expanded by the addition of three Reverse Osmosis (RO) trains that would utilize the Floridan Aquifer. If the RO system is constructed, the total installed potable water production capacity at the Peele Dixie WTP site would be 18 million gallons per day. Figure 3-2 illustrates a simplified schematic of the Peele-Dixie WTP.



Source: Hazen and Sawyer

Figure 3-2: Peele-Dixie WTP Schematic

3.2.5 Prospect Wellfield

Raw water to the Fiveash WTP used to be supplied from groundwater wells that surround Prospect Lake plus wells that surround the Fort Lauderdale Executive Airport. The wells at the executive airport are not in use. As a result, all the raw water supplied to the Fiveash WTP is pumped from wells around Prospect Lake. This site is known as the Prospect Wellfield.

The Prospect Wellfield has 29 active production wells (Well Numbers 25 through 28, 30 through 49 and 50 through 54) that were constructed from 1969 through 2006. The wells have pumping capacities of approximately 2,100 gallons per minute (gpm) each, which equates to a total wellfield capacity of approximately 87 million gallons per day.

3.2.6 Dixie Wellfield

Raw water to the Peele-Dixie WTP is supplied from groundwater from the Dixie Wellfield. The Dixie Wellfield includes eight wells. The wells and pumping equipment where constructed in 2008. Each well has an approximate capacity of 2.5 million gallons per day. The wells are located within the Fort Lauderdale County Club golf course. The total capacity of all wells is approximately 20 million gallons per day. The wellfield withdrawal permit limits the maximum withdrawal to 15 million gallons per day on a maximum day basis.

In 2007, the City completed the construction of two Floridan Aquifer test wells at the Dixie Wellfield site. The purpose of these wells was to collect water quality and drawdown data for the planning the addition of reverse osmosis treatment at the Peele-Dixie WTP.

3.2.7 Saline Intrusion Monitoring (SALT) Program

The City of Fort Lauderdale operates a SALT program. The goal of the SALT program is to locate and monitor the saltwater interface in and around the City's wellfields. The purpose of the program is to provide an early warning monitoring system to assist wellfield managers in tracking the location and to manage withdrawals to limit the inland movement of the salt front. The City currently has 10 saltwater monitor wells.

3.2.8 Distribution System Water Storage Facilities

The City has two distribution system storage sites. These sites are known as the Poinciana Park Water Tank and Pump Station and the Northwest Second Avenue Water Tank and Pump Station. In 2006, the existing tank and pump station at the Poinciana Park Water Tank and Pump Station site were replaced with a 2.0-million-gallon pre-stressed concrete ground storage tank and pumping station with backup power diesel engine generator. The Poinciana Park pump station also includes remote monitoring and control at the Fiveash WTP.

The existing elevated steel water tank at the Northwest Second Avenue site is 1.0 million gallons. The pump station was refurbished in 2012 with a new pump, electrical supply and automated controls system that included remote monitoring and control at the Fiveash WTP. The interior and exterior of the water tank was rehabilitated and painted in 2019.

3.2.9 Raw Water Aquifer Storage and Recovery

The City's existing Aquifer Storage and Recovery (ASR) well is located at the Fiveash WTP. The ASR well was constructed in 1998. Performance testing to date has shown less than anticipated water recovery rates. The ASR well currently has a "no flow" permit.

3.2.10 Finished Water Distribution System

The City of Fort Lauderdale's water distribution system consists of over 770 miles of 2 to 54-inch diameter water mains that convey the finished water from the treatment facilities to the individual customers. In general, the larger diameter transmission mains radiate from the treatment facilities and decrease in size as they extend throughout the service area. The major transmission mains travel east from the WTPs to the populated portions of the service area and the two systems are interconnected along major north-south avenues.

3.2.11 Interlocal Agreements and Bulk Sales

The City of Fort Lauderdale sells finished water in bulk to the jurisdictions listed below. The water sold is measured via master meters.

- Broward County Water and Wastewater Services (serving Unincorporated Broward County)
- City of Oakland Park
- City of Tamarac

- City of Wilton Manors
- Port Everglades
- Town of Davie

The City neither buys nor sells raw water.

3.2.12 Areas of Self-Supply

There are no existing areas within the City of Fort Lauderdale's water service area that self-supply potable water. There are no plans for future domestic self-supplied systems.

3.2.13 Distribution System Interconnects

The City of Fort Lauderdale maintains distribution system interconnects with other utilities. Table 3-2 identifies the location and size of each interconnect. The isolation valves on all interconnects are closed.

Table 3-2: City of Fort Lauderdale Water System Interconnects

Item	Area Serviced	Location	Size	Meter	Status
1	Broward County	NW 9 AVE / 62 ST	10"	No	Operable
2	Broward County	SW 35 AVE / W Broward BLVD	10"	No	Operable
3	Broward County	SW 34 ST / 9 AVE	8"	No	Operable
4	Broward County	SW 34 ST/ 2 AVE	6"	005014099	Operable
5	Broward County	SW 20 ST / SR 7 (Broadview)	6"	004237769	Operable
6	Broward County	NW 24 AVE / 19 ST	6"	No	Interconnect is capped and will be removed
7	Plantation	Peters RD / SR 7	8"	No	Operable
8	Pompano	5450 N Ocean DR	10"	No	Operable
9	Pompano	NE 68 ST/ 20 TERR	6"	No	Operable
10	Pompano	McNab & Lyons (NW 31 AVE)	12"	No	Operable

Source: City of Fort Lauderdale spreadsheet titled "Emergency Interconnects.xlsx" provided to Hazen on February 14, 2019.

3.2.14 Treatment Losses

Treatment losses, for the purpose of this report, is defined as the difference between raw water pumped and finished water pumped. The terminology "treatment loss" may be misleading since the water is not actually "lost" but is repurposed for ground water recharge or other beneficial use.

Treatment losses vary with the efficiency of the treatment technology utilized. The treatment loss for the Fiveash WTP, which uses lime softening technology, is roughly one to three percent of the raw water pumped. The treatment loss for the Peele-Dixie WTP, which uses nanofiltration softening technology, is roughly 15 percent of the raw water pumped. The historic amount of raw water pumped and finished water produced in mgd and the overall treatment loss in mgd and as a percent of raw water pumped from 2010 to 2018 is summarized in Table 3-3. The overall average water treatment loss over the nine-year period was 4.0 percent of raw water pumped.

Table 3-3: Raw Water, Finished Water and Overall Treatment Loss, 2010 to 2018

Water Use Category	Annual Average Day Flow (mgd)								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
(1) Raw Water (Biscayne Wellfields)	41.71	41.39	39.75	39.18	39.25	41.45	40.64	40.24	41.49
(2) Finished Water Pumped from WTPs	40.20	40.17	38.36	37.78	37.45	39.75	38.95	38.44	39.49
(3) Treatment Loss = (1) - (2)	1.51	1.22	1.39	1.40	1.80	1.70	1.68	1.80	2.00
(4) Loss as % of Raw Water Pumped = [(3) / (1)] x 100	3.6%	3.0%	3.5%	3.6%	4.6%	4.1%	4.1%	4.5%	4.8%

Source: City of Fort Lauderdale spreadsheet titled "wtrhist2.xlsx". Data provided to Hazen on May 24, 2019.

3.2.15 Distribution System Losses

Distribution system losses are presented in Table 3-4. The percent distribution system loss is based on a percent of finished water pumped. The distribution system losses have averaged 11.4 percent over the last nine years (2010 to 2018).

Table 3-4: Calculation of Historical Distribution System Water Loss, 2010 to 2018

Water Use Category	Annual Average Day Flow (mgd)								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
(1) Raw Water (Biscayne Wellfields)	41.71	41.39	39.75	39.18	39.25	41.45	40.64	40.24	41.49
(2) Finished Water Pumped from WTPs	40.20	40.17	38.36	37.78	37.45	39.75	38.95	38.44	39.49

Table 3-4: Calculation of Historical Distribution System Water Loss, 2010 to 2018

Water Use Category	Annual Average Day Flow (mgd)								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
(3) Billed Authorized Consumption	39.08	34.71	32.33	33.17	33.04	35.23	32.44	33.53	32.92
(4) Unmetered Authorized Consumption (1.25% estimated for flushing) = 0.0125 x (2)	0.50	0.50	0.48	0.47	0.47	0.50	0.49	0.48	0.49
(5) Total Authorized Consumption = (3) + (4)	39.58	35.21	32.81	33.64	33.51	35.73	32.93	34.01	33.41
(6) Distribution System Loss = (2) – (5)	0.62	4.96	5.55	4.14	3.94	4.03	6.03	4.42	6.07
(7) % Distribution System Loss = [(6) / (2)] x 100	1.5%	12.3%	14.5%	11.0%	10.5%	10.1%	15.5%	11.5%	15.4%

Source: City of Fort Lauderdale spreadsheet titled "wtrhist2.xlsx". Data provided to Hazen on May 24, 2019.

Authorized unmetered water consumption at the WTPs and the distribution system are included in the distribution system loss reported in Table 3-4. City staff believe this consumption is significant. However, no data on unmetered water consumption within the WTPs or in the distribution system are currently available. Hence, the actual distribution system loss is believed to be lower than that indicated in the table. The City is planning to implement improvements to incorporate meters to measure water consumption at the WTPs.

3.2.16 Outstanding Compliance Issues

There are no outstanding regulatory compliance issues related to the City of Fort Lauderdale's water facilities.

3.2.17 Planned Upgrades or Expansions

The City has planned the following major improvements at its water treatment plant:

- Reliability Upgrades and Disinfection System Replacement: This project was bid in 2019 and the scope is being reevaluated to align with the City's desire to construct a replacement water treatment facility elsewhere. This project's scope will likely be adjusted to focus on critical short term repairs.

- Plant Evaluation at the Fiveash Water Plant: This project evaluated the treatment plant with recommendations for meeting treatment quality as well as reliability requirements into the foreseeable future and has a recommendation to build a new water treatment facility to replace the Fiveash Water Treatment Plant.
- CUSMP Projects: The City completed its Comprehensive Utility Strategic Master Plan (CUSMP) in 2017. Each fiscal year, the City incorporates recommendations from the CUSMP for future year utility projects into the City's Community Investment Plan through the budgeting process.

3.3 Summary of Existing Wastewater Treatment Facilities

3.3.1 Introduction

The City owns and operates the George T. Lohmeyer (GTL) Wastewater Treatment Plant (WWTP). The GTL WWTP is located on a 9.6-acre site near Southeast 17th Street and Eisenhower Boulevard. The plant provides secondary treatment followed by deep-well injection via five injection wells located approximately one-quarter mile south of the site. The WWTP treats wastewater generated in a region encompassing the following areas:

- City of Fort Lauderdale
- City of Wilton Manors
- City of Oakland Park
- Port Everglades
- A portion of the City of Tamarac
- A portion of unincorporated Broward County
- A portion of the Town of Davie

3.3.2 Treatment Capacity

The facility has been expanded several times over the years. It was converted from a small trickling filter plant to a 22 million gallon per day facility in 1978, with effluent disposal via an outfall to the Intracoastal Waterway. In 1984, four deep injection wells were constructed for effluent disposal and the plant was converted and expanded to a permitted capacity of 38 million gallon per day. New clarifiers and biosolids dewatering facilities were added to the existing treatment train.

In 1994, the Florida Department of Environmental Protection (FDEP) issued a permit with a capacity of 43 million gallon per day, on a maximum three-month average daily flow (M3MADF) basis. In 2001, FDEP issued a permit modification that increased the design capacity of the plant to 54.0 MGD, pending

approval of the increase in disposal capacity of the underground injection well system. The FDEP issued a permit that re-rated the plant to 56.6 million gallon per day on a M3MADF basis.

3.3.3 Deep Well Injection Wells

The GTL WWTP effluent pump station discharges to five deep injection wells via 3,500 feet of 54-inch-diameter force main. The wells are permitted to operate at up to 10 feet per second (fps) flow velocity on a sustained basis and 12 fps during emergencies. These velocities yield total injection well capacities of 93.25 and 112 MGD, respectively. The existing deep injection wells do not require high level disinfection (HLD) under the United Stated Environmental Protection Agency Underground Injection Control (UIC) Program. If a new injection well is required it would require HLD under the UIC program. HLD is not required for the existing injection wells under current regulations.

3.3.4 Reclaimed Water

The existing facility does not currently include reclaimed water treatment facilities. However, on average the plant uses about 4 MGD of its own secondary effluent as in-plant re-use instead of potable water.

3.4 Population and Water Demand Forecasts

3.4.1 Population Forecast

The population forecast was prepared by the City based on University of Florida's Bureau of Economic and Business Research (BEBR) data. Table 3-5 presents the population forecast for the City of Fort Lauderdale's water service area from 2020 through the year 2040. Historical population for the year 2015 is also included.

Table 3-5: Population by Jurisdiction, Actual 2015 and Forecasted 2020 to 2040

Jurisdiction	2015	2020	2025	2030	2035	2040
Fort Lauderdale	175,228	179,997	208,747	222,915	232,419	240,134
Lauderdale-by-the-Sea	4,147	3,689	3,996	3,940	3,890	3,850
Sea Ranch Lakes	700	693	680	715	734	746
Unincorporated Broward County	6,457	7,060	7,854	8,561	8,854	9,486
Davie	529	526	700	821	919	1,016
Lauderdale Lakes	381	383	378	386	386	390
Lauderhill	2,917	2,862	3,085	3,306	3,450	3,571
Lazy Lake	26	25	27	29	30	31

Table 3-5: Population by Jurisdiction, Actual 2015 and Forecasted 2020 to 2040

Jurisdiction	2015	2020	2025	2030	2035	2040
North Lauderdale	358	352	1,145	1,145	1,133	1,123
Oakland Park	31,111	31,952	32,719	34,693	36,114	37,145
Tamarac	2,054	2,037	2,007	2,032	2,054	2,041
Wilton Manors	11,932	11,878	13,132	14,225	14,935	15,576
Port Everglades	Population is included in Unincorporated Broward County					
Total	**235,840**	**241,454**	**274,470**	**292,768**	**304,918**	**315,109**

Source: Population data are based on University of Florida's Bureau of Economic and Business Research (BEBR) as processed by The Corradino Group and provided to Hazen on May 24, 2019.

3.4.2 Comparison With 2018 LECWSP Update Population Forecast

Figure 3-3 compares the BEBR population forecast presented above with the population forecast in the 2018 LECWSP Update.

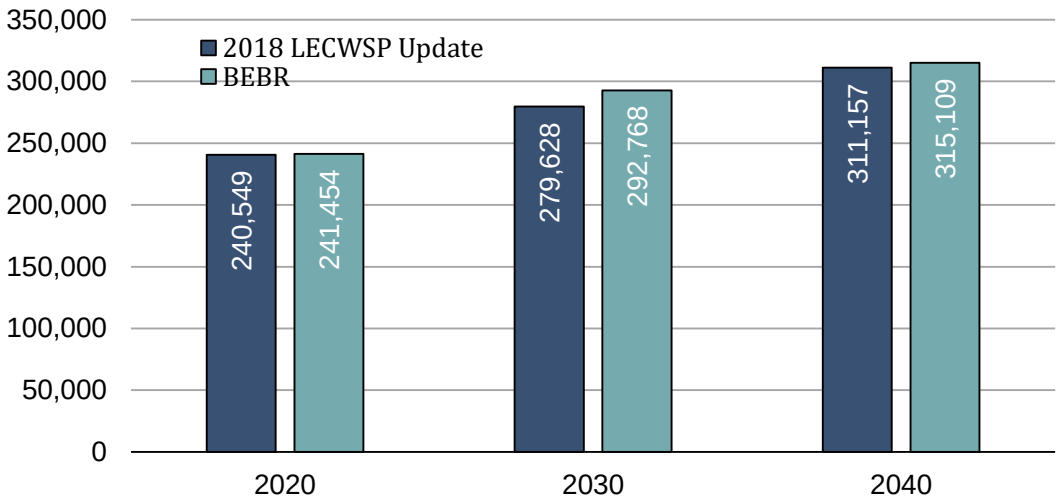


Figure 3-3: Population Forecast Comparison

Source 1: "BEBR" population data are based on University of Florida's Bureau of Economic and Business Research (BEBR) as processed by The Corradino Group and provided to Hazen on May 24, 2019.

Source 2: "2018 LECWSP Update" population data based on South Florida Water Management District 2018 Lower East Coast Water Supply Plan Update – Appendices, pg. E-37.

The BEBR population forecast is 3,952 persons higher in the year 2040 than that presented in the 2018 LECWSP Update. The BEBR population forecast is used to develop the water demand forecast presented in this report.

3.4.3 Areas of Self-Supply

There are no existing areas within the City of Fort Lauderdale's water service area that self-supply potable water. There are no plans for future domestic self-supplied systems.

3.4.4 Maps of Current and Future Served Areas

Figure 3-4 depicts the City of Fort Lauderdale water service area. The City of Fort Lauderdale provides water within the Fort Lauderdale as well as the following jurisdictions:

- Entirety of the City of Lauderdale-by-the Sea
- Entirety of the Village of Sea Ranch Lakes
- Small areas of Unincorporated Broward County (i.e., Roosevelt Gardens, Franklin Park, Washington Park, and Boulevard Gardens communities)
- Small area of the Town of Davie
- Small area of the City of Lauderdale Lakes
- Small area of the City of Lauderhill
- Entirety of the Village of Lazy Lake
- Small area of the City of North Lauderdale
- Entirety of the City of Oakland Park
- Portions of the City of Tamarac
- Entirety of the City of Wilton Manors
- Port Everglades

Certain jurisdictions are fed through master meter accounts of an upstream consecutive user, as follows:

- Lauderdale Lakes is fed through an Oakland Park Master Meter;
- Lazy Lake is a village contained entirely within the borders of the City of Wilton Manors and is fed through a Wilton Manors master meter.

The balance of the City's customers are supplied with water through individual retail customer water meters (multifamily, single family, commercial and irrigation accounts), including the following:

- City of Fort Lauderdale
- City of Lauderdale-by-the Sea
- Village of Sea Ranch Lakes
- Unincorporated Broward County

- City of Lauderhill

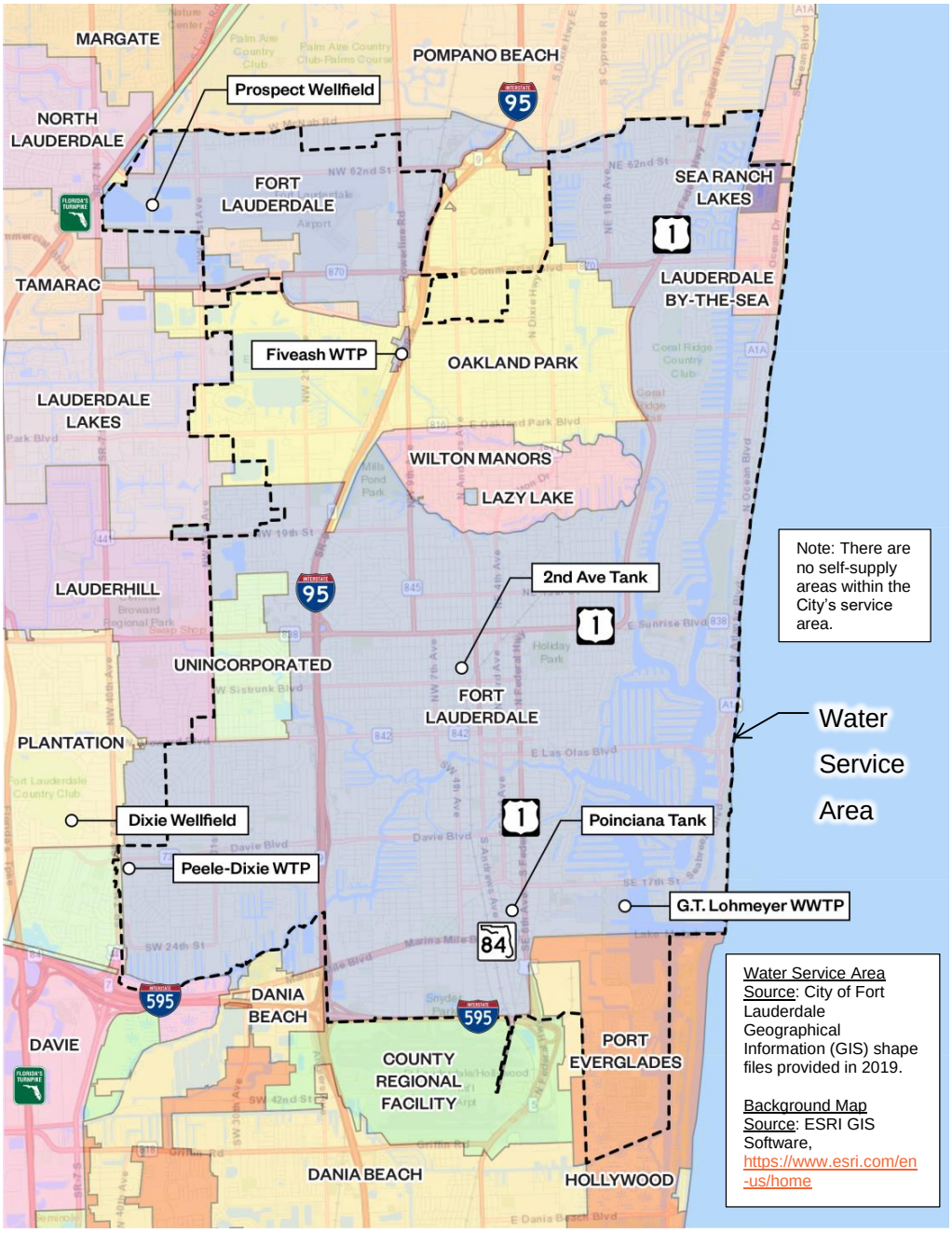


Figure 3-4: Water Service Area

The City has no plans to alter the water service area in the future.

3.4.5 Potable Water Level-of-Service Standard

The City of Fort Lauderdale has set level-of-service standards for its water system as summarized in Table 3-6. This table is based upon the CUSMP (Reiss Engineering, 2017) unless noted otherwise in the table.

Table 3-6: Water System Level-of-Service Standards

Component	Level-of-Service Standard / Goal	Does the City meet this LOS Goal?
Raw Water Supply	Maximum Day Demand with 20 percent of wells out of service for maintenance *Source: City of Fort Lauderdale standard design criteria.*	Yes
Treatment Capacity	Maximum day demand with all units in service *Source:* (Committee of the Great Lakes-Upper Mississippi River Board of State Sanitary Engineers, 2018)*; Article 2.1.*	Yes
Minimum system pressure during peak hour demand with largest pump out of service during non-fire flow conditions	Maintain a minimum of 40 psi in the distribution system *Source:* (Reiss Engineering, 2017)*; Table WA4-1.*	Yes
Minimum system pressure during maximum day demand plus fire flow	Maintain a minimum of 30 psi in the distribution system *Source:* (Reiss Engineering, 2017)*; Table WA4-1.*	Yes
Finished Water Pumped Per Capita – City Goal	It is the City's goal to reduce the finished water pumped level of service to 170 gallons per capita per day through conservation by the year 2028 according the City's Comprehensive Plan Evaluation Measures SWS 3.1.2 and SWS 3.2.1. *Source:* (City of Fort Lauderdale, 2019a).	Yes
Finished Water Storage	Comply with FAC 62-555.320(19): minimum requirement of 25 percent of maximum day demand plus maximum fire flow volume with all tanks in service. Maximum fire flow storage based upon a 5,000 gallons per minute (gpm) fire over a four-hour period. *Source: Florida Administrative Code, Rule 62-555.320(19).*	Yes
Maximum Distribution System Water Loss	10 Percent of Finished Water Pumped *Source:* (South Florida Water Management District, 2015)*; Article 4.1.2.*	No

3.4.6 Historical Annual Average Raw Water and Finished Water Use

Table 3-7 presents historical Annual Average Daily Flow (AADF) pumping data from the City's WTPs (finished water) and wellfields (raw water) along with the estimated service area population from 2014 to 2018. The historical per capita water use during this time frame are also presented.

Table 3-7: Historical Raw and Finished Water Average Annual Daily Flow (AADF) Data, 2014 to 2018

Year	Water Service Area Population	AADF Raw Water Pumped		AADF Finished Water Produced	
		Raw Water Pumping Rate (mgd)	Per Capita (Gallons per person per day)	Finished Water Pumping Rate (mgd)	Per Capita (Gallons per person per day)
2014	233,289	39.25	168	37.45	161
2015	235,840	41.45	176	39.75	169
2016	236,938	40.64	172	38.95	164
2017	238,048	40.24	169	38.44	161
2018	239,166	41.49	173	39.49	165
2014 to 2018 Average:		40.61	172	38.82	164

Source 1: Population data were based on University of Florida's Bureau of Economic and Business Research (BEBR) as processed by The Corradino Group and provided to Hazen on May 24, 2019.

Source 2: Raw water and finished water pumping rate data were provided by the City of Fort Lauderdale in a spreadsheet titled "wtrhist2.xlsx". Data provided to Hazen on May 24, 2019.

The City has established a finished water per capita goal of 170 gallons per person per day by the year 2028 which appears to have been met as of 2018.

3.4.7 Maximum Day Factor

Table 3-8 presents the data used to determine the maximum day factor.

Table 3-8: Maximum Day Factor

Year	Finished Water Pumped (millions of gallons)	Annual Avg Day (mgd)	Maximum Day (mgd)	Maximum Day Factor
2014	13,843	37.9	49.4	1.30
2015	14,507	39.7	50.8	1.28
2016	14,213	38.9	47.2	1.21
2017	14,912	40.9	45.3	1.11
2018	14,414	39.5	50.0	1.27
Maximum Day Factor (averaged from 2014 to 2018)				**1.23**

Source: Data were provided by the City of Fort Lauderdale in a spreadsheet titled "wtrhist2.xlsx". Data provided to Hazen on May 24, 2019.

Based on the above data, a maximum day factor of 1.23 was used to forecast future maximum day flows.

3.4.8 Overall Water Demand Forecast

Table 3-9 presents the overall water demand forecast for the City of Fort Lauderdale's water service area through the year 2040. The table also presents historical data for the year 2015. Forecasts are presented for the Biscayne Aquifer raw water and finished water demands on an AADF basis. Additionally, the maximum day water demand is provided based upon the historical maximum day to annual average day ratio of 1.23 (based upon water pumping data from 2014 to 2018). The data in the table below assumes that the City future finished water per capita water demand will be 164-gallons-per-capita-per-day (gpcd) which is the average per capita water use from 2014 to 2018. It is below the goal established in 2008 of 170-gpcd by the year 2028.

Table 3-9: Overall Water Demand Forecast

Year	Population	Biscayne Aquifer Raw Water			Finished Water		
		Per Capita (gpcd)	AADF Demand (mgd)	Max Day Demand (mgd)	Per Capita (gpcd)	AADF Demand (mgd)	Max Day Demand (mgd)
2015	235,840	176	41.5	51.0	169	39.8	48.9
2020	241,454	172	41.5	51.1	164	39.6	48.7
2025	274,470	172	47.2	58.1	164	45.0	55.4
2030	292,768	172	50.4	61.9	164	48.0	59.1
2035	304,918	172	52.4	64.5	164	50.0	61.5
2040	315,109	172	54.2	66.7	164	51.7	63.6

Source: Population data were based on University of Florida's Bureau of Economic and Business Research (BEBR) as processed by The Corradino Group and provided to Hazen on May 24, 2019.

Source: Per Capita values for year 2015 come from Table 3-7.

Source: Per Capita values for 2020 through 2040 assumes that the City future finished water per capita water demand will be 164-gallons-per-capita-per-day (gpcd) which is the average per capita water use from 2014 to 2018 as indicated in Table 3-7.

Source: Per Capita values for 2020 through 2040 assumes that the City future raw water per capita water demand will be 172-gallons-per-capita-per-day (gpcd) which is the average per capita water use from 2014 to 2018 as indicated in Table 3-7.

Note: The above analysis assumes no change in treatment technology. As of the writing of this plan, the City has made no plans to change treatment technologies.

3.4.9 Biscayne Aquifer Water Supply Deficit is Predicted by the Year 2035

The Biscayne Aquifer allocation is limited to 52.55 mgd on an annual average day basis. Figure 3-5 and Figure 3-6 illustrate the forecasted Biscayne Aquifer raw water demand and finished water demand, respectively, on an AADF basis. Based on these projections, a Biscayne Aquifer water supply deficit is predicted beginning in the year 2035. By the year 2040, an estimated 1.6 mgd water supply deficit is

expected that will need to be addressed through alternative water sources. The City plans and expects that this deficit will be addressed through reverse osmosis of water pumped from the Floridan Aquifer.

Figure 3-6 is based upon the City operating the Peele-Dixie WTP to produce approximately 6-mgd of finished water indefinitely. Furthermore, this figure assumes that lime softening is continued at the Fiveash WTP indefinitely. If the City increases finished water produced at the Peele-Dixie WTP or decides to change the treatment technology at the Fiveash WTP to a lower efficiency technology, then the demand curve would increase – resulting in a water supply deficit earlier than currently forecasted.

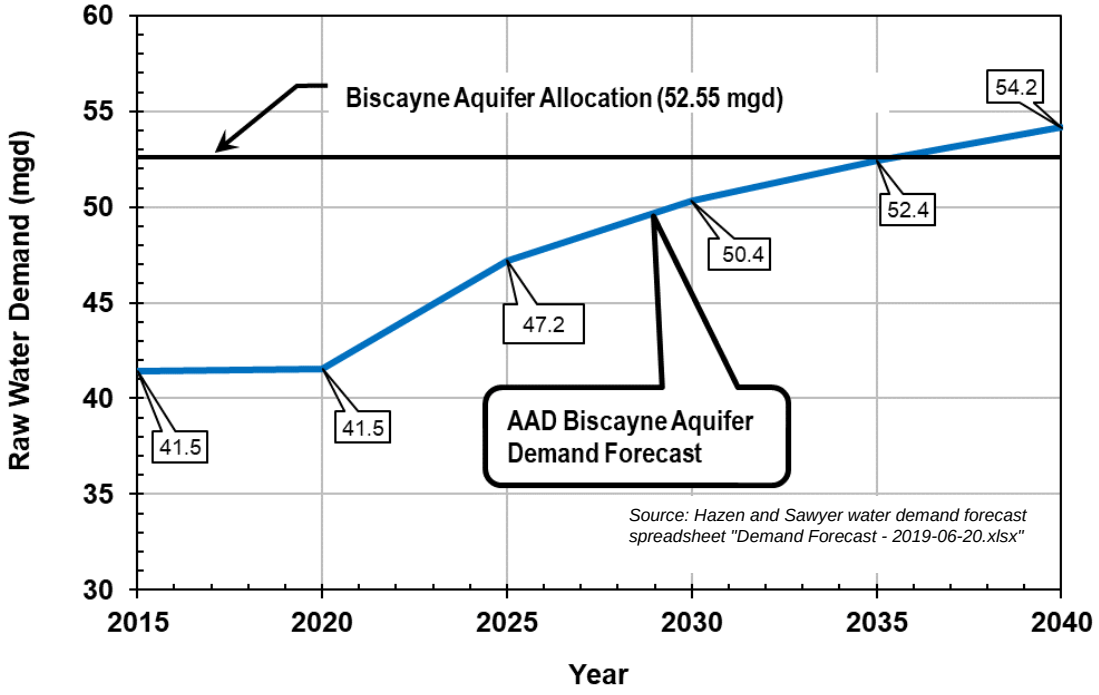


Figure 3-5: Biscayne Aquifer Raw Water Demand Forecast Annual Average Day (mgd)

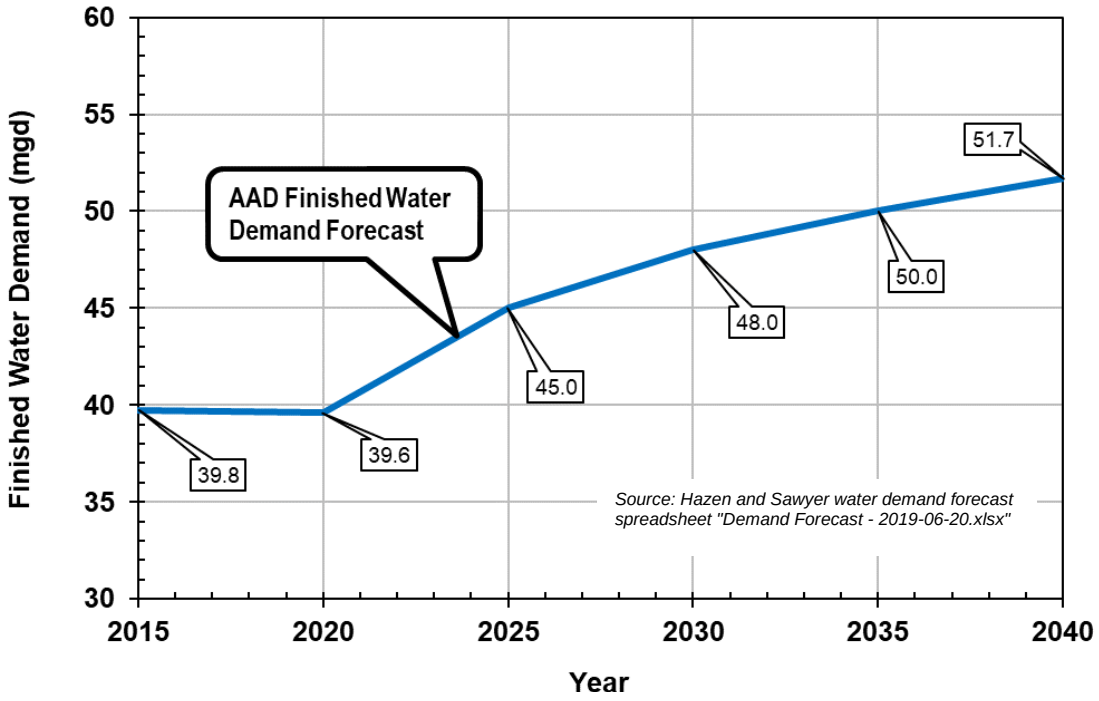


Figure 3-6: Finished Water Demand Forecast Annual Average Day (mgd)

3.4.10 Maximum Day Finished Water Demand Forecast

The Fiveash WTP treats the Biscayne Aquifer via lime softening. The Peele-Dixie WTP treats the Biscayne Aquifer via nanofiltration softening. The designed treatment capacity of these existing facilities are as follows:

- Peele-Dixie WTP Finished Water Designed Capacity: 12-mgd
- Fiveash WTP Finished Water Designed Capacity: 70-mgd

The above capacities are based on the permits for each WTP. The overall treatment capacity (Fiveash plus Peele-Dixie) is 82-mgd. A prior study indicates that the Fiveash WTP capacity may be limited to 60-mgd due to a hydraulic "bottleneck" (Montgomery Watson, 1996). If this limitation exists, the overall treatment capacity (Fiveash plus Peele-Dixie) would be 72-mgd.

Figure 3-7 illustrates the finished water demand forecast on a maximum day basis based on the data in Table 3-9. The maximum day demand for 2020 through 2040 is based on a 164-gpcd times the max day factor of 1.23, which equals 201.72-gpcd. The existing lime softening and nanofiltration treatment technology at the Fiveash WTP and the Peele-Dixie WTP has adequate capacity to meet the maximum day demand with all treatment units in service.

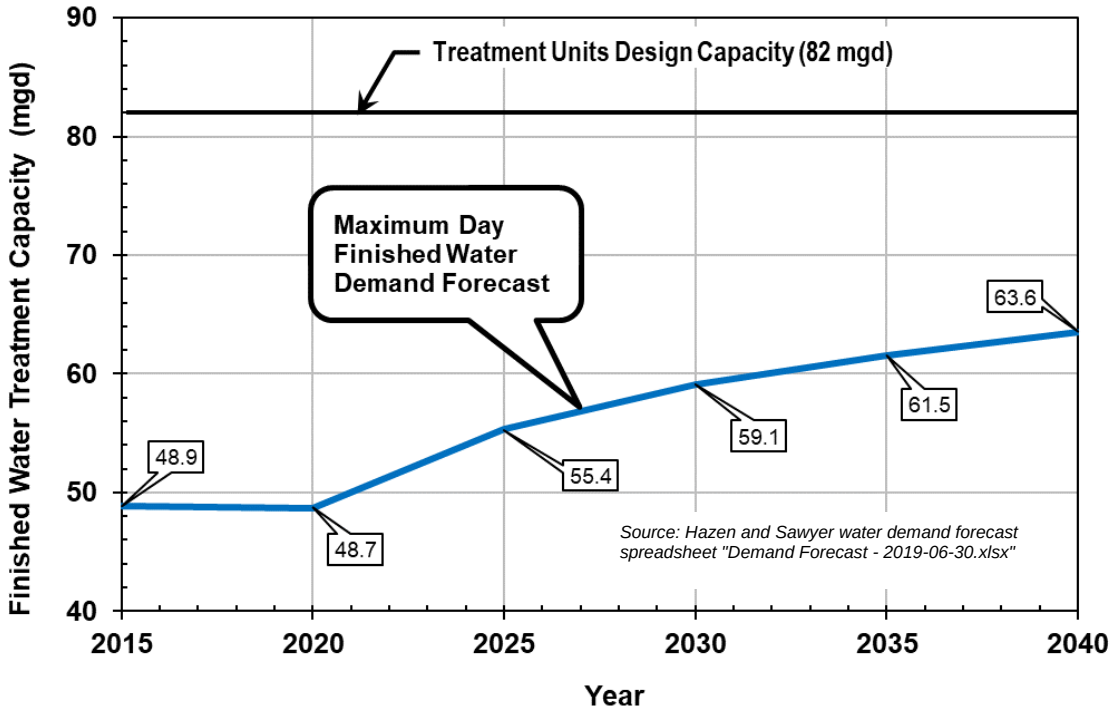


Figure 3-7: Maximum Day Finished Water Demand Forecast (mgd)

3.4.11 Raw Water Demand by Jurisdiction AADF

Table 3-10 presents the Biscayne Aquifer raw water demands on an AADF basis broken down by municipal jurisdictions within the City of Fort Lauderdale's water service area.

Table 3-10: Biscayne Aquifer Raw Water Demand AADF (mgd) by Jurisdiction

Jurisdiction	2015	2020	2025	2030	2035	2040
Fort Lauderdale	29.4	29.4	34.2	36.4	38.0	39.2
Lauderdale-by-the Sea	0.70	0.60	0.65	0.64	0.64	0.63
Sea Ranch Lakes	0.12	0.11	0.11	0.12	0.12	0.12
Unincorporated Broward plus Port Everglades	2.94	3.21	3.57	3.90	4.03	4.32
Davie	0.09	0.09	0.11	0.13	0.15	0.17
Lauderdale Lakes	0.06	0.06	0.06	0.06	0.06	0.06
Lauderhill	0.49	0.47	0.50	0.54	0.56	0.58

Table 3-10: Biscayne Aquifer Raw Water Demand AADF (mgd) by Jurisdiction

Jurisdiction	2015	2020	2025	2030	2035	2040
Lazy Lake	0.004	0.004	0.004	0.005	0.005	0.005
North Lauderdale	0.06	0.06	0.19	0.19	0.19	0.18
Oakland Park	5.22	5.22	5.35	5.67	5.91	6.06
Tamarac	0.34	0.33	0.33	0.33	0.34	0.33
Wilton Manors	2.00	1.94	2.15	2.33	2.44	2.54
Total	**41.5**	**41.5**	**47.2**	**50.4**	**52.4**	**54.2**

Source: The values in this table are calculated valves based on the population and per capita rate. These calculations were prepared in the Hazen and Sawyer spreadsheet titled "Demand Forecast - 2019-06-30.xlsx".

3.4.12 Finished Water Demand by Jurisdiction

Table 3-11 presents the finished water demands on an AADF basis broken down by municipal jurisdictions within the City of Fort Lauderdale's water service area.

Table 3-11: Finished Water Demand AADF (mgd) by Jurisdiction

Jurisdiction	2015	2020	2025	2030	2035	2040
Fort Lauderdale	28.2	28.1	32.6	34.7	36.2	37.4
Lauderdale-by-the Sea	0.67	0.58	0.62	0.61	0.61	0.60
Sea Ranch Lakes	0.11	0.11	0.11	0.11	0.11	0.12
Unincorporated Broward plus Port Everglades	2.82	3.06	3.41	3.71	3.84	4.12
Davie	0.09	0.08	0.11	0.13	0.14	0.16
Lauderdale Lakes	0.06	0.06	0.06	0.06	0.06	0.06
Lauderhill	0.47	0.45	0.48	0.52	0.54	0.56
Lazy Lake	0.004	0.004	0.004	0.005	0.005	0.005
North Lauderdale	0.06	0.05	0.18	0.18	0.18	0.17
Oakland Park	5.01	4.98	5.11	5.41	5.63	5.78
Tamarac	0.33	0.32	0.31	0.32	0.32	0.32
Wilton Manors	1.92	1.85	2.05	2.22	2.33	2.42
Total	**39.8**	**39.6**	**45.0**	**48.0**	**50.0**	**51.7**

Source: The values in this table are calculated valves based on the population and per capita rate. These calculations were prepared in the Hazen and Sawyer spreadsheet titled "Demand Forecast - 2019-06-30.xlsx".

3.5 Alternative Water Supply Plan

The data in Figure 3-5 indicate that demand is projected to exceed the Biscayne Aquifer supply in the year 2035. The City plans that this supply deficit will be addressed via RO treatment of the FAS. The City reserves the right to alter this plan based on the findings of ongoing City studies and future CUSMP updates. Additionally, this plan may be altered as additional data becomes available regarding the risks presented by unexpected changes to water quality in the FAS.

In 2008, the City completed conceptual plans for implementing 6-mgd of finished water capacity RO at the Peele-Dixie WTP. Five FAS wells were also conceptually planned. The planning documents (illustrated in Figure 3-8) are titled "Floridan Aquifer Conceptual Plan for the Dixie Wellfield" and "Peele-Dixie Reverse Osmosis Basis of Design Report".

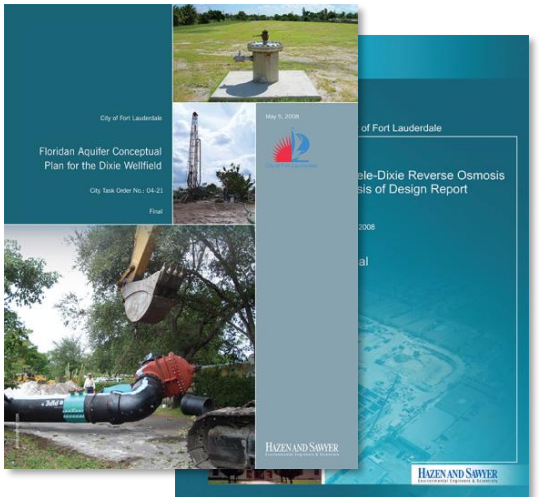


Figure 3-8: Alternative Water Supply Planning Documents

These plans provide the City with a roadmap to quickly implement this alternative water supply in advance of demand exceeding its traditional Biscayne Aquifer supply. It is estimated that it would require approximately five years to implement FAS wells and RO treatment at the Peele-Dixie WTP. The cost for implementing this project is presented in Section 4.

3.6 Seawater Desalination

The use of desalinated seawater from the Atlantic Ocean is an Alternative Water Supply source option for the Lower East Coast Planning Area. The SFWMD does not require water use permits for seawater. Three power plants in the Lower East Coast Planning Area use seawater from tidally influenced water bodies for cooling purposes: Florida Power and Light (FPL) Riviera Beach Next Generation Clean Energy Center, FPL Port Everglades Next Generation Clean Energy Center, and FPL Dania Beach Energy Center. The ocean is an abundant source of water; however, desalination is required before seawater can be used for most water supply purposes. Desalination treatment technologies include distillation, RO, and electrodialysis reversal. RO is the most common desalination technology in the Lower East Coast Planning Area. There are two RO seawater desalination facilities in the Lower East Coast Planning Area. Both plants are in Monroe County (Stock Island and Marathon) and operated by the Florida Keys Aqueduct Authority (South Florida Water Management District, 2018a).

The City is currently preparing a study titled "Granular Activated Carbon Pilot and Plant Evaluation at the Fiveash Water Plant". The study will evaluate treatment technology changes at the Fiveash WTP to achieve the City's color water quality goal. Seawater desalination will be one of many treatment technologies evaluated in the study to recommend a long-term plan for achieving the City's water supply and treatment goals.

3.7 Conservation

The City of Fort Lauderdale has been promoting water conservation for more than 25 years. Conservation is a proven strategy for delaying implementation of expensive alternative water supply technologies. In 2008, the City established a goal of reducing finished water demand to 170-gpcd by the year 2028. This goal has been met. The annual average day finished water produced averaged 164-gpcd from 2014 to 2018. The following subsections summarize the City of Fort Lauderdale's ongoing conservation initiatives.

3.7.1 Broward Water Partnerships

The City of Fort Lauderdale is a member of the Broward Water Partnership, which is a government service consisting of 19 municipalities and water utilities that collaborate on water conservation implementation.

3.7.2 ConservationPay$ Program

The City of Fort Lauderdale participates in a water conservation incentive program through an interlocal agreement (ILA) with Broward County marketed under the program name "Conservation Pay$". The City of Fort Lauderdale became partners with Broward County in the program on June 21, 2011.

The program provides rebates and free water-conserving devices to qualifying water customers, and it has a focused outreach and education component. Rebate dollars are used for the replacement of older, wasteful toilets in addition to the distribution of other water efficient fixtures and devices such as aerators and commercial pre-rinse spray valves. A consistent marketing and media campaign advances water conservation efforts. The program goal is to reach a sustained minimum 10 percent reduction in water use county-wide over 20 years.

3.7.3 NatureScape Irrigation Services

Broward County's NatureScape Irrigation Service (NIS) is a water conservation program offered in partnership with 18 local water utilities. The goal of the NIS is to reduce urban water consumption and improve the quality of surface waters through efficient irrigation and environmentally-friendly landscape practices. The NIS program targets large properties, such as government facilities, parks, schools, and multi-family residential complexes, where water conservation efforts can produce the greatest water savings.

Table 3-12 presents the historical water savings from completed contract years under the NatureScape program.

Table 3-12: Historical NatureScape Program Water Savings

Contract Year	Water Saved (gallons)
FY 2010 - 2011	11,599,796
FY 2011 - 2012	24,378,385

Table 3-12: Historical NatureScape Program Water Savings

Contract Year	Water Saved (gallons)
FY 2012 - 2013	7,431,746
FY 2013 - 2014	27,152,112
FY 2014 - 2015	7,662,119
FY 2015 - 2016	8,266,284
FY 2016 - 2017	5,761,938
FY 2017 - 2018	7,019,896
Total	**99,272,276**

Source: Data supplied by the City of Fort Lauderdale.

3.7.4 Water Matters Day

The City of Fort Lauderdale is a sponsor of Broward County's Water Matters Day program. Water Matters Day is a one-day water conservation event where participants learn about our local and regional water resources, how water is managed and how utilities are planning for future water needs. Participants receive tips and information on water conservation, receive rebates and incentives for upgrading to water-conserving devices, and learn how to create "Florida friendly" and drought tolerant landscapes. The goal of the program is to promote long-term water demand reductions.

3.7.5 Conservation Rate Structure

A conservation rate ordinance was originally enacted by the City in 1996 and has been in continuous use. A conservation rate structure provides progressively higher rates as water usage increases. The Fiscal Year 2020 water and sewer rate structure is provided in Table 3-13. These rates became effective on October 1, 2019.

Table 3-13: Fiscal Year 2020 Water and Sewer Rate Structure

Customer Type	Tier	Consumption Per Month in Gallons	Water Rate	Sewer Rate
Single-Family Rates in 1,000 gallons per month	Tier 1	0 – 3,000	$2.45	$4.16
	Tier 2	4,000 – 8,000	$5.41	$9.19
	Tier 3	9,000 – 12,000	$6.77	
	Tier 4	13,000 – 20,000	$9.13	
	Tier 5	> 20,000	$13.25	

Table 3-13: Fiscal Year 2020 Water and Sewer Rate Structure

Customer Type	Tier	Consumption Per Month in Gallons	Water Rate	Sewer Rate
Multifamily Residential (1,000 gallons per month X number of dwelling units X 0.55)	Tier 1	0 – 3,000	$2.45	$4.16
	Tier 2	4,000 – 8,000	$5.41	$9.19
	Tier 3	9,000 – 12,000	$6.77	
	Tier 4	13,000 – 20,000	$9.13	
	Tier 5	> 20,000	$13.25	

Source: City of Fort Lauderdale utility billing website: https://www.fortlauderdale.gov/departments/finance/utility-billing/new-utility-rates

3.7.6 Water Shortage Restrictions

Section 28-1A of the Code of Ordinances (in effect since 2009) requires that in the event the South Florida Water Management District declares a drought and mandates water restrictions in one of the four established drought phases (Phase I, II, II or IV), the City of Fort Lauderdale implements a surcharge on water usage. The amount of the surcharge is based on the level of water restrictions (Phase I, II, II or IV) and the number of gallons used. The surcharge is applied to water, wastewater and sprinkler meter accounts.

3.7.7 Florida-Friendly Landscaping

Per Section 28-1A of the Code of Ordinances (in effect since 2009), it is the City's policy to encourage use of Florida-friendly drought resistant plants and trees within the City. Following Florida-Friendly Landscaping™ principles, conservation of 40 to 60 percent of the water that traditional landscapes require may be feasible. The City's Code of Ordinances requires Florida-Friendly Landscaping for new development and re-development.

3.7.8 Green Infrastructure Development Guidelines

The City has embraced the concept of green and blue infrastructure. It has established Policy CC 1.2.2 in its draft Comprehensive Plan to investigate and implement innovative stormwater capture techniques within the public right-of-way, including permeable surfaces, etc (City of Fort Lauderdale, 2019a).

In addition, the City adopted an update to the City's Downtown Master Plan on February 4, 2014 to include transit-oriented development (TOD) guidelines. The adopted TOD guidelines aim to create pedestrian-friendly, vibrant station areas to support the continued growth of the Downtown as a live, work, and play environment.

The TOD guidelines also included green building, green site design and green infrastructure guidelines that apply to new residential development in the Downtown Regional Activity Center (RAC). The TOD guidelines recommend that new residential projects should comply with the County's Comprehensive Plan – Climate Change Element, and recommend that projects incorporate green infrastructure and green landscaping into site design, such as the use of porous pavement, bioswales, raingardens, green roofs, drip irrigation, drought tolerant and native landscaping, and Florida-Friendly Landscaping.

3.7.9 Green Infrastructure Design Details and Specification

The City has developed engineering specifications and engineering details for certain green infrastructure, including: bioswales, sidewalk subsurface storage, precast porous pavement, porous pavers, porous asphalt, and rain gardens. The drawings and specifications facilitate implementation of the City's commitment to stormwater capture and aquifer recharge. Additionally, the City is developing a "Green Design Manual".

3.7.10 Irrigation System Design Code

Per Section 28-1A of the Code of Ordinances (in effect since 2009), all new irrigation systems permitted after 2009 require rain sensors to automatically shutdown if rain is detected.

3.7.11 Landscape Irrigation Restrictions

On June 16, 2009, the City adopted City Ordinance 09-13, which created Section 28-1 in the City of Fort Lauderdale Code of Ordinances to restrict landscape irrigation to three days per week. The City of Fort Lauderdale recognizes the SFWMD promulgated Rule 40E-24 of the Florida Administrative Code (Mandatory Year-Round Landscape Irrigation Conservation Measures), which limits landscape irrigation water use to two days per week. Furthermore, the City recognizes in 2010 that Broward County adopted an ordinance that limits landscape irrigation water use to two days per week.

The City promotes compliance with Broward County's two days per week irrigation limits as evidenced by its "Green-Your-Routine" website "water-efficiently" content at the following link: https://gyr.fortlauderdale.gov/greener-government/natural-resources-preservation/florida-friendly-landscaping/the-nine-principles-of-florida-friendly-landscaping/2-water-efficiently. The City supports progressive irrigation and conservation policies. The City is working with the SFMWD staff to review the City's current irrigation ordinance to determine any necessary revisions to comply with the SFWMD's Year-Round Irrigation Rule.

3.7.12 Water for Heating or Process Water

Per Section 28-1A of the Code of Ordinances (in effect since 2009), a water conservation device conforming to such specifications as may be required by the City, shall be installed on heating, processing or other industrial or commercial uses of water whenever the City determines in its discretion that recycling of the water without treatment is practical. A water conservation device is any equipment, process or procedure whereby all water used for heating or processing is either consumed in the intended use, or is recycled for the same purpose until it is unusable.

3.7.13 Water Used for Cooling Including Condensate

Per 28-1B of the City's Code of Ordinances (in effect since 2009), all new construction and replacements of cooling equipment whose function is evaporative or refrigerated cooling uses and air conditioning facilities that deliver water or condensate to a drain or other discharge facility are prohibited. This includes any equipment, process or procedure which relies upon the temperature of the water supply for cooling purposes.

3.7.14 Commercial Power Washing

Per 28-1B of the City's Code of Ordinances (in effect since 2009), commercial enterprises for which cleaning with water is an essential element of their business shall use only high efficiency equipment that uses 1.6 gallons per minute or less and is certified by the manufacturer.

3.7.15 Water for Decorative Features

Per 28-1B of the City's Code of Ordinances (in effect since 2009), decorative water features or similar water operating devices using potable or recycled water shall recirculate water within the device. Each device connected to the water system must have an approved back-flow prevention assembly.

3.7.16 Lakes and Ponds

Per 28-1B of the City's Code of Ordinances (in effect since 2009), potable water shall not be used to fill or maintain water levels in lakes and ponds.

3.7.17 Leak Detection

The City initiated a leak detection program in 1990 which was completed in 1992. The entire main distribution system was surveyed and the City continues to perform visual checks by field personnel.

3.7.18 Meter Replacement Program

The City implemented an improved compound meter testing program and changes out all water meters 10 years old or older.

3.7.19 Broward County Adopts Low-Flow Plumbing Fixtures

During each update of the Florida Building Code (FBC), the Broward County Board of Rules and Appeals adopts a revised version of FBC-Plumbing Table 604.4 that requires new construction within Broward County (which includes the City of Fort Lauderdale) to use "low-flow" plumbing fixtures. Table 3-14 documents the most recently adopted 2017 FBC (Florida Department of Business and Professional Regulation, 2019) flow requirements and the "low-flow" Broward County requirements (Broward County, 2019) of key fixtures. The "low-flow" plumbing fixtures promote water conservation within all of Broward County.

Table 3-14: Maximum Flow Rates and Consumption for Key Fixtures in New Construction

Fixture	2017 FBC	Broward County
Lavatory, Private	2.2-gpm	1.5-gpm
Shower Head	2.5-gpm	2.0-gpm
Urinal	1.0 gallon per flush	0.5 gallon per flush
Toilet	1.6 gallon per flush	1.28 gallon per flush

Source 1: The data in the column labeled "2017 FBC" is based on the Florida Building Code – Plumbing (2017 Edition), Table 604.4.

Source 2: The data in the column labeled "Broward County" is based on the Florida Building Code – Plumbing, Table 604.4 as amended by the Broward County Board of Rules and Appeals and accessible at the following link: https://www.broward.org/CodeAppeals/AboutUs/Documents/FBC%206th%20Edition%20(2017)%20Amendments%20-%20Plumbing.pdf

3.7.20 Water Conservation Education Program

The City publishes a variety of brochures and literature, promoting water conservation that are available to members of the public upon request. The City also maintains an active public information campaign on water conservation and restrictions on irrigation using Environmental Inspectors, Code Enforcement Officers, and Police Officers. In addition, the City maintains a website (http://www.fortlauderdale.gov) that includes water conservation information.

3.7.21 Sustainability Action Plan 2011 Update

The City's Sustainability Action Plan 2011 Update identified the following actions to reach the 170 gallons per capita per day (gpcd) goal (the action numbers identified in the Sustainability Action Plan 2011 Update are shown for consistency):

- Action 1.1.1 - Expedited, Continuing Escalation of High-User Potable Water Fees in Single-Family Zoning.
- Action 1.1.2 - Implement and enforce landscape ordinance requiring low volume / avoidance watering.

- Action 1.1.3 - Directly engage all large water users in long-range water resource planning and conservation.
- Action 1.1.4 - Consider innovative projects including water reuse and harvesting rainwater.

Table 3-14 provides a summary of the current status of implementing the actions described in the Sustainability Action Plan 2011 Update.

Table 3-14: Water Conservation Action Status

Action	Status
Action 1.1.1 - Expedited, Continuing Escalation of High-User Potable Water Fees in Single-Family Zoning.	The City of Fort Lauderdale continues to establish a conservation rate structure (progressively higher rates as water usage increases) to encourage a water conservation ethic.
Action 1.1.2 - Implement and enforce landscape ordinance requiring low volume / avoidance watering.	Per Section 28-1A of the Code of Ordinances (in effect since 2009), it is the City's policy to encourage use of Florida-friendly drought resistant plants and trees within the City.
Action 1.1.3 - Directly engage all large water users in long-range water resource planning and conservation.	The City of Fort Lauderdale continues to conduct ongoing discussions with its wholesale customers relative to opportunities to reduce water consumption.
Action 1.1.4 - Consider innovative projects including water reuse and harvesting rainwater.	The City of Fort Lauderdale was part of a partnership with Broward County that explored the feasibility of regional wastewater reuse opportunities. Additionally, the City is collaborating with other utilities in exploring the feasibility of harvesting rainwater via the proposed C-51 Reservoir project. The City evaluates water reuse and rainwater harvesting projects as the opportunities are identified.

Source: City of Fort Lauderdale document titled "Sustainability Action Plan 2011 Update" accessible at the following link: https://gyr.fortlauderdale.gov/home/showdocument?id=5733

3.7.22 2035 Fast Forward Vision Plan

The City has developed a planning document titled Fast Forward Fort Lauderdale that envisions the City through the year 2035. The document is also known as the Fast Forward Fort Lauderdale Vision for 2035. The Fast Forward Plan is a compilation of ideas/goals that are used to guide the City's decision making. A key aspect of the 2035 Vision Plan is ensuring that the City enhance water conservation efforts to ensure a sustainable water supply (City of Fort Lauderdale, 2019b).

3.7.23 Press Play Fort Lauderdale Strategic Plan: Our City, Our Strategic Plan 2024

This document complements the Fast Forward Fort Lauderdale Vision for 2035. Fast Forward

establishes the overarching goals of the City, while Press Play establishes specific initiatives to be completed over the next 5 years to make progress at reaching the goals. Key objectives related to water supply included in the 2024 Strategic Plan are as follows (City of Fort Lauderdale, 2019c):

- Proactively maintain our water, wastewater, stormwater, road, and bridge infrastructure
- Secure our community's water supply and support water conservation measures

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3.7.24 Identify any Local Financial Responsibilities

The City of Fort Lauderdale participates in a water conservation incentive program through an interlocal agreement (ILA) with Broward County marketed under the program name "Conservation Pay$". The City of Fort Lauderdale became partners with Broward County in the program on June 21, 2011. Under this program, City residents can receive a $100 rebate when they replace an older toilet with a Water Sense® High Efficiency Model.

3.8 Reuse

3.8.1 Introduction

Florida law supports reuse efforts. Florida's utilities, local governments, and water management districts have led the nation in the quantity of reclaimed water reused and public acceptance of reuse programs. Section 373.250(1) F.S. provides "the encouragement and promotion of water conservation and reuse of reclaimed water, as defined by the department, are state objectives and considered to be in the public interest." In addition, Section 403.064(1), F.S., states "reuse is a critical component of meeting the state's existing and future water supply needs while sustaining natural systems."

3.8.2 Local Government Specific Actions, Programs, Regulations, or Opportunities

This section describes the City of Fort Lauderdale's ongoing assessment of reuse opportunities within the City's service area. The City of Fort Lauderdale's GTL WWTP is a regional facility used to treat wastewater in a region encompassing the following:

- City of Fort Lauderdale
- City of Wilton Manors
- City of Oakland Park
- Port Everglades

- A portion of the City of Tamarac
- A portion of unincorporated Broward County
- A portion of the Town of Davie

The facility does not currently treat effluent to reclaimed water standards for public irrigation or other off-site uses. However, on average the plant uses about 4-mgd of its own secondary effluent as in-plant re-use instead of potable water. Additionally, the City is participating in the County-wide Integrated Water Resources Plan Grants for feasibility studies related to potential beneficial reuse. These have included a 2008 feasibility study for selected reclaimed water projects within the City for a 50% cost share for $125,000. A second feasibility study in 2009 was for the reclaimed water in the area of the Convention Center Broward County provided a 50% cost share for $5,000.

The City of Fort Lauderdale prepared a report assessing reclaimed water opportunities in November 2008 titled "Feasibility Study for the Implementation of Selected Reclaimed Water Projects with the City of Fort Lauderdale". Key conclusions of the report were (CDM, 2008):

- The GTL WWTP is located far from any significant users of reclaimed water, such as golf courses. Therefore, the construction of an irrigation-quality reclaimed water production facility at or near the plant to provide further treatment of effluent to public reuse standards is not feasible. There is little available space on the plant site or plant vicinity to construct the required treatment facilities. In addition, due to high levels of infiltration into gravity sewer piping located near coastal areas and waterways, the chloride concentration in the treated effluent over 1,100-mg/L, resulting in unaffordable levels of treatment to reuse standards at the GTL WWTP site. Therefore, the only practical alternatives for implementing reuse systems are off-site and near potential beneficial uses of reclaimed water;
- Two options studied (reclaimed water facilities at the E-Repump Station and the Former Composting Facility[1]) are technically feasible but are not be economically viable.

The City of Fort Lauderdale continues to assess water reuse opportunities to identify and assess cost-effective alternative water supply opportunities. Indirect potable reuse systems have been evaluated by the City; none have emerged as economically feasible. However, due to the dual benefits of providing more disposal capacity and augmenting local water supplies, the City continues to contemplate indirect potable reuse opportunities when assessing alternative water supply investment decisions.

3.8.3 Identify any Local Financial Responsibilities

The City of Fort Lauderdale does not have any financial responsibilities relative to reuse. Hence, this section is not applicable to the City of Fort Lauderdale.

[1] In 2018, ten years after completion of above referenced report, the City of Fort Lauderdale sold the Former Composting Facility land.

3.9 Sector Plans

This section is not applicable to the City of Fort Lauderdale.

4. Capital Improvements

4.1 Introduction

This section provides a brief description of the City of Fort Lauderdale Capital Improvements Program (Fort Lauderdale uses the term "Community Investment Plan") for Water Supply.

4.2 Water Supply, Treatment and Distribution Capital Improvements Schedule for FY2020 through FY2024

Table 4-1 presents City of Fort Lauderdale's Community Investment Plan (CIP) for fiscal year 2020 – 2024 schedule for traditional water supply, treatment, storage, and distribution system infrastructure projects. The CIP costs include engineering services along with construction costs. The projects are intended to be implemented over the next five years to maintain the City's existing level of service standards. The CIP projects do not expand or diversify water supply capacity over the next five years.

4.3 Unfunded Amounts in Table 4-1

Projects costs presented in Table 4-1 that are within the fiscal year 2020 to 2024 columns are funded. Project costs in the column labeled "Unfunded Amount (Beyond FY 2024)" are not funded. All unfunded amounts are considered by the City as a high priority for receiving funding given that that water projects are fundamental to maintaining the health and welfare of the community.

4.4 Dixie Floridan Water Supply / Treatment Project

4.4.1 Introduction

In 2008, the City completed conceptual plans for implementing 6-mgd of finished water capacity reverse osmosis at the Peele-Dixie WTP along with five FAS wells. The planning documents are titled "Floridan Aquifer Conceptual Plan for the Dixie Wellfield" and "Peele-Dixie Reverse Osmosis Basis of Design Report". This alternative water supply project was designated the "Dixie Floridan Water Supply / Treatment Project" in Exhibit 9A of the Water Use Permit Staff Report (South Florida Water Management District, 2008).

4.4.2 Schedule

These plans provide the City with a roadmap to quickly implement this alternative water supply in advance of demand exceeding its traditional Biscayne Aquifer supply. It is estimated that it would require approximately five years to implement FAS wells and RO treatment at the Peele-Dixie WTP. It is estimated that pilot testing and design for this project would need to begin in 2029.

4.4.3 Cost

The costs for implementing 6-mgd of finished water capacity RO at the Peele-Dixie WTP along with five FAS wells are presented in the reports titled "Floridan Aquifer Conceptual Plan for the Dixie Wellfield" and "Peele-Dixie Reverse Osmosis Basis of Design Report". The cost total from these reports is $36.7 in 2008 dollars. Escalating the cost to 2019 dollars amounts to $49.1 million using Engineering News-Record Construction Cost Indexes of 8,310 for 2008 and 11,118 for 2019. This cost includes construction cost plus contingency along with engineering services (Engineering News-Record, 2019). This is a Class 5 estimate as defined by Association for the Advancement of Cost Engineering (AACE) International. The expected accuracy of this estimate is +50% to -30%.

4.4.4 Coordination With the 2018 LECWSP Update

The City has coordinated with the SFWMD to include this project in the 2018 Lower East Coast Water Supply Plan Update.

4.4.5 Funding

The cost for the Dixie Floridan Water Supply / Treatment Project is not currently included in the City's CIP. The City will incorporate this project into future CIPs in its budgeting process. Furthermore, the City will escalate the cost of the project to future years using standard cost indexing practices. The City will determine the funding source for this project during future CIP budgeting.

4.5 Projects Needed Beyond the Five-Year CIP

The City's Comprehensive Utility Strategic Master Plan (CUSMP), completed by Reiss Engineering, Inc., in 2017 is a planning document that evaluated the City's water and wastewater systems and recommends improvements to maintain or improve levels of service over a twenty-year period ending in 2036. The CUSMP recommended approximately $1.2 billion in projects. The City continues to evaluate the recommendations of the CUSMP and prioritize the recommended projects for inclusion in its CIP.

The City has begun a project titled "Granular Activated Carbon Pilot and Plant Evaluation at the Fiveash Water Plant". This project includes evaluation of treatment technologies to achieve the City's color goal at the Fiveash WTP. The project is ongoing and is expected to be completed in late 2019. This study will recommend to either replace all or part of the Fiveash WTP and includes evaluation of alternative water supply technologies. The City will use this report to inform future CIP scheduling decisions.

Table 4-1: Five Year (FY2020 to FY2024) Water Supply, Treatment and Distribution Community Investment Plan

Project #	Project Title	Unspent Balance as of September 17, 2019	Available Balance as of September 17, 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	Funded Total (Through FY2024)	Unfunded Amount (Beyond FY 2024)	Priority for Funding
P11901	VICTORIA PK STH SM WATERMAINS IMPROVEMNT	2,895,712	566,234	(300,000)	-	-	-	-	2,595,712	-	
P11887	NW SECOND AVE TANK RESTORATION	848,159	690,097	(700,000)	-	-	-	-	148,159	-	
P12485	FIVEASH WTP FILTERS REHABILIATION	1,999,817	1,999,817	-	-	-	-	-	1,999,817	-	
P12462	CORAL RIDGE SMALL WATERMAIN IMPROVEMENTS	1,897,500	1,886,315	(1,800,000)	4,100,000	-	-	-	4,197,500	-	
P12294	FIVEASH WTP ELECTRICAL VOLTAGE UPGRADE	1,497,954	552,591	-	-	-	-	-	1,497,954	-	
P12190	UTILITIES ASSET MANAGEMENT SYSTEM	841,938	441,393	573,400	573,400	573,400	573,400	573,400	3,708,938	2,238,677	High
P12463	CORAL SHORES SML WATERMAIN IMPROVEMENTS	819,084	809,199	(163,702)	-	-	-	-	655,382	-	
P12484	REFURB FIVEASH WTP MG STEEL TANK (NORTH)	747,883	747,883	-	-	-	-	-	747,883	-	
P11247	DISTRIBUTION & COLLECTION REPAIR/REPLACE	718,892	718,892	-	-	-	-	-	718,892	-	
P12180	CROISSANT PARK SMALL WATER MAINS	632,506	632,506	(500,000)	-	-	-	-	132,506	-	
P12429	RENO 6300 NW 21 AVE METER SHOP RELOCATIO	599,416	599,416	-	-	-	-	-	599,416	-	
P12295	PLE DIXIE AIR STRIPPERS & HYPOCHLORITE	500,705	374,210	-	-	-	-	-	500,705	-	
P12476	FIVEASH WELLFIELD PUMP REPLACEMENT	500,000	13,610	-	-	-	-	-	500,000	2,400,000	High
P12431	PEELE DIXIE MEMBRANE REPLACEMENT	236,224	236,224	-	-	-	-	-	236,224	-	
P12181	WTP FACILITIES CONCRETE RESTORATION	219,153	198,885	-	-	-	-	-	219,153	-	
P12182	LAKE ESTATES SMALL WATER MAINS	196,359	193,357	-	-	-	-	-	196,359	-	
P12275	PEELE DIXIE WTP RENEWAL & REPLACEMENT	200,000	200,000	(200,000)	-	-	-	-	-	-	
P11246	WATER TREATMENT PLANT REPAIR/REPLACEMENT	198,050	198,050	-	-	-	-	-	198,050	-	
P12372	FIVEASH SKYLIGHTS AND RE-ROOFING	157,006	157,006	-	-	-	-	-	157,006	-	
P12179	TANBARK LANE SML WATER MAIN REPLACEMENT	127,337	65,572	-	-	-	-	-	127,337	-	
P11905	ANNUAL UTILITIES RESTORATION 2014	104,598	97,366	-	-	-	-	-	104,598	-	

Table 4-1: Five Year (FY2020 to FY2024) Water Supply, Treatment and Distribution Community Investment Plan

Project #	Project Title	Unspent Balance as of September 17, 2019	Available Balance as of September 17, 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	Funded Total (Through FY2024)	Unfunded Amount (Beyond FY 2024)	Priority for Funding
P10850	VICTORIA PARK A NORTH-SMALL WATERMAINS	57,773	57,773	-	-	-	-	-	57,773	-	
P11685	WATER MONITORING SYSTEM (SCADA)	48,088	48,088	-	-	-	-	-	48,088	-	
P11589	FIVEASH WTP DISINFECTION IMPROVEMENTS	36,322	36,322	-	-	-	-	-	36,322	-	
P11080	PORT CONDO SMALL WATER MAIN IMPROVEMENTS	17,330	-	-	-	-	-	-	17,330	-	
P11932	AERATION BASIN REHAB AT FIVEASH WTP	11,653	11,653	-	-	-	-	-	11,653	-	
FY 20200842	FIVE-ASH WELLFIELD WEST GENERATOR REPLACEMENT	-	-	650,000	-	-	-	-	650,000		
FY 20200834	PEELE DIXIE WTP - GEOLOGICAL PLANNING DOCUMENT	-	-	225,000	-	-	-	-	225,000		
P12296	NEW UTILITIES CENTRAL LABORATORY-PEELE DIXIE WATER	-	-	179,500	959,000	-	-	-	1,138,500		
FY 20200882	SOIL MITIGATION AT SLUDGE PIT PROPERTY	-	-	100,000	200,000	-	-	-	300,000		
P12401	PROSPECT WELLFIELD BONDING AND GROUNDING TESTING	-	-	99,000	-	-	-	-	99,000		
FY 20190721	CONVERSION OF BACK WASH PUMP	-	-	90,000	-	-	-	-	90,000		
FY 20200835	PEELE DIXIE WTP INJECTION WELL MECHANICAL INTEGRITY	-	-	60,000	-	-	-	-	60,000		
FY 20200833	FIVEASH WTP-SLUICE GATES REPLACEMENT	-	-	20,000	200,000	200,000	-	-	420,000		
FY 20200832	FIVEASH WTP-DIESEL BLDG SOUND PROOF CEILING PANEL	-	-	20,000	-	-	500,000	-	520,000		
P12393	FIVEASH ELECTRICAL SYSTEM REPLACEMENTS (2015-2020)	-	-	-	2,438,834	2,438,834	2,438,834	-	7,316,502	500,000	High
P12399	FIVEASH WTP PCCP REPLACEMENT	-	-	-	1,135,894	-	-	-	1,135,894	-	
P12403	PEELE-DIXIE WTP CHEMICAL STORAGE IMPROVEMENTS	-	-	-	950,000	-	-	-	950,000	-	
FY 20150184	CORAL RIDGE COUNTRY CLUB SMALL WATERMAIN	-	-	-	300,000	3,360,000	-	-	3,660,000	-	

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FY 20150185	SEA RANCH LAKES SMALL WATER MAINS	-	-	-	300,000	3,296,958	-	-	3,596,958	-	
FY 20150187	LAUDERDALE BY THE SEA SMALL WATER MAIN IMPROVEMENTS	-	-	-	300,000	1,902,000	-	-	2,202,000	-	
FY 20190722	WELLFIELD COMMUNICATIONS	-	-	-	300,000	400,000	100,000	-	800,000	-	
FY 20150189	LAKE AIRE PALM VIEW SMALL WATER MAINS	-	-	-	280,000	760,316	-	-	1,040,316	-	
FY 20190720	CONVERSION OF FOUR HIGH SERVICE PUMPS TO VFD	-	-	-	250,000	250,000	100,000	-	600,000	-	
P12417	MISCELLANEOUSE WATER QUALITY IMPROVEMENTS	-	-	-	67,000	-	-	-	67,000	-	
FY 20190735	MEMBRANE CLEANING SYSTEM UPGRADE	-	-	-	20,000	80,000	-	-	100,000	-	
FY 20150190	BAY COLONY SMALL WATER MAIN IMPROVEMENTS	-	-	-	-	320,000	2,400,460	-	2,720,460	-	
FY 20150191	LAUDERGATE ISLES SMALL WATER MAIN IMPROVEMENTS	-	-	-	-	280,000	515,835	-	795,835	-	
FY 20190748	SMALL WATER MAIN REPLACEMENT - NE 51ST STREET	-	-	-	-	-	1,920,000	-	1,920,000	7,680,000	High
FY 20190739	SW 11 STREET & SW 30 AVENUE SMALL WATER MAIN REPLACEMENT	-	-	-	-	-	1,069,795	-	1,069,795	-	
FY 20200840	FIVE-ASH WELLFIELD EAST GENERATOR FUEL TANK REPLACEMENT	-	-	-	-	-	735,000	-	735,000	-	
FY 20200838	RIVERLAND ROAD WATERMAINS	-	-	-	-	-	350,000	-	350,000	4,496,842	High
FY 20200836	CORDOVA ROAD WATERMAIN	-	-	-	-	-	200,028	-	200,028	769,340	High
FY 20190746	SMALL WATER MAIN REPLACEMENT - SEABREEZE BLVD	-	-	-	-	-	-	3,318,000	3,318,000	7,742,000	High
P12398	FIVEASH WTP GST AND CLEARWELL UPGRADES	-	-	-	-	-	-	800,000	800,000	-	

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FY 20150175	TWIN LAKES (NW) WATERMAIN	-	-	-	-	-	-	611,310	611,310	4,132,946	High
FY 20150176	SW 29 STREET SMALL WATERMAINS	-	-	-	-	-	-	397,353	397,353	-	
FY 20190747	SMALL WATER MAIN REPLACEMENT - SW 10TH COURT	-	-	-	-	-	-	338,000	338,000	792,500	High
P11465	17TH STREET CAUSEWAY - LARGE WATER MAIN REPLACEMENT	-	-	-	-	-	-	337,960	337,960	3,319,510	High
FY 20190749	SMALL WATER MAIN REPLACEMENT - HENDRICKS ISLE	-	-	-	-	-	-	300,000	300,000	1,450,400	High
FY 20200837	PIER SIXTY-SIX WATER MAIN	-	-	-	-	-	-	140,020	140,020	538,538	High
P12416	WATERMAIN IMPROVEMENTS AREA 1	-	-	-	-	-	-	99,276	99,276	546,013	High
P11589	FIVEASH WTP DISINFECTION IMPROVEMENTS	32,907,569	32,686,867	(1,468,998)	-	-	-	-	31,438,571	-	
P12391	BERMUDA RIVIERA SML WTRMN IMPROVEMENTS	5,036,881	482,348	(300,000)	-	-	-	-	4,736,881	-	
P11901	VICTORIA PK STH SM WATERMAINS IMPROVEMNT	4,992,728	2,115	-	-	-	-	-	4,992,728	-	
P12404	EXCAVATE & DISPOSE OF DRY LIME SLUDGE	4,584,639	75,549	-	-	-	-	-	4,584,639	-	
P12399	FIVEASH WTP PCCP REPLACEMENT	3,985,685	3,976,628	-	-	-	-	-	3,985,685	-	
P10850	VICTORIA PARK A NORTH-SMALL WATERMAINS	3,799,381	220,269	(200,000)	-	-	-	-	3,599,381	-	
P10814	CENTRAL NEW RIVER W/MAIN RIVER CROSSING	1,621,095	1,613,791	-	-	-	-	-	1,621,095	-	
P12180	CROISSANT PARK SMALL WATER MAINS	1,033,523	375,780	(400,000)	-	-	-	-	633,523	-	
P11080	PORT CONDO SMALL WATER MAIN IMPROVEMENTS	540,459	432,949	-	-	-	-	-	540,459	-	
P12184	DAVIE BLVD 18" WM ABAN I-95 TO SW 9 AVE	518,491	195,215	1,550,000	-	-	-	-	2,068,491	-	
P12395	PEELE DIXIE ELECTRICAL STUDIES	206,496	206,496	-	-	-	-	-	206,496	-	
P12400	PROSPECT WELLFIELD ELC STUDIES & TESTING	183,832	183,832	-	-	-	-	-	183,832	-	

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P12402	PEELE DIXIE WELLFIELD ELC STUD & TESTING	148,540	148,540	-	-	-	-	-	148,540	-	
P12396	PEELE DIXIE SURGE PROTECTION UPGRADES	98,540	98,540	-	-	-	-	-	98,540	-	
P12463	CORAL SHORES SML WATERMAIN IMPROVEMENTS	-	-	1,118,998				-	1,118,998		
	TOTAL	**$78,159,512**	**$54,544,215**	**($1,346,802)**	**$12,374,128**	**$13,861,508**	**$10,903,352**	**$6,915,319**	**120,867,017**	**$286,056,921**	

Source: City of Fort Lauderdale Adopted FY 2020 - 2024 Community Investment Plan; accessible at the following link: https://www.fortlauderdale.gov/home/showdocument?id=42638

5. Goals, Objectives and Policies

The City of Fort Lauderdale Comprehensive Plan addresses the needs and aspirations of the community. This has tremendous implications regarding the importance of community input in the development and implementation of the Comprehensive Plan.

The Comprehensive Plan also plays a significant role within Florida's growth management system. The Comprehensive Plan is required to be consistent with the State Comprehensive Plan (Chapter 187, Florida Statutes), and to be consistent with the Regional and County Comprehensive Plans. In short, the Comprehensive Plan provides a critical link between the City of Fort Lauderdale, State of Florida, Regional, and Broward County plans. The Comprehensive Plan establishes long-term direction of goals as well as short-term objectives and policies to guide implementation efforts.

The City of Fort Lauderdale's comprehensive plan goals, objectives, and policies (GOPs) relevant to water supply have been reviewed and are consistent with the 10-year Water Supply Facilities Work Plan 2020 Update.

References

Broward County. (2019). *Broward County Code Appeals.* Retrieved September 27, 2019, from Broward County Amendments to the FBC: https://www.broward.org/CodeAppeals/Pages/AmendmentsInterpretations.aspx

CDM. (2008). *Feasibility Study for the Implementation of Selected Reclaimed Water Projects with the City of Fort Lauderdale.*

City of Fort Lauderdale. (2018). *2018 Annual Saltwater Intrusion Monitoring Report.*

City of Fort Lauderdale. (2019a, September 27). *Fort Lauderdale Comprehensive Plan (Draft).*

City of Fort Lauderdale. (2019b, June 19). *Fast Forward Fort Lauderdale 2035.* Retrieved June 14, 2019, from https://www.fortlauderdale.gov/home/showdocument?id=4202

City of Fort Lauderdale. (2019c, June 20). *Press Play Fort Lauderdale Strategic Plan: Our City, Our Strategic Plan 2024.* Retrieved June 8, 2020, from https://www.fortlauderdale.gov/departments/city-manager-s-office/structural-innovation-division/strategic-plan

City of Hallandale Beach. (2018). *Agreement for Capacity Allocation in Phase 1 of the C-51 Reservoir City of Hallandale Beach*. Retrieved September 26, 2019, from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwi7--38ve7kAhXmzVkKHf6aDtQQFjAAegQIARAC&url=http%3A%2F%2Fapps.sfwmd.gov%2Fentsb%2Fdocdownload%3Fobject_id%3D0900eeea8aac3958&usg=AOvVaw0pbn2e-aIwUclI46we53fh

Committee of the Great Lakes-Upper Mississippi River Board of State Sanitary Engineers. (2018). *Recommended Standards for Water Works.*

Elsken, K. (2019, February 1). *Lake Okeechobee News.* Retrieved from https://lakeokeechobeenews.com/lake-okeechobee/governor-calls-for-lower-lake/

Engineering News-Record. (2019, 06 20). Retrieved from https://www.enr.com/economics/historical_indices/construction_cost_index_history

Florida Department of Business and Professional Regulation. (2019). *Florida Building Code.* Retrieved September 27, 2019, from https://www.floridabuilding.org/bc/bc_default.aspx

Hazen and Sawyer. (2008a). *Floridan Aquifer Conceptual Plan for the Dixie Wellfield.*

Hazen and Sawyer. (2008b). *Peele-Dixie Reverse Osmosis Basis of Design Report.*

Hazen and Sawyer in association with MacVicar, Federico & Lamb, Inc. (2009). *Conceptual Feasibility of a Sub-Regional Lower East Coast Water Supply Solution.*

Hughes, J. S. (2016). *Potential Effects of Alterations to the Hydrologic System on the Distribution of Salinity in the Biscayne Aquifer in Broward County.* United States Geological Survey Scientific Investigations Report 2016-5022. Retrieved June 25, 2019, from http://dx.doi.org/10.3133/sir20165022

Montgomery Watson. (1996). *Fiveash WTP Filtration and Aeration Treatment Evaluations Final Report.*
Reiss Engineering. (2017). *City of Fort Lauderdale Comprehensive Utility Strategic Master Plan.*
South Florida Water Management District. (2008). *Water Use Permit No. 06-00123-W Staff Report.*
South Florida Water Management District. (2015). *Applicant's Handbook for Water Use Permit Applications.*
South Florida Water Management District. (2018a). *2018 Lower East Coast Water Supply Plan Update - Planning Document.*
South Florida Water Management District. (2018b). *2018 Lower East Coast Water Supply Plan Update - Appendicies.*
South Florida Water Management District. (2018c, August). *East Coast Floridan Model Overview and Results Lower East Coast Planning Region*.
Southeast Florida Climate Compact. (2019, June 19). Retrieved from http://southeastfloridaclimatecompact.org/regional-climate-action-plan/
United States Geological Survey. (2017). *Sequence Stratigraphy, Seismic Stratigraphy, and Seismic Structures of the Lower Intermediate Confining Unit and Most of the Floridan Aquifer System, Broward County, Florida.*