JEA

FINAL

REPORT

INTEGRATED WATER RESOURCES PLAN

APRIL 2021

CDM Smith

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Acronyms

CDP - Criterium Decision Plus™

CIP – Capital Improvement Program

CUP – Consumptive Use Permit

DPR – Direct Potable Reuse

DSM – Demand-Side Management

FDEP – Florida Department of Environmental Protection

FDOT – Florida Department of Transportation

GIS – Geographic Information Systems

LFA – Lower Floridan Aquifer

IPR – Indirect Potable Reuse

IWRP – Integrated Water Resource Plan

MFL – Minimum Flows and Minimum Water Levels

MGD – Million Gallons per Day

NGS – Northside Generating Station

NRW – Non-Revenue Water

O&M – Operations and Maintenance

RO – Reverse Osmosis

SIPS – Southside Integrated Piping System

SJCUD – St. Johns County Utility Department

SJRWMD – St. Johns River Water Management District

TDS – Total Dissolved Solids

TMDL – Total Maximum Daily Load

TWMP – Total Water Management Plan

WPF – Water Purification Facility

WRF – Water Reclamation Facility

WTP – Water Treatment Plant

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Section 1

Introduction

The Greater Jacksonville Metropolitan Area of about 1.5 million people represents a vibrant growth region for the State of Florida. To support this region's growing economy and high-quality of life for its residents, reliable utility services are essential. JEA is a community-owned utility that provides water, sewer, reclaimed water and power to customers within a 900 square-mile service area for all of Duval County and parts of Clay, St. Johns and Nassau Counties. JEA is the largest water utility in Florida and the eight largest community-owned utility in the United States.

JEA's water system serves approximately 370,000 customers and is divided into two major interconnected grids (the North Grid and the South Grid), as well as additional smaller discrete subgrids. In addition, the North Grid and South Grid are interconnected through two major pipeline river crossings allowing water to move from the North Grid to the South Grid. All grids use groundwater wells to draw water from the Floridan Aquifer. The groundwater is pumped to small-scale water treatment plants for disinfection and aeration for sulfur removal, then sent to the water distribution system to meet customer water demands. In 2019 the average daily demand for the JEA water system was 125 million gallons per day (MGD).

JEA's sewer system is divided into service areas that do not align directly with the water distribution grids. The JEA sewer system serves approximately 290,000 customers, receiving an annual average of 83 MGD of flow. Most of the water reclamation facilities discharge into the St. Johns River. JEA has continued to meet Total Maximum Daily Load (TMDL) for nitrogen discharge to the river. Improvements to address the TMDL have included facility phase outs, process improvements, infiltration and inflow reduction programs, as well as increased production and use of reclaimed water.

JEA's reclaimed water system currently serves approximately 18,000 reclaimed water customers. The total reclaimed production capacity is 41 MGD to serve an average daily demand of 19 MGD. Current reclaimed capacity is split between the North Grid, the South Grid and the satellite grids. The South Grid currently delivers public access quality reclaimed water to a customer distribution system where the water is used predominately for landscape irrigation. In Nassau County, public access quality reclaimed water is also produced and provided to golf courses. In the North Grid and smaller satellite grids, non-public access reclaimed water is used for either internal uses at the water reclamation facilities, pumped off-site to serve non-potable water needs, or infiltrated. JEA is committed to continuing to expand the reclaimed water system to reduce nutrient discharges into the St. Johns River and reduce the demand on Floridan aquifer withdrawals for non-potable irrigation.

1.1 Water Resources Challenges and Drivers for Change

JEA and the local community have access to one of the world's most productive groundwater aquifers, the Floridan Aquifer, which covers over 100,000 square miles throughout five southeastern states. This high-producing, high-water quality aquifer has served as the sole source of water supply in the Jacksonville region going back as far as the 1800s and has allowed JEA to reliably serve its customers with some of the lowest cost water in Florida.

And while groundwater will continue to be the main source of JEA's water supply, a more diversified water supply portfolio is needed. Driving the need for this diversification is the renewal of JEA's existing 20-year groundwater consumptive use permit (CUP) with the St. Johns River Water Management District (SJRWMD). For this renewal in 2031, SJRWMD will examine how JEA meets its customer water supply needs, while also protecting the environment and making continued strides in water conservation and expansion of alternative water supplies. Furthermore, the future allocation of additional groundwater may be limited and is likely going to be tied to continued advancements by JEA in pursuing alternative water supply. This includes the potential for a purified water program, either through aquifer recharge or direct use of the purified water.

Preservation of water quality is another concern at the forefront of JEA's long term planning efforts. To help ensure water quality on the South Grid, aquifer recharge can be a viable strategy to help maintain low chlorides in the existing JEA wellfields.

Another consideration is that the SJRWMD and the Florida Department of Environmental Protection (FDEP) are responsible for implementing regional Minimum Flows and Minimum Water Levels (MFLs) in order to balance meeting public water supply needs while maintaining the healthy natural systems that are essential to the region's economy and quality of life. There are several on-going MFLs moving toward implementation that could have an impact on regional public water supplies. These include two in the Sandhill Lakes Region (Lake Brooklyn and Lake Geneva) in Keystone Heights and the Lower Santa Fe and Ichetucknee River MFLs in the Suwannee River Water Management District.

JEA'S PURIFIED WATER PROGRAM

Reusing or recycling water through a water purification treatment process provides a safe and reliable new source of drinking water supply. JEA has a Purified Water Program used to evaluate this potential source of supply. The program started by evaluating two industry-leading purification technologies in partnership with SJRWMD with plans to build a demonstration facility to further evaluate the selected treatment process. Purified water can be utilized for aquifer recharge (pumping purified water into the ground for storage and later retrieval as a drinking water supply). This is a type of indirect potable reuse (IPR). Purified water can also be used directly as a source for drinking water supply, often being blended with existing sources. This is called direct potable reuse (DPR).

Finally, another challenge for JEA is the potential Florida legislative initiative that could come into law as early as 2021 that requires utilities in Florida to eliminate treated wastewater discharge to surface water over a potential 5-year implementation period. While this proposed legislation supports JEA's long-term goals for potable reuse, the proposed timeline for implementation of this legislative initiative is very aggressive and prohibitively costly.

To address these water resources challenges, JEA embarked on the development of an Integrated Water Resources Plan (IWRP) to comprehensively evaluate its current utility systems, analyze future water resources challenges and opportunities, and recommend strategies and capital improvement projects over a 50-year planning horizon. As part of this effort, a Water Demand-Side Management (DSM) Strategy was also developed to guide the implementation of water conservation measures.

1.2 Goals for the IWRP

As an industry leader, JEA recognizes the benefit of taking a "One Water" viewpoint when planning for long-term reliability and resiliency. One Water is a powerful framework for viewing all water as one resource that undergoes several transformations through the urban water cycle. Viewing water resources in this integrated fashion, provides for a more comprehensive assessment of resource challenges and allows for multi-purpose, multi-benefit solutions to rise to the forefront. JEA's IWRP is based on this One Water framework, as depicted in **Figure 1-1**. As seen in this figure, water, sewer, reclaimed water, and to some extent stormwater, are viewed as being interconnected which allows JEA to develop sustainable solutions. Water conservation is used to extend current water supplies, reduce treated wastewater discharges, and reduce utility costs. Expansion of traditional reclaimed water for irrigation reduces the need for potable water to be used for non-potable demands. Water purification allows for even greater recycled water for both indirect and direct potable reuse. And strategic capturing of stormwater can help augment the reclaimed water system for demand peaking.

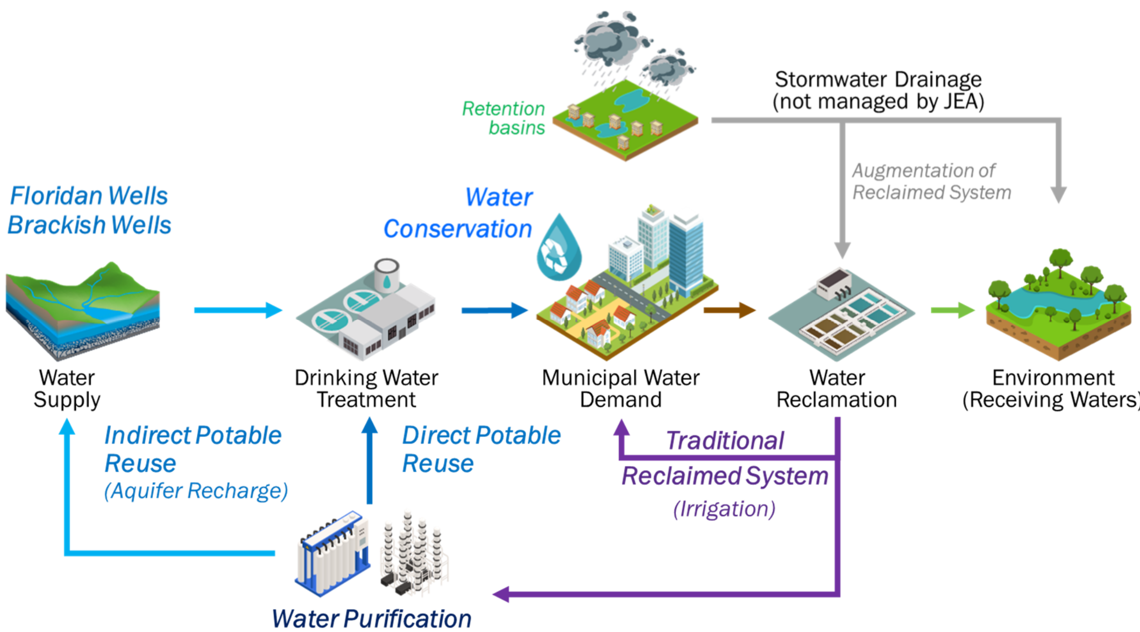

Figure 1-1. Integrated Water Resources Planning

When embarking on a comprehensive plan such as an IWRP, it is important to develop overall goals that are expected to be achieved. This is typically accomplished by the creation of a "mission statement" at the start of the planning process. A mission statement, along with specified goals, is considered the "north star" of the planning process. In early 2019, a facilitated workshop of JEA executive managers developed the following mission statement for JEA's IWRP and Water DSM Strategy (shown on next page).

Mission Statement

JEA will prepare an Integrated Water Resource Plan and Water Demand-Side Management Strategy that results in:

- Water supply certainty in meeting current and future water demands;
- Maximum use of reclaimed water;
- Well-targeted and cost-effective water conservation programs;
- Enhanced resiliency, accounting for future uncertainties; and
- Recommendations for specific projects and programs that are aligned with JEA's Strategic Areas of Focus (earn customer loyalty, deliver business excellence, and develop an unbeatable team).

Together, the IWRP and DSM Strategy serve as a road map for implementing water supply projects and water conservation programs through the year 2070.

1.3 Report Organization

The IWRP report is organized as follows:

- **Section 1:** An introduction to drivers and challenges, and goals for the IWRP [this Section].
- **Section 2:** An overview of the IWRP planning process utilized to arrive at the final recommendation
- **Section 3:** A JEA service area description, including current flows, capacities, and constraints for the water, sewer, and reclaimed water systems.
- **Section 4:** The water supply needs, including water demand forecast, CUP limits, reclaimed water supply, and future supply needs by grid**.**
- **Section 5:** Identification of new alternatives including: water conservation, expanded reclaimed water, stormwater augmentation, purified water, desalination, and conveyance.
- **Section 6:** An evaluation of new alternatives, decision models and tools, risk assessment, and recommended strategies for the short and long term.
- **Section 7:** A recommended Capital Improvement Program (CIP) for 10 and 20 year timeframe.
- **Technical Appendices:** Detailing methods for water demand forecasting, systems modeling, hydraulic analyses and related studies.

Section 2
Planning Process

Having a well-established and agreed-upon planning process and evaluation framework is essential to ensure that the IWRP's recommendations are objective, transparent and defensible. The planning process is summarized in this section and utilized the following terminology:

Objectives	Performance Measures	Options	Alternatives
Broadly stated goals of the IWRP that drive the evaluation process	Metrics that indicate how well objectives are being achieved	Individual water supply and demand management projects or programs	Combinations of options evaluated against the performance measures

The overall planning process is shown in **Figure 2-1**, with the specific steps described on the next page.

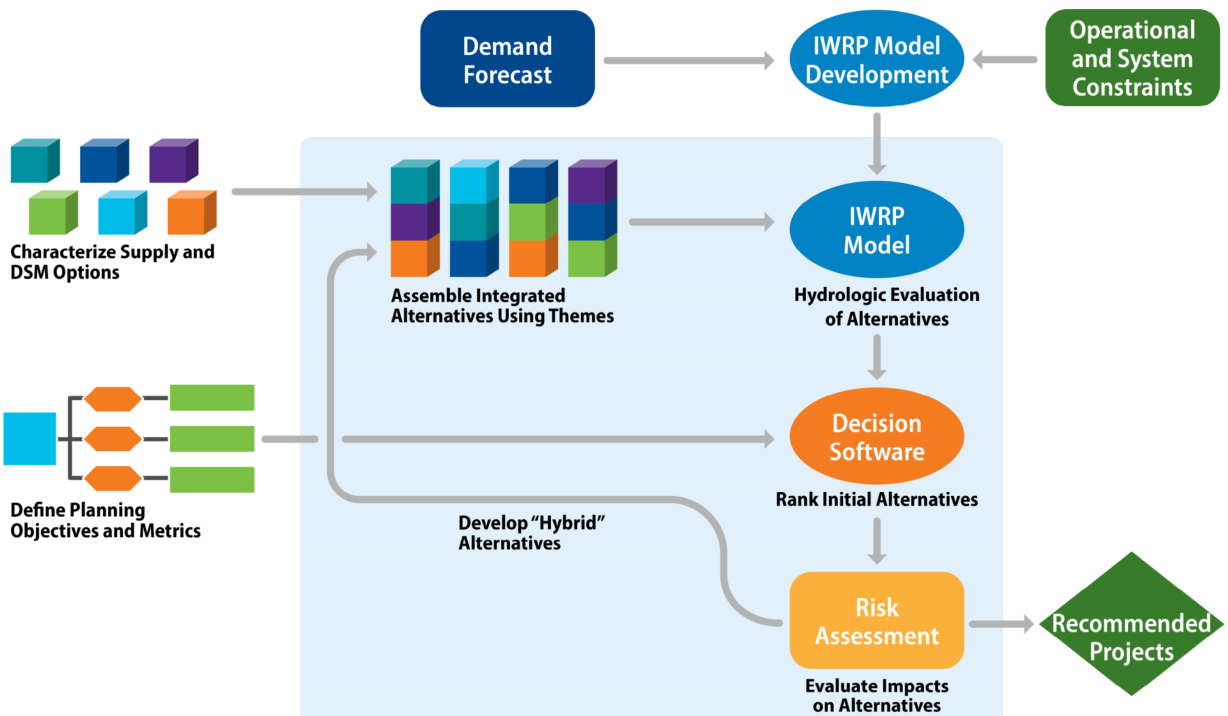

Figure 2-1. JEA's IWRP Planning Process

Steps within the IWRP planning process include the following:

- **Define Planning Objectives and Metrics:** The overall objectives of the IWRP are determined as well as how the objectives will be measured.
- **Water Demand Forecast:** Projection of JEA's future water demands over the planning horizon.
- **Operational and System Constraints:** Defining and quantifying JEA's existing water, sewer and reclaimed water system infrastructure, particularly key operational and system constraints.
- **Characterize Supply and DSM Options:** Determine individual water supply projects and conservation programs which could help meet future demands.
- **IWRP Model Development:** Developing the IWRP Systems Model that represents and simulates JEA's integrated utility system under future water demands, and evaluates how different water supply options can be used to meet demands.
- **Assemble Integrated Alternatives Using Themes:** Create initial combinations of supply options built around themes.
- **Hydrologic Evaluation of Alternatives:** Use the IWRP Model to evaluate the performance of the initial alternatives against the developed performance metrics.
- **Rank Initial Alternatives:** Use decision software to take the output of the IWRP Model for performance metrics and rank the alternatives for how well they meet the overall IWRP objectives.
- **Risk Assessment:** Test the performance of the alternatives to variations in key assumption to assess how resilient they are to varying future conditions.
- **Develop "Hybrid" Alternatives:** Take insights from the initial ranking and risk assessment and recombine supply options into improved alternatives.
- **Reevaluation:** Run the new hybrid alternative through the IWRP model, decision software and risk assessment to compare results to the baseline alternatives and gather further insights.
- **Recommended Projects:** Keep iteratively reevaluating alternatives as required to arrive at a set of recommended projects.

2.1 Planning Objectives

Planning objectives are defined to drive the evaluation of IWRP alternatives. Based on standard principles of decision science and consulting best practices, objectives should have the following attributes:

- **Distinctive:** able to easily distinguish between the alternatives
- **Measurable:** either through quantitative or qualitative metrics in order to determine if they are being achieved
- **Non-Redundant:** for avoidance of overlap and to prevent biased ranking of the alternatives
- **Concise:** focused on what is most important in decision-making
- **Understandable:** are easily explainable and clear to multiple audiences

Through collaboration with JEA, five IWRP objectives were defined that met the above attributes:

Water Supply Certainty	Cost-Effectiveness	Environmental Stewardship	Community Acceptance/ Implementation Ease	Operational Flexibility
Ability to meet seasonal water demands during average and dry weather conditions	Accounts for both near-term change in customer water rates and long-term levelized unit cost of water supply	Reduces treated wastewater discharge to St. Johns River and increases groundwater sustainability	Addresses community concerns and ease of implementation of projects	Ability to move water supplies from part of water service area to another to maximize reliability

Because objectives are rarely equal in importance, weights were applied to the objectives by JEA staff, as shown in **Figure 2-2**.

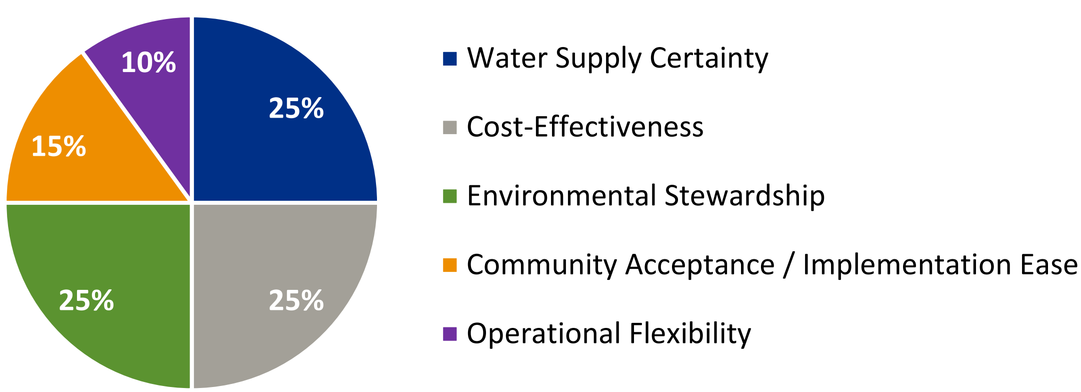

Figure 2-2. Objective Weights

2.2 Performance Metrics

For each objective, at least one performance metric is required. The performance metrics are used to indicate how well an objective is being achieved and serve as the criteria by which future alternatives are evaluated. Where possible, quantitative performance metrics are preferred, but in some instances qualitative metrics are needed. Just as weights are assigned to objectives, so are they assigned to each performance metric. **Table 2-1** presents the planning objectives for the IWRP and associated performance metrics. Also included in the table are the units of measurement for the metrics.

Table 2-1. JEA IWRP Planning Objectives and Performance Measures

Objective	Objective Weight	Performance Metric	Performance Weight	Performance Units
Water Supply Certainty	25%	Ability to meet 2040 demands (max month dry weather)	70%	% Reliable
		Ability to meet 2070 demands (max month dry weather)	30%	% Reliable
Cost-Effectiveness	25%	Change in unit cost from 2020 to 2040	60%	$/1,000 gal
		Levelized unit cost of new supplies and conservation in 2070	40%	$/1,000 gal
Environmental Stewardship	25%	Reduction of treated wastewater discharge to the St. John's River by 2070	70%	MGD of Discharge
		Reduction in annual reliance on groundwater by 2040 under average weather	30%	% Reliance
Community Acceptance / Implementation Ease	15%	Community acceptance	50%	Qualitative Scoring (1-5)
		Simplicity of implementation	50%	# of Projects x Supply Yield
Operational Flexibility	10%	Increased capacity to move water supply between subgrids through 2070	100%	MGD of Capacity

All of the performance metrics, except community acceptance, are provided by the IWRP Model. For community acceptance, qualitative scores from 1 to 5 were assigned to each supply option, where 1 = least acceptance and 5 = greatest acceptance. A weighted qualitative score was then derived for each alternative based on the supply options included. The details of how these performance metrics were derived and used to rank alternatives is described in Section 6.

Section 3

System Capacities and Constraints

When modeling the water, sewer, and reclaimed water systems, it is important to reflect the current capacities and constraints. These constraints include groundwater CUP allocations and permit, water treatment capacities, major conveyance capacities, wastewater generation and treatment capacities, and reclaimed water system capacities.

3.1 Water System and Constraints

The JEA water distribution system is divided into six distinct service grids: North, South, Nassau, Ponte Vedra, Ponce de Leon, and Mayport. For the IWRP, the North Grid and South Grid were further divided into subgrids representing separate portions of the distribution system to help refine the analysis. **Figure 3-1** shows a map of the JEA Water Supply Subgrids. Palm Valley is also included as a separate grid within the IWRP analysis, as it is distinct from the other grids and receives water that JEA purchases from St. Johns County Utility Department (SJCUD).

JEA currently has 38 active water treatment plants (WTPs) throughout the service area which draw groundwater from the Floridan aquifer. The amount of water which can be pumped and treated at each WTP is based on JEA's Consumptive Use Permit (CUP) as well as the Florida Department of Environmental Protection (FDEP) permitted capacity for each facility. The total CUP allocation and permitted capacity within each subgrid is provided in **Table 3-1**. Nassau West does not have any current water treatment capacity, as this is an assumed future growth area with no existing infrastructure. Additionally, the Palm Valley subgrid does not have any water treatment capacity since it is served water via SJCUD.

Table 3-1. Modeled WTP Capacities Per Subgrid

Subgrid	Average Annual CUP Allocation (MGD)	FDEP Permitted Capacity (MGD)
Mayport	0.09	0.8
North Grid: Core City	33.7	45.3
North Grid: North	13.5	20.9
North Grid: West	37.6	73.0
Nassau East	3.49	8.9
Nassau West	0	0
Palm Valley	0	0
Ponce de Leon	0.52	1.1
Ponte Vedra	1.26	3.1
South Grid: Arlington	5.48	18.0
South Grid: Central	10.5	56.0
South Grid: East	30.9	81.2
South Grid: St Johns County*	3.4 (2020); 5.3 (2022)	10.9
Total	142	319

*The RiverTown WTP in the St Johns County subgrid is planned to come online in 2022 increasing the available CUP Allocation.

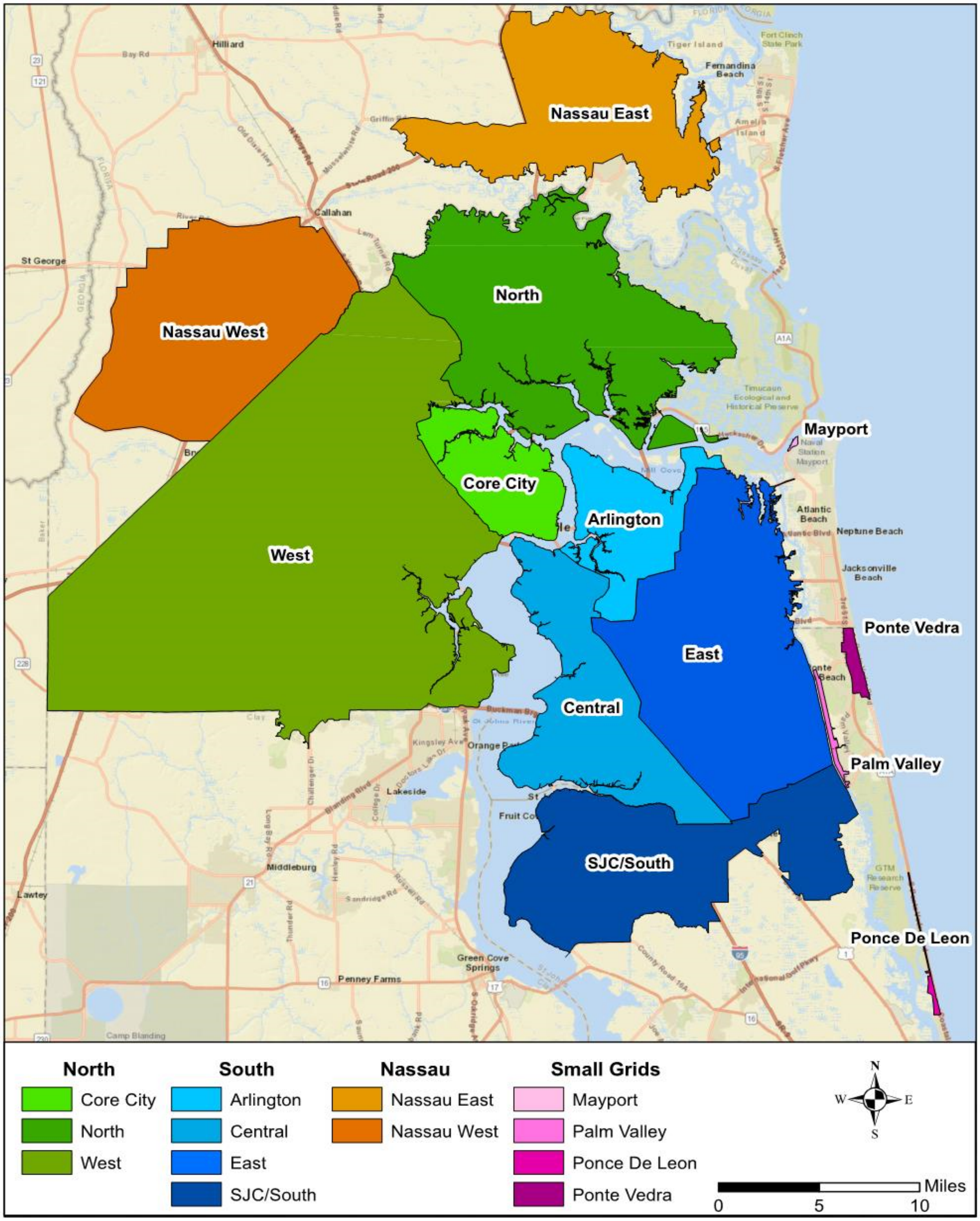

Figure 3-1. JEA Water Supply Subgrids

JEA does have the capacity to transfer raw water between the North Grid and South Grid via two transmission mains that cross the St. Johns River, referred to as the Total Water Management Plan (TWMP) mains. The Southside Integrated Piping System (SIPS) program builds off the existing TWMP mains to ensure effective utilization of the available water. **Figure 3-2** shows the raw water transfer mains from the North Grid to the South Grid. Raw water that is available to be transferred includes an annual average of 23 MGD from Main Street WTP, 2 MGD from Fairfax WTP, and 2 MGD from McDuff WTP. The total hydraulic capacity of the river crossings is 39 MGD.

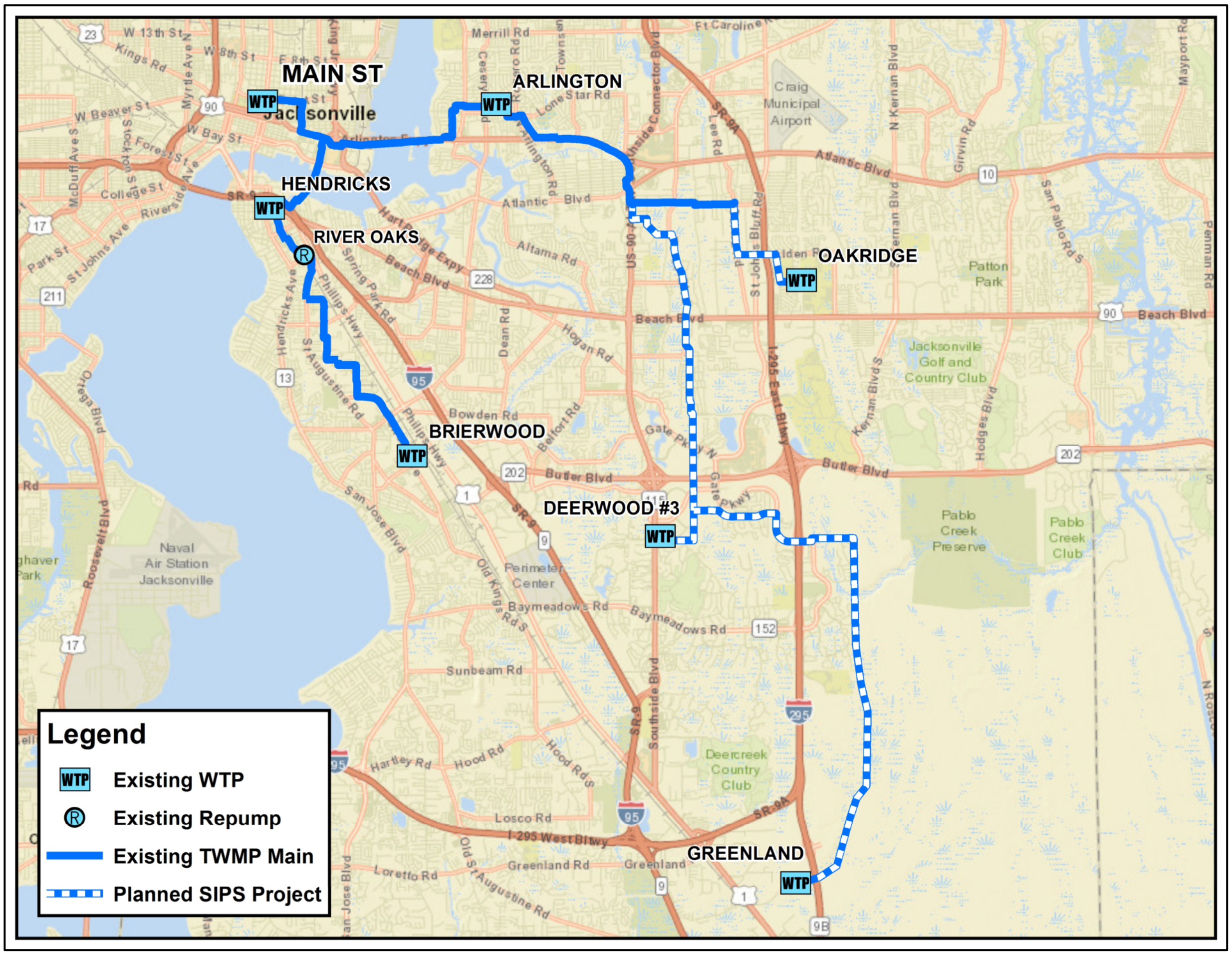

Figure 3-2. Raw Water Transfer Mains from the North Grid to the South Grid (JEA 2020)

Within the IWRP analysis, the maximum raw water which could be delivered via the raw water transfer mains to individual subgrids as well as how much finished water could be moved between subgrids via the distribution system is shown in **Figure 3-3**.

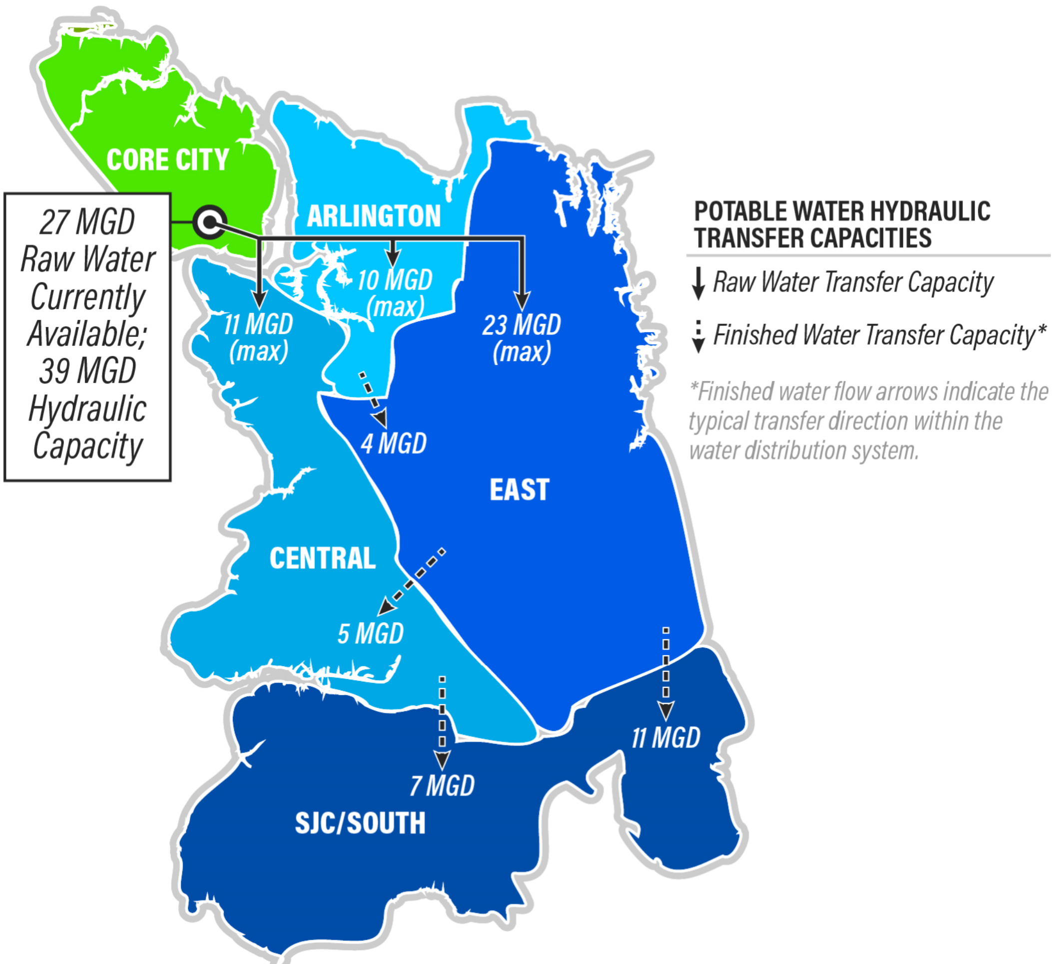

Figure 3-3. Raw and Finished Water Transfer Capacities within the South Grid

3.2 Sewer System and Constraints

JEA currently operates 11 water reclamation facilities (WRF) throughout the service area. Current plants include: three in the north grid area (Buckman, Cedar Bay, and Southwest), five within the South Grid (Arlington East, Blacks Ford, JCP, Monterey, and Mandarin), and one plant each within the Ponte Vedra, Ponce De Leon and Nassau grids (**Figure 3-4**). The Greenland WRF is a future plant currently under design and construction in the South Grid, planned to be in operation in 2023. As the service area continues to grow, additional plants may also be added to the North Grid and Nassau Grid. While the exact timing and capacity of the potential future plants is unknown, three additional future WRF were considered in the IWRP analysis. The permitted capacity of each WRF, as well as currently planned capacity improvements and assumptions are provided in **Table 3-2**. Projected wastewater flows per plant were provided by JEA through the year 2045 and extended through 2070 as part of the IWRP analysis.

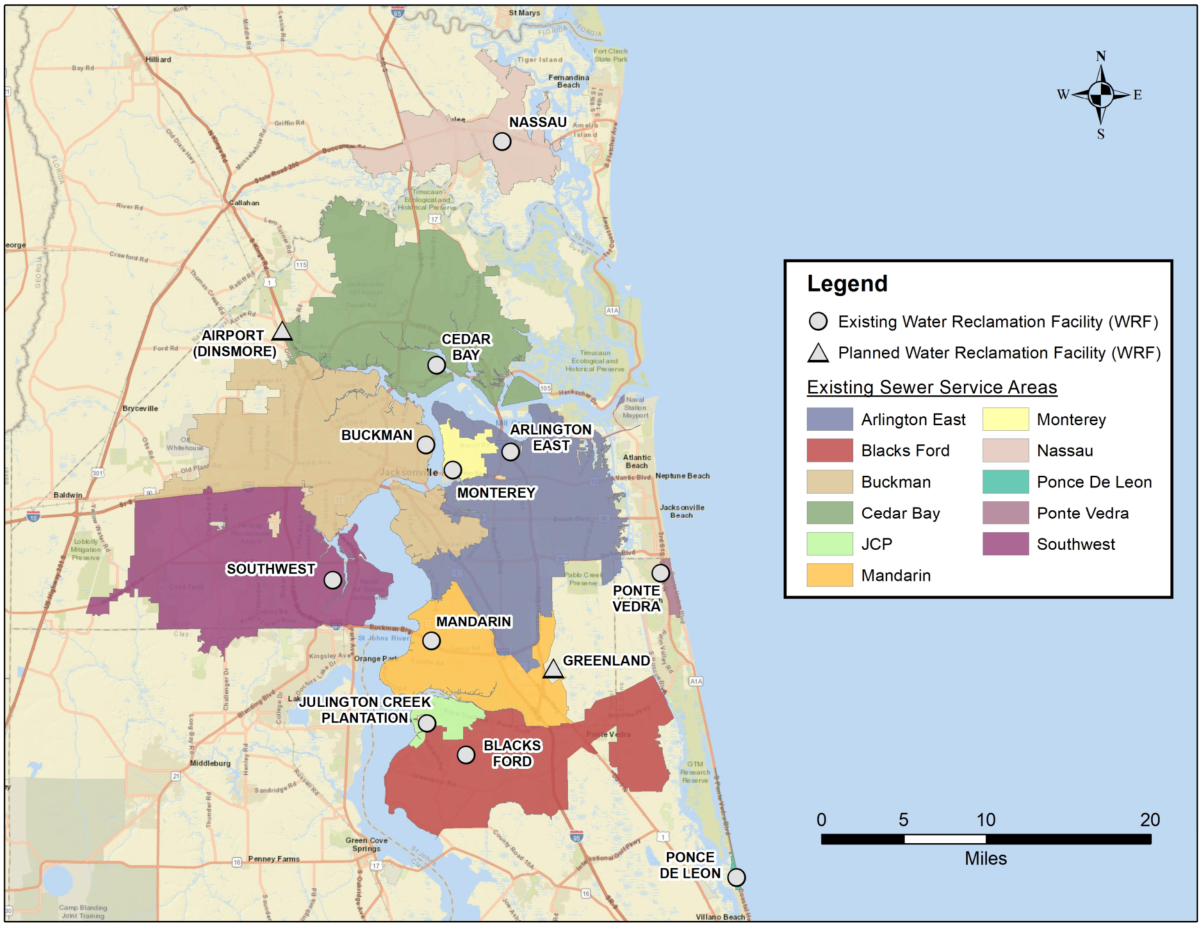

Figure 3-4. JEA Sewer Service Areas and Plants

Table 3-2. WRF Permitted Capacity

Status	WRF	Subgrid	Permitted Capacity (MGD)
Existing	Arlington East	South Grid: Arlington	25.00
	Blacks Ford	South Grid: SJC	6.00; 9.00 (2034)
	JCP	South Grid: SJC	1.00
	Mandarin	South Grid: Central	8.75
	Cedar Bay	North Grid: North	10.00
	Buckman	North Grid: Core City	52.50
	Southwest	North Grid: West	14.00; 18.00 (2024)
	Monterey	South Grid: Arlington	3.60
	Nassau	Nassau East	1.55*; 4.00 (2023)
	Ponce de Leon	Ponce de Leon	0.24
	Ponte Vedra	Ponte Vedra	0.80
Planned	Greenland	South Grid: East	0; 6.00 (2023)
Potential Future	Airport	North Grid: North	0; 1 (2028); 2 (2040); 3 (2055)
	Peterson	North Grid: West	0; 2 (2035); 5 (2044); 7 (2060)
	Nassau West	Nassau West	0; 1 (2035)

*Nassau can treat up to 2 MGD but is only permitted to discharge 1.55 MGD.

3.3 Reclaimed Water System and Constraints

Reclaimed water is produced at 10 of JEA's 11 current WRFs for either distribution to reclaimed customers (public access), or in order to decrease nutrient discharges (non-public access). **Table 3-3** documents the reclaimed water production capacity and planned capacity upgrades, as well as whether the reclaimed water is rated for public access uses. The table also lists the current on-site use of reclaimed water at each plant.

Table 3-3. Reclaimed Water Production Capacity

WRF	Reclaimed Water Production Capacity (MGD)	Production Type	On-Site Reclaimed Use (MGD)
Arlington East	8.00; 12.00 (2022); 16.00 (2032)	Public Access	1.4*
Blacks Ford	6.00; 9.00 (2034)	Public Access	0.01
Greenland	0; 6.00 (2023)	Public Access	0
JCP	1.00	Public Access	0.02
Mandarin	8.75	Public Access	0.62*
Cedar Bay	6.00	Non-Public Access	1.31
Buckman	7.70	Non-Public Access	3.54
Southwest	0.80	Non-Public Access	0.33
Nassau	1.55; 4.00 (2024)	Public Access	0.39
Ponce de Leon	0.24	Non-Public Access	0
Ponte Vedra	0.80	Public Access	0

*While reclaimed water is used on-site at Arlington East and Mandarin, it does not impact the production capacity for off-site use. For the other plants, the on-site reclaimed water utilized is part of the total production capacity.

The reclaimed water system within the South Grid is an interconnected system allowing reclaimed water produced in one subgrid to be transferred for use in other subgrids. **Figure 3-5** shows the near-term production capacities at the South Grid WRFs along with transmissions capacities between subgrids. Reclaimed water produced outside of the South Grid has more limited distribution and can only be utilized in the particular subgrid where it is produced.

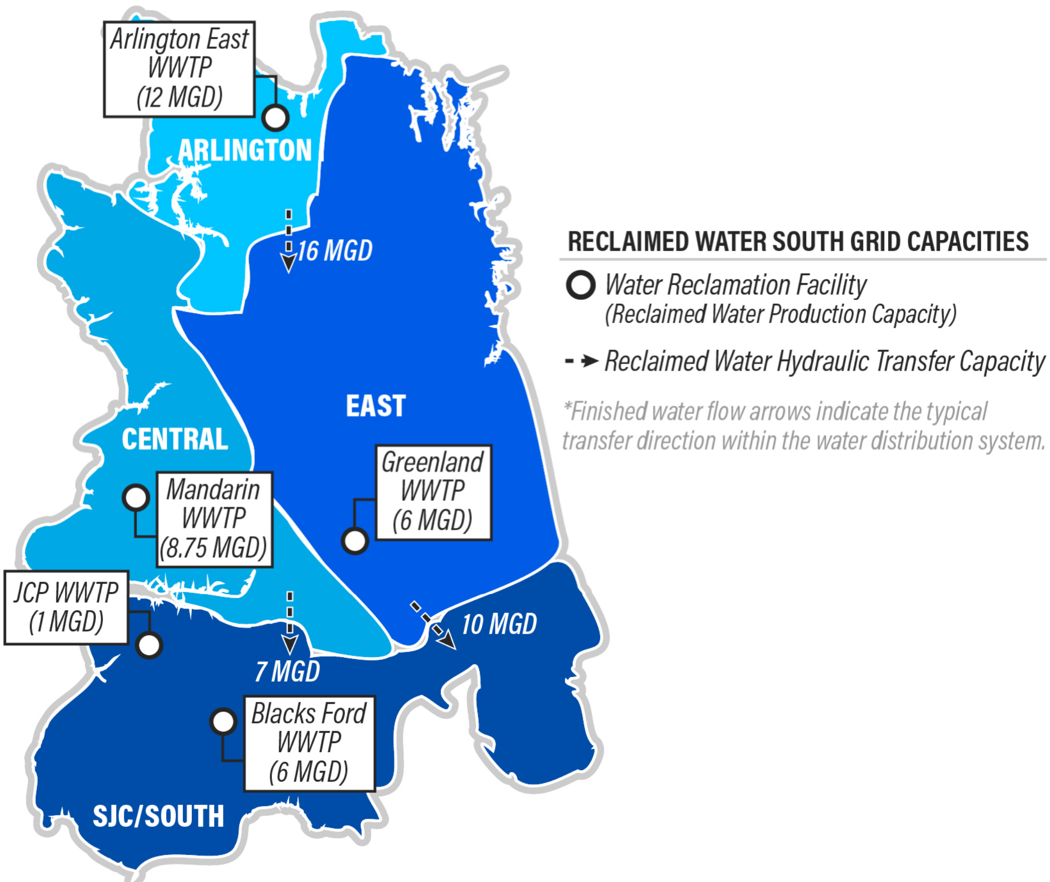

Figure 3-5. Near-Term Reclaimed Water Production and Transfer Capacities per Subgrid

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Section 4

Water Supply Needs

To properly plan for the future use of JEA's water resources, it is critical to understand how and where water is currently used, as well as to estimate how much water will be needed in the future.

4.1 Water Demand Forecast

Prior to the IWRP project, JEA had developed a water demand forecast through 2040 using a per capita water use approach. As a part of the IWRP project, this forecast was extended through 2070 and was spatially disaggregated to a neighborhood scale and also divided into indoor and outdoor demands. By analyzing water needs and future growth at the neighborhood level, specific conservation measures could be targeted to those areas where the largest water savings could be achieved.

4.1.1 Methodology

The neighborhood-level forecast started with customer-level billing data and neighborhood demographics in order to estimate water use by customer type and neighborhood. Some neighborhoods have higher or lower per unit water use based on factors such as lot size or income levels. Similarly, some neighborhoods may become built out with only small amounts of projected growth, while others will have significant growth potential. With the demand forecast extending through 2070, it was also necessary to consider the potential future expansion of JEA's service area.

The methodology for developing the spatially-disaggregated water demand forecast was extensive and is presented in full in the technical memorandum ***Spatially-Disaggregated Water Demand Forecast: Detailed Methodology*** included as **Appendix A**. A summary of this methodology is summarized below and is also depicted in **Figure 4-1**.

JEA's water customers are divided into major "sectors" based upon the type of service agreement, in conjunction with county appraiser property data. These water use sectors are:

- Single-family, Single-Family Metered Irrigation, and Single-Family Reclaimed (which were combined for this project into a category called Single-Family Residential);
- Multifamily (which for this project is a stand-alone category); and
- Commercial, Industrial, Institutional, and CII Irrigation (which were combined for this project into a category called CII).

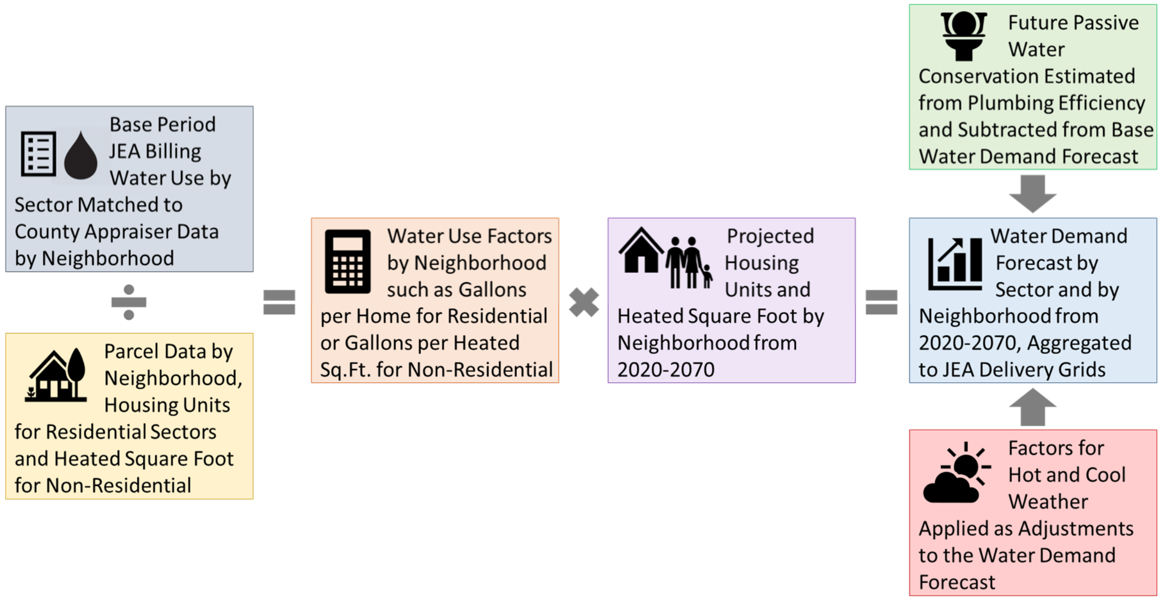

Figure 4-1. IWRP Spatially Disaggregated Water Demand Forecast Methodology

JEA water billing data for these sectors were matched to parcel-level data obtained from each county's appraiser. This parcel-level data included the number of single-family and multifamily housing units, the CII heated square footage, as well as other attributes such as lot size, age of home, presence of swimming pool, etc. Water use factors for each sector were derived by taking billed water use for the base period and dividing it by the appropriate demographic/lot attribute data. The base period includes years with relatively average weather conditions (2014, 2017, and 2018). As an example of the calculation, for the single-family sector, all the single-family billed water use was lumped together and divided by single-family housing units to arrive at a total water use factor of gallons per day per unit. For the commercial sector, the commercial billing water use was divided by commercial heated square footage. These water use factors were derived at the neighborhood level.

The water use factors at the neighborhood level were then multiplied by projections of future housing units and heated square footage in order to get a "baseline" sector water demand forecast for 2020 through 2070 for each neighborhood.

Indoor and Outdoor Water Use Methodology

In order to assess future reclaimed water alternatives and to evaluate water conservation measures, it was necessary to split the water demands by sector into indoor and outdoor uses. For this assessment cooling towers were tagged as an outdoor demand. Several different methods were used to estimate this indoor and outdoor water use split, including using minimum monthly water use as the basis for estimating indoor use and use of the ***Water Research Foundation Residential End Use Study*** statistical regression model for single-family. These methods are discussed in full in **Appendix A**.

Passive Water Conservation

As a result of the national water fixture plumbing codes and standards, indoor water demand has become more water-efficient over time. It is expected that this trend will continue as newer homes and businesses include more water-efficient fixtures. These gains in water efficiency occur without JEA's DSM strategy or intervention, and as such are referred to as "passive" water conservation. To estimate passive conservation, two time periods were used for new development in JEA's service area: 2020-2029 and 2030-2070. **Table 4-1** presents the water efficiency assumptions by fixture that were utilized for new homes and businesses to estimate the passive water conservation. It should be noted that the fixture efficiencies presented in Table 4-1 do not represent the best available technology, but rather the current codes and standards**.**

Table 4-1. Water Fixture Efficiency Assumptions for Estimating Passive Water Conservation

Fixture	2020 - 2029	2030-2070	Flow Measurement
Toilet	1.6	1.28	Gallons per flush
Urinal	1.0	0.5	Gallons per flush
Showerhead	2.5	2.0	Gallons per minute
Faucet	2.2	1.6	Gallons per minute
Clothes Washer	6.0	3.5	Gallons per cubic foot

Using the DSM demand model that further disaggregates the indoor and outdoor water demands into end uses (e.g., toilets, showers, clothes washing, cooling towers, irrigation, etc), passive water conservation was estimated for each demand sector and neighborhood through 2070. The passive water conservation savings were then subtracted from the baseline water demand.

The analysis estimated passive water savings at around 2.5 MGD for 2070. This number is relatively small, as JEA is a fast- growing service area with large portions of customers already at current plumbing code standards. However, future water conservation measures that JEA can implement as part of its DSM strategy are expected to produce larger conservation savings. This would be achieved by targeting select end uses of water demand and then driving them to greater levels of efficiency beyond current standards using rebates, cost-sharing and education.

Grid Level Water Demand Forecast

The water demand forecast at the neighborhood level with passive water conservation savings was aggregated up to JEA's water delivery grids using geographic information systems (GIS) software. Non-revenue water (NRW), which represents the difference between total water supply production and total water sales, is added to the sector water demands. NRW includes system losses, meter error, and non-billed water for fire hydrant flushing, reservoir tank cleaning, and other legitimate uses. Based on ten years of historical data, NRW currently represents 10.3 percent of total water use which is considered reasonable for a utility of JEA's size.

Weather Adjustments

Weather can impact water demands from year to year, as in some years it is hotter and drier than average, which results in greater water use; while in other years it is cooler and wetter than average, which results in lower water use. An analysis of weather and water demands for the last 10 years indicated that 2017 had relatively hot temperatures and drier than normal rainfall, which resulted in JEA's water demands being greater than average. Conversely, 2013 had relatively cooler temperatures and more rainfall than normal, which resulted in JEA water demands being lower than average. Weather adjustments to the demand forecast were applied to the outdoor demands, since these demands are more weather dependent than indoor uses. Based on the historical analysis, dry weather increased outdoor demands by 11 percent while wetter weather reduced outdoor demands by 17 percent. The indoor demands are assumed to stay constant over all weather conditions and the NRW percentage remains as 10.3 percent of the total flows.

Seasonal Analysis

Outdoor water demands also vary seasonally throughout the year due to more water being needed for irrigation during the hotter summer months. The projected outdoor annual water demands are converted into monthly demands using seasonal peaking factors developed from historical data. Each subgrid has a slightly different seasonal pattern depending on the types of developments. **Figure 4-2** shows the patterns for each subgrid. May is typically the peak month for outdoor water needs with demands staying elevated through the summer months then dropping through December, January, and particularly February, before rising again in the spring.

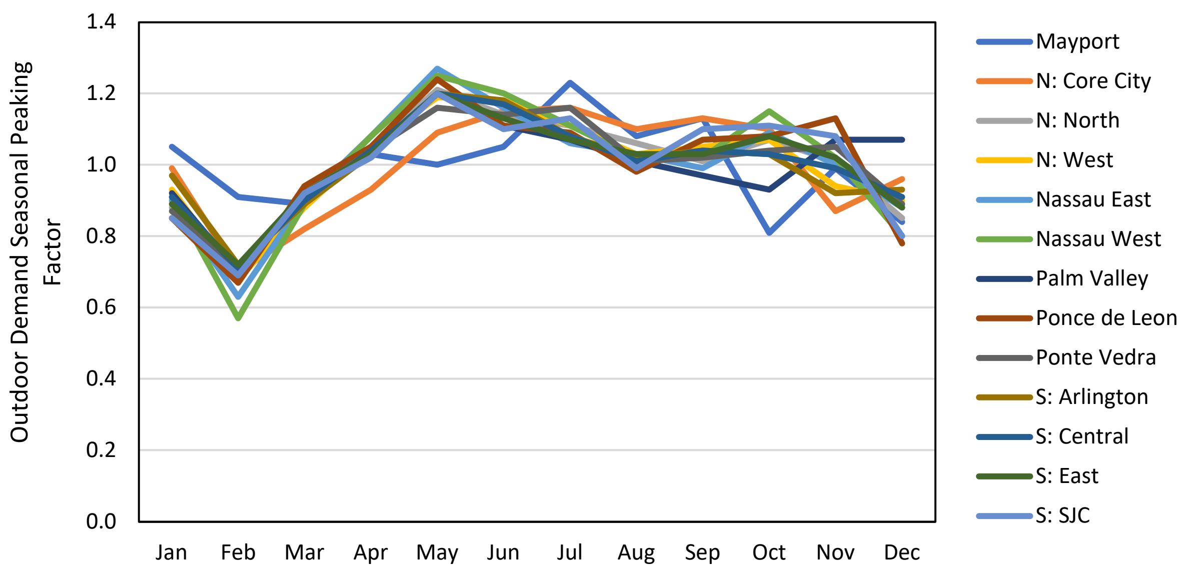

Figure 4-2. Outdoor Water Demand Seasonal Peaking Factors

4.1.2 Forecast Summary

The IWRP forecasted water demands are presented in **Table 4-2** for average weather conditions by sector (including passive water conservation). Single-family residential makes up the majority of water demand, at about 62 percent, while multifamily residential makes up about 8 percent. Single-family includes not only detached homes, but townhomes and some larger condominiums. The CII sector represents the second largest water demand, at 20 percent. **Figure 4-3** presents the total water demand forecast with weather variability (inclusive of passive water conservation). Typically, when planning for new water supplies, it is important to use above-normal water demands that are associated with hot/dry weather conditions.

The water demand forecast focused on municipal demands within the JEA water service area; however, additional demands were considered as part of the IWRP system modeling and analysis:

- *Potable Water Provided to SJCUD*: JEA has a contract with SJCUD to serve areas in St. Johns County adjacent to the JEA service area. The contract amount increases within the model from 2.0 MGD in 2020 to 2.2 MGD in 2025 and then 2.25 MGD in 2030 and beyond.

- *Reclaimed Water Demand*: The portion of reclaimed water served which provides a direct offset to municipal demands is included within the IWRP water demand forecast. However, the total amount of reclaimed water served is higher due to factors outlined in the following section.

Table 4-2. IWRP Municipal Water Demand Forecast by Sector under Average Weather (MGD)

Year	SF	MF	CII	NRW	TOTAL
2020	78.85	12.76	23.13	13.18	127.93
2025	84.82	13.25	25.47	14.19	137.73
2030	89.85	13.69	27.44	15.04	146.02
2035	94.03	14.04	29.29	15.77	153.13
2040	98.12	14.30	30.51	16.41	159.35
2050	105.72	14.61	33.74	17.69	171.76
2060	112.83	14.80	36.02	18.79	182.45
2070	119.11	15.08	38.15	19.79	192.13

SF = single-family, MF = multifamily, CII = commercial/institutional/industrial, NRW = non-revenue water

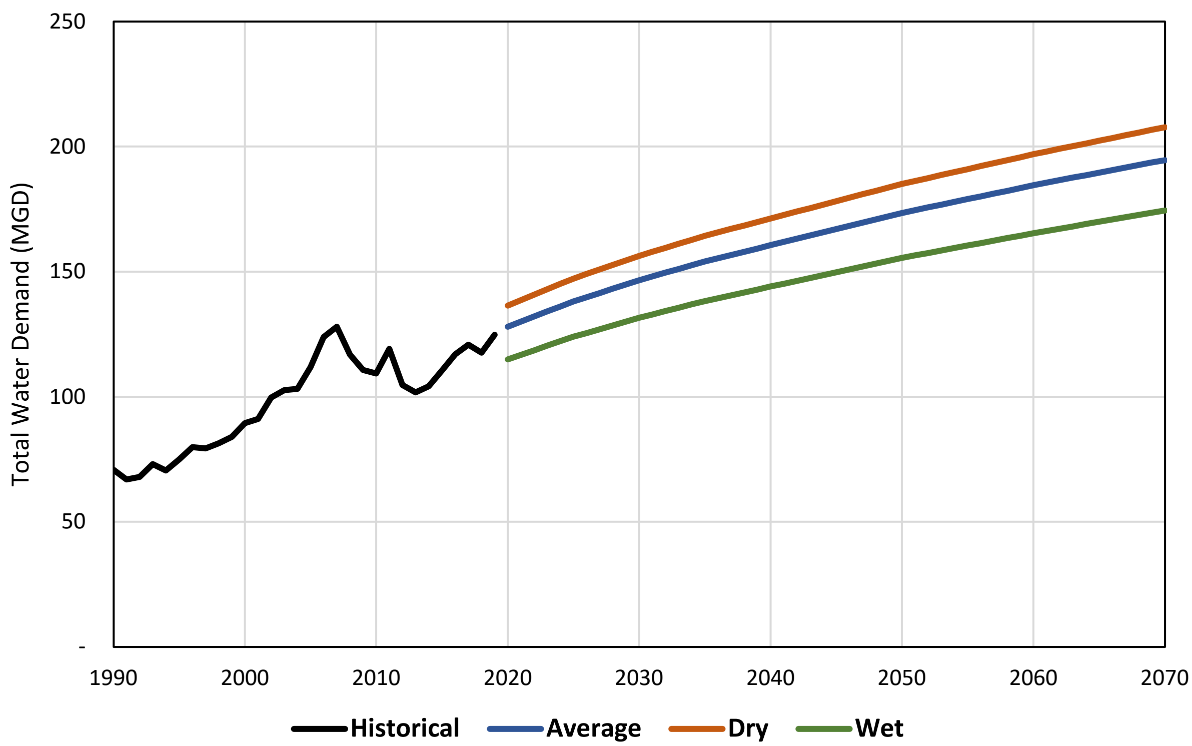

Figure 4-3. IWRP Municipal Water Demand Forecast with Passive Water Conservation Under Different Weather

The water demand forecast by JEA service grids is presented in **Table 4-3** for average, hot/dry and cool/wet weather conditions. The change in water demand between 2020 and 2070 is presented as a heat map by major neighborhood in **Figure 4-4**. The projected fastest growing areas are those on the outer edges of JEA's current service area.

Table 4-3. IWRP Municipal Water Demand Forecast by Service Grid

	Year	Mayport	Nassau	North Grid	Palm Valley	Ponce de Leon	Ponte Vedra	South Grid	Total
AVERAGE	2020	0.04	4.74	46.26	0.40	0.50	1.45	74.54	127.93
	2025	0.04	5.46	51.17	0.46	0.53	1.46	78.61	137.73
	2030	0.04	6.15	55.82	0.49	0.55	1.46	81.51	146.02
	2035	0.05	6.73	60.08	0.50	0.55	1.46	83.77	153.13
	2040	0.05	7.18	64.06	0.51	0.55	1.46	85.54	159.35
	2050	0.05	8.00	72.18	0.51	0.55	1.46	89.01	171.76
	2060	0.05	8.80	79.36	0.51	0.55	1.46	91.72	182.45
	2070	0.05	9.61	86.09	0.51	0.55	1.46	93.87	192.13
	Year	Mayport	Nassau	North Grid	Palm Valley	Ponce de Leon	Ponte Vedra	South Grid	Total
DRY	2020	0.04	5.07	49.04	0.43	0.55	1.57	79.67	136.38
	2025	0.04	5.85	54.32	0.50	0.57	1.58	84.01	146.87
	2030	0.05	6.59	59.31	0.53	0.60	1.58	87.09	155.75
	2035	0.05	7.20	63.90	0.55	0.60	1.58	89.50	163.37
	2040	0.05	7.68	68.19	0.56	0.60	1.58	91.38	170.03
	2050	0.05	8.57	76.94	0.56	0.60	1.58	95.08	183.38
	2060	0.05	9.42	84.66	0.56	0.59	1.58	97.97	194.84
	2070	0.05	10.29	91.90	0.56	0.59	1.58	100.25	205.22
	Year	Mayport	Nassau	North Grid	Palm Valley	Ponce de Leon	Ponte Vedra	South Grid	Total
WET	2020	0.04	4.22	41.95	0.34	0.44	1.25	66.62	114.86
	2025	0.04	4.86	46.34	0.39	0.46	1.26	70.24	123.60
	2030	0.04	5.47	50.49	0.43	0.48	1.26	72.83	130.99
	2035	0.04	5.98	54.28	0.44	0.48	1.26	74.83	137.30
	2040	0.04	6.37	57.84	0.44	0.48	1.26	76.40	142.83
	2050	0.04	7.10	65.02	0.44	0.48	1.26	79.47	153.80
	2060	0.05	7.81	71.41	0.44	0.47	1.26	81.86	163.30
	2070	0.04	8.53	77.43	0.44	0.47	1.26	83.74	171.92

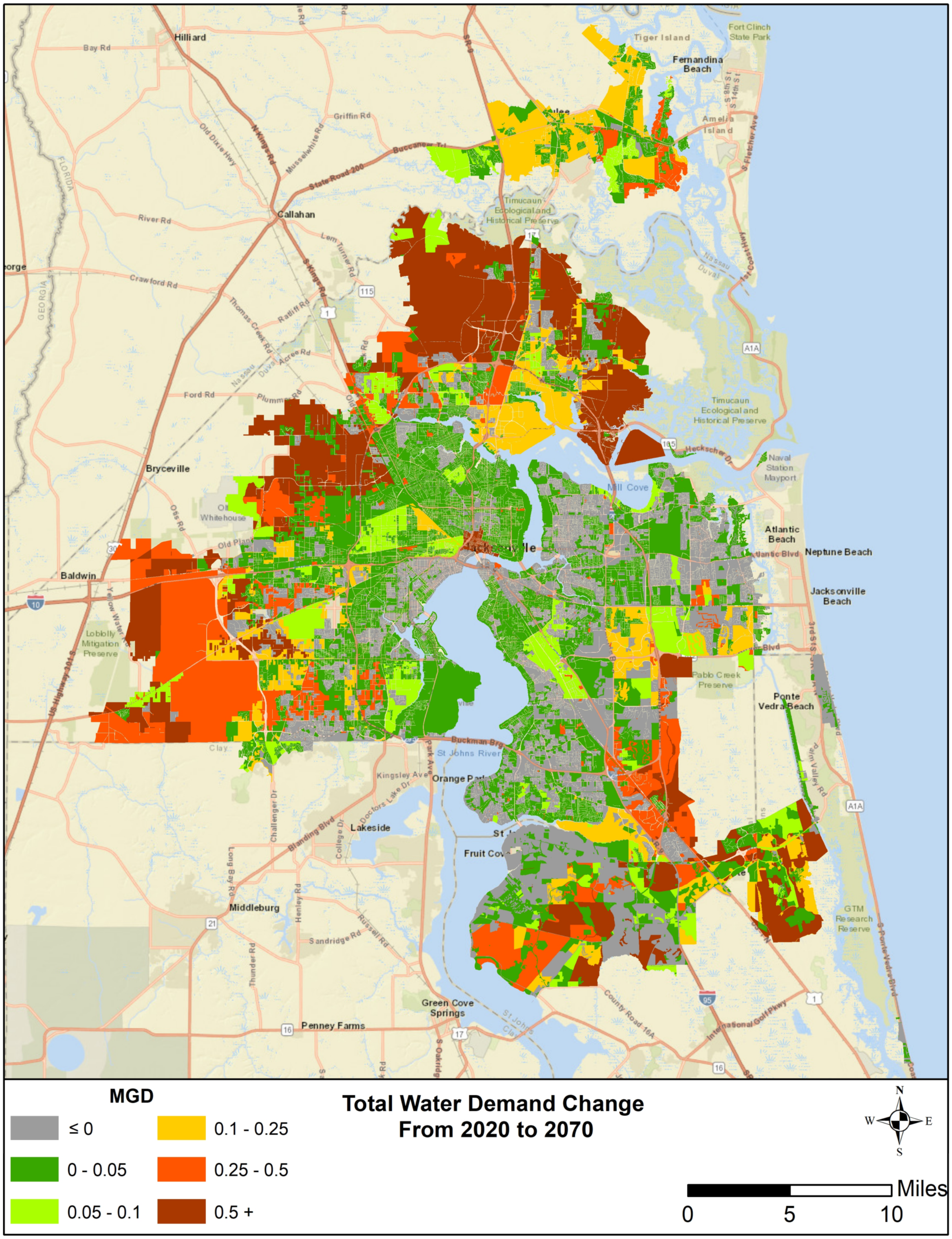

Figure 4-4. Change in Forecasted Water Demands (Million Gallons per Day)

4.2 Current and Committed Reclaimed Water Supply

JEA currently serves retail reclaimed water to customers in the south grid. In St Johns County, investments have also been made in reclaimed infrastructure such that reclaimed water use will continue to grow as the area develops. Projections were developed, in consultation with JEA, for expected baseline reclaimed use without additional infrastructure. These projections are summarized in **Table 4-4**. Based on JEA's experience, as customers install a designated irrigation meter, either potable or reclaimed, their total outdoor water use increases. It is possible that cost may be influencing this behavior, as customers do not need to pay a sewerage charge on designated outdoor water use. An additional 80 percent increase in demand on the reclaimed water system was assumed to account for this change in behavior. As a result, for every 1 MGD of potable water demand that is switched to be served by reclaimed water, it is assumed that 1.8 MGD of reclaimed water is utilized to meet the same demand.

Besides providing reclaimed water to retail customers, JEA also serves reclaimed water to bulk customers and SJCUD. This reclaimed water does not go toward meeting the projected total water demand but is important to track for future supply planning.

A seasonal pattern for the retail reclaimed usage was developed based on historical data from 2015 through 2018. The monthly peaking factors used in the model for reclaimed demands are shown in **Figure 4-5**.

Table 4-4. Baseline Reclaimed Water Use Assumptions on the South Grid (MGD)

Year	Municipal Potable Offset					Additional Usage Factor	Bulk Customers	SJCUD	Total South Grid Committed Reclaimed (MGD)
	South Arlington	South Central	South East	South SJC	South Grid Total				
2018	0	0.6	0.50	6.30	7.4	0.00	1.93	0	9.33
2020	0	0.6	0.50	6.92	8.0	0.25	1.93	0	10.18
2025	0	0.6	0.86	8.29	9.7	0.50	1.93	0.29	12.42
2030	0	0.6	1.19	9.20	11.0	1.88	1.93	0.69	15.5
2035	0	0.6	1.42	10.10	12.1	2.87	1.93	1.09	17.99
2040	0	0.6	1.66	10.70	13.0	3.78	1.93	1.50	20.21
2045	0	0.6	1.89	11.31	13.8	4.45	1.93	1.50	21.68
2050	0	0.6	2.12	11.92	14.6	5.12	1.93	1.50	23.15
2055	0	0.6	2.30	12.39	15.3	5.79	1.93	1.50	24.52
2060	0	0.6	2.49	12.86	15.9	6.31	1.93	1.50	25.64
2065	0	0.6	2.59	13.33	16.5	6.84	1.93	1.50	26.77
2070	0	0.6	2.70	13.80	17.1	7.30	1.93	1.50	27.83

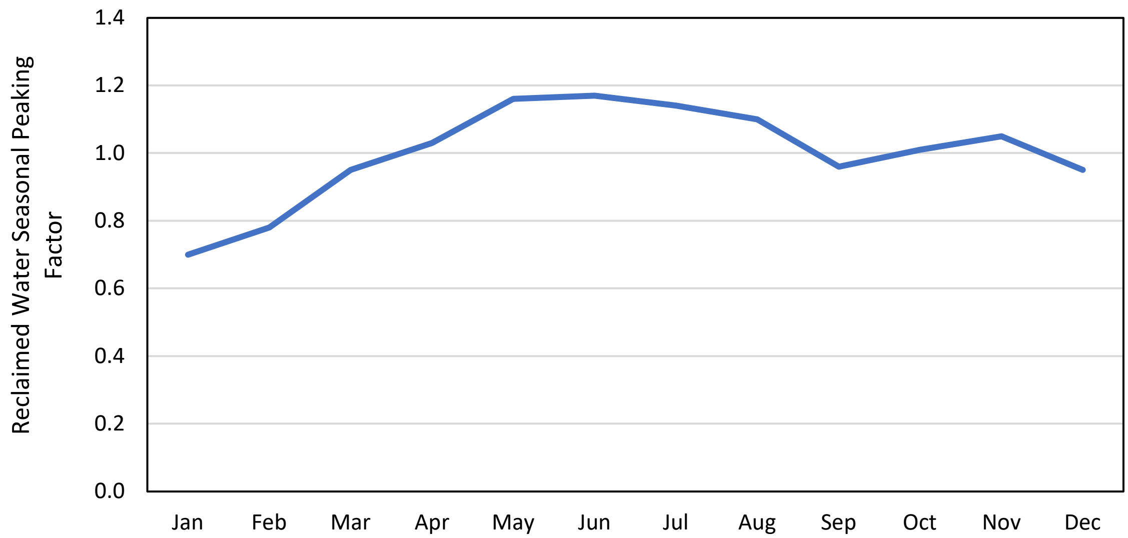

Figure 4-5. Reclaimed Retail Water Demands Seasonal Peaking Factors

4.3 Consumptive Use Permit

JEA's sole source of potable supply is currently groundwater from the Floridan aquifer, which is regulated through a Consumptive Use Permit (CUP) that determines the total volume which can be withdrawn from various wellfields. The total allocation is 142 MGD in 2021 with potential increases annually based on meeting various requirements. The final potential value is 155 MGD in 2031 under the current permit. However, groundwater quality degradation, as well as future allocation decisions, make permit increases uncertain. The IWRP took a conservative approach and held the CUP groundwater allocation constant at the current values, as outlined in **Table 4-5**.

Table 4-5. Consumptive Use Permit Groundwater Allocation per Grid and Subgrid

Grid/Subgrid		Groundwater Allocation Under Current CUP (MGD)
Mayport		0.09
North Grid	Core City	33.69
	North	13.50
	West	37.60
	North Grid Total	*84.79*
Nassau East		3.49
Nassau West		0
Palm Valley		0
Ponce de Leon		0.52
Ponte Vedra		1.26
South Grid	Arlington	5.48
	Central	10.49
	East	30.87
	SJC	5.27
	South Grid Total	*52.11*
	Total Allocation	**142.26**

Figure 4-6 shows JEA's potable water demand forecast as compared to the current CUP allocation. The potable demand is dependent on the assumed level of future reclaimed water use. The graph has the volume of reclaimed water projected under the IWRP recommended strategy subtracted from the projected demands to compare against the available CUP. The annual average demand is projected to exceed the current allocation by 2028 for dry weather conditions and by 2038 for average weather conditions. The CUP allocation is an average annual value so monthly and daily pumping can exceed the average values.

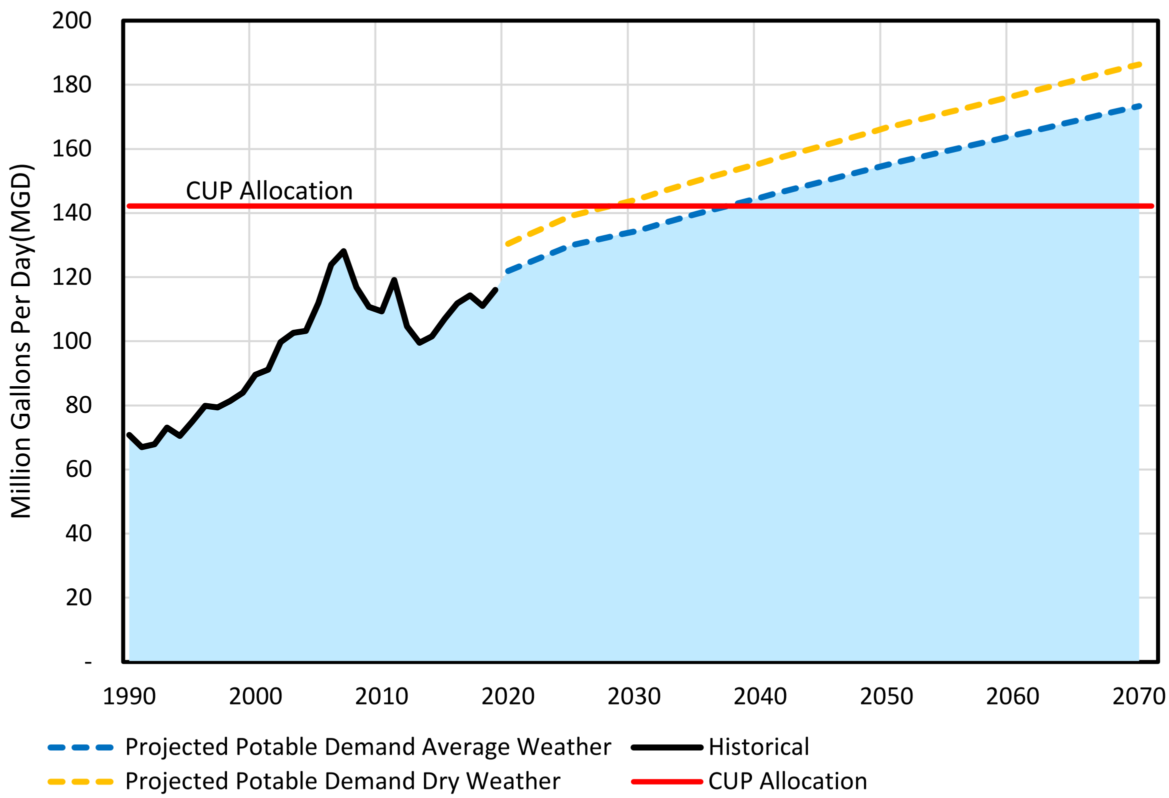

Figure 4-6. JEA Total Potable Water Demand Forecast Compared to CUP Allocation

4.4 Future Water Supply Needs by Grid

A needs assessment was performed to characterize how much additional water supply is needed to meet JEA's projected future water demands. The existing groundwater supply, as well as existing and projected future committed reclaimed supplies, were compared against the projected demands for each subgrid. The analysis was run for both average weather and dry weather conditions with annual average values as well as seasonal peaking of demands. The identified supply gaps under each type of analysis rolled up to the major grids are provided in **Table 4-6** and **Figure 4-7.**

Table 4-6. Identified Supply Gaps

Analysis	Year	North	Nassau	South	Total
Annual Average Weather (MGD)	2018	0.0	1.0	0.0	1.0
	2020	0.0	1.3	0.0	1.3
	2025	0.0	2.0	0.0	2.0
	2030	0.2	2.7	0.0	2.9
	2035	1.8	3.3	0.0	5.1
	2040	3.6	3.8	0.0	7.3
	2050	10.9	4.6	1.6	17.1
	2060	18.2	5.4	3.0	26.6
	2070	24.9	6.2	4.1	35.2
Annual Dry Weather (MGD)	2018	0.0	1.3	0.0	1.3
	2020	0.0	1.6	0.0	1.6
	2025	0.0	2.4	0.0	2.4
	2030	1.2	3.2	0.8	5.2
	2035	3.0	3.8	4.0	10.8
	2040	7.1	4.3	5.2	16.6
	2050	15.0	5.2	8.2	28.4
	2060	22.7	6.1	9.9	38.7
	2070	30.0	7.0	11.1	48.0
Max Month Dry Weather (MGD)	2018	0.0	1.5	0.8	2.3
	2020	0.0	1.9	2.2	4.1
	2025	0.0	2.9	2.9	5.8
	2030	1.5	3.8	8.3	13.5
	2035	3.6	4.5	9.3	17.4
	2040	8.4	5.1	10.4	23.8
	2050	17.3	6.2	13.0	36.5
	2060	26.0	7.2	14.6	47.8
	2070	34.2	8.2	15.7	58.1

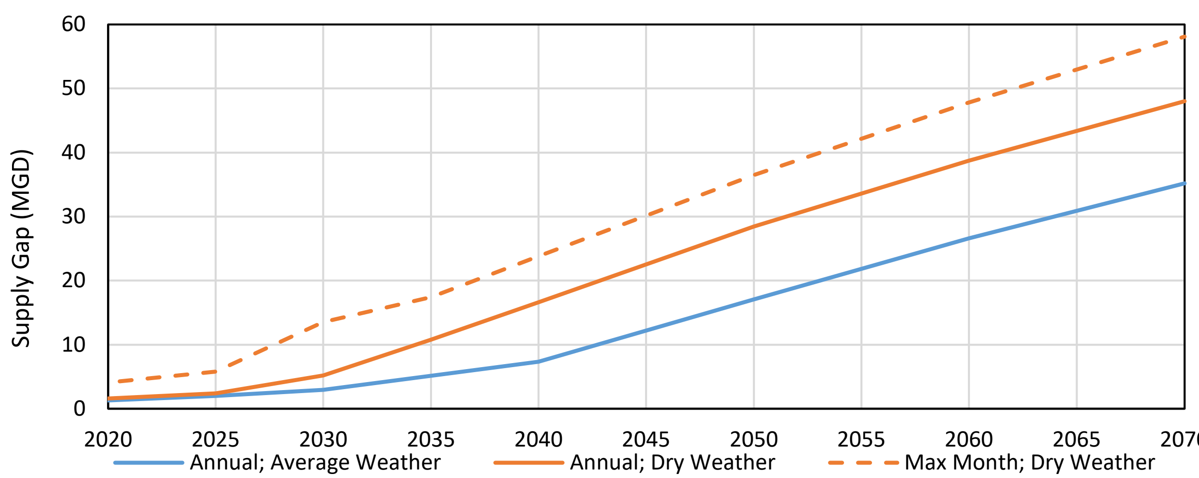

Figure 4-7. Total Water Supply Gaps

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Section 5

New Supply Options

While the current CUP allocation is sufficient for present customer water demands, as population and water use in the region rise, JEA will need to consider diversifying its water supply portfolio with alternative water supply options.

As a component of the IWRP process, future water supply options which could satisfy JEA's long-term water supply needs were evaluated. The list of considered options was developed cooperatively with JEA. This section provides a description of each supply option, as well as summary tables to easily compare the cost of options. Detailed information on each option is available in **Appendix B**. Appendix B includes a factsheet for each option which details required facilities, key assumptions, environmental impacts, community acceptance, water quality, finished water volume, planning level costs, modeling assumptions, and related studies.

5.1 Supply Option Summary

This section provides a short description of each water supply option. **Table 5-1** lists the water supply options as well as the finished water volume or potable offset each can provide. Some supply options, like demand side management and reclaimed water, do not have a single yield but instead, the potable water offset provided builds over time as the program grows. Other options, like ocean desalination, have a potentially unlimited supply but a representative cost for a specific yield was developed.

Table 5-1. Water Supply Options

Type	Supply Options	Finished Water Volume or Potable Offset (MGD)
Demand Side Management (DSM)	Baseline DSM	4.97*
	Expanded DSM	6.54*
Reclaimed Water	Expanded Reclaimed Water in the South Grid	5.72*
	New Reclaimed Water in Growth Areas of North Grid North	1.27*
	New Reclaimed Water in Growth Areas of North Grid West	3.05*
	New Reclaimed Water in Nassau East	1.22*
	New Reclaimed Water in Nassau West	0.21*
Stormwater	Distributed Stormwater Collected from FDOT facilities	5
Direct Potable Reuse (DPR)	Cedar Bay	5
	Southwest	11
	Buckman	Up to 25 MGD (Priced at 10 MGD)
	Arlington East	10
	Mandarin	5
	Nassau	1.5

Type	Supply Options	Finished Water Volume or Potable Offset (MGD)
Indirect Potable Reuse (IPR)	Cedar Bay	4.5
	Southwest	9.9
	Buckman	Up to 22.5 MGD (Priced at 9 MGD)
	Arlington East	9
	Mandarin	4.5
	Nassau	1.35
Desalination	Brackish Groundwater	As required (priced at 2-15 MGD)
	St. Johns River at Shands Bridge	As required (priced at 10 MGD)
	St. Johns River at NGS Site	Up to 30 MGD (priced at 10 MGD)
	Intracoastal Waterway Seawater Quality	As required (priced at 10 MGD)
	Ocean	As required (priced at 10 MGD)
Conveyance	North Grid Core City to North Grid West	As required (priced at 2 MGD)
	North Grid Core City to North Grid North	As required (priced at 2 MGD)
	North Grid West to Nassau West	As required (priced at 2 MGD)
	South Grid East to South Grid Central	As required (priced at 2 MGD)
	North Grid West to South Grid Central (River Crossing)	10 MGD

* The potable water offset provided by demand side management and reclaimed water grows as the project develops. The values stated are the maximum annual potable offset expected through 2070.

5.1.1 Water Conservation

A Demand-Side Management (DSM) Strategy was prepared for JEA as part of the IWRP project in order to promote water conservation. This strategy was based on the economic evaluation of thirteen DSM measures. Measures included in the recommended strategy are as follows:

- Residential
  - Single-Family High Efficiency Toilet Direct Install
  - Multi-Family High Efficiency Toilet Direct Install
  - Single-Family High Efficiency Clothes Washer Rebate
  - Smart Irrigation Controller Rebate
- Non-Residential
  - Green Restaurant Program
  - Ice Machine Rebate
  - Cooling Tower Cost Sharing

The customer targets for the DSM Strategy were based on JEA neighborhoods with specific housing/socioeconomic attributes (e.g., age of home, lot size, and income) for residential measures, and number of participating business establishments for non-residential measures. For residential measures, the DSM Strategy assumed that 60 percent of the customer targets would implement the conservation measure with monetary rebates from JEA over a 5-year period. For non-residential measures, the DSM Strategy assumed a more conservative participation level (10 to 20 percent) over a 5-year period. These initial target assumptions will be revisited as JEA implements the recommended DSM measures over time. The estimated water savings for the DSM Strategy were not intended to be projections used for the IWRP, as the Strategy is designed around a pilot program approach to test the effectiveness of the implementation of DSM measures over an initial 5-year period. The IWRP represents long-term projections based on the full implementation of water supply projects and the DSM programs that could likely be implemented over the next 10 to 30 years.

To estimate a more likely projection of water conservation, an IWRP Baseline Water Conservation Option was developed. The IWRP Baseline Water Conservation Option is based on a more aggressive targeting of customers and a longer implementation (10 vs 5 years) of the recommended DSM Strategy. In addition to the Baseline Water Conservation Option, an Expanded Water Conservation Option was also created for the IWRP. The Expanded Water Conservation Option is also based on an aggressive targeting of customers, a longer implementation period and two additional DSM measures (High Efficiency Dishwasher Rebate and Landscape Transformation Rebate).

5.1.2 Expanded Traditional Reclaimed

JEA currently serves retail reclaimed water to customers in the South Grid for irrigation use. In St Johns County, investments have also been made in reclaimed water infrastructure such that reclaimed water use will continue to grow as the area develops. Within the IWRP, growth of reclaimed water demand within areas already outfitted with reclaimed water infrastructure is referred to as 'committed' reclaimed water and is included within all analyzed alternatives.

This supply option looks at further expansion of the South Grid reclaimed water system beyond the neighborhoods with current reclaimed water infrastructure and into additional neighborhoods as development occurs. This expansion of the reclaimed water system within the South Grid is currently part of JEAs long-term plan, but under the IWRP was considered as an option which could either continue to be included or not. Not including the further expansion of the reclaimed water system allowed for investigating the use of that water for other purposes such as purified water. Beside the South Grid, the introduction of new reclaimed water infrastructure into future growth areas in both the North Grid and Nassau County was also considered as a project option.

5.1.3 Stormwater Augmentation of Reclaimed System

This option considers augmenting reclaimed water supply for irrigation by harvesting water from horizontal wells that are adjacent to Florida Department of Transportation (FDOT) highway stormwater retention ponds in the South Grid. A series of horizontal wells would be installed adjacent to the storm ponds along the FDOT roadways. Harvested stormwater would be filtered through the soil matrix, disinfected and pumped to nearby reclaimed water facilities.

5.1.4 Potable Reuse

Direct Potable Reuse

In this supply option, reclaimed water from one of JEA's water reclamation facilities (WRFs) is conveyed to a new Water Purification Facility (WPF) that produces water of potable quality to be blended with finished water at a water treatment plant (WTP). Although purified water is safe for public consumption at the WPF, and is partially-stabilized with post-treatment chemicals, blending with the finished water at a WTP utilizes the natural hardness and alkalinity of the groundwater to further stabilize the purified water and enhance its taste. This water would more closely resemble the familiar aesthetics of JEA's Floridan aquifer supply. DPR WPFs could be located at several of JEA's WRFs, or at an alternate location in the service territory.

Indirect Potable Reuse

Indirect potable reuse (IPR) is also referred to as aquifer recharge. In this option, reclaimed water from one of JEA's WRFs is conveyed to a WPF that produces purified water of potable quality. The purified water would be used to directly recharge the Floridan aquifer, resulting in beneficial reuse credits for the JEA CUP, and allowing additional proportionate withdrawals in excess of historical CUP limiting conditions. Use of IPR also has the benefit of alleviating groundwater quality degradation by recharging a high-quality water supply. IPR aquifer recharge WPFs could be located at several of JEA's WRFs or an alternate location in the service territory.

5.1.5 Desalination

Desalination provides the ability to produce a new source of potable water supply by treating water that would otherwise be too high in dissolved salts for traditional treatment. One key consideration for desalination options is how to dispose of the concentrated brine, which is produced via the treatment process. For the IWRP, it is assumed that deep well injection can be utilized to dispose of the concentrate. However, the sensitivity of results to this assumption will be completed by considering cost implications if onsite zero liquid discharge needs to be utilized.

Brackish Groundwater

This option considers developing additional groundwater capacity by treating brackish groundwater in the Fernandina Permeable Zone, located at the base of the Lower Floridan aquifer (LFA). Brackish groundwater reverse osmosis facilities in Florida can typically treat water with salinity in the range from 1,000 mg/L to 6,000 mg/L. This supply is expected to be located between 1,900 to 2,500 feet below the surface in the South grid. While a brackish groundwater layer is not confirmed within the North grid area and Nassau County, the IWRP analysis allows for a brackish groundwater option to be considered within any subgrid.

St. Johns River at Shands Bridge (Lower Salinity)

This option provides an additional supply source to supplement the existing groundwater supply source by treating upper St. Johns River surface water for South Grid potable supply using a low-pressure reverse osmosis membrane WTP. The RO WTP facility could be sited in the South Grid, near the Shands Bridge at SR 16 in St. Johns County, within the JEA water service area and in proximity of future high growth service areas. Finished water would be sent directly to the South Grid distribution system to serve demands within the St. Johns County subgrid. This option was priced for 10 MGD; however, costs are scaled within the IWRP model based upon the selected capacity.

St. Johns River at the NGS Site (Higher Salinity)

In this option, surface water from the lower St. Johns River would be treated and desalinated for the North Grid and/or South Grid potable water supply. The option was priced as a 10 MGD RO based WTP constructed on the existing Northside Generating Station (NGS) electric power site. The source water salt content would be higher than brackish water, but lower than seawater. An average total dissolved solids (TDS) of 25,000 mg/L was assumed; however, salinity in the lower St. Johns River is tidally influenced, and any potential intraday variability in TDS exceeding 10,000 mg/L would complicate operations.

The NGS currently discharges approximately 300 MGD of cooling water blowdown (i.e. used cooling water) to the St. Johns River. This option considers diverting used cooling water blowdown to the RO WTP for treatment. Thus, additional water supply withdrawal from the St. Johns river would not be required. Finished water from the RO WTP could be either utilized in the North Grid or transferred to the South Grid through a new transmission main to Ridenour WTP for distribution. RO concentrate and other process wastewaters would be co-mingled with the NGS cooling water in the discharge canal, located downstream of the St. Johns River intake.

Intracoastal Waterway

This option assumes that surface water from the Intracoastal Waterway would be withdrawn from a location between St. Mary's River to the north, and the George Crady Bridge to the south. Water would be treated and desalinated for potable water supply within the Nassau East grid. Tidally influenced variation in TDS is assumed to be small enough in magnitude to be managed operationally without interrupting the continuous duty of the WTP. An average TDS of 35,000 mg/L was assumed. This option assumes a RO based WTP, sized for 10 MGD for comparison to other supply options. Demand within the Nassau East subgrid however is not projected to reach 10 MGD, so the costs are scaled down within the model, depending on the size selected for implementation, using an exponent of 0.75. Under this assumption, a 2 MGD facility would cost about 60 percent more per gallon than a 10 MGD facility.

Atlantic Ocean

This option provides an additional source water supply to supplement the existing groundwater supply source. Atlantic Ocean water would be treated and desalinated for potable water supply within the South East subgrid. An average TDS of 35,000 mg/L is assumed. This option assumes a RO based WTP sized for 10 MGD.

5.1.6 Conveyance

JEA's water system is divided into six distinct service grids, with the largest two being the North Grid and the South Grid. Within the IWRP, these major grids were further divided into subgrids, based on hydraulic limitations within the distribution systems. JEA has the capacity to transfer raw water between the North Grid and the South Grid via two transmission mains that cross the St. Johns River. Finished water within the South Grid can also be pumped to neighboring subgrids for distribution. This supply option looks at additional opportunities for conveying finished water between subgrids in order to balance the available supply in one subgrid with unmet demands in another subgrid, including a third transmission main across the St. Johns River.

5.2 Supply Option Cost

For each water supply option, preliminary capital and operation and maintenance (O&M) costs were developed. These costs were intended for use as a screening level evaluation for conceptual projects. The developed costs rely on a mix of previous feasibility studies and JEA planning reports. If previous studies were not available, cost estimates were determined in a manner consistent with planning level order-of-magnitude cost estimates, utilizing the SJRWMD's special publication on "Water Supply Facilities Cost Equations for Application to Alternative Water Supply Projects Investigations and Regional Water Supply Planning" and other resources. Cost data from all resources were updated to 2019 dollars. Baseline assumptions for supply option capital and O&M cost development are included in **Tables 5-2 and 5-3**, respectively.

Table 5-2. Supply Option Capital Cost Standard Assumptions

Cost Component	Cost Assumptions
Indirect Costs	
Permits, Bonds, and Insurance	3.5% of direct project costs
Sales Tax	7% of direct project costs
General Conditions	10% of direct project costs
Contractors Overhead and Profit	10% of direct project costs
Construction Contingency	25% of direct project costs
Additional Costs	
Engineering and Design	10% of direct and indirect project costs
Permitting	3% of direct and indirect project costs

Table 5-3. Supply Option O&M Cost Standard Assumptions

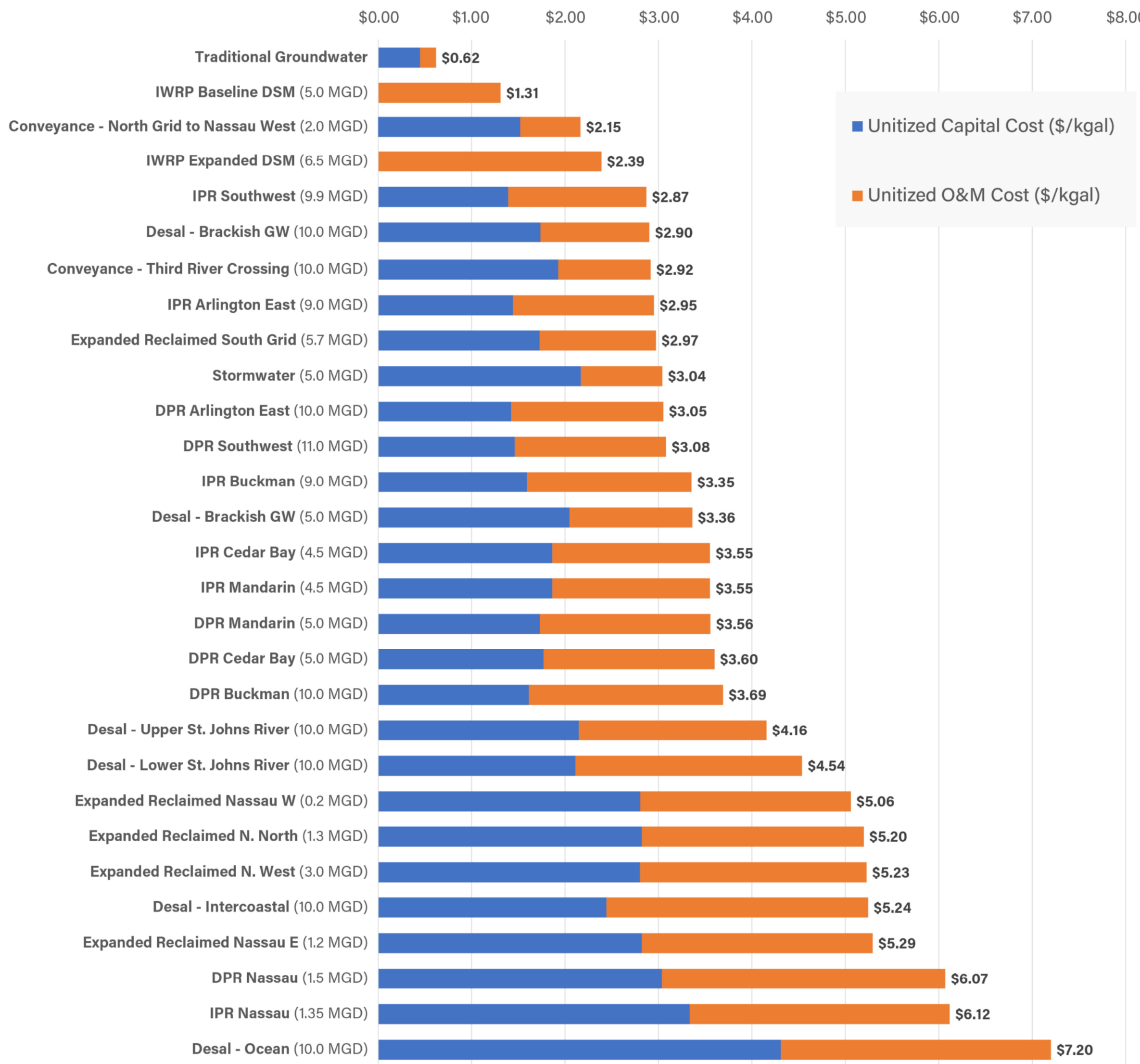
Cost Component	Cost Assumptions
Electrical Power	$0.05768 per kilowatt hour
O&M Contingency	20% of O&M costs

Table 5-4 provides a summary of the capital and O&M costs for the supply option, as well as an annualized cost with debt service. Debt service assumes a 30-year payment period and a 2.5 percent interest rate. For the annualized cost, all capital is assumed to be financed; however, in the system model, only 25 percent of the capital is assumed to be financed. Within the factsheets, operating costs are further divided into annual fixed costs, which occur each year, and variable costs (such as energy and chemicals), which depend on the amount of flow through the facilities. **Figure 5-1** plots the annualized cost of each supply option for a visual comparison of the relative values. The 2018 annualized cost of the current potable water and reclaimed water system, including O&M costs and debt service, is also included on the figure for reference.

Table 5-4. Summary of Supply Options Costs

Type	Supply Options	Yield (MGD)	Capital Cost ($M)	Annual O&M Cost at Full Capacity ($M)	Annualized Cost ($/kgal)
Demand Side Management (DSM)	Baseline DSM[1]	4.97			$1.31
	Expanded DSM[1]	6.54			$2.39
Direct Potable Reuse (DPR)	Southwest	11	$122.9	$6.50	$3.08
	Buckman	10	$123.3	$7.58	$3.69
	Arlington East	10	$108.60	$5.95	$3.05
	Mandarin	5	$66.10	$3.33	$3.56
	Cedar Bay	5	$67.60	$3.34	$3.60
	Nassau	1.5	$34.80	$1.66	$6.07
Indirect Potable Reuse (IPR)	Southwest	9.9	$105.3	$5.34	$2.87
	Buckman	9	$109.6	$5.78	$3.35
	Arlington East	9	$99.10	$4.96	$2.95
	Mandarin	4.5	$64.10	$2.77	$3.55
	Cedar Bay	4.5	$64.10	$2.77	$3.55
	Nassau	1.35	$34.40	$1.37	$6.12
Traditional Reclaimed	Expanded Reclaimed in the South Grid	5.72	$75.5	$2.6	$2.97
	New Reclaimed in North Grid North	1.27	$27.4	$1.1	$5.20
	New Reclaimed in North Grid West	3.05	$65.3	$2.7	$5.23
	New Reclaimed in Nassau East	1.22	$26.3	$1.1	$5.29
	New Reclaimed in Nassau West	0.21	$4.5	$0.2	$5.06
Stormwater	Distributed Stormwater Collected from FDOT facilities	5	$82.90	$1.6	$3.04
Desalination	Brackish Groundwater	10	$132.70	$4.25	$2.90
	Brackish GW	5	$78.20	$2.40	$3.36
	St. Johns River Brackish Quality	10	$164.10	$7.33	$4.16
	St. Johns River Seawater Quality	10	$161.30	$8.85	$4.54
	Intracoastal Waterway Seawater Quality	10	$186.70	$10.22	$5.24
	Ocean	10	$329.20	$10.55	$7.20
Conveyance	North Grid Core City to North Grid West	2	$20.0	$0.37	$1.82
	North Grid Core City to North Grid North	2	$17.0	$0.32	$1.56
	North Grid West to Nassau West	2	$24.0	$0.42	$2.15
	South Grid East to South Grid Central	2	$16.7	$0.31	$1.52
	Third River Crossing (North Grid West to South Grid Central)	10	$147.3	$3.61	$2.92

[1]The costs for the DSM program are a net unit cost which includes the cost of the program and operational cost savings from conserving water.



**Conveyance options such as the Third River Crossing do not ultimately provide new supply and would need to be in addition to a new supply option in order to meet long term supply needs.*

Figure 5-1. Comparison of Annualized Cost of Supply Options

Section 6

Alternative Evaluation

As a component of the IWRP process, future water supply and demand side management options were combined into various baseline alternatives that were evaluated against the IWRP objectives. The baseline alternatives were designed to push the boundaries, by maximizing certain objectives in order to see trade-offs between them. Sensitivity analysis was also conducted on the baseline alternatives in order to test their potential exposure to risk and uncertainty.

The evaluation results and sensitivity analysis of the base alternatives was then used to develop hybrid alternatives which were designed to increase overall performance by balancing the scoring between the IWRP objectives. The hybrid alternatives then formed the basis for the recommended IWRP strategy for JEA.

6.1 Models and Tools

6.1.1 IWRP Systems Model

The IWRP Systems Model was developed using STELLA (Systems Thinking Experimental Learning Laboratory with Animation), which was created by isee systems. STELLA is a graphical system simulation package that allows users to model physical flow systems with operational-level or planning-level resolution. The software allows users to develop on-screen control interfaces that can facilitate rapid adjustments of system variables for alternatives and sensitivity analyses. Since dozens of alternatives are feasible (e.g., alternate water sources, use and reuse guidelines, operational triggers), STELLA can help planners and decision makers quickly screen information, identify key drivers, and understand their relationships using a high-level overview of an otherwise complex system.

STELLA can be used to generate information and promote more informed and balanced decisions via a rapid comparison of the performance of alternatives using physical, environmental, and economic metrics. Its ability to include multi-sectoral interests in an analytical framework distinguishes it from more traditional hydraulic or hydrologic models, which evaluate systems in a purely physical setting. STELLA models do not simulate finely discretized distribution or collection systems, groundwater aquifers, pumps, or hydraulic structures but does include key system elements and their interdependencies in a lower-resolution network framework in which physical, environmental, and economic response patterns can be effectively examined. The model results are used to judge the influence of projects and policies on IWRP performance metrics. Fast model run times allow for small, or incremental, changes to be made to arrive at solutions that achieve important objectives.

The JEA IWRP Systems Model runs a 53-year simulation beginning in 2018 and running through 2070 on a monthly time-step, allowing for data output for each month of the simulation. For each subgrid of the model, demands are differentiated between indoor and outdoor uses, as well as non-revenue water. Within the model, the demands can be adjusted for dry weather or wet weather conditions. The model can also be run utilizing average annual values, or with the seasonal monthly pattern, for the outdoor demands incorporated.

Capacity Constraints

In trying to meet projected water demands, the system model considers capacity constraints of the current infrastructure. Each water treatment plant has a specific CUP allocation and FDEP permitted capacity which the model aggregates per subgrid. The model also includes the ability to transfer raw water between the North Grid and South Grid via the two existing St. Johns River crossings, considering both the raw water available to be transferred as well as the hydraulic capacity of the pipelines. Treated water is also able to be transferred between subgrids on the South Grid via the distribution system. When meeting demand, water supplies within the model are first utilized within their local subgrid. If unmet demand remains, the model next looks for excess supply which can be transferred into the subgrid to meet the remaining demand.

Within the sewer system, the model considers the permitted capacity of each WRF and tracks future projected wastewater flow. The model also connects indoor water demands to projected wastewater flows so that any reductions in indoor water use via demand management is also reflected within the tracked wastewater flows.

For the reclaimed water system, the reclaimed water production capacity at each WRF is considered, as is reclaimed water usage on-site. At some plants where water for on-site use is pulled from the high service pumps, the on-site volume is subtracted from the available production capacity. At other plants, water for on-site use is pulled from discharge streams and does not impact the reclaimed water capacity for delivery off-site.

Each WRF also has a maximum ratio within the model for reclaimed water production compared to wastewater flow projections. Due to storage availability and diurnal flow patterns, the full wastewater flow is not available for use within the reclaimed water system. Values of 85 to 95 percent are used within the model based on available storage at each plant. The range was developed by examining flow ratios at Blacks Ford WRF before and after storage upgrades.

In the South Grid, where the reclaimed water system has interconnected plants, the model includes transmission capacity between subgrids to allow for the distribution of reclaimed water to meet non-potable demands. Similar to the potable water system, the reclaimed water system in the model first uses the local WRFs to provide supply and then takes available flow from farther plants if unmet demand remains. If there are reclaimed water demands which cannot be met via the reclaimed water system, the model assumes the demand is met with potable supply. A list of main constraints included within the model for each system is provided in **Table 6-1**, a more complete list of all model inputs is provided in **Appendix C**.

Table 6-1. Summary of Modeled System Constraints

System	Modeled Constraints
Water System	Subgrid CUP allocation Subgrid well field permitted capacity Hydraulic capacity of SIPS lines Raw water available to SIPS lines Finished water transfer capacity between subgrids
Sewer System	Permitted capacity per plant Projected wastewater flows
Reclaimed Water System	Production capacity per plant South Grid reclaimed water transfer capacity between subgrids Mandarin offsite pumping restriction Ratio of reclaimed water production to wastewater flow projections On-site reclaimed water usage

Modeled Demand

The demand input for the model is the IWRP demand forecast under average weather conditions for each subgrid, divided into indoor and outdoor demands. The outdoor demands are increased or decreased depending on if dry or wet conditions are selected, and monthly peaking factors are also added to the outdoor water demands. The model then incorporates the 10.3 percent for non-revenue water on top of the combined indoor and outdoor demands. Contracted water provided to SJCUD is a separate input within the model to be served by the potable water system.

The reclaimed water demand in the model is the baseline committed reclaimed water for each subgrid plus any expansions selected. Reclaimed water to bulk customers as well as SJCUD is also an input. The model also incorporates the 80 percent increase in demand as new customers are added to the reclaimed water system. Thus, as reclaimed water use grows, the total demand also grows.

Water Supply Options

As new supply options are considered within the model, there is a set order to how supplies are assigned to meet demands. The logic within the model is meant to assess if there is adequate supply to meet demand under the scenarios analyzed and not to represent operational decisions.

1. **Conservation:** Savings from any demand management options are subtracted from the demand before water supply sources are considered. Projected savings are assigned to either indoor or outdoor water demands

2. **Reclaimed Water**: The model serves reclaimed water demands before potable demands, so that any unmet demands from the reclaimed water system can then be served by potable water supplies. Reclaimed water demands within each subgrid are first meet by WRFs within that subgrid. Remaining supplies can then be transferred to other subgrids with remaining demands as capacity constraints allow.

3. **Purified Water for Direct Use**: Any direct use of purified water is supplied first within the model to meet potable demands. This supply is utilized first since there is no long-

term storage available. However, DPR cannot serve more than 50 percent of demand within a subgrid due to assumed blending requirements.

4. **Brackish Groundwater**: Any brackish groundwater options are used within the model next to meet demand.

5. **Surface Water Desalination**: Any surface water desalination projects utilizing water from the St Johns River, Intracoastal Waterway, or Atlantic Ocean are used next to meet demand.

6. **Purified Water for Aquifer Recharge:** The model tracks how much purified water has been stored in the aquifer for future use. When utilized in the same subgrid as originally injected, the model assumes 90 percent of the water stored is available for utilization. The assumption drops to 75 percent if the water is utilized in a different subgrid; although only withdrawals from the same side of the St. Johns River as originally recharged are allowed within the model (i.e., water injected within the North Grid cannot then be pumped from South Grid wellfields for utilization).

7. **Traditional Groundwater:** Any remaining demand after utilization of the new supply sources is met with traditional groundwater under the CUP.

Another key component of the model is tracking the flow available for utilization within the reclaimed water system and potential reuse projects. **Figure 6-1** shows the assumed losses moving from reclaimed water to purified water for either direct potable use or aquifer recharge.

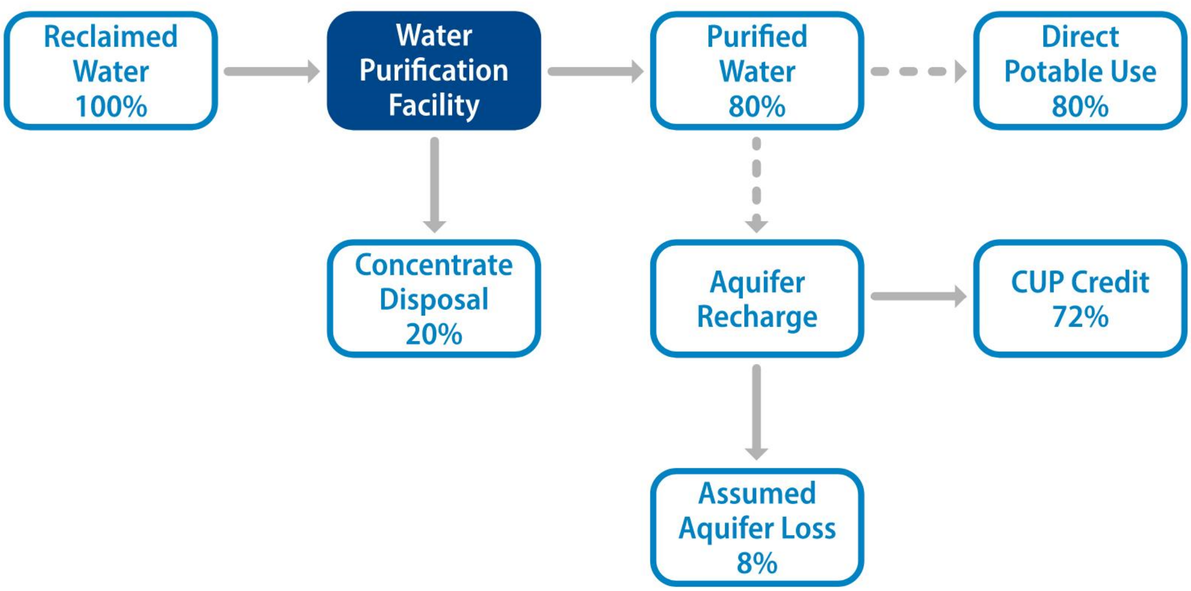


Figure 6-1. Diagram of Flow from Reclaimed Water to Purified Water Uses

6.1.2 Demand Side Management Tools

To estimate the cost-effectiveness of DSM measures, a DSM End Use Model was developed by CDM Smith that breaks down JEA's water use by sector (e.g., Single-Family Residential, Multifamily, CII) and by major end uses of water (e.g., toilets, showers, landscape irrigation, cooling towers, etc.). **Figure 6-2** depicts the major structure of JEA's DSM end-use model.

The JEA Demand Forecast contains a current gallons per day (gpd) value for each water use category, as well as the current and future number of housing units by water use category per subgrid. The housing units by water use category were used in the End-Use Model in order to identify potential customer groups for targeting water DSM measures.

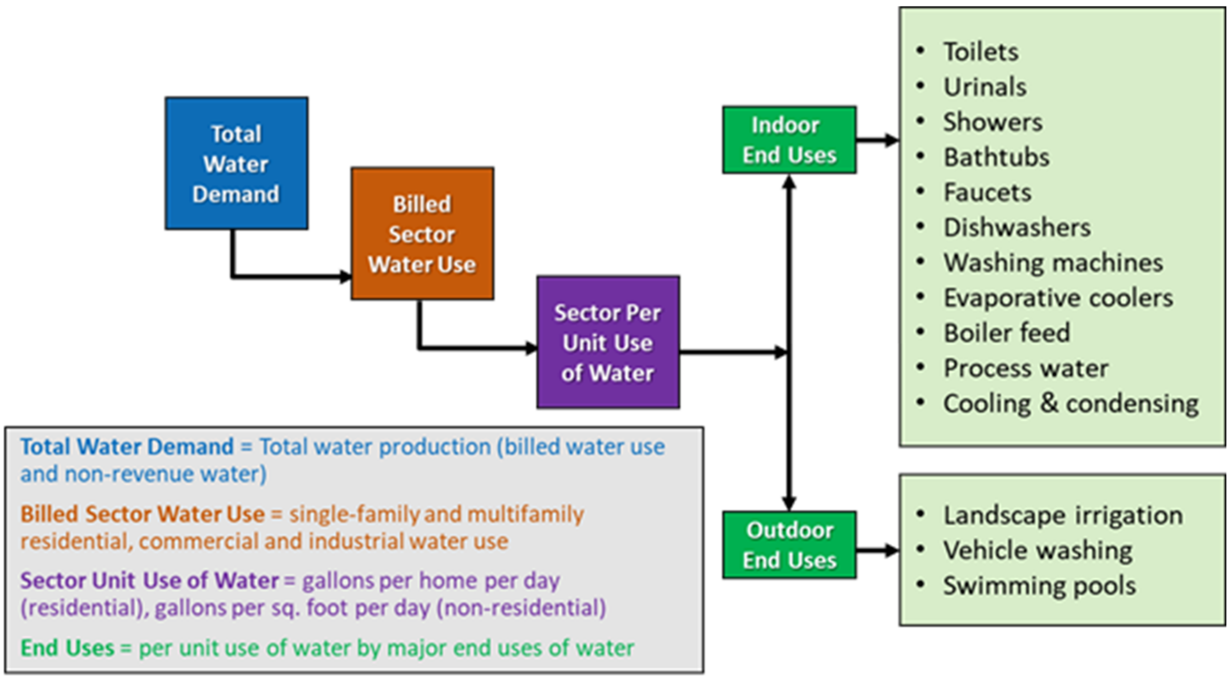


Figure 6-2. Major Structure of JEA's DSM End-Use Model

To estimate the cost-effectiveness of DSM measures, CDM Smith also developed the DSM Economic Tool that incorporates the following:

- Estimated water savings by DSM measure per participating unit (e.g., household) from the DSM End-Use Model
- Estimated customer participation pools from the IWRP water demand forecast
- Estimated costs for DSM measures from literature review, and
- Estimated utility benefits from reduced water demands

This tool can evaluate the cost-effectiveness of both individual DSM measures and the overall DSM strategy or program. Complete details on these tools can be found in the ***JEA Water DSM Strategy Report***.

6.1.3 Criterium Decision Plus

The performance metrics, along with metric weights and objective weights, are input into a multi-criteria decision analysis software package called Criterium Decision Plus™. This decision software program normalizes the metrics (since they are measured in different units), applies the weights of importance, and then ranks the alternatives. A decision score is generated for each objective and a total score is generated for each alternative. This allows for any trade-offs to be easily seen.

Figure 6-3 presents an overview of the multi-attribute rating technique used in CDP for each of the portfolios or alternatives.

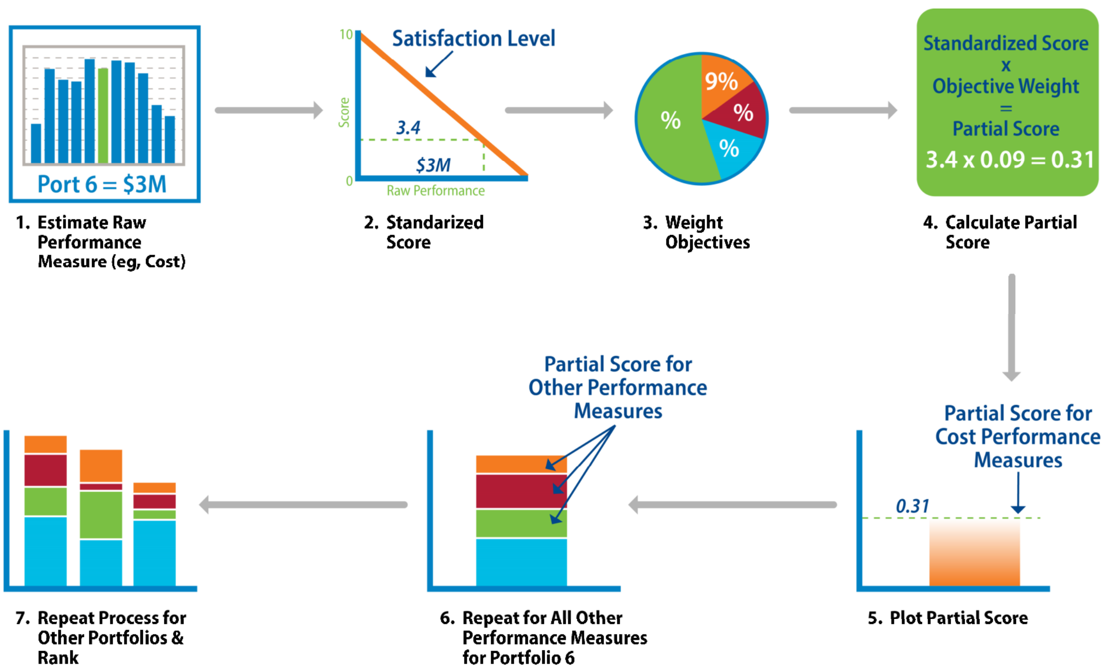


Figure 6-3. Multi-Attribute Rating Technique Used by CDP Software to Score Portfolios

The multi-attribute rating technique uses seven steps to score and rank portfolios:

- **Step 1** compares the raw performance for all the portfolios for a given metric. In this example, Portfolio 6 has a raw cost (or performance) of $3 million.
- **Step 2** standardizes the performance into a score from 0 to 10. In the above example, Portfolio 6's cost performance is fairly expensive, so its standardized score is fairly low (e.g., 3.4 out of 10). This step is important because performance can be measured in different units for each metric (i.e., cost in dollars, energy in kWh).
- **Step 3** assigns weights to the metrics.

- **Step 4** calculates a partial score for a given portfolio based on the multiplication of the standardized score (Step 2) and weight (Step 3).
- **Step 5** plots the partial score.
- **Step 6** repeats the process for all the other performance measures. This creates a total score for the portfolio.
- **Step 7** repeats all the previous steps for any other portfolios, so they can be compared and ranked.

6.2 Baseline Alternatives and Evaluation

6.2.1 Defining Baseline Alternatives

In order to define a set of baseline alternatives, every viable alternative was set to meet a minimum level of reliability, which was defined as the maximum month water demand during average weather in 2040. Four baseline alternatives were developed. All met this minimum reliability threshold, but varied in terms of cost, ability to reliably meet dry water demands in 2040 and 2070, environmental benefits, implementation ease, and operational flexibility. In addition, three other baseline alternatives were developed as comparative alternatives. These three other baseline alternatives were designed to answer several questions that were raised by JEA senior management, such as: "What level of reliability would be achieved with only committed capital projects?" or "Could JEA be fully reliable by expanding traditional reclaimed water in the South Grid or by greatly expanding water conservation?" **Table 6-2** presents the definition of the baseline alternatives, while **Table 6-3** presents the supply and water conservation options that are included in the alternatives.

Table 6-2. Definition of Baseline Alternatives

Alternative Name	Definition
No Action*	Current groundwater and existing reclaimed plus committed reclaimed water in the South Grid, with no additional (future) water supply or water conservation included.
Expanded Water Conservation*	Expanded levels of water conservation, coupled with existing reclaimed plus committed reclaimed water in the South Grid.
Expanded Reclaimed System in South Grid*	Committed and new expansions of reclaimed water in the South Grid, coupled with baseline level of water conservation.
Low Cost	Committed and new expanded reclaimed water in South Grid, brackish groundwater desalination, new intra-grid conveyance, and expanded levels of water conservation.
Minimize Treated Wastewater Discharge to St. Johns River (DPR Focus)	Committed and new expanded reclaimed water in the South Grid, direct potable reuse projects, new intra-grid conveyance, and baseline levels of water conservation.
Minimize Treated Wastewater Discharge to St. Johns River (IPR Focus)	Committed and new expanded reclaimed water in the South Grid, indirect potable reuse, new intra-grid conveyance, and baseline levels of water conservation.
High Reliability	Committed and new expanded reclaimed water in the South Grid, brackish desalination, including river/intracoastal desalination, new intra-grid conveyance, and baseline levels of water conservation.

* Does not meet minimum reliability threshold, developed only for comparative purposes.

Table 6-3. Options Included in Baseline Alternatives

			Alternative mgd yield (year active)						
Supply Group	**Supply Option**	**Plant/Subgrid**	**No Action**	**Expanded Water Conservation**	**Expanded Reclaimed System in South Grid**	**Low Cost**	**Minimize Discharge (DPR)**	**Minimize Discharge (IPR)**	**High Reliability**
Water Conservation	Baseline	All			5.0		5.0	5.0	5.0
	Expanded	All		6.5		6.5			
Potable Reuse	Direct Potable Reuse	N North (Cedar Bay)					5 (2030)		
		Nassau E (Nassau)					1.5 (2025)		
		N West (Southwest)					11 (2034)		
		N Core City (Buckman)					10 (2050)		
		S Arlington (Arlington East)					5 (2035)		
		S Central (Mandarin)							
	Indirect Potable Reuse	N North (Cedar Bay)						4.5 (2030)	
		Nassau E (Nassau)						1.35 (2025)	
		N West (Southwest)						9.9 (2034)	
		N Core City (Buckman)						9 (2050)	
		S Arlington (Arlington East)						4.5 (2035)	
		S Central (Mandarin)							
Desal	Brackish Groundwater	N Core City							
		N North				3.5 (2030)			5 (2060)
		N West				3 (2039)			15 (2034)
		Nassau E				2.5 (2025)	2 (2025)	2 (2025)	
		Nassau W							
		S Arlington							
		S Central							4 (2025)
		S East							
		S SJC							
	St. Johns River in Jacksonville	N North							
		N North and S Arlington							10 (2030); 20 (2042)
	St. Johns River at Shands Bridge	S SJC							5 (2052)
	Intracoastal	Nassau East							3 (2025) 5 (2042)
	Ocean	S East							
Traditional Reclaimed	Committed Reclaimed	South Grid	16.5	16.5	16.5	16.5	16.5	16.5	16.5
	Expanded Reclaimed	N North					1.3	1.3	
		N West					3.1	3.1	
		Nassau E							
		Nassau W					0.2	0.2	
		S East			1.7	1.7	1.7	1.7	
		S SJC			4	4	4	4	
	Stormwater Aug.	South Grid							
Other	Additional Subgrid Conveyance	Core City to N West							2 (2055)
		Core City to N North							
		N West to Nassau W				2 (2025)	2 (2025)	2 (2025)	2 (2025)
		S East to S Central							
		Additional River Crossing							

6.2.2 Evaluation of Baseline Alternatives

JEA's IWRP systems model was used to evaluate the baseline alternatives for all but one of the performance metrics. A description of how each performance measure was calculated is provided in the following sections.

Water Supply Certainty

The IWRP systems model tracks potential maximum monthly water shortages for average and dry weather years, by grid and through time. These shortages are divided by the maximum monthly water demands in order to estimate the amount of water demand met, expressed as a percent of demand. As an example, **Figure 6-4** presents this calculation for the Minimize Treated Wastewater Discharge with IPR Focus Alternatives. Two time periods are used for the overall scoring for this metric, namely 2040 and 2070.

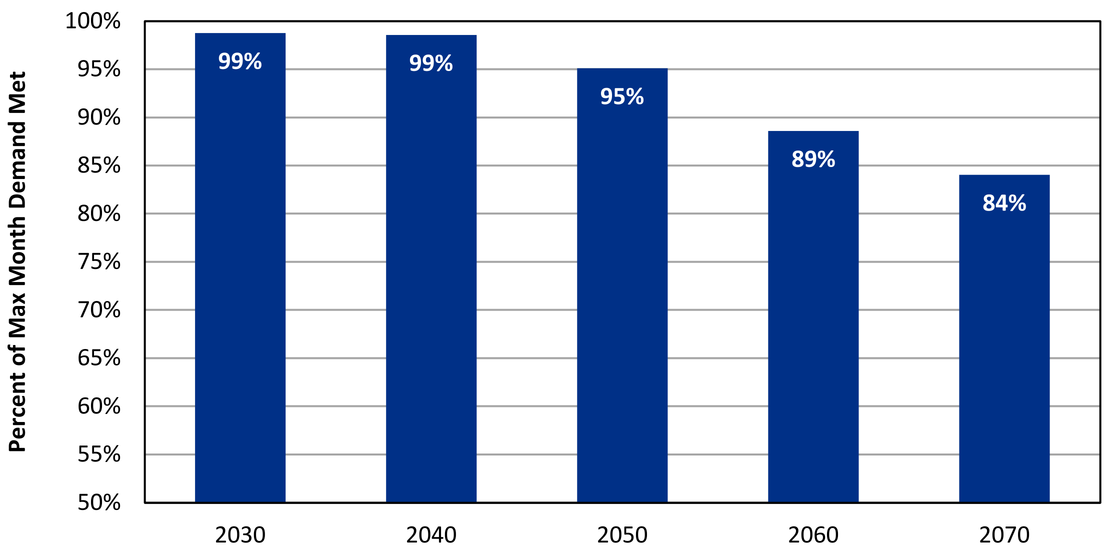


Figure 6-4. Ability to Meet Water Demand Performance Metric for the Minimize Treated Wastewater Discharge to St. Johns River (IPR) Alternative

Cost-Effectiveness

There are two performance metrics to evaluate cost-effectiveness. The change in total unit cost from 2020 to 2040 emphasizes potential near-term rate impacts while the levelized unit cost of new supplies and conservation through 2070 evaluates costs over the full modeled period.

Change in Total Unit Cost (2020 to 2040)

To estimate the potential financial impacts to JEA and its customers, the change in total unit cost for JEA's water, sewer, and reclaimed water from 2020 to 2040 was estimated for each alternative. The cost components for this calculation include:

- *Existing Costs Common to All Alternatives:* For the year 2020, all the baseline alternatives had the same existing costs for JEA's water, sewer, and reclaimed water systems. These existing costs were then divided into the sum of all potable water sales, wastewater treated effluent, and reclaimed water deliveries to get an existing unit cost ($/1,000 gallons).

- *Planned Future Costs Common to All Alternatives:* For the year 2040, all the baseline alternatives also included new capital costs and associated O&M costs for committed JEA projects. These projects included planned expansion of the reclaimed water system, upgrades to several water reclamation facilities, and several new smaller water reclamation facilities.

- *Supply Option Costs that Differ for Each Alternative:* For the year 2040, capital costs and O&M costs for new water supply options and water conservation that are unique to each baseline alternative were added to the planned future costs as described above.

- *2040 Unit Cost:* The planned future costs common to all alternatives plus the new future costs that differ for each alternative were then added together and divided by potable water sales, treated wastewater effluent, and reclaimed water deliveries in order to get a 2040 unit cost ($/1,000 gallons).

- *Change in Total Unit Cost:* The difference between 2020 and 2040 unit cost is then calculated as the final metric.

Levelized Unit Cost of New Supplies Through 2070

The levelized unit cost of new supplies through 2070 represents a good metric for assessing the overall cost-effectiveness for the baseline alternatives. The levelized unit cost is estimated by using the following calculations:

- Capital and O&M costs for new supplies and conservation through 2070 are summed and then brought back to present value terms using a real discount rate of 2.5 percent for each alternative.

- Supply yield through 2070 is summed and then brought back to present value terms using a real discount rate of 2.5 percent for each alternative.

- The present value cost is divided by the present value supply yield in order to get a levelized unit cost for new supplies ($/1,000 gallons).

Environmental Stewardship

Two performance metrics were utilized to capture the environmental benefits from reduced discharges to the St. Johns River as well as improved aquifer sustainability through reduced reliance on groundwater.

Reduction of Treated Wastewater Discharge to St. Johns River

The JEA IWRP model estimates future wastewater collection as a function of projected indoor water demands. The model also tracks how much collected wastewater is treated and discharged to the St. Johns River. For each alternative, the amount of reclaimed water delivery plus indirect and direct potable reuse is totaled as treated wastewater no longer being discharged. In addition, future water conservation is separated into indoor and outdoor water savings, with indoor water savings also reducing treated wastewater discharge. The metric is calculated as the net reduction to discharges between 2070 and 2018 for a given alternative.

Reduction in Annual Reliance on Groundwater

The JEA IWRP model tracks the usage of current and future water supply sources. For this metric the percent of demand served by groundwater in 2040 for each alternative is compared to the no action alternative to determine how much the alternative has reduced JEA reliance on groundwater to meet supply. This metric is calculated under average weather conditions within the model.

Community Acceptance of New Supplies

Community Acceptance

The community acceptance metric is qualitative in nature, and the scoring is based the best judgement of JEA staff and the consultant team. The overall score was split into two separate components: community perceived benefits and community concerns. These were then averaged into an overall community acceptance score. The scoring criteria utilized to guide the scoring for the metric is provided in **Table 6-4**. Proposed scores for community acceptance for each supply option are provided in **Table 6-5**. Notes on why each score was given are provided within the factsheets in **Appendix B**. The final metric for an alternative is calculated by taking a weighted average of the community acceptance scores for each supply based on the amount utilized in 2040 under average weather.

Table 6-4. Qualitative Performance Measure Scoring Criteria

Planning Metric	Qualitative Metric	Scoring Criteria
Community Acceptance of New Supplies	Community Perceived Benefits	1=low degree of perceived benefits by community 5=high degree of perceived benefits by community
	Community Concerns	1=significant community concerns to be addressed 5=full community support expected
	Community Acceptance	Average of Community Perceived Benefits and Community Concerns Scores

Table 6-5. Qualitative Scores per Supply Option

Supply Options	Community Benefits	Community Concerns	Community Acceptance
Demand Side Management	5	4	4.5
Direct Potable Reuse	3	2	2.5
Indirect Potable Reuse	4	4	4
Expanded Reclaimed Water	5	5	5
Stormwater	4	4	4
Desalination: Brackish Groundwater	3	3	3
Desalination: St. Johns River at Shands Bridge	2	2	2
Desalination: St. Johns River at NGS Site	2	2	2
Desalination: Intercoastal	2	2	2
Desalination: Ocean	2	1	1.5
Traditional Floridan Groundwater including Conveyance	3	4	3.5

Simplicity of Implementation

The multiplication of the number of projects and the number of supply sources produces a metric that is used to represent ease of implementation challenges, with smaller numbers indicating greater implementation ease.

Operational Flexibility

Operational flexibility is measured as the increased capacity to move water supply between grids or subgrids through 2070. Supply options improving operational flexibility include conveyance projects and indirect potable reuse.

6.2.3 Ranking Alternatives

The performance metrics scores for each baseline alternative are summarized in **Table 6-6**. These performance metric scores, along with metric weights and objective weights, were input into Criterium Decision Plus™ to produce a decision score for each objective and a total for each alternative. The ranking of baseline alternatives is presented on **Figure 6-5**.

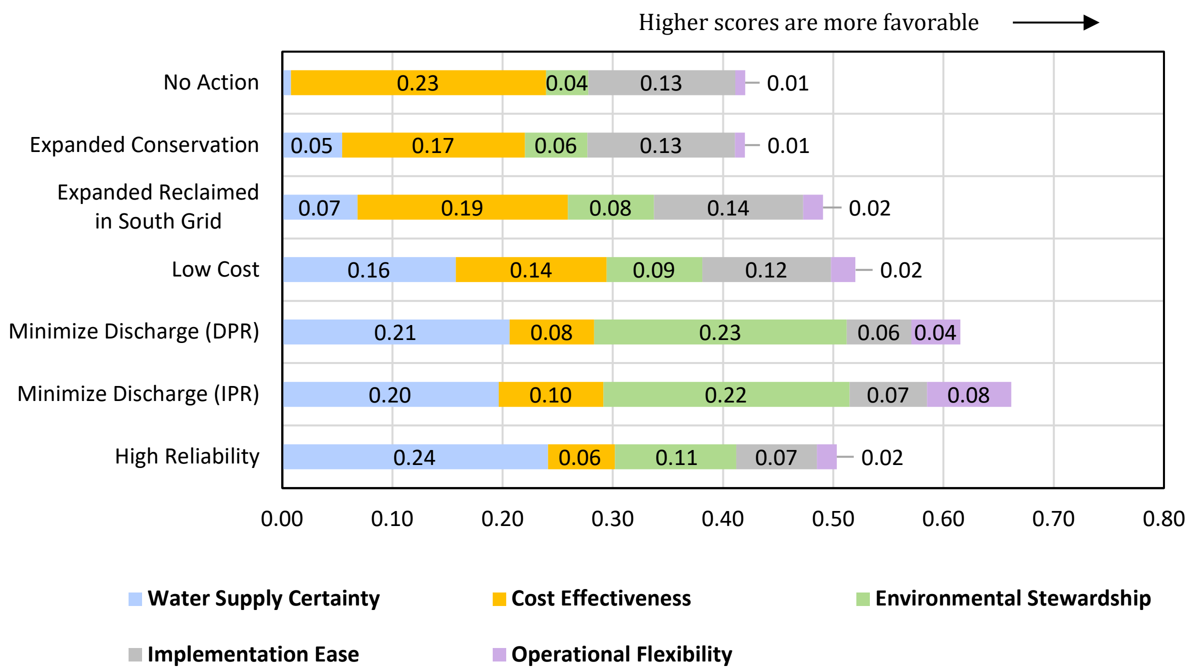


Figure 6-5. Ranking of Baseline Alternatives

The longer the colored bars shown in the bar graph on Figure 6-5, the better the performance for the five objectives. Results of this ranking indicate that the two Minimize Discharge alternatives (i.e. DPR and IPR) have the best overall score due to both the high levels of water supply certainty and the very high levels of environmental benefits.

Table 6-6. Performance Metrics for Baseline Alternatives

Objective	Performance Measures	Units	Better Score	Baseline Alternatives: No Action*	Expanded Conservation*	Expanded Reclaimed in South Grid*	Low Cost	Minimize Discharge (DPR)	Minimize Discharge (IPR)	High Reliability
Water Supply Certainty	Ability to meet 2040 demands (max month dry weather)	%	higher	83%	87%	89%	97%	99%	99%	100%
	Ability to meet 2070 demands (max month dry weather)	%	higher	71%	73%	72%	76%	87%	84%	97%
Cost-Effectiveness	Change in unit cost from 2020 to 2040	$/kgal	lower	$1.24	$0.98	$1.50	$3.52	$6.80	$5.99	$6.96
	Levelized unit cost of new supplies and conservation in 2070	$/kgal	lower	$0.00	$3.12	$1.65	$2.72	$3.20	$2.93	$3.82
Environmental Stewardship	Reduction of treated wastewater discharge to the St. John's River by 2070	MGD	higher	15.3	18.9	23	23.3	67.2	67.2	18.5
	Reduction in annual reliance on groundwater by 2040 under average weather	%	higher	0%	2.5%	5.5%	7.6%	16.3%	14.8%	17.0%
Community Acceptance / Implementation Ease	Community acceptance	Qual	higher	4.12	4.29	4.44	4.39	3.90	4.52	3.53
	Simplicity of Implementation	Projects * Supplies	lower	0	2	3	16	52	52	36
Operational Flexibility	Increased capacity to move water supply between subgrids through 2070	MGD	higher	4	4	8	10	20	34.4	8

*These alternatives do not meet the minimum threshold for watersupply certainty and are shown only for comparitive purposes.

6.3 Risk Assessment

A number of uncertainties were analyzed to determine risk. These uncertainties were narrowed down to five sensitivities which were then analyzed for the four baseline alternatives that met the minimum reliability threshold:

1) **Reduction in Traditional Groundwater CUP:** The uncertainty of future allowable withdrawals from the Floridan aquifer, with a 10 percent reduction in current CUP allocation.

2) **Groundwater Withdrawal Limitations:** The difficulty in withdrawing anticipated groundwater for indirect potable reuse credit and brackish desalination, with a 50 percent IPR recovery ratio and 50 percent reduction in groundwater produced from brackish desalination outside of the South Grid.

3) **Zero Liquid Discharge:** The increased capital and O&M costs associated with zero liquid discharge concentrate disposal for IPR, DPR, and desalination options (i.e. brackish GW and surface).

4) **Membrane Treatment Technology:** The decreased capital and O&M costs associated with future technology gains in membrane treatment, assuming a 30 percent decrease in capital cost and 10 percent decrease in O&M cost.

5) **Stranded Cost:** The stranded capital costs associated with greater levels of water conservation that occur after new water supply projects are implemented.

6.3.1 Reduction in Traditional Groundwater CUP

Table 6-7 presents impacts on supply reliability assuming a 10 percent reduction in the current CUP allocation within all subgrids for groundwater from the Floridan aquifer. The Low Cost alternative has the greatest risk exposure to CUP reductions, while the high reliability alternative has the least exposure. Greater amounts of alternative water supply within an alternative can balance out CUP reductions with less impact to the overall supply reliability.

Table 6-7. Risk Assessment for Reduction in Traditional Groundwater CUP

Alternative	Ability to Meet 2040 Demands (max month dry weather)			Ability to Meet 2070 Demands (max month dry weather)		
	Original	Sensitivity	Change	Original	Sensitivity	Change
Low Cost	96.6%	86.8%	↓9.8%	76.3%	69.6%	↓6.7%
Minimize Discharge (DPR)	98.9%	94.0%	↓4.9%	86.8%	82.7%	↓4.1%
Minimize Discharge (IPR)	98.6%	93.6%	↓5.0%	84.0%	78.7%	↓5.3%
High Reliability	100%	97.4%	↓2.6%	96.5%	91.3%	↓5.2%

6.3.2 Groundwater Withdrawal Limitations

Table 6-8, shown below, presents the impacts on supply reliability assuming reductions in anticipated groundwater from IPR credit and brackish desalination for 2040 and 2070. In 2040, the Minimize Discharge (DPR) and High Reliability alternatives have the lowest risk exposure, i.e. they provide the greatest resiliency if anticipated groundwater recovery is lower than anticipated. By 2070, only the Minimize Discharge (DPR) alternative provides resiliency against this uncertainty.

Table 6-8. Risk Assessment for Groundwater Withdrawal Limitations

Alternative	Ability to Meet 2040 Demands (max month dry weather)			Ability to Meet 2070 Demands (max month dry weather)		
	Original	Sensitivity	Change	Original	Sensitivity	Change
Low Cost	96.6%	92.3%	↓4.3%	76.3%	74.5%	↓1.8%
Minimize Discharge (DPR)	98.9%	98.3%	↓0.6%	86.8%	86.4%	↓0.4%
Minimize Discharge (IPR)	98.6%	94.2%	↓4.4%	84.0%	79.2%	↓4.8%
High Reliability	100%	99.4%	↓0.6%	96.5%	92.7%	↓3.8%

6.3.3 Concentrate Disposal via Zero Liquid Discharge

Table 6-9, shown below, presents the increased costs associated with zero liquid discharge concentrate disposal for projects that produce brine from advanced water treatment. In terms of capital cost, the High Reliability alternative has the most risk exposure to this uncertainty in cost increase and in percent change in cost, followed by the Minimize Discharge alternatives (both IPR and DPR). In terms of O&M costs, the High Reliability alternative also has the greatest cost increase.

Table 6-9. Risk Assessment for Zero Liquid Discharge Concentrate Disposal

Alternative	Capital Costs ($M)			O&M ($M)		
	Original	Sensitivity	Change	Original	Sensitivity	Change
Low Cost	$291	$431	↑48%	$8	$15	↑84%
Minimize Discharge (DPR)	$673	$1,278	↑90%	$31	$49	↑62%
Minimize Discharge (IPR)	$634	$1,239	↑95%	$26	$44	↑65%
High Reliability	$962	$1,947	↑102%	$38	$73	↑94%

6.3.4 Membrane Treatment Technology

Table 6-10, shown below, presents the decreased costs associated with future technology gains for projects that rely on advanced membrane treatment. The High Reliability alternative has the largest benefit of reduced capital and O&M costs, followed by the Minimize Discharge alternatives (both IPR and DPR).

Table 6-10. Risk Assessment for Membrane Treatment Technology Cost Improvements

Alternative	Capital Costs ($M)			O&M ($M)		
	Original	Sensitivity	Change	Original	Sensitivity	Change
Low Cost	$291	$236	↓19%	$8.1	$7.6	↓6%
Minimize Discharge (DPR)	$673	$532	↓21%	$31	$28	↓8%
Minimize Discharge (IPR)	$634	$505	↓20%	$26	$24	↓7%
High Reliability	$962	$689	↓28%	$38	$34	↓10%

6.3.5 Stranded Costs

Table 6-11, shown below, presents the potential stranded capital costs if new water supply projects are implemented and the water conservation savings is greater than projected. The High Reliability alternative has the greatest potential for stranded investments in absolute value, while the Low Cost alternative has the greatest potential on a percentage basis.

Table 6-11. Risk Assessment for Stranded Costs

Alternative	Capital Costs ($M)		
	Original	Sensitivity	Change
Low Cost	$291	$164	↓56%
Minimize Discharge (DPR)	$673	$138	↓20%
Minimize Discharge (IPR)	$634	$130	↓20%
High Reliability	$962	$173	↓18%

6.3.6 Risk Assessment Summary

Table 6-12, shown below, provides an overall assessment of the baseline alternatives in terms of their ranking and exposure to risk from the sensitivity analysis. A green color indicates relatively greater benefits/lower risk, while a red color indicates relative lower benefits/higher risk. A yellow color indicates the benefits/risk lie somewhere in-between green and red. The results of this comprehensive assessment of baseline alternatives can be used to develop higher-performing hybrid alternatives, which will be the next phase of the IWRP process.

Table 6-12. Baseline Alternatives Risk Assessment Summary

Alternative	Rank Score	CUP Reduction	Groundwater Recovery	Concentrate Disposal	Membrane Technology Cost	Stranded Investment Risk
Low Cost	0.52	High	High	Low	Medium	High
Minimize Discharge (DPR)	0.62	Medium	Low	Medium	High	Medium
Minimize Discharge (IPR)	0.66	Medium	High	Medium	High	Medium
High Reliability	0.50	Low	Medium	High	High	High

Based on this “heat map”, the High Reliability and Low Cost alternatives have lower rank scores and higher potential risk exposure to uncertainties. While the Minimize Discharge (IPR) alternative has the best rank score. It has a slightly higher risk exposure compared to the Minimize Discharge (DPR) alternative.

6.4 Hybrid Alternatives and Evaluation

The baseline alternatives evaluation and risk assessment were used in the development of hybrid alternatives. Hybrid alternatives are not constrained by themes but instead can contain any mix of project options with the goal of improving overall scores and more fully achieving the IWRP objectives. The mix of projects was adjusted in an iterative process before arriving at a final recommended strategy.

The following conclusions can be made based on the evaluations of baseline and hybrid alternatives:

1. Single-family residential water customers account for most of JEA's water demands, at about 62 percent of current total demand.

2. Landscape irrigation can represent 20 to 92 percent of total single-family residential water demand, with an overall service area average of almost 60 percent for landscape irrigation. The range is noticeably large due to the fact that it is greatly dependent on the residential lot size and affluence of the neighborhoods.

3. If all JEA's water customers were at their maximum-level of water efficiency for indoor and outdoor water uses, the theoretical water conservation savings by 2040 would be about 20 mgd. This would be extremely costly and difficult to achieve.

4. Building on JEA's Water DSM Strategy Report, more achievable water conservation savings under the IWRP range from 4 to 7 mgd by 2040.

5. Traditional reclaimed water supply used to meet non-potable water demands can be beneficial within service areas where JEA has already made substantial investments in water reclamation treatment and reclaimed conveyance.

6. Implementation of targeted water conservation as well as use of traditional reclaimed water will allow JEA to use greater amounts of groundwater under its CUP, yet there will be additional needs for alternative water supplies between 2025 and 2030 in order to meet seasonal water demands under dry weather conditions.

7. Potable reuse, either indirect or direct, offers multiple benefits such as providing alternative water supplies and reducing the discharge of treated wastewater discharge to the St. Johns River. However, the source for this water supply (e.g., location of WRFs) is not always ideal.

8. In some JEA service areas, brackish groundwater desalination is more cost-effective and easier to implement than potable reuse due to the size or location of available WRFs.

9. Water conveyance and river crossings to transfer available groundwater from one area to another area (with greater supply needs) can be beneficial, as long as future water demands in the area where groundwater is being transferred from do not increase significantly and cause stranded conveyance investments.

The options included within the final recommended strategy as compared to the four main baseline alternatives is provided in **Table 6-13** while the performance metric scores are summarized in **Table 6-14**. When the performance metric scores were normalized and weighted the final ranking of the recommended strategy compared to the baseline alternatives is presented in **Figure 6-6**. As seen, the recommended strategy performs best overall.

Table 6-13. Options Included in the Recommended Strategy Compared to Baseline Alternatives

Supply Group	Supply Option	Plant/Subgrid	Low Cost	Minimize Discharge (DPR)	Minimize Discharge (IPR)	High Reliability	Recommended Strategy
Water Conservation	Baseline	All		5.0	5.0	5.0	
	Expanded	All	6.5				6.5
Potable Reuse	Direct Potable Reuse	N North (Cedar Bay)		5 (2030)			
		Nassau E (Nassau)		1.5 (2025)			
		N West (Southwest)		11 (2034)			
		N Core City (Buckman)		10 (2050)			20(2050)
		S Arlington (Arlington East)		5 (2035)			
		S Central (Mandarin)					
	Indirect Potable Reuse	N North (Cedar Bay)			4.5 (2030)		2 (2030); 4 (2035)
		Nassau E (Nassau)			1.35 (2025)		
		N West (Southwest)			9.9 (2034)		3(2035); 9(2043)
		N Core City (Buckman)			9 (2050)		
		S Arlington (Arlington East)			4.5 (2035)		5(2027)
		S Central (Mandarin)					
Desal	Brackish Groundwater	N Core City					
		N North	3.5 (2030)			5 (2060)	2(2040); 5(2045); 9(2054)
		N West	3 (2039)			15 (2034)	
		Nassau E	2.5 (2025)	2 (2025)	2 (2025)		2(2030); 3(2040); 4(2047)
		Nassau W					
		S Arlington					
		S Central				4 (2025)	
		S East					
		S SJC					
	St. Johns River in Jacksonville	N North					
		N North and S Arlington				10 (2030); 20 (2042)	
	St. Johns River at Shands Bridge	S SJC				5 (2052)	
	Intracoastal	Nassau East				3 (2025) 5 (2042)	
	Ocean	S East					
Traditional Reclaimed	Committed Reclaimed	South Grid	16.5	16.5	16.5	16.5	16.5
	Expanded Reclaimed	N North		1.3	1.3		
		N West		3.1	3.1		
		Nassau E					1
		Nassau W		0.2	0.2		
		S East	1.7	1.7	1.7		
		S SJC	4	4	4		3
	Stormwater Aug.	South Grid					
Other	Additional Subgrid Conveyance	Core City to N West				2 (2055)	
		Core City to N North					
		N West to Nassau W	2 (2025)	2 (2025)	2 (2025)	2 (2025)	2 (2030)
		S East to S Central					
		Additional River Crossing					

Table 6-14. Performance Metrics for Recommended Strategy Compared to Baseline Alternatives

Objective	Performance Measures	Units	Better Score	Low Cost	Minimize Discharge (DPR)	Minimize Discharge (IPR)	High Reliability	Recommended Strategy
Water Supply Certainty	Ability to meet 2040 demands (max month dry weather)	%	higher	97%	99%	99%	100%	99%
	Ability to meet 2070 demands (max month dry weather)	%	higher	76%	87%	84%	97%	98%
Cost-Effectiveness	Change in unit cost from 2020 to 2040	$/kgal	lower	$3.52	$6.80	$5.99	$6.96	$4.78
	Levelized unit cost of new supplies and conservation in 2070	$/kgal	lower	$2.72	$3.20	$2.93	$3.82	$3.43
Environmental Stewardship	Reduction of treated wastewater discharge to the St. John's River by 2070	MGD	higher	23.3	67.2	67.2	18.5	67.7
	Reduction in annual reliance on groundwater by 2040 under average weather	%	higher	7.6%	16.3%	14.8%	17.0%	11.5%
Community Acceptance / Implementation Ease	Community acceptance	Qual	higher	4.39	3.90	4.52	3.53	4.42
	Simplicity of Implementation	Projects * Supplies	lower	16	52	52	36	55
Operational Flexibility	Increased capacity to move water supply between subgrids through 2070	MGD	higher	10	20	34.4	8	43.5

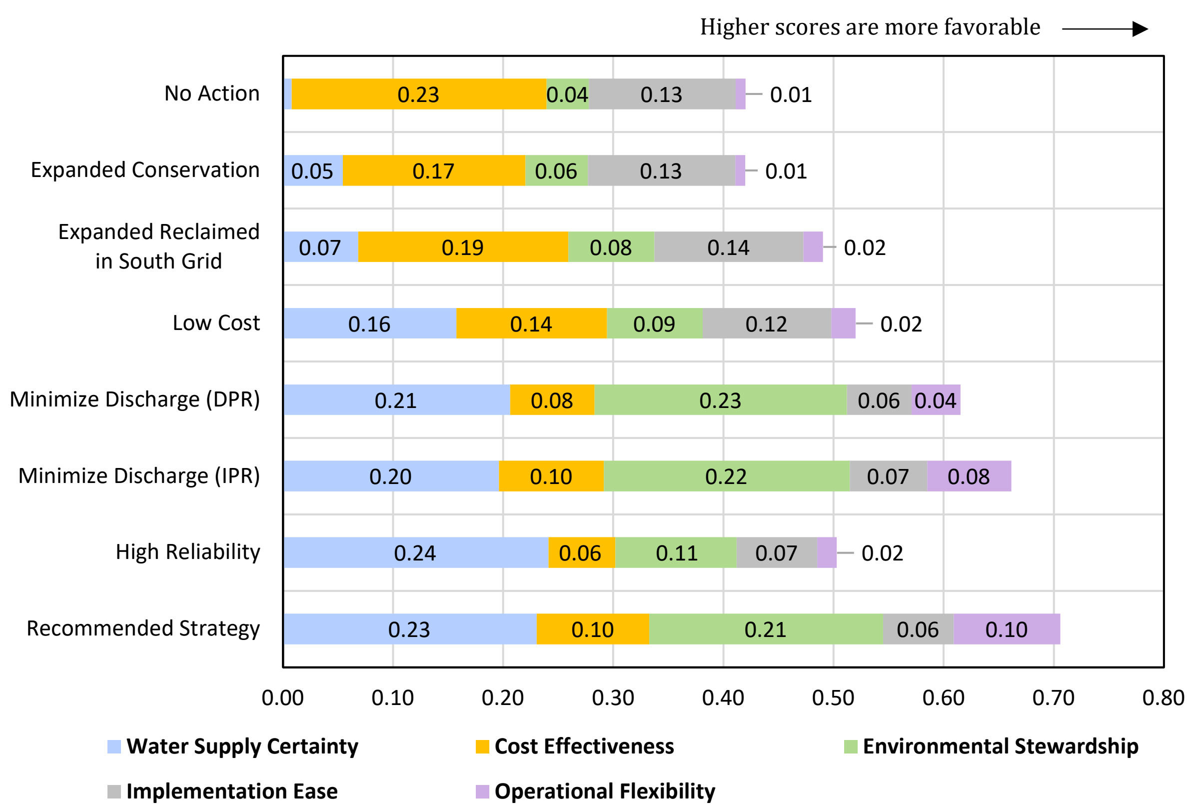


Figure 6-6. Ranking of Final Recommended Alternative Compared to Baseline Alternatives

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Section 7

Recommendations

Based on the evaluation of alternatives in Section 6, a set of recommendations were made along with a detailed capital improvement program (CIP).

7.1 Recommendations

The IWRP recommendations are presented for the near-term, the mid-term, and the long-term. The IWRP will be continuously monitored, with the mid-term and the long-term recommendations being revisited should future conditions change. The current recommendations are as follows:

Short-Term Recommendations (2020-2030)

- Implement water conservation programs in alignment with JEA's Water DSM Strategy
- Complete implementation of the SIPS project to transfer more available groundwater water from the North grid to South grid.
- Work with developers to continue to expand traditional reclaimed water in the South Grid, providing an additional 3.0 mgd of non-potable water in St. Johns County.
- Complete public outreach, permitting, design and construction of an initial demonstration facility and then an expansion to provide 2.7 mgd of purified water for aquifer recharge on the South Grid utilizing supply from the Arlington East WRF.
- Complete the design and construction of water reclamation treatment and conveyance to expand reclaimed water, providing an additional 1.0 mgd of non-potable water in Nassau East grid.
- Complete the permitting, design and construction for a 3.0 mgd brackish groundwater desalination facility for the Nassau East grid. The first phase of operations will provide 2.0 mgd of supply.
- Complete the design and construction of a new water conveyance pipeline to transfer groundwater from the North Grid to the Nassau West grid.
- Complete the permitting, design and construction for a 4.0 mgd purified water for aquifer recharge facility at Cedar Bay WRF. The first phase of operations will provide 1.8 mgd of alternative water supply for the North sub-grid of the North Grid.

Mid-Term Recommendations (2030-2040)

- Expand operations for the second phase of purified water for aquifer recharge at Cedar Bay WRF, providing an additional 1.8 mgd of alternative water supply for the North sub-grid of the North Grid.
- Complete the permitting, design and construction of the first phase of purified water for aquifer recharge at Southwest WRF, providing an additional 2.7 mgd of alternative water supply for the West sub-grid of the North Grid.
- Expand operations for the second phase of brackish groundwater desalination, providing an additional 1.0 mgd of alternative water supply for Nassau East grid.
- Complete the permitting, design and construction of the first phase of brackish groundwater desalination, providing an additional 2.0 mgd of alternative water supply for North sub-grid of the North Grid.

Long-Term Recommendations (Beyond 2040)

- Complete public outreach, permitting, design and construction of direct potable reuse at Buckman WRF, providing an additional 8.0 mgd of alternative water supply for the South Grid and 12 mgd of alternative water supply for West sub-grid of the North Grid.
- Complete the permitting, design and construction of the second phase of purified water for aquifer recharge at Southwest WRF, providing an additional 5.4 mgd of alternative water supply for West sub-grid of the North Grid.
- Complete the permitting, design and construction of the third phase of brackish groundwater desalination, providing an additional 1.0 mgd of alternative water supply for Nassau East grid.
- Complete the permitting, design and construction of the second phase of brackish groundwater desalination, providing an additional 7.0 mgd of alternative water supply for North sub-grid of the North Grid.

7.2 Capital Improvement Program

A detailed capital improvement program (CIP) was developed for the next 10 and 20 years, showing project timing for design/permitting, construction, demonstration/training and anticipated first year for operations. Beyond 2040, long-term projects are shown with specific timing to be determined. Projects were grouped around five-year increments but could be further staggered based on changing needs and available resources. The recommended CIP is presented in **Figure 7-1**.

CIP Phase	Project	Grid	Capacity Size (MGD)	Water* Supply (MGD)	2020 to 2024	2025 to 2029	2030 to 2034	2035 to 2039	2040 and Beyond
10 Year	Purified Water South Grid (1.0 MGD Demo)	S Arlington	0.0	--					
	Aquifer Recharge South Grid	S Arlington	3.0	2.7					
	Brackish GW Desalination – Nassau	Nassau East	3.0	2.0/3.0					
	Aquifer Recharge at Cedar Bay WRF	N North	4.0	1.8/3.6					
	New Conveyance – Nassau West	Nassau West	2.0	1.0†					
20 Year	Aquifer Recharge at Southwest WRF	N West	3.0	2.7					
	Brackish GW Desalination – North	N North	2.0	2.0					
Long-Term	Purified Water for Direct Use at Buckman WRF	S Grid (8) / N West (12)	20.0	20.0					*Timing TBD*
	Aquifer Recharge at Southwest WRF – Expansion	N West	6.0	5.4					*Timing TBD*
	Brackish GW Desalination – Nassau East – Expansion	Nassau East	1.0	1.0					*Timing TBD*
	Brackish GW Desalination – North – Expansion	N North	7.0	7.0					*Timing TBD*

WRF – Water Reclamation Facility; Design & Permit; Construction; Demonstration & Training; Operational

**The supply available for withdrawal from aquifer recharge projects is assumed as 90 percent of the water stored.*
†New conveyance helps to meet localized supply gaps but does not represent a new source of supply.

Figure 7-1. Recommended IWRP CIP for JEA

Implementation of water conservation and planned expansion of the reclaimed water system in the South Grid and Nassau East Grid are critical first-step elements for JEA's IWRP. These first step actions, along with recommended CIP projects will meet the water supply gaps outlined in **Table 7-1**. Detailed tables of water demands and supplies are provided in **Appendix D**. In the near term, JEA has operational flexibility within the CUP to distribute groundwater pumping between grids, which provides additional buffer for near-term project timing.

Table 7-1. Meeting Identified Supply Gaps

		2030	2040	2070
	Identified Supply Gap (MGD) →	**14**	**24**	**58**
Supply Category (MGD)	Conservation	6.5	6.5	6.5
	Expanded Reclaimed	3.3	4.4	6.3
	New Supply (CIP)	6.5	14.0	47.4
	Total Additional Supply	**16.3**	**24.9**	**60.2**

The capital costs for new alternative water supply projects within the CIP through 2040 are shown in **Figure 7-2**. These costs include engineering, design, permitting, JEA indirect costs and a two-percent annual escalation factor. As previously noted, projects were grouped into five-year increments but could be further staggered to distribute financing requirements.

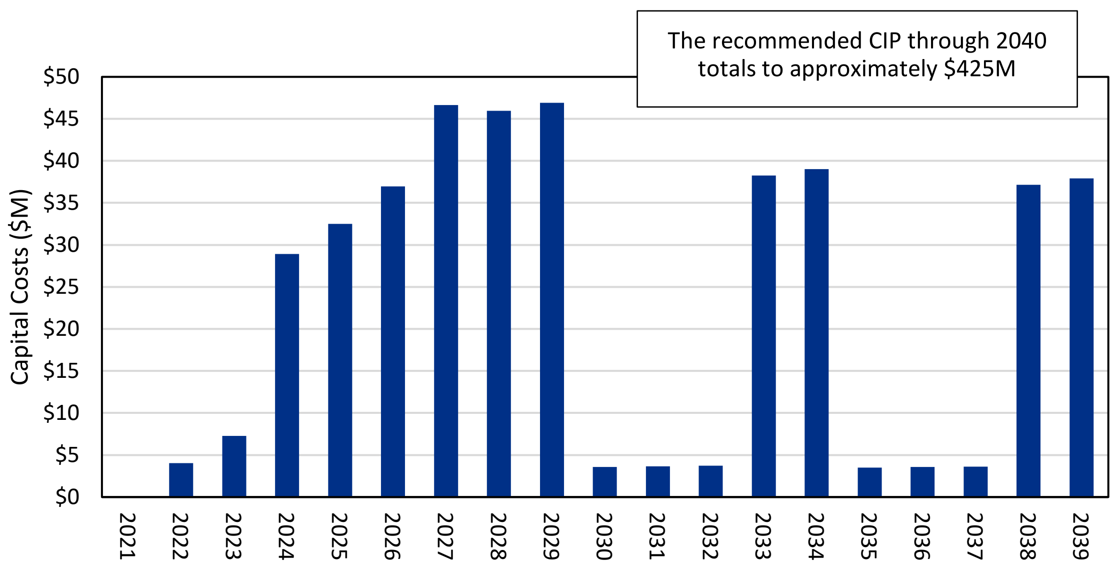

Figure 7-2. Capital Costs for IWRP CIP

7.3 DSM Strategy

Water conservation is an important component for JEA's IWRP, as it provides multiple benefits such as extending existing groundwater and reclaimed water supplies, reducing JEA's current operating costs for water and sewer, reducing/deferring future capital investments, and providing increased customer satisfaction by increasing water use efficiency and reducing water bills. Successful implementation of water conservation programs in JEA's service area requires a DSM Strategy.

In order to advance the DSM Strategy, existing and new water customers were characterized by neighborhood in terms of irrigable lot size, age of home, and income to develop a highly-targeted program that maximizes water conservation savings in a cost-effective manner. A five-year initial DSM Strategy was developed to first implement those water conservation measures with the highest net benefit to determine which ones have the greatest customer acceptance. Implementation of the initial DSM strategy is expected to conserve about 4 MGD of sustained water savings over the next 10 or so years, with a total cost of just under $40 million. **Table 7-2** presents the cost details for this strategy.

Table 7-2. JEA Water DSM Strategy Costs

DSM Strategy Cost Categories	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incentive and Administration Costs ($ millions)						
SF High Efficiency Toilet Direct Install	$0.96	$0.96	$0.96	$0.96	$0.96	$4.80
MF High Efficiency Toilet Direct Install	$1.73	$1.73	$1.73	$1.73	$1.73	$8.64
SF High Efficiency Clothes Washer Rebate	$3.52	$3.52	$3.52	$3.52	$3.52	$17.61
Green Restaurant Program	$0.05	$0.05	$0.05	$0.05	$0.05	$0.25
Ice Machine Rebate	$0.01	$0.01	$0.01	$0.01	$0.01	$0.05
Cooling Tower Cost Sharing	$048	$0.48	$048	$0.48	$0.48	$2.40
Smart Irrigation Controller Rebate	$0.58	$0.58	$0.58	$0.58	$0.58	$2.90
Sub-total	$7.33	$7.33	$7.33	$7.33	$7.33	$36.65
Programmatic Costs ($ millions)						
Marketing/Public Education	$0.40	$0.40	$0.40	$0.40	$0.40	$2.00
Program Evaluation	$0.08	$0.08	$0.08	$0.08	$0.38	$0.70
Sub-total	$0.48	$0.48	$0.48	$0.48	$0.78	$2.70
Total Costs	**$7.81**	**$7.81**	**$7.81**	**$7.81**	**$8.11**	**$39.35**

Based on the useful life of these DSM measures and the reduced costs for JEA's operations and deferred capital investments, the anticipated net benefit of this initial strategy is approximately $15 million.

Because it is important that JEA continue implementation of water conservation measures beyond the initial five-year DSM Strategy, increased customer participation was projected over a 10-year expanded program implementation for the IWRP. Based on this expanded program, longer-term water savings were estimated to be between 6.5 and 7 MGD, with a cost of implementation being approximately $130 million, or $13 million per year.

7.4 Hydraulic Analysis

While the IWRP Model was utilized to test the ability of new projects in meeting supply needs and other IWRP objectives, hydraulic models of the water distribution system were also utilized to provide additional insight into potential locations for future supply recommendations.

Key findings from this hydraulic analysis include:

- In the South Grid, the Greenland WTP is recommended as a beneficial location for utilizing additional CUP credits through the South Grid aquifer recharge supply projects.

- In the North-North Subgrid, any supply increases will need to be supported by enhanced transmission capacity:
  - As a single point, the area in the vicinity of Starratt Road and Dunn Creek Road was found to be the most efficient supply site, if no transmission improvements were made.
  - With enhanced transmission along Eastport Road/Faye Road, the Highlands WTP would be roughly equivalent to the Starratt Road and Dunn Creek Road location and is recommended as a potential location for utilizing additional CUP credits through the Cedar Bay WRF aquifer recharge project.
  - Brackish groundwater development in the North-North Subgrid should be coordinated with similar development in the Nassau Grid to determine whether a single site can supply both grids while achieving economies of scale. This site would ideally be sited in the northern portion of the North Grid
- In the North-West Subgrid, the Cecil Commerce Center WTP is a potential location for utilizing additional CUP credits from the Southwest WRF aquifer recharge project. Expanded transmission capacity out of the plant to the east or north will be required to achieve the benefit of the expanded allocation.
- In the Nassau Grid, a hydraulic model was not provided, but the Nassau Regional WTP would be a potential location for brackish groundwater development. As noted above, economies of scale may be achievable by combining projects to serve both the Nassau and North Grids

Details of the hydraulic analysis are available in **Appendix E**.

7.5 Adaptive Management

While recommendations for the timing of supply options have been outlined based on the data and projections utilized within the IWRP, the implementation strategy will need to remain flexible to future conditions. Potential disruptions such as new regulatory drivers, changes in development patterns, changes in water demands, or additional permit restrictions may create a need to either speed up or slow down the recommended timeline.

Parallel to developing the IWRP recommendations, an analysis was performed to develop planning alternatives to eliminate surface water discharges of wastewater effluent from JEA's WRFs. The analysis was prompted by the possibility that the Florida Legislature may implement legislation that would impose strict discharge elimination requirements for treated effluent. Six different discharge elimination alternatives were evaluated, and high-level costs developed.

A final hybrid alternative was then developed picking the most favorable alternative for each WRF considering technical feasibility and cost. Documentation of this analysis is provided in **Appendix F.**

Section 8
References

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Appendix A

Spatially-Disaggregated Water Demand Forecast: Detailed Methodology

CDM Smith

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Memorandum

To: *George Porter, P.E., JEA*

From: *Bill Davis, CDM Smith*
Dan Rodrigo, CDM Smith
Shayne Wood, P.E., CDM Smith

Date: *November 15, 2019*

Subject: JEA Integrated Water Resources Plan
Task 4 Spatial Disaggregation of JEA Water Demand Forecast: Detailed Methodology

Overview

JEA is developing an Integrated Water Resources Plan (IWRP) and Demand-Side Management (DSM) Strategy that will serve as a road map for implementing water supply projects and water conservation programs through the year 2070. Task 4 calls for the spatial disaggregation of the current JEA water demand forecast into spatial units to facilitate water resource planning at a finer resolution than simply the entire service area. This disaggregation of the water demand forecast will used in conjunction with the distribution modeling of the service area and in the evaluation of future demand management strategies. The main objectives of Task 4 include:

a. Identification of homogenous water-using neighborhoods
b. Spatial delineation of grid level water demand forecast
c. Extension of current water demand forecast from 2045 to 2070

The technical memorandum of July 19, 2019 discussed the data and data analysis for the identification of homogenous water-using neighborhoods. A large number of data files were obtained and processed into a unified database, which was used to identify homogenous neighborhoods for various JEA water customer sectors. In addition, the July 19, 2018 memorandum presented preliminary water use factors by the identified classifications for each sector based on an analysis of 2018 billing data.

The JEA water customers are divided into major “sectors” based upon the type of service agreement in conjunction with county appraiser property data described below. The resulting water use sectors are single-family, multifamily, commercial, industrial, institutional (collectively referred to as CII), and CII irrigation. Note that billed reclaimed water for single-family customers was added with single-family irrigation and single-family potable water use to represent water use for the single-family sector. Billed reclaimed water for CII customers was added the CII Irrigation water use. There are a few multifamily irrigation accounts and other miscellaneous potable water customers that are not included in this analysis.

A “unit” is defined for each sector as the metric of water use for that sector. For example, the number of single-family and multifamily dwelling units are the units for those two sectors, respectively. For the CII sectors, the units are the number of heated square feet for each sector. The units serve as the denominator of the water use factor (i, e., gallons per day per unit) for each sector and are also the “demographic” that is projected into the future for each sector.

County property appraiser data from each of the four counties provided parcel-level information on lot size, land use type, number of dwelling units, presence of swimming pools, heated square footage, year built and a neighborhood identifier. U.S. Census data provided block group level data on unit occupancy, persons per household and median household income. JEA billing data provided monthly water consumption by service agreement type and meter location. The billing data by service agreement type, appraiser data and census data were aggregated by neighborhood resulting in monthly water use by service agreement type and customer characteristics for 2,054 neighborhoods. Lot size, median household income and year built (pre- and post- 1994) characteristics were used to group the single-family and multifamily water use into 16 homogenous neighborhood classifications. An average water use factor was determined for each sector by neighborhood classification. Commercial, industrial and institutional water use factors were derived for each neighborhood with either commercial, industrial and institutional water use.

Using parcel-based GIS models, GIS Associates developed 2020-2070 forecasts of population; single-family and multifamily units; and commercial, industrial and institutional (CII) heated square footage by neighborhood. These projections start with the same county-level populations used to develop the JEA 2017 estimate of future water demand by grid. The population projections for the JEA service area are spatially disaggregated down to the neighborhood level based upon undeveloped parcels, trends in residential housing densities, and neighborhoods identified for future development resulting is estimates of future persons per household, single-family and multifamily dwelling units and single-family lot size for each neighborhood. The availability of undeveloped CII parcels, trends in development densities and neighborhoods identified for future development were used to estimate the future CII heated square footage for neighborhoods with CII land use designations.

Discussions with JEA staff indicate that water service is likely to expand beyond the current JEA service boundaries. Five primary areas of expansion were identified and GIS Associates developed demographic projections for these five expansion areas.

The water use factors by sector and neighborhood are multiplied by the demographic drivers (units) for each sector, neighborhood and year to derive the estimated future water use. The average water use per unit for each water use sector is used to estimate the future water demand for the expansion areas. The estimates of future water demand derived at the neighborhood level are aggregated by sector and grid for each of the forecast years. As water use estimates by sector and neighborhood are aggregated, a non-revenue (NRW) volume is calculated assuming NRW as 10.3 percent of total demand to account for distribution system losses.

The JEA estimates of future total annual water demand by grid is based upon the projections of the JEA customer service population for each grid multiplied by a per capita water use factor representing JEA potable water demand in each grid. The grid-level per capita water use values are 'weather normalized" based upon 2012 -2017 weather normalized aquifer demand and held constant over time for each grid. Thus, the JEA forecast uses a "gross" per capita water use estimate for each grid that encompasses all water users.

Alternatively, the neighborhood-level forecast starts with customer-level billing data and neighborhood demographics to estimate water use by customer type and neighborhood and 'build up" to the grid level forecast. Some neighborhoods have higher per unit water use while others may have lower per unit water use. Similarly, some neighborhoods may be built out with little projected growth while others may have potential for significant growth. Thus, one grid may contain a mix of low and high water using neighborhoods in combination with low and high growth neighborhoods, in addition to the mix of neighborhoods that are residential, nonresidential (CII) or mixed use. The outcome of which is a more refined estimate of future water use for the grid than the grid-level estimate based upon the gross per capita and grid-level population growth.

The scope of this project calls for the water demand forecast to be developed through the year 2070. For near-term water supply planning purposes, the forecast is provided at 5-year increments from 2020 to 2040 followed by a projection for the years 2050 and 2070. Projections of demographic trends are relatively stable beyond 2040 thus the annual rate of change in demographics beyond that point are consistent to 2070, resulting in a consistent growth pattern of water demand from 2040 to 2070. Thus, the water demand forecast is estimated for 2020 to 2040 in 5-year increments followed by estimates for the years 2050 and 2070.

Indoor water use fixture have become more water efficient over time due to national water fixture standards. Thus, newer homes and businesses have more water efficient fixtures than older construction. The impact of the national fixture standards on water use is referred to as "passive savings." The JEA water demand forecast based upon current levels of water use is identified as the "**baseline**" forecast. An alternate water demand forecast that incorporates improved water efficiency in future construction is identified as the "**passive**" forecast.

Three weather scenarios are developed from the analysis of historical water use and weather data from the last 10 years. These three scenarios represent average weather conditions, dry and warmer, wet and cooler weather conditions.

Figure 1 illustrates the flow of the water demand model from water use factors and demographic projections to the baseline water demand forecast and the passive water demand forecast. Details on the water use factors, demographic projections, passive conservation assumptions, and the water demand forecast are provided in this technical memorandum.

Table 1 shows the baseline and passive forecast for the current JEA service area for the three weather scenarios as well as the forecasts for that include the future expansion areas.

Figure 1. Flow Diagram of Water Demand Model

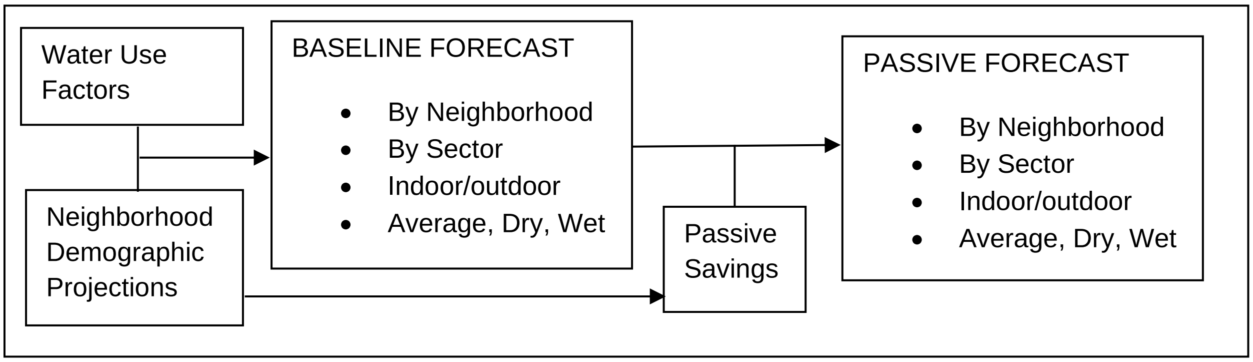

Table 1. Baseline and Passive Forecast by Weather Scenario

JEA SERVICE AREA (NO EXPANSION)						
	BASELINE			WITH PASSIVE CONSERVATION		
	AVERAGE MGD	DRY MGD	WET MGD	AVERAGE MGD	DRY MGD	WET MGD
Base Year	121.51	129.52	109.14	121.51	129.52	109.14
2020	125.52	133.81	112.73	125.41	133.69	112.61
2025	134.57	143.47	120.81	134.21	143.11	120.45
2030	141.93	151.34	127.38	141.40	150.81	126.85
2035	148.29	158.14	133.07	147.38	157.23	132.16
2040	153.25	163.44	137.50	152.09	162.28	136.34
2050	162.61	173.49	145.80	161.04	171.92	144.23
2060	169.82	181.21	152.21	167.92	179.31	150.31
2070	175.78	187.59	157.53	173.53	185.33	155.28
JEA SERVICE AREA with EXPANSION AREAS						
	BASELINE			WITH PASSIVE CONSERVATION		
	AVERAGE MGD	DRY MGD	WET MGD	AVERAGE MGD	DRY MGD	WET MGD
Base Year	123.62	131.77	111.01	123.62	131.77	111.01
2020	128.04	136.50	114.98	127.93	136.38	114.86
2025	138.10	147.24	123.97	137.73	146.87	123.60
2030	146.58	156.30	131.54	146.02	155.75	130.99
2035	154.08	164.32	138.25	153.13	163.37	137.30
2040	160.58	171.26	144.06	159.35	170.03	142.83

2050	173.45	185.07	155.50	171.76	183.38	153.80
2060	184.54	196.93	165.39	182.45	194.84	163.30
2070	194.67	207.75	174.45	192.13	205.22	171.92

Table 2 summarizes the average weather scenario baseline water demand forecast with the expansion areas by grid. The forecast by grid represents the total water demand including potable demand, metered reclaimed water sales and system losses (non-revenue water).

Table 3 is the JEA per capita water demand forecast by grid. Reclaimed water deliveries are listed separately. Not shown is the 2.5 MGD contractual water transfer to St. John's County (SJC). The average weather baseline forecast aligns well with the JEA per capita forecast.

Figures 2, 3 and **4** illustrate the spatial demand for average weather baseline water in gallons per day (GPD) by neighborhood for 2018, 2040 and 2070, respectively. **Figure 5** shows the percent change in water demand from 2018 to 2070 by neighborhood. Grey shaded neighborhoods have no demand or no increase in demand. Neighborhoods shaded dark red are expected to increase by more than 0.5 MGD over the next 50 years. Much of the expected increase in demand occurs in perimeter neighborhoods, while more central neighborhood are expected to experience less increase over time. Note that this illustration does not include the expansion areas.

The spatial demand in gallons per day (GPD) by neighborhood provides an indication of where water demand is greater and most likely to increase spatially. The demographic projections and water demand forecasts by neighborhood are transferred from Microsoft Excel into a geo-spatial database to be aligned with the JEA service area hydraulic model by grid and sub-grid areas for distribution modeling and IWRP planning. In addition, the GPD by neighborhood will be used in the assessment of demand-side management potential by neighborhood.

Table 2. Baseline Forecast by Grid with Expansion Areas in MGD

Year	Mayport	Nassau	North Grid	Palm Valley	Ponce de Leon	Ponte Vedra	South Grid	Total Water Demand
2018	0.04	4.44	44.35	0.42	0.49	1.55	72.31	123.62
2020	0.04	4.74	46.33	0.45	0.50	1.56	74.42	128.04
2025	0.04	5.47	51.37	0.51	0.53	1.56	78.61	138.10
2030	0.04	6.17	56.15	0.55	0.55	1.57	81.55	146.58
2035	0.05	6.75	60.66	0.56	0.55	1.57	83.94	154.08
2040	0.05	7.21	64.84	0.57	0.55	1.57	85.79	160.58
2050	0.05	8.06	73.26	0.57	0.55	1.57	89.40	173.45
2060	0.05	8.87	80.69	0.57	0.55	1.57	92.24	184.54
2070	0.05	9.70	87.69	0.57	0.55	1.57	94.54	194.67

Table 3. JEA Per Capita Forecast by Grid in MGD

Year	Mayport	Nassau	North	Ponce De Leon	Ponte Vedra	South	South Reuse	Total Water Demand
2020	0.05	3.08	44.6	0.59	1.16	65.3	10.0	124.74
2025	0.05	3.60	48.1	0.63	1.17	67.7	16.5	137.73
2030	0.06	4.04	51.3	0.67	1.17	69.3	21.2	147.72
2035	0.06	4.44	54.2	0.67	1.18	70.5	24.4	155.56
2040	0.06	4.76	57.2	0.67	1.18	71.6	27.3	162.74
2045	0.06	5.05	59.8	0.67	1.18	72.5	30.0	169.35
2050	0.06	5.32	62.5	0.67	1.18	73.3	32.2	175.17
2055	0.06	5.61	65.0	0.67	1.18	74.0	34.0	180.48
2060	0.07	5.90	67.6	0.67	1.18	74.6	35.7	185.78
2065	0.06	6.20	70.4	0.67	1.18	75.1	37.1	190.65
2070	0.06	6.51	73.0	0.67	1.18	75.7	38.6	195.72

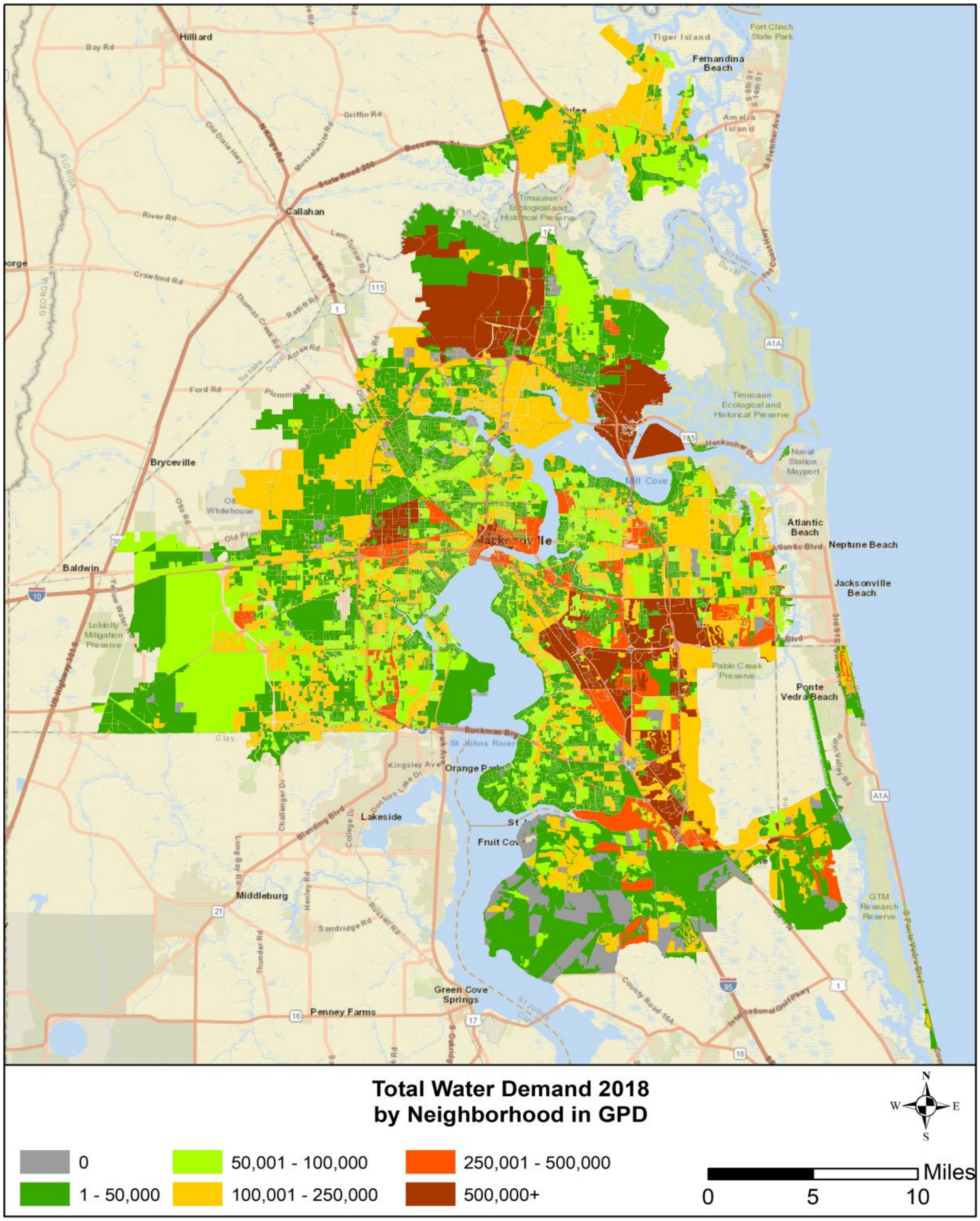

Figure 2. Baseline Forecast by Neighborhood in GPD for 2018

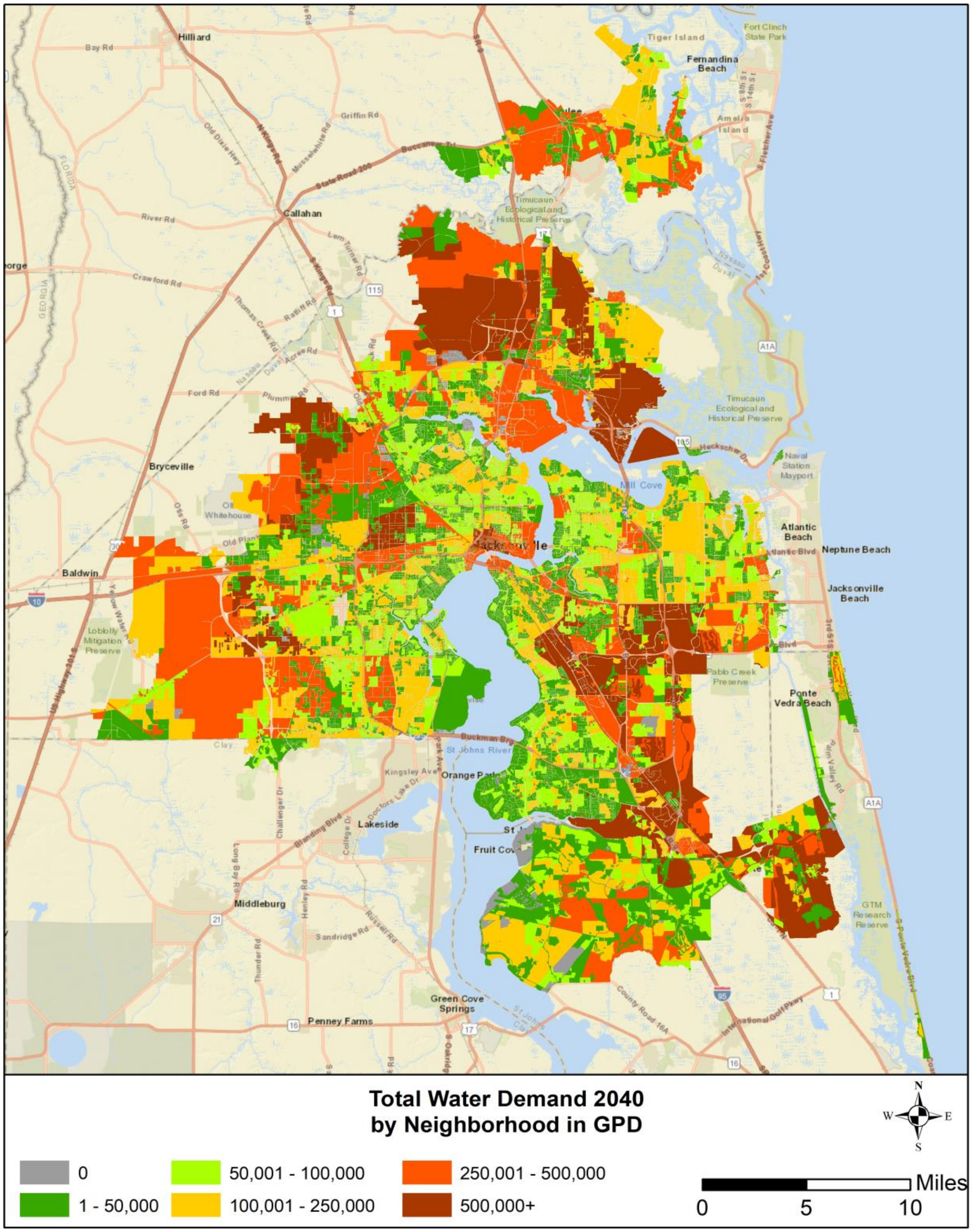

Figure 3. Baseline Forecast by Neighborhood in GPD for 2040

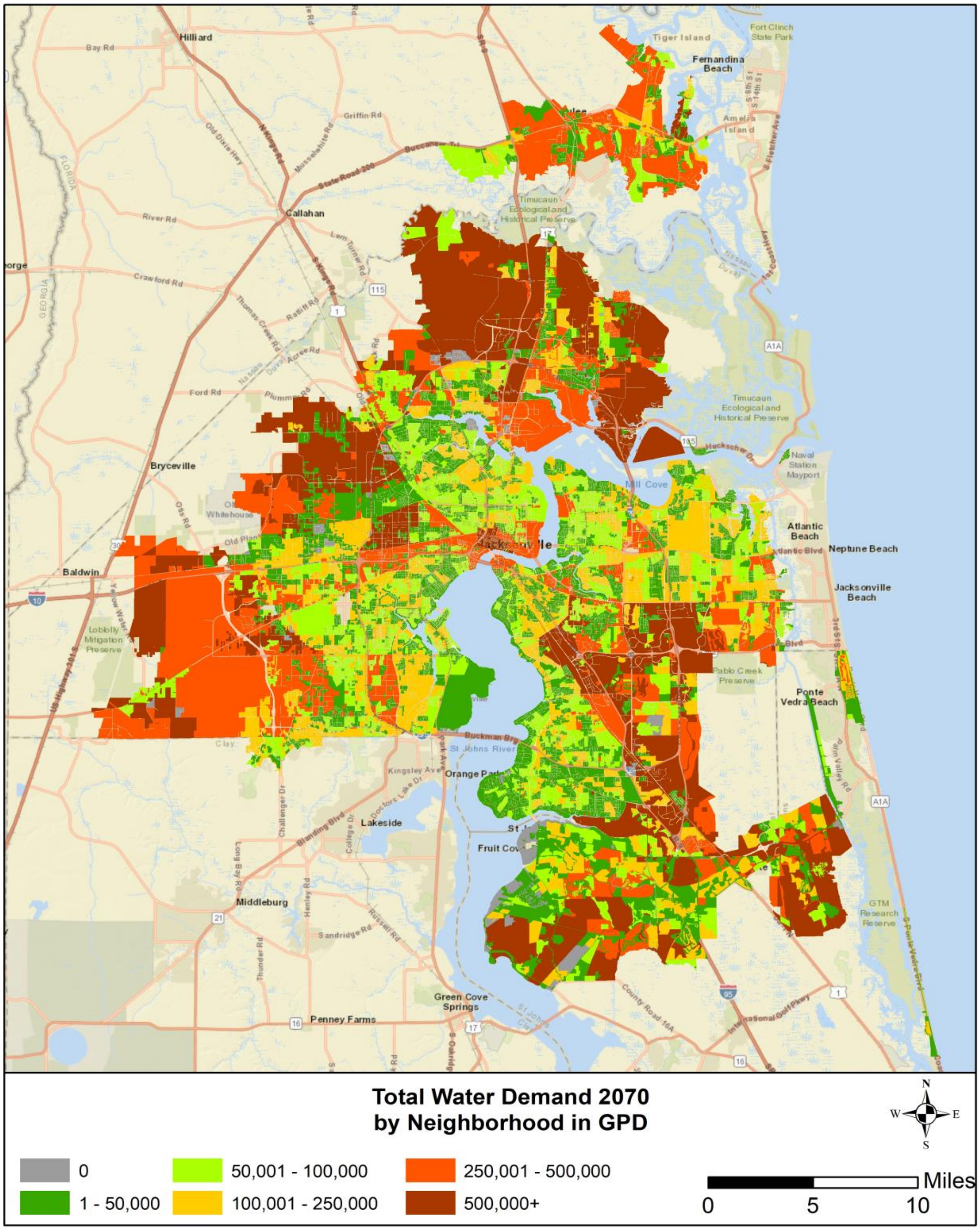

Figure 4. Baseline Forecast by Neighborhood in GPD for 2070

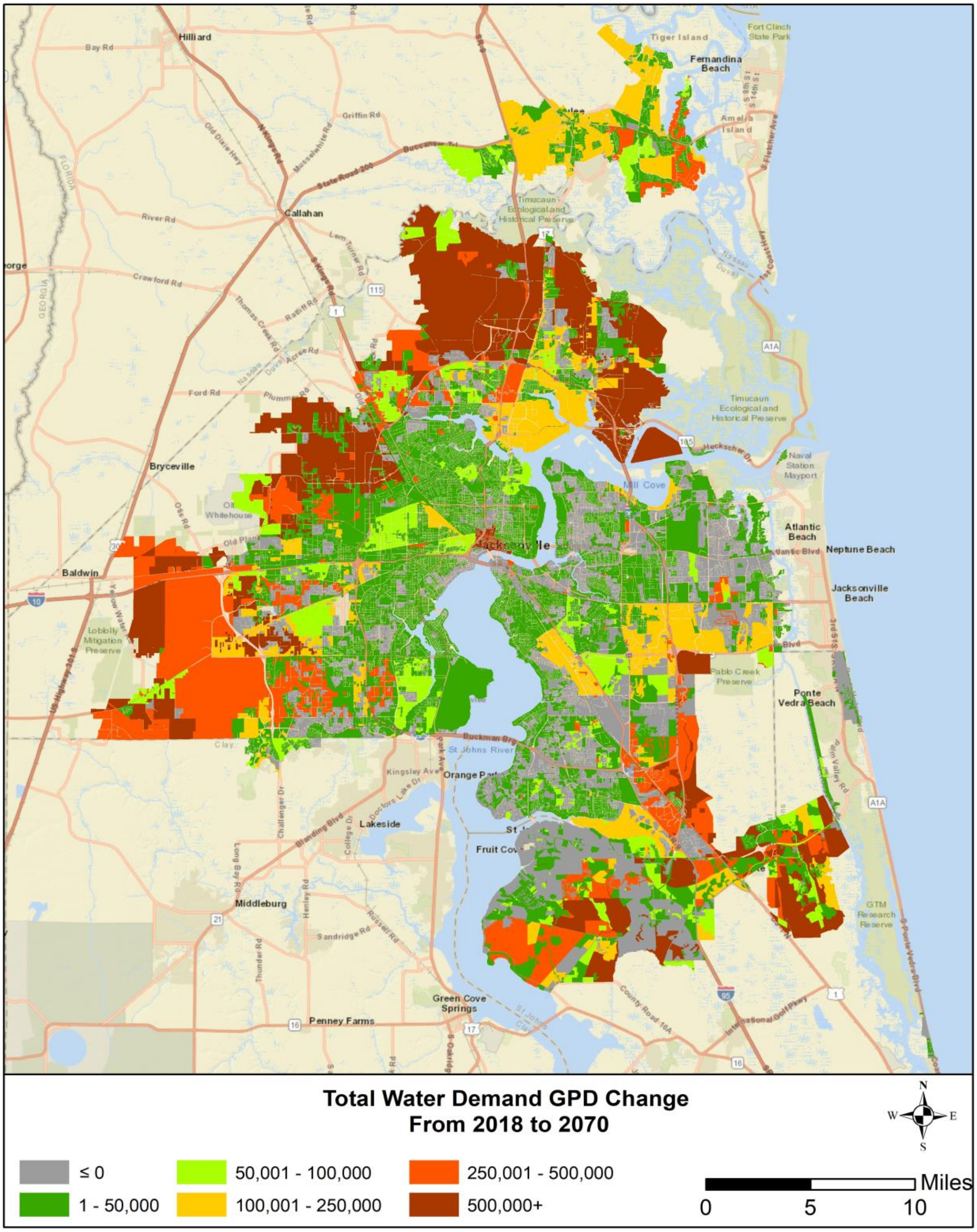

Figure 5. Change in MGD in Baseline Forecast 2018 to 2070

Historical Water Use Trends

This section presents a discussion of recent trends in JEA water production and metered water use.

Monthly Water Production, Sales and Non-Revenue Water

JEA provided monthly water production and water sales (billing) from January 2009 to December 2018. **Figure 6** illustrates the monthly variation in total water production and water sales for this time period. A distinct seasonal cycle is evident with higher water use and production occurring in the summer months although the summer peak is more pronounced in some years than in others.

Total monthly water production over this 10-year period averages 113.4 million gallons per day (MGD), reaching a maximum of 150.4 MGD in May 2011 and a low of 83.6 MGD in February 2010.

Total monthly water sales over the same period averages 97.9 MGD, reaching a maximum of 138.4 MGD in June 2011 and a low of 74.7 MGD in March 2014. The winter month low was often about 80 MGD until the last few years in which the winter low has increased by about 10 MGD.

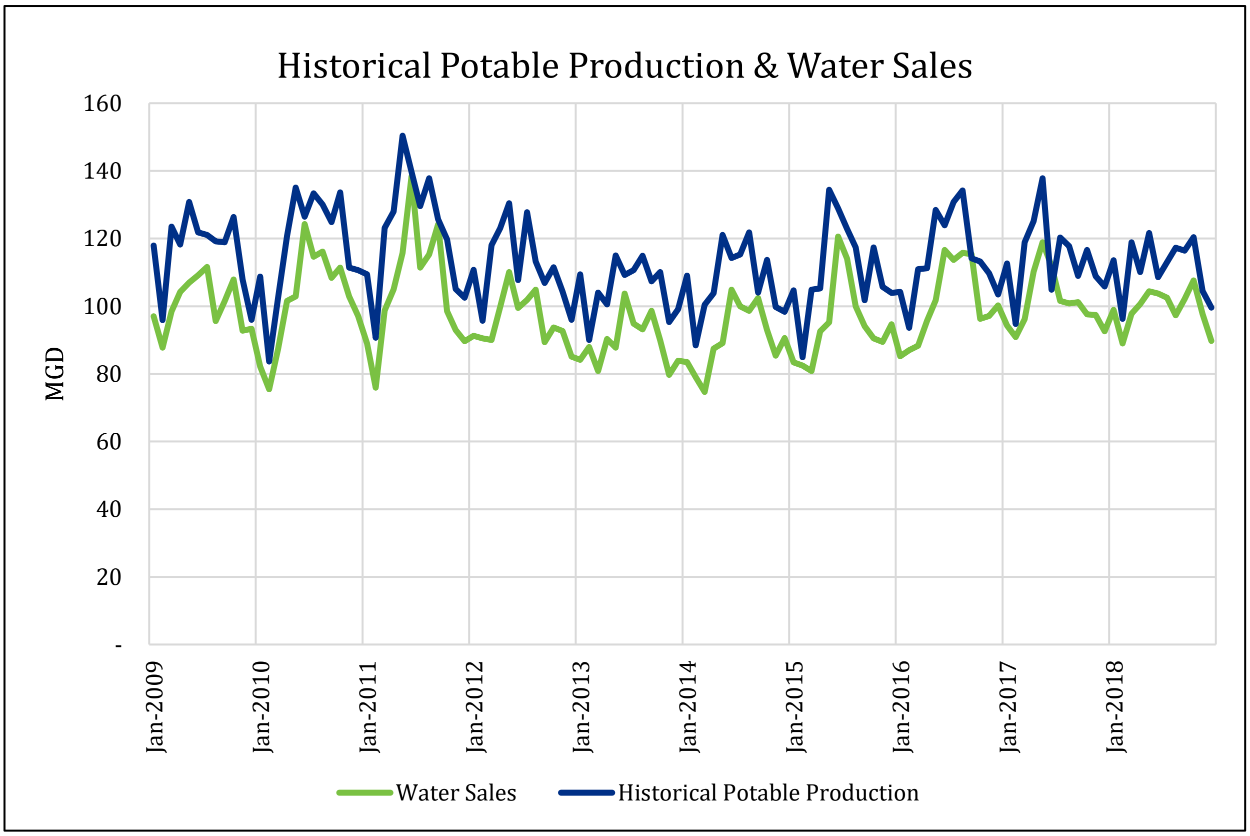

Figure 6. Historical Monthly Total Production and Sales

Non-Revenue Water (NRW) is the difference between water production and metered sales. This metric includes unmetered water use, meter and billing inaccuracies, and system water loss. Over the last 8 years NRW has averaged about 10.3 percent of total production based on information provided in the JEA file *Non-revenue Unbilled Water.xls* as illustrated in **Figure 7.**

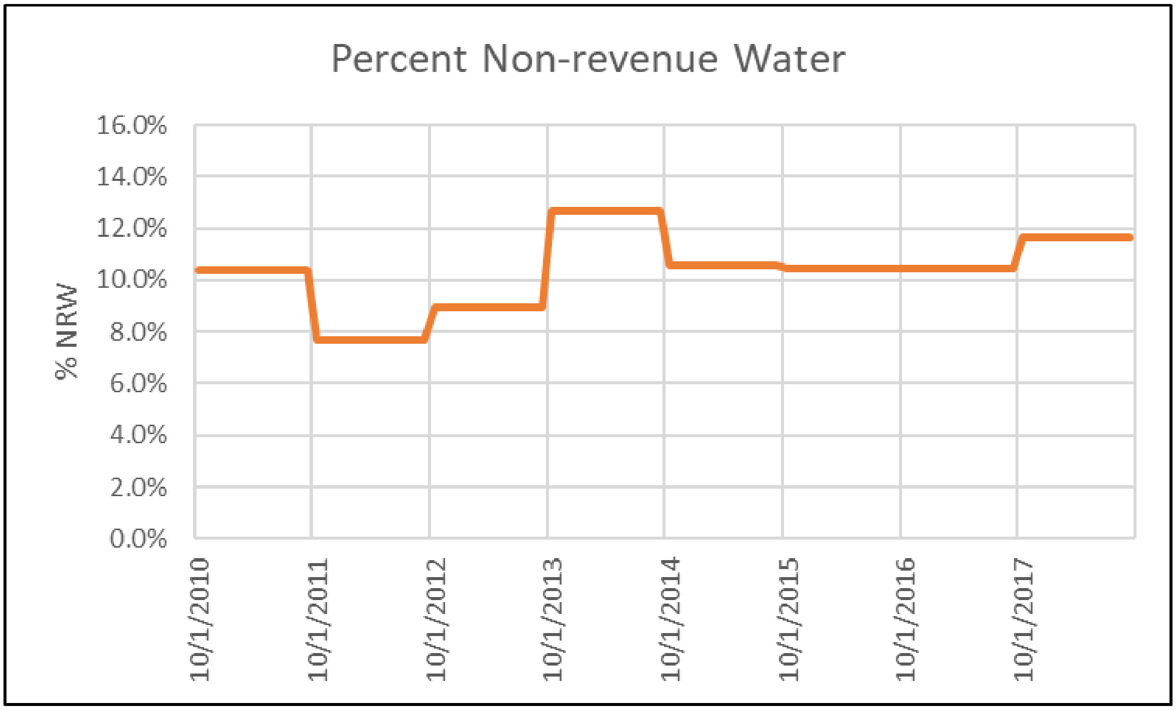

Figure 7. Historical Annual Percent Non-revenue Water (NRW)

Within the spatial demand forecast model water demand is estimated by sector and neighborhood as discussed in following sections. A percent NRW is added to the sum of the demand by sector for each neighborhood in order to derive an estimate of total water demand by neighborhood. The average of 10.3 percent NRW is used throughout the water demand model for all forecast years.

Weather Scenarios

Water use varies in response to the weather. In particular, water use typically increases with higher temperatures and decreases with more precipitation. This response to weather in driven by the demand for water used for irrigation and for commercial and industrial cooling. The spatial demand forecast model provides an estimation of monthly demand to reflect the seasonality of demand. The monthly seasonality facilitates supply planning. The variation in demand by monthly can be addressed with demand-side management programs that target irrigation and nonresidential cooling uses.

Historical JEA monthly billing data of individual service agreements were made available from 2009 to 2018. The corresponding monthly weather data includes the monthly average of the daily maximum temperatures and the monthly total precipitation. For the historical period of 2009 to 2018, the monthly precipitation averages 4.25 inches per month with lower precipitation in the winter months and higher precipitation in the summer months (May – September). On average, December has the lowest precipitation with 1.8 inches and June receives an average of 7.84 inches. The monthly precipitation during the historical period ranges from zero in October 2010 to 16.6 inches in June 2012.

The monthly average of the daily maximum temperature during this period averages 80.2 degrees Fahrenheit (°F) with the lowest average maximum temperature of 65.3 °F in January and the highest average maximum temperature of 91.8 °F in July. The monthly average of daily maximum temperature during this period ranges from 60.1°F in January 2014 up to 95.8 °F in July 2016.

Figure 8 shows the average monthly water sales, average monthly precipitation and monthly average of maximum temperature. Monthly average daily maximum temperature and monthly precipitation both increase in the summer months. Water sales begin to increase in March as temperatures increase yet precipitation is low. Precipitation begins to increase in May and peaks in June. Water use peaks in May and decreases throughout the remaining summer months as higher precipitation offsets the influence of higher temperatures.

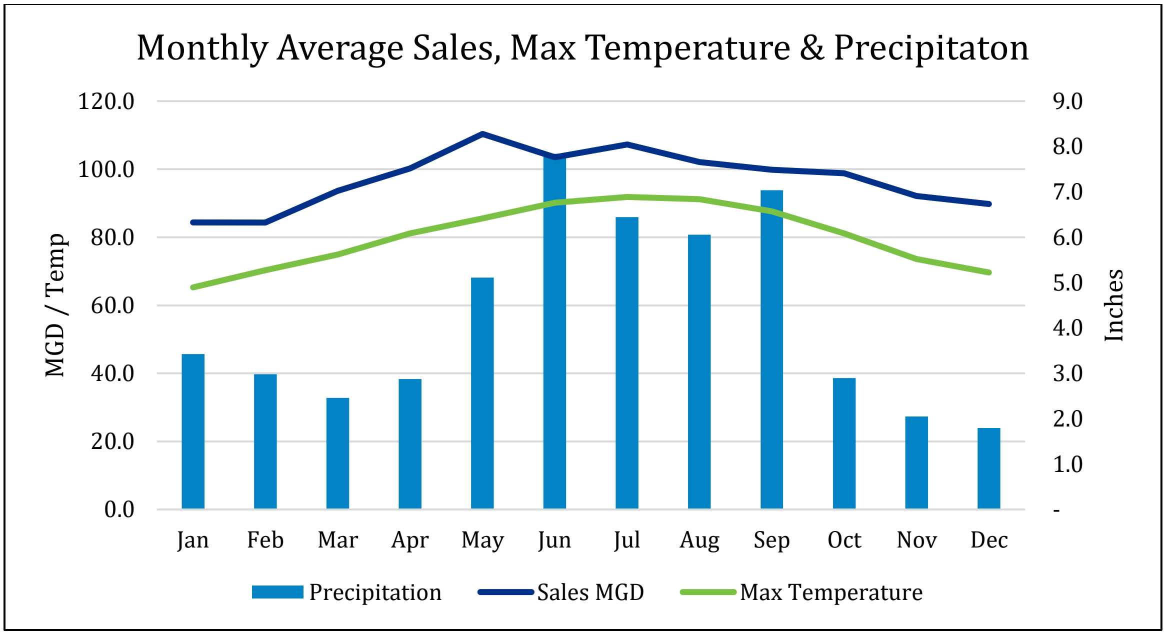

Figure 8. Average Monthly Sales (MGD), Maximum Temperature and Precipitation

Table 4 summarizes the annual total precipitation and annual average of monthly maximum temperature for the years 2009 – 2018. Also shown is the annual average demand in MGD, which includes both aquifer demand and metered reclaimed water sales.

Table 4. Historic Annual Weather Conditions

Year	Total Precipitation (inches)	Average Maximum Temperature (degrees F)	Annual Average MGD
2009	56.4	80.3	102.9
2010	33.91	78.7	105.0
2011	32.98	81.4	108.6
2012	65.05	81.7	99.3
2013	51.06	79.4	92.5
2014	41.84	80.9	94.6
2015	33.63	83.6	99.8
2016	36.08	82.5	109.1
2017	47.3	82.0	110.0
2018	45.15	80.9	108.1
10-yr AVG	44.3	81.1	103.0

Red indicates hot/dry, Green indicates cool/wet.

Total annual precipitation over the 10 years from 2009 – 2018 varies from 33 to 65 inches per year while the average daily maximum temperature varies only five degrees from 79 to 84 degrees. The year 2012 high precipitation is biased by tropical storms in both May and June. Above average water use and average temperatures in other months of that year resulted in 2012 not being selected as representative of wet weather conditions.

Figure 9 shows the monthly water demand pattern for each of these years. The year 2013 has the lowest annual use, relatively low water use in all months, above average precipitation and below average temperature. Therefore, 2013 is selected as representative of water use under wet weather conditions. The year 2017 has near average annual precipitation and temperature but the highest annual water use and the highest monthly water use during the Spring and early Summer. Thus, 2017 is deemed representative of water use under dry conditions.

It is assumed that indoor water use remains the same under each weather scenario. Therefore, the outdoor portion of estimated water use under average weather conditions is increased by a factor of 1.11 to reflect water demand under dry weather conditions and decreased by a factor of 0.83 to reflect water demand under wet weather conditions.

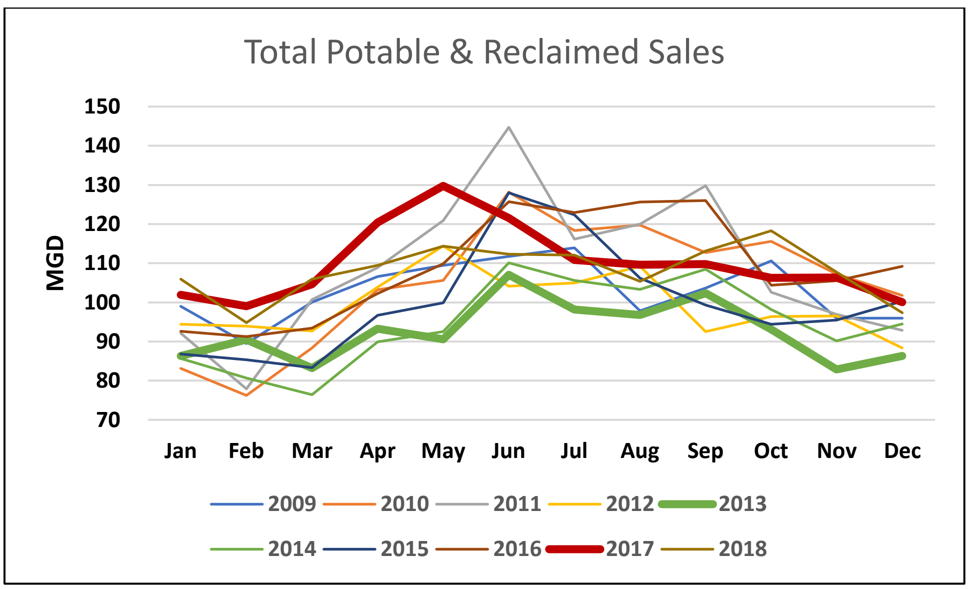

Figure 9. Monthly Demand 2009 - 2018

Water Use Factors

JEA monthly billing data include records by service agreement (e.g., water, sewer, irrigation, reclaimed) and are matched with parcel-level county appraiser data and census block group level census data as described in the technical memorandum of July 19, 2019. Note that JEA water service agreements are identified for residential, residential irrigation, multifamily, commercial and commercial irrigation.

Figure 10 shows the 10-year average water sales by the major water use sectors defined for this water demand analysis and forecast. Residential (i.e., single-family) water use averages about 43 MGD or 42 percent of total water demand followed by water use in the commercial, industrial and institutional sectors combined (and identified as commercial in Figure 10) averages about 21 MGD or 19 percent of total demand.

The JEA service agreement types are combined with appraiser land use codes to identify records for water service agreements as one of six water use sectors: Single-family, Multifamily, Commercial, Industrial, Institutional and CII Irrigation. Note that billed reclaimed water for single-family customers was added with single-family irrigation and single-family potable water use to represent water use for the single-family sector. Billed reclaimed water for CII customers was added the CII Irrigation water use.

The land use codes were used to separate the JEA commercial water service agreements among the commercial, industrial and institutional use as described in the technical memorandum of July 19, 2019.

Note that while the JEA forecast was developed on a per capita basis, the spatially- disaggregated forecast is developed on a per unit basis by sector as described in the technical memorandum of July 19, 2019. The GPD per unit for each sector are:

- Single-family GPD per household (dwelling unit)
- Multifamily GPD per household (dwelling unit)
- Commercial GPD per heated square foot
- Industrial GPD per heated square foot
- Institutional GPD per heated square foot
- CII irrigation GPD (total per neighborhood)

As described in the technical memorandum of July 19, 2019, the residential (SF, SF irrigation, MF) sectors have sufficient neighborhood characteristics to permit the differentiation of neighborhoods by multiple criteria whereas the nonresidential sector data is limited to acres and heated square footage. Thus, the nonresidential water use factors are not as differentiated as the residential water use factors. Note that the CII irrigation volume per neighborhood is increased over time in proportion to the growth of CII water demand for the neighborhood.

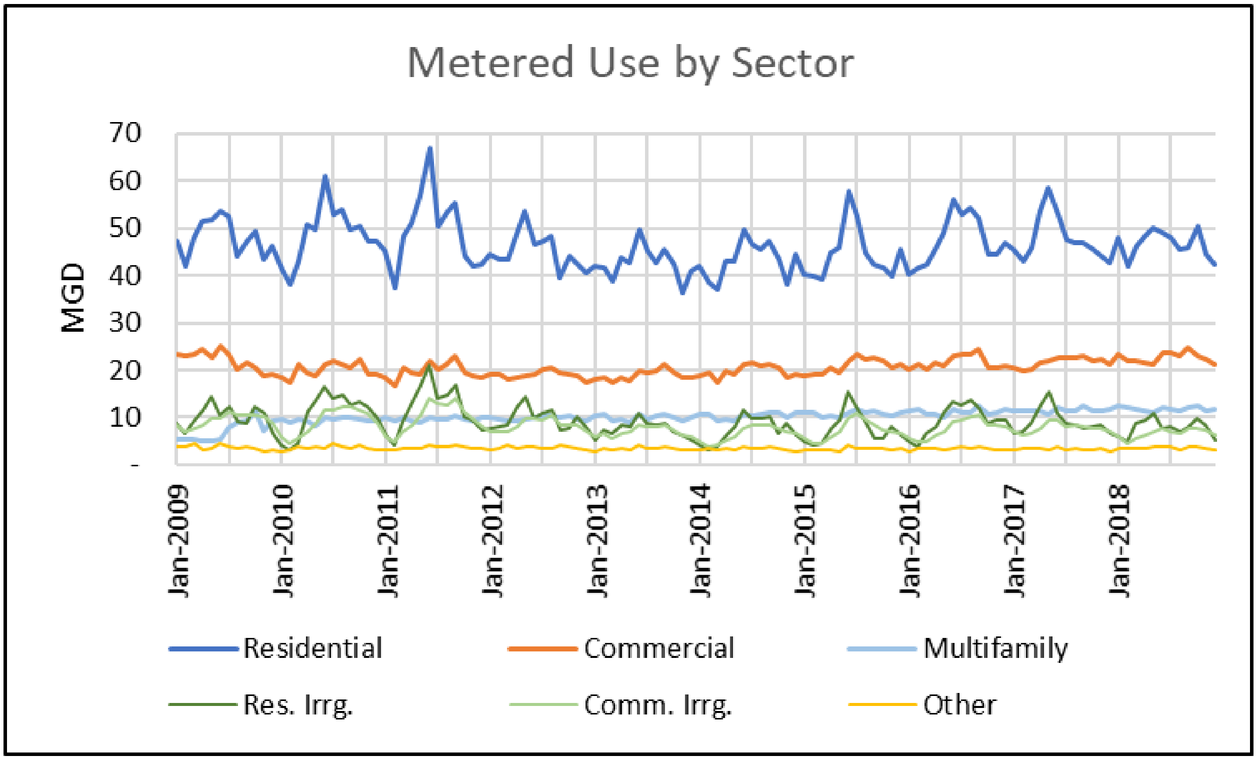

Figure 10. Metered water use by sector 2009 - 2018

Single-family Water Use Factors

There are 1,884 neighborhoods in the JEA service area with single-family water use. The average, monthly single-family water use by service agreement is summed by neighborhood for each weather scenario and month. Single-family water use is a combination of single-family potable metered use, single-family metered irrigation use and single-family metered reclaimed water use. The monthly water use is divided by the number of single-family service agreements in the neighborhood to derive an average gallons per day per household (GPD/unit) for each month and neighborhood. Outlier values were removed if the GPD/unit in a given neighborhood and month is below 30 GPD or extremely high relative to other months for that neighborhood. The resulting "cleaned" monthly GPD/unit values by weather scenario were averaged across neighborhoods for each of the 18 single-family neighborhood categories based on lot size, median household income and year built as described in the technical memorandum of July 19, 2019.

Table 5 shows the annual average GPD per unit water use factors for each of the single-family categories. The forecast model uses monthly water use factors in order for the forecast to replicate the seasonality of water use. **Figure 11** shows the average residential water use in gallons per day (GPD) per household for the base period by neighborhood. Neighborhoods without residential water use are shown in dark green. Light green neighborhoods use an average of 150 GPD or less. Those neighborhoods in red have an average water use greater than 350 GPD per household. These higher water-using neighborhoods are potential DSM target areas.

Table 5. Single-family Water Use Factors by Neighborhood Characteristics

Lot Size	Income	Year Built	Count of Neighborhoods	Average Weather Annual Average GPD/unit
Large Lot Size	Higher	Post-1994	30	1,158
	Higher	Pre-1994	32	413
	Middle	Post-1994	57	918
	Middle	Pre-1994	143	229
	Lower	Post-1994	4	249
	Lower	Pre-1994	68	186
Medium Lot Size	Higher	Post-1994	75	688
	Higher	Pre-1994	32	395
	Middle	Post-1994	206	352
	Middle	Pre-1994	185	218
	Lower	Post-1994	15	217
	Lower	Pre-1994	111	143
Small Lot Size	Higher	Post-1994	62	460
	Higher	Pre-1994	8	166
	Middle	Post-1994	272	257
	Middle	Pre-1994	151	153
	Lower	Post-1994	91	217
	Lower	Pre-1994	319	143
Average				279

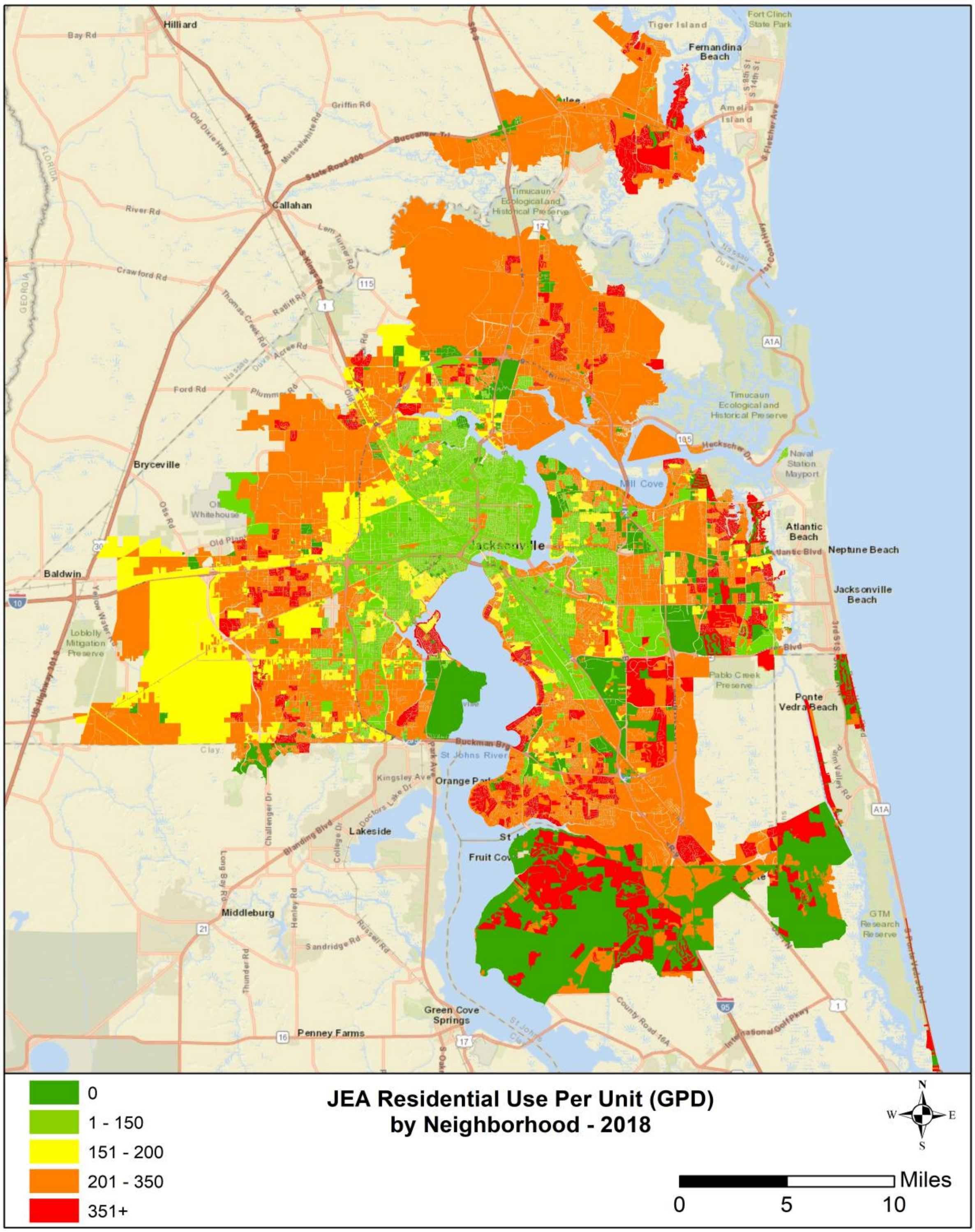

Figure 11. Spatial Distribution of SF Neighborhoods by Gallons per Day per Household (GPHD)

Multifamily Water Use Factors

As discussed in the technical memorandum of July 19, 2019, the assessment of multifamily water use is complicated by the JEA definition of multifamily service agreements and county appraiser definitions of multifamily use. Unlike single-family water use where one service agreement is assumed to reflect one housing unit, with multifamily service agreements the challenge is to estimate the number of multifamily housing units associated with each service agreement. For this analysis, the number of multifamily service agreements by neighborhood from JEA billing data is matched with appraiser number of multifamily units by neighborhood.

The neighborhood average of multifamily heated square footage (Ht.Sq.Ft.) is used as a neighborhood characteristic along with income and the effective year built to provide categories of neighborhoods with multifamily water use. The JEA billed multifamily monthly volume per neighborhood is matched with the appraiser number of multifamily units for the neighborhood to derive the average GPD per unit by month for each neighborhood. These values are averaged across all neighborhoods within the designated category.

Table 6 shows the annual average for each category. The forecast model uses monthly water use factors in order for the forecast to replicate the seasonality of water use. **Figure 12** illustrates the spatial distribution of neighborhoods with multifamily water use. Neighborhoods without multifamily water use are shown in grey. Neighborhoods with more than 150 GPD per household could be evaluated for potential DSM strategies.

Table 6. MF Water Use Factors by Neighborhood Characteristic

Ht.Sq.Ft	Income	Year Built	Count	Average Weather GPD/Unit
H (>1000)	Higher	Post-1994	6	108
	Higher	Pre-1994	8	81
	Middle	Post-1994	25	119
	Middle	Pre-1994	15	104
	Lower	Post-1994	4	144
	Lower	Pre-1994	22	119
M (500-1000)	Higher	Post-1994	3	107
	Higher	Pre-1994	n/a	n/a
	Middle	Post-1994	6	144
	Middle	Pre-1994	67	116
	Lower	Post-1994	9	99
	Lower	Pre-1994	231	101
L (<500)	Higher	Post-1994	n/a	n/a
	Higher	Pre-1994	n/a	n/a
	Middle	Post-1994	1	52
	Middle	Pre-1994	1	198
	Lower	Post-1994	n/a	n/a
	Lower	Pre-1994	n/a	n/a
Average				108

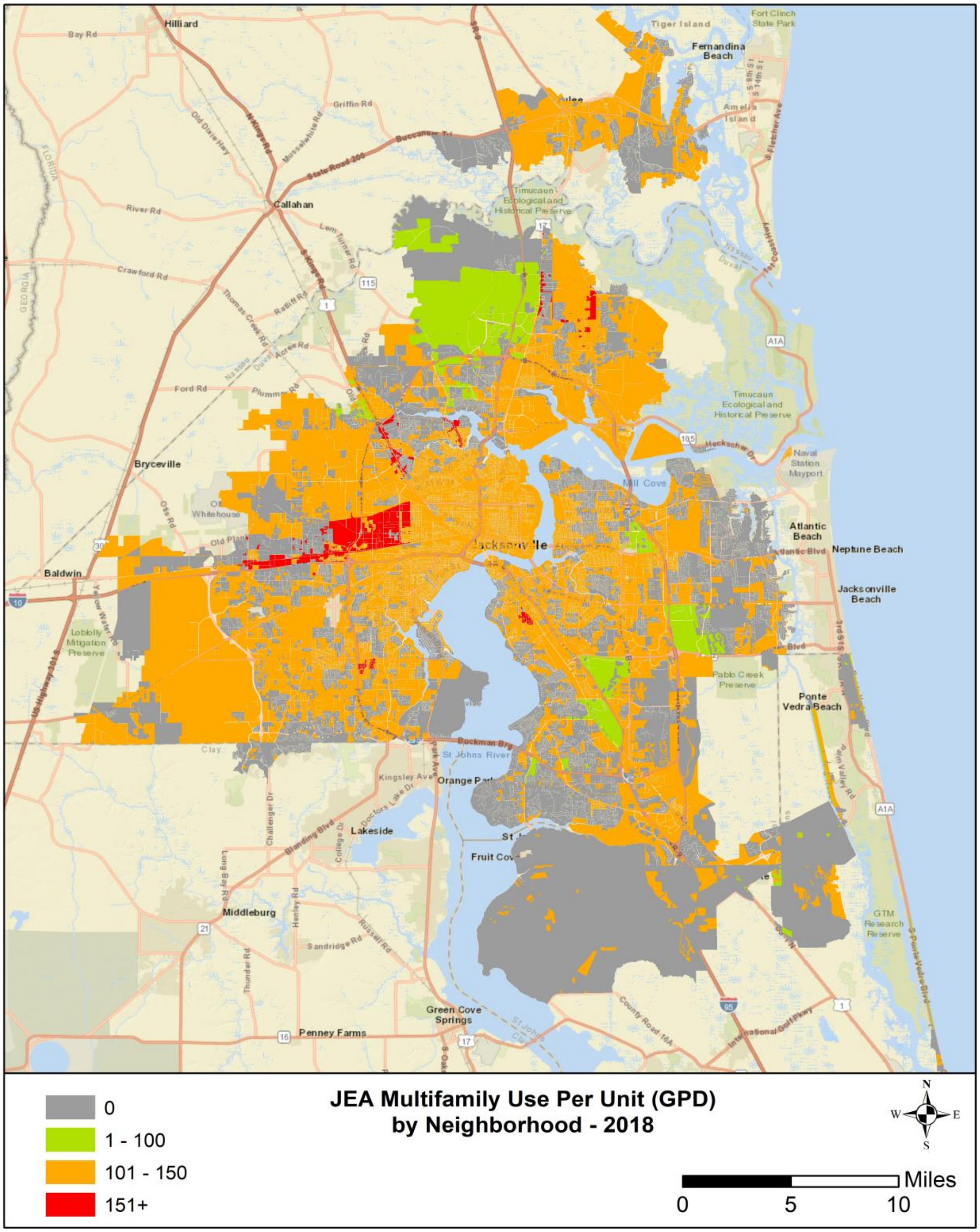

Figure 12. Spatial Distribution of MF Neighborhoods by Gallons per Day per Household

CII Water Use Factors

About 4.5 percent of JEA water service agreements are classified as commercial, industrial or institutional (CII) water users. This may include some residential water use and "mixed use" service agreements in which a master meter serves a mix of water users. Note that the JEA billing codes use the code "COM" to represent all of these service agreements. However, the county appraiser data include land use codes which allow parcels with JEA COM service agreements to be classified as either commercial, industrial, or institutional users. About 71 percent of the JEA COM water service agreements are associated with commercial land use, about 16 percent are associated with industrial land use and 13 percent are associated with institutional land use.

The nearly 15,000 CII water use service agreements are located in 286 neighborhoods within the JEA service area. The billing data is separated between commercial, industrial or institutional categories by associated parcel data land use designations, aggregated by neighborhood and matched with the appraiser data heated square footage by neighborhood. The monthly gallons per day of CII water use for each neighborhood is divided by the CII heated square footage of the neighborhood to derive the monthly gallons per day per heated square foot for the commercial, industrial and institutional water sectors.

Tables 7, 8 and **9** show the average of the water use factors across all neighborhoods for each grid for each of the CII categories, respectively. **Figures 13, 14** and **15** show neighborhoods with commercial, industrial and institutional water, respectively.

The forecast model uses monthly water use factors for each neighborhood with current commercial, industrial or institutional water use. All other neighborhoods are assigned the monthly average water use factor in the event that commercial, industrial or institutional land use is designated for the neighborhood. In addition, the forecast model uses monthly water use factors in order for the forecast to replicate the seasonality of water use.

Table 7. Average Commercial Water Use Factors (GPD per heated square foot) by Grid

GRID	Count	Average Year
Mayport	1	0.9453
Nassau	8	0.0629
North	87	0.0845
Ponce De Leon	2	0.0814
Ponte Vedra	16	0.6538
South	103	0.1088
Average		0.1149

Table 8. Average Industrial Water Use Factors (GPD per heated square foot) by Grid

GRID	Count	Average Year
Mayport	1	0.0839
Nassau	2	0.0040
North	67	0.0563
Ponce De Leon	n/a	n/a
Ponte Vedra	2	0.0036
South	64	0.0605
Average		0.0460

Table 9. Average Institutional Water Use Factors (GPD per heated square foot) by Grid

GRID	Count	Average Year
Mayport	1	0.0886
Nassau	6	0.0286
North	95	0.1365
Ponce De Leon	1	0.6361
Ponte Vedra	3	0.2396
South	87	0.0668
Average		0.0886

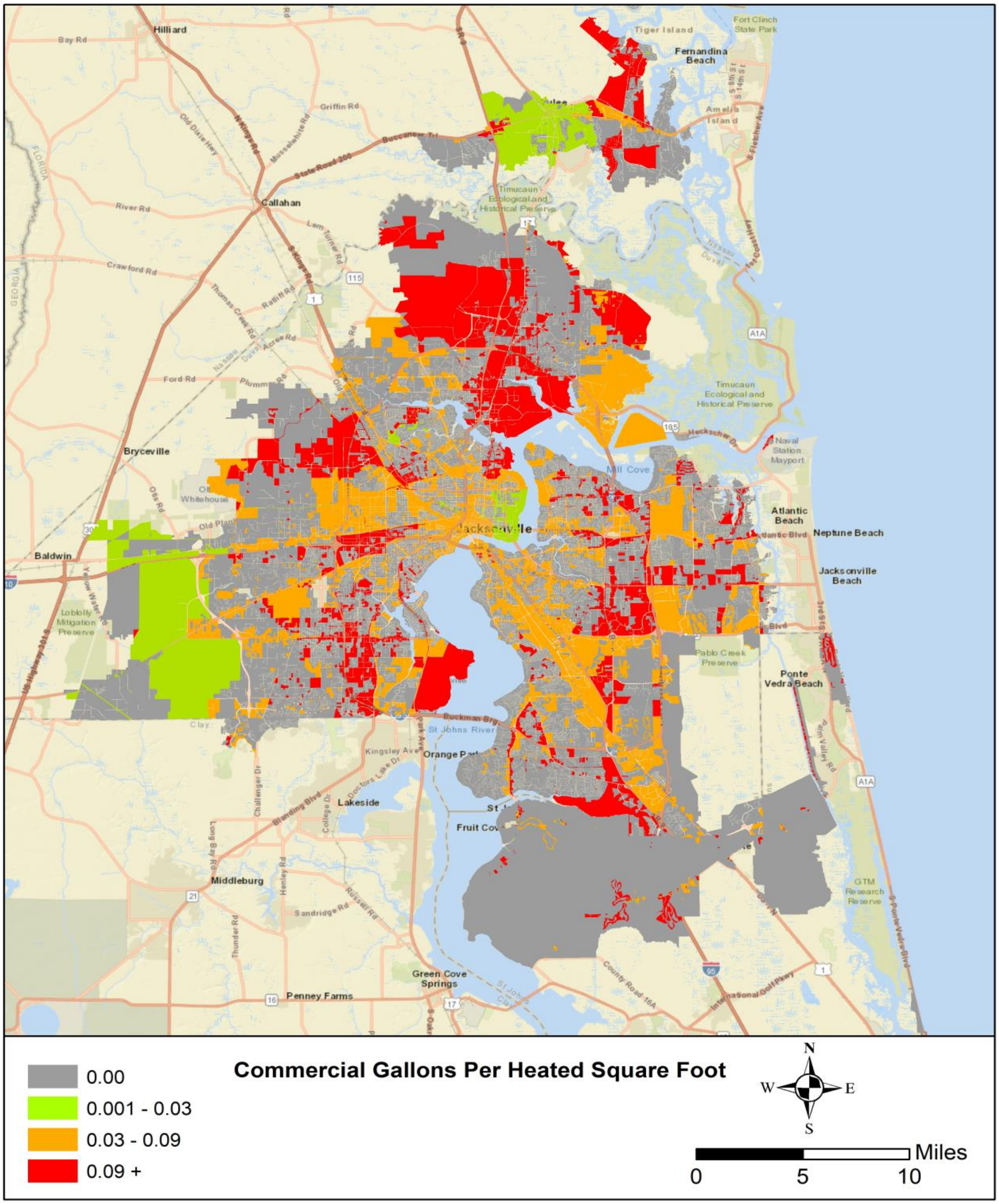

Figure 13. Spatial Distribution of Neighborhoods with Commercial Water Use by Gallons per Day per Heated Square Foot

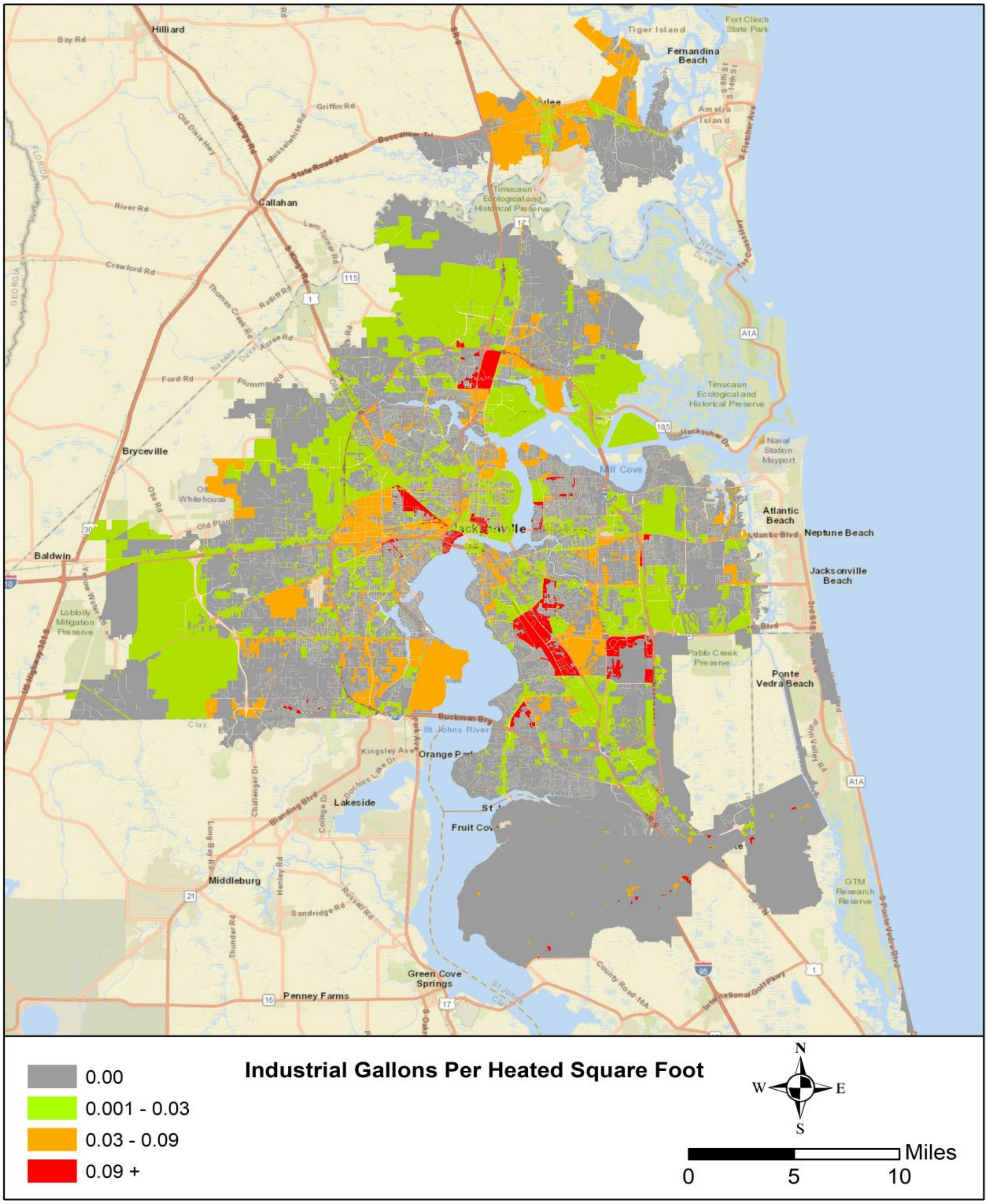

Figure 14. Spatial Distribution of Neighborhoods with Industrial Water Use by Gallons per Day per Heated Square Foot

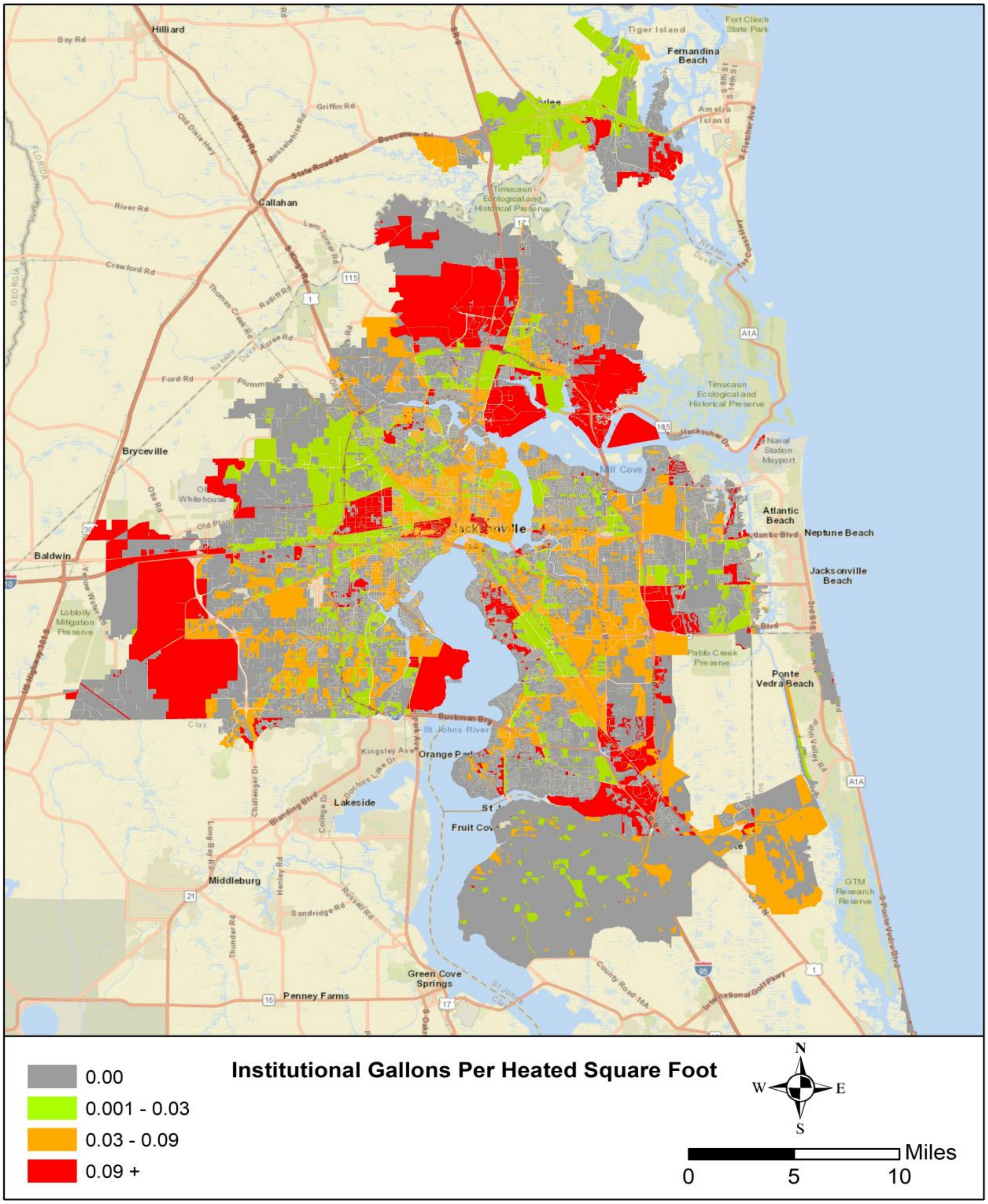

Figure 15. Spatial Distribution of Neighborhoods with Institutional Water Use by Gallons per Day per Heated Square Foot

CII Irrigation Water Use Factors

There are 2,313 JEA commercial irrigation service agreements across 217 neighborhoods. Acreage or average parcel square footage for CII land uses by neighborhood among these neighborhoods with irrigation accounts could not be reasonably associated with the CII irrigation water use due to the mis-match in number of CII irrigation service agreements and CII parcels by neighborhood. Thus, the CII irrigation volume is summed for each neighborhood. CII irrigation use is a combination of potable CII metered irrigation and metered CII reclaimed water sales.

Table 10 shows the total CII irrigation water use across all neighborhoods for each grid. **Figure 16** shows the spatial distribution of neighborhoods with CII irrigation water use in gallons per day. Neighborhoods in grey do not have CII irrigation.

Note that for the water demand forecast, the CII irrigation volume per neighborhood is increased over time in proportion to the growth of CII water demand for each neighborhood.

Table 10. Number of Service Agreements and Total CII Irrigation Water Use by Grid

GRID	Count	GPD
Mayport	1	49
Nassau	53	76,615
North	810	1,344,164
Palm Valley	10	43,184
Ponce De Leon	2	1,898
Ponte Vedra	48	105,862
South	1,849	5,617,575
Total	2,773	7,189,347

Potable and Reclaimed Irrigation

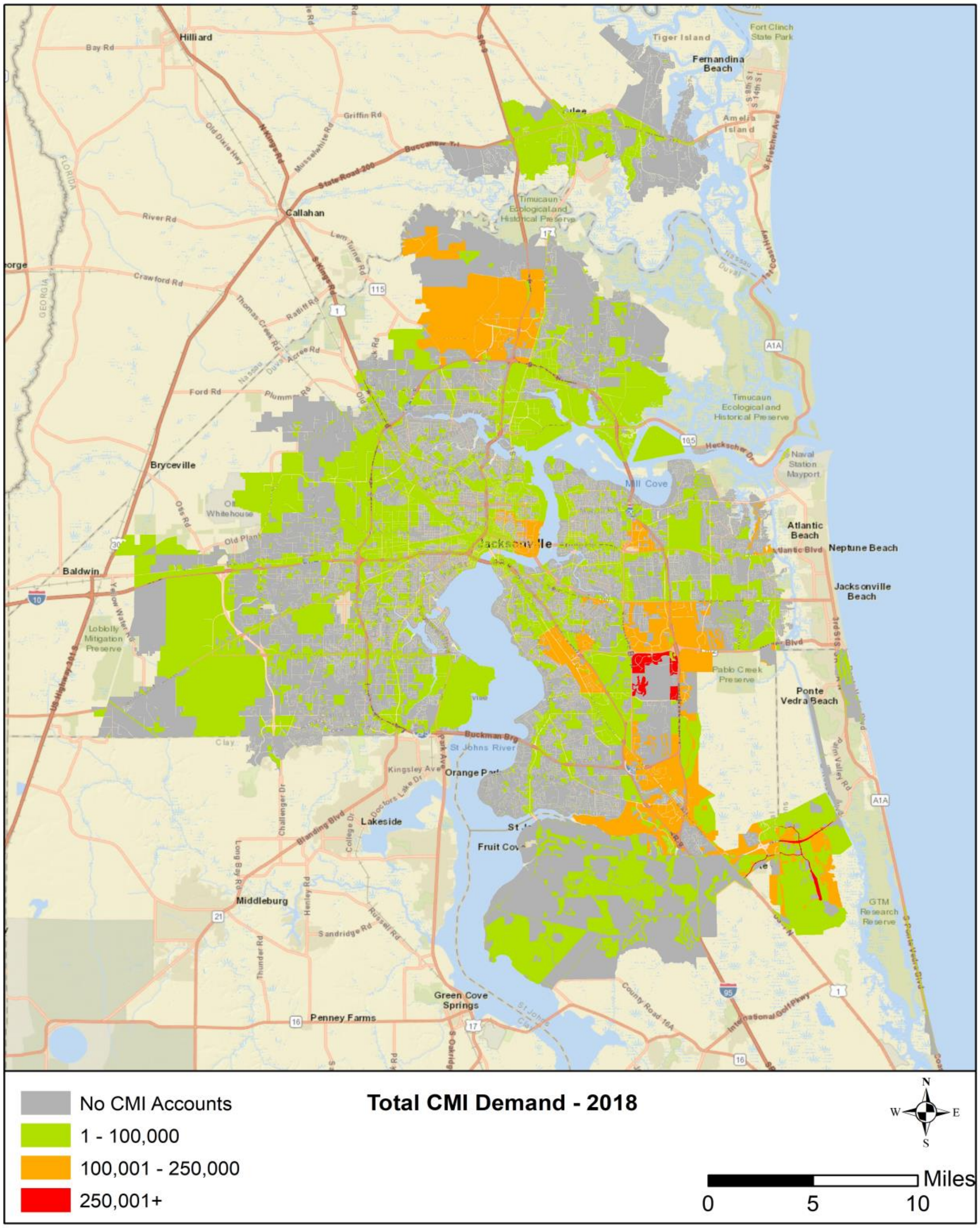

Figure 16. Spatial Distribution of Neighborhoods with CII irrigation Water Use by Gallons per Day

Indoor Water Use Estimates

One purpose of the disaggregated water demand forecast is the development of DSM strategies for the JEA service area. Task 6 will disaggregate the average water use per sector into end uses for that purpose. The spatially disaggregated neighborhood water demand forecast model in Microsoft Excel includes a calculation of indoor and outdoor water use for each sector. The total per unit water use is estimated on a monthly basis for each sector as describe in the preceding sections. The monthly water use per unit can be separated between indoor water use and outdoor water use per month for analysis of seasonal water demand for water supply planning. The indoor and outdoor water use estimates by sector and neighborhood will facilitate the targeting of DSMs by neighborhood and sector.

Numerous statistical studies have been conducted to assess single-family indoor water use. The most comprehensive of these studies is the Water Research Foundation Residential End Use Study (WRF-REUS) of 2016. This study is a replica of a prior study of single-family water use conducted in 1999. Both studies conducted data extensive data-logging of household meters in conjunction with surveys of occupants among hundreds of single-family households across the US and Canada. One component of this WRF study was to develop a predictive model of single-family indoor water use as shown in **Figure 17**.

For the single-family sector, demographic data compiled by GIS Associates for each JEA neighborhood and results of the 2019 JEA survey of single-family water customers summarized by grid provide sufficient data to utilize the WRF-REUS indoor water use model to develop estimates of indoor single-family water use for each JEA single-family neighborhood. Results of the estimated single-family indoor water use for the JEA neighborhoods range from 47 to 172 gallons per day per household. The average estimated indoor use is 102 gallons per day per household while the median is 104 gallons per day per household.

For the remaining water use sectors, analysis of recent JEA monthly water use by sector as described previously provides estimates of the minimum month water use by sector for each neighborhood. For the JEA service area, it is assumed that some portion of the minimum month water use is outdoor water use. For the multifamily sector, it is assumed that indoor water use is 90 percent of the minimum month for each neighborhood. For the commercial, industrial and institutional sectors, it is assumed that indoor water use is 60 percent of the minimum month for each neighborhood with that respective water use. Looking ahead to the development of DSM strategies for the CII sector, it is assumed that water used for cooling purposes is classified as outdoor water use.

Table 7.1 Estimated model of indoor water use for combined indoor use

Dependent Variable: ln (logged indoor use)						
Iteratively Re-Weighted Least Squares Parameter Estimates						
Parameter	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	3.281	0.309	2.675	3.888	112.55	<.0001
ln (persons residing at the home)	0.748	0.043	0.664	0.832	304.55	<.0001
ln (number of persons 12 years of age and under + 1)	-0.186	0.054	-0.291	-0.080	11.92	0.0006
ln (size of parcel in sq. ft.)	0.122	0.033	0.057	0.188	13.39	0.0003
Indicator for swimming pool (0/1)	0.082	0.043	-0.002	0.165	3.67	0.0554
ln (sewer rate, $/kgal)	-0.112	0.051	-0.211	-0.013	4.87	0.0274
Indicator for presence of efficient toilets/flushes (0/1)	-0.174	0.036	-0.245	-0.103	22.94	<.0001
Indicator for presence of efficient clothes washers/wash loads (0/1)	-0.073	0.035	-0.142	-0.005	4.39	0.0362
Indicator for home water treatment system (0/1)	0.155	0.055	0.047	0.262	7.94	0.0048
Indicator for hot water recirculating system (0/1)[17]	-0.109	0.054	-0.216	-0.003	4.06	0.0440
Number of Observations	723					
Outliers detected	14					
Leverage points detected	188					
Robust R-Square	0.3041					

Figure 17. Water Research Foundation Residential End Use Study (2016) Predictive Model used to estimate Single-family Indoor Water Use

Demographic Projections

Growth within the JEA Service Area

Demographic projections are developed by GIS Associates for the JEA service area by neighborhood using parcel-based GIS models. The 2020-2070 projections include the number of single-family dwelling units, average single-family lot size, number of multifamily dwelling units and the number of heated square footage for commercial, industrial and institutional buildings for each neighborhood. Note that the volume of CII irrigation increases over time in proportion to the estimated CII water use by neighborhood, therefore there are no projections of units for the CII irrigation sector described in this section.

These projections start with the same county-level populations used to develop the JEA estimate of future water demand by grid. The population projections for the JEA service area are spatially disaggregated down to the neighborhood level based upon undeveloped parcels, trends in residential housing densities, and neighborhoods identified for future development resulting is estimates of future persons per household, single-family and multifamily dwelling units and single-family lot size for each neighborhood. The availability of undeveloped CII parcels, trends in development densities and neighborhoods identified for future development were used to estimate the future CII heated square footage for neighborhoods with CII land use designations. The projections by neighborhood are summarized by grid in **Tables 11 – 16**.

Although the neighborhood water demand forecast is not a per capita forecast, population by neighborhood and persons per household are underlying components of the demographic projections. The change in population by neighborhood from 2018 to 2035 is illustrated in **Figure 18**.

Figures 19 and **20** show the change from 2018 to 2035 in single-family housing units and multifamily housing units, respectively. Neighborhoods without residential units are shown as zero percent change. **Figure 21** shows the change from 2018 to 2035 in CII heated square footage. Neighborhoods without CII land use are shown as zero percent change.

Table 11. Number of Single-family Units by Grid and Year

Grid	2018	2020	2030	2040	2050	2060	2070
Mayport	88	89	102	105	103	128	112
Nassau	8,624	9,061	11,086	12,534	13,689	14,873	16,119
North	127,626	131,798	150,635	165,721	177,739	189,283	198,751
Ponce De Leon	794	824	955	955	955	955	955
Ponte Vedra	1,639	1,645	1,651	1,653	1,653	1,653	1,653
South	161,028	165,724	180,631	188,365	194,601	198,497	202,110
Total	**300,289**	**309,664**	**345,697**	**370,001**	**389,407**	**406,058**	**420,368**

Table 12. Median Single-family Lot Size (in square feet) by Grid and Year

Grid	2018	2020	2030	2040	2050	2060	2070
Mayport	6,843	6,819	6,659	6,634	6,657	6,429	6,559
Nassau	11,481	11,351	10,877	10,642	10,487	10,352	10,231
North	8,270	8,247	8,234	8,345	8,469	8,580	8,872
Ponce De Leon	11,355	11,202	10,653	10,653	10,653	10,653	10,653
Ponte Vedra	10,962	10,954	10,949	10,947	10,947	10,947	10,947
South	9,052	8,994	8,920	8,928	8,984	9,069	9,134
Total	**8,883**	**8,818**	**8,621**	**8,505**	**8,466**	**8,436**	**8,457**

Table 13. Number of Multifamily Units by Grid and Year

Grid	2018	2020	2030	2040	2050	2060	2070
Mayport	9	9	9	9	9	9	9
Nassau	1,530	1,536	1,561	1,579	1,594	1,609	1,624
North	42,832	43,619	46,914	49,038	49,981	50,303	50,306
Ponce De Leon	282	285	297	297	297	297	297
Ponte Vedra	886	893	918	928	929	929	929
South	69,124	70,385	74,969	77,714	78,703	79,019	79,052
Total	**114,717**	**116,781**	**124,723**	**129,620**	**131,568**	**132,220**	**132,271**

Table 14. Total Commercial Heated Square Feet (in millions) by Grid and Year

Grid	2018	2020	2030	2040	2050	2060	2070
Mayport	0.017	0.017	0.018	0.018	0.019	0.020	0.020
Nassau	2.356	2.431	3.187	3.613	4.023	4.225	4.282
North	36.600	38.160	46.624	51.439	53.801	55.271	56.210
Ponce De Leon	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ponte Vedra	0.863	0.874	0.882	0.883	0.883	0.883	0.883
South	59.630	60.900	64.204	68.011	70.953	74.051	76.713
Total	**99.465**	**102.383**	**114.915**	**123.964**	**129.679**	**134.451**	**138.109**

Note: one acre is 43,560 square feet.

Table 15. Total Industrial Heated Square Feet (in millions) by Grid and Year

Grid	2018	2020	2030	2040	2050	2060	2070
Mayport	0.025	0.026	0.026	0.026	0.026	0.026	0.026
Nassau	1.737	1.755	1.990	2.141	2.256	2.369	2.488
North	66.143	68.267	77.100	84.429	88.991	92.891	96.002
Ponte Vedra	0.003	0.003	0.003	0.003	0.003	0.003	0.003
South	21.640	22.318	24.123	24.939	25.455	25.748	26.009
Total	**89.548**	**92.370**	**103.242**	**111.538**	**116.731**	**121.037**	**124.527**

Note: one acre is 43,560 square feet.

Table 16. Total Institutional Heated Square Feet (in millions) by Grid and Year

Grid	2018	2020	2030	2040	2050	2060	2070
Mayport	0.042	0.042	0.042	0.042	0.042	0.042	0.042
Nassau	1.746	1.774	1.905	1.983	2.036	2.081	2.122
North	28.438	29.625	34.636	38.065	40.245	42.177	43.833
Ponce De Leon	0.024	0.024	0.024	0.024	0.024	0.025	0.025
Ponte Vedra	0.229	0.229	0.230	0.230	0.231	0.231	0.231
South	18.657	19.061	20.416	21.176	21.628	21.988	22.279
Total	**49.136**	**50.755**	**57.252**	**61.520**	**64.206**	**66.544**	**68.531**

Note: one acre is 43,560 square feet.

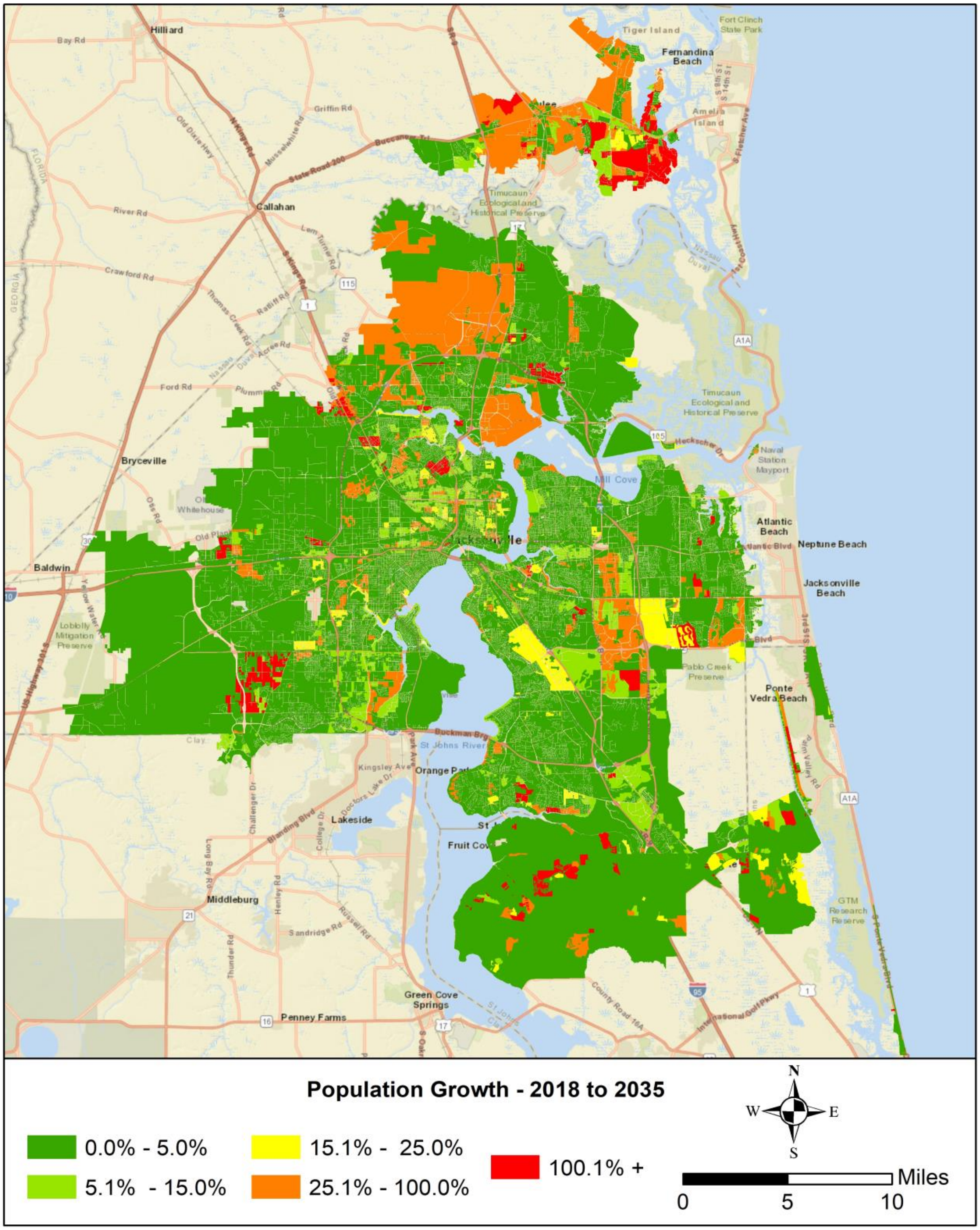

Figure 18. Percent Change in Population by Neighborhood from 2018 – 2035

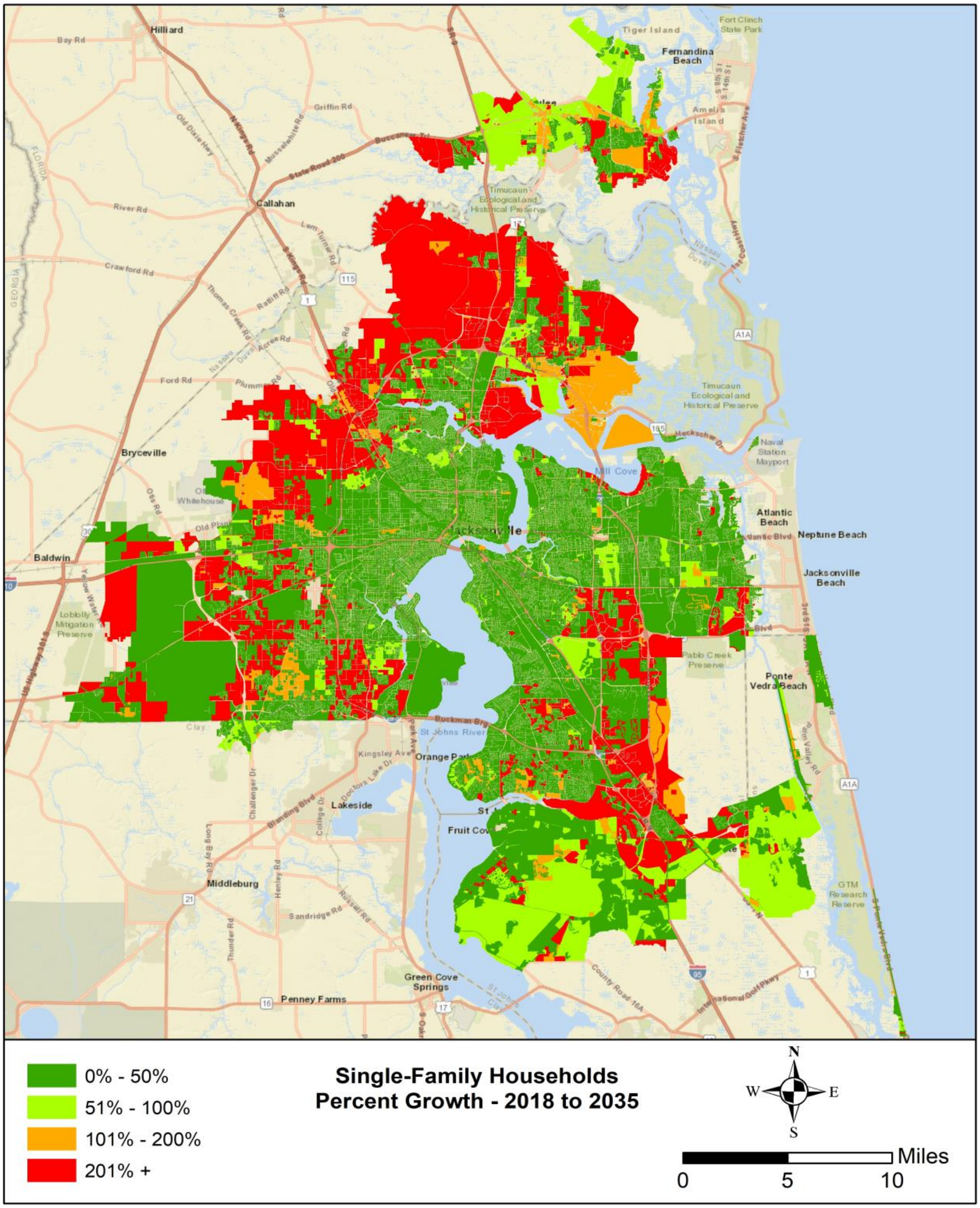

Figure 19. Percent Change in SF Housing by Neighborhood from 2018 – 2035

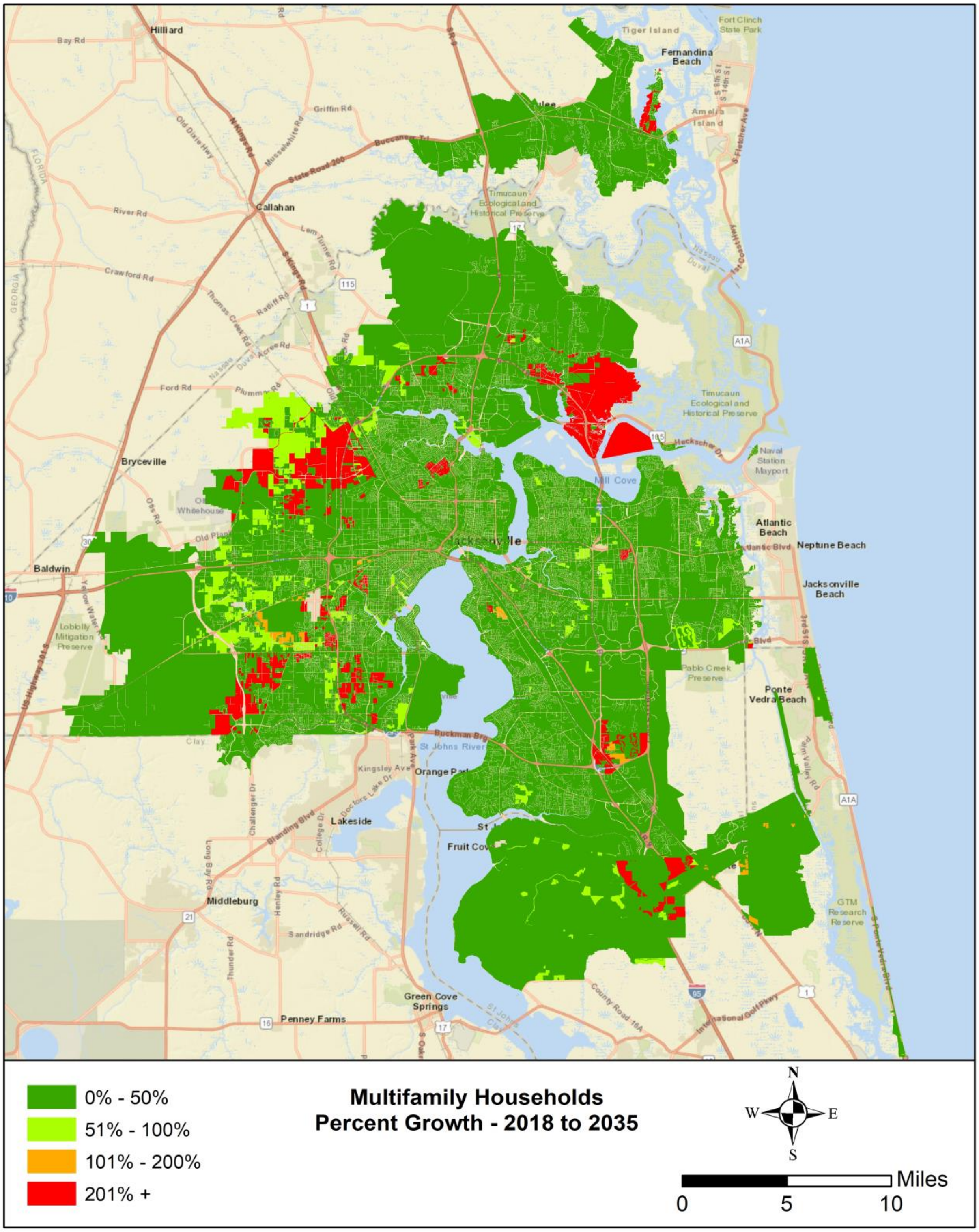

Figure 20. Percent Change in MF Housing by Neighborhood from 2018 – 2035

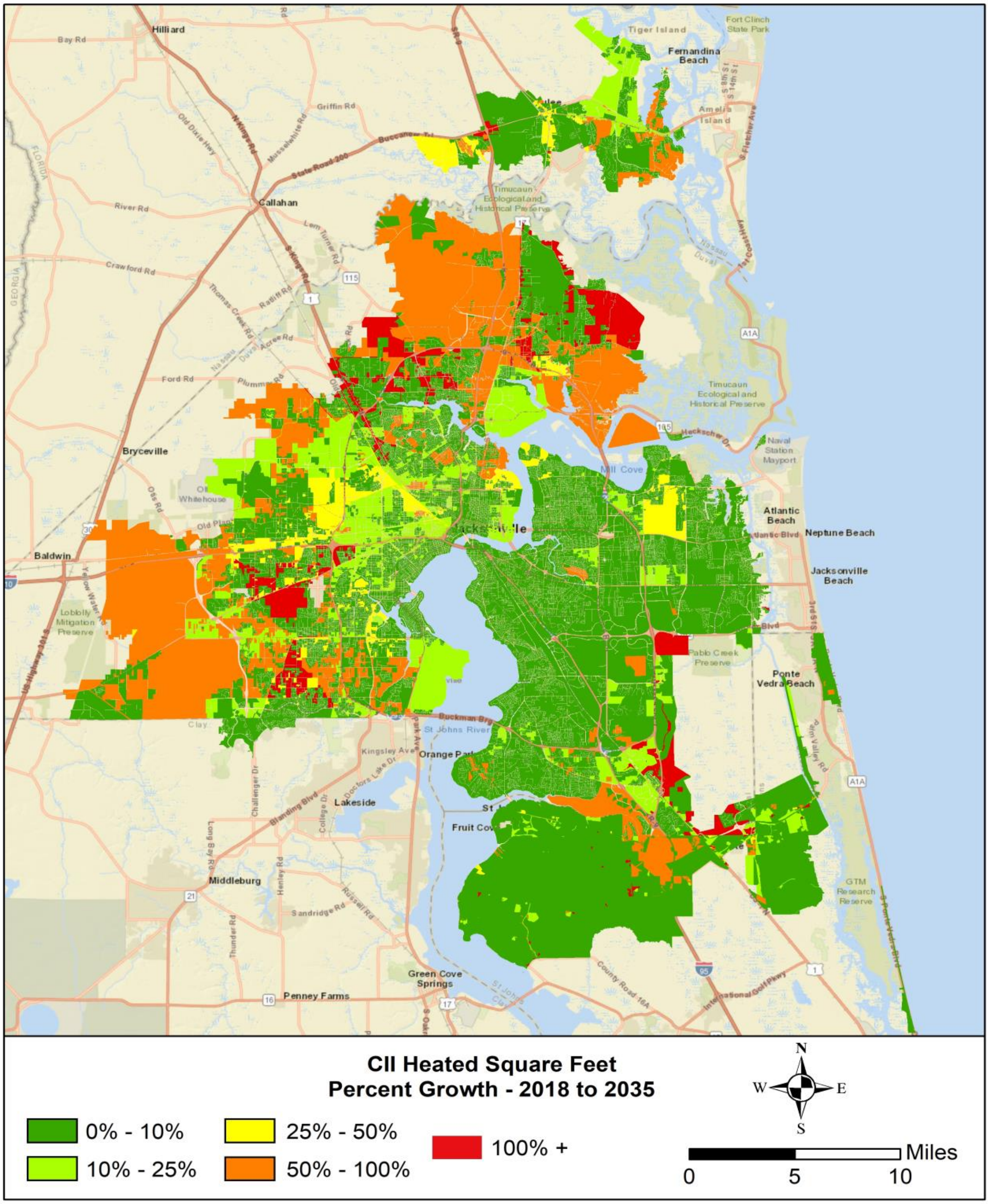

Figure 21. Percent Change in CII Heated Square Footage by Neighborhood from 2018 – 2035

Expansion of JEA Service Area

Discussions with JEA staff indicate that water service is likely to expand beyond the current JEA service boundaries. **Figure 22** shows the areas into which JEA water service is anticipated. There are five primary areas of expansion.

- The "East" expansion area is an area east of the south grid and west of Palm Valley known as D Dot Ranch.
- The "North" expansion area is in the northern portion of the north grid and extends up to the Duval County line.
- The "West" expansion area is in the western portion of the north grid and extends out to the Duval County line.
- The "Nassau East" expansion area is adjacent to the current JEA service area in Nassau County.
- The "Nassau West" expansion area is west of the current JEA service area in Nassau County.

GIS Associates developed demographic projections for these five expansion areas as shown in **Tables 17 – 22**. Because there is no current JEA service in these areas, the average water use per unit for each water use sector is used to estimate the future water demand for these expansion areas.

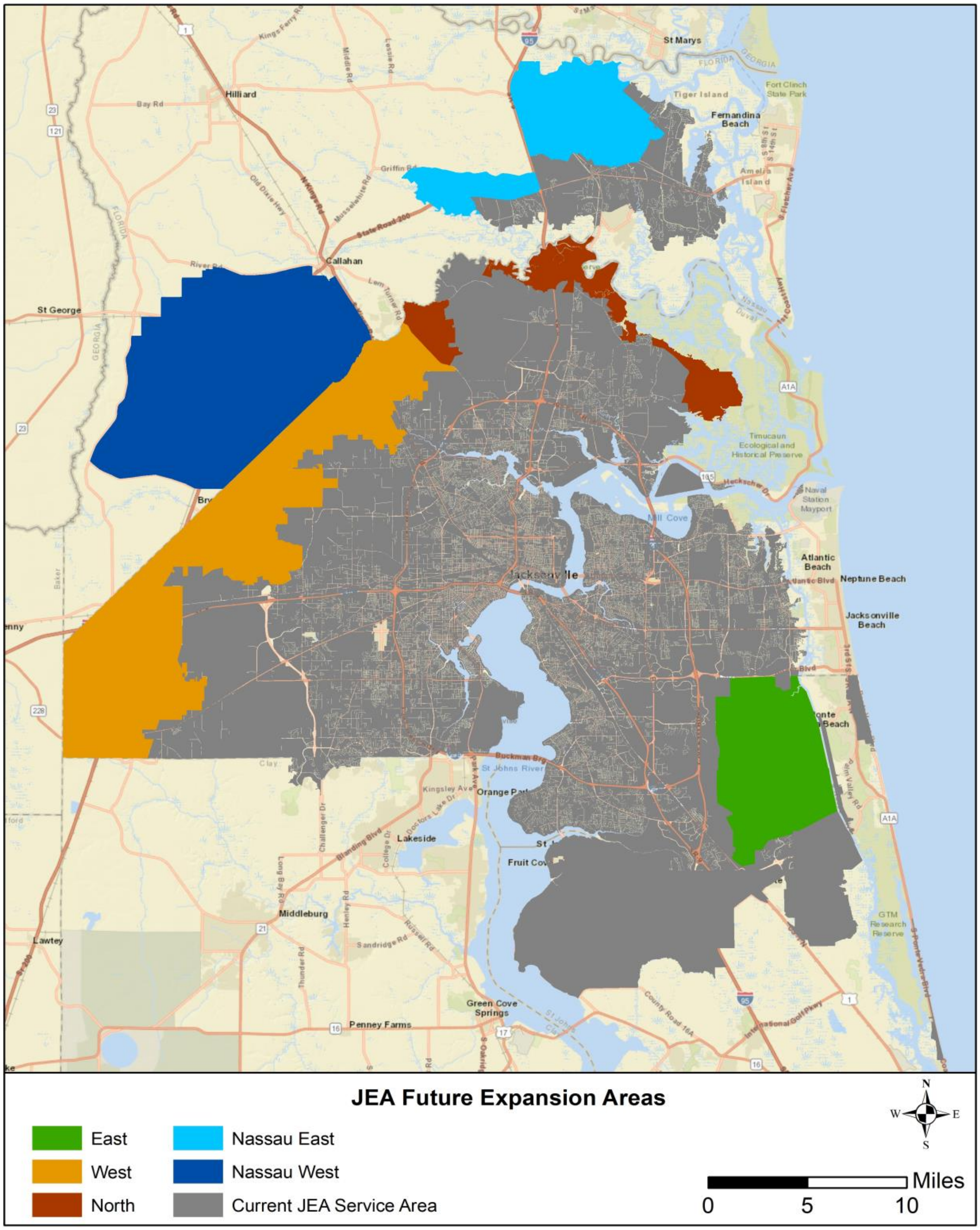

Figure 22. Location of JEA future expansion areas

Table 17. Population Projections for Expansion Areas

Future Expansion Areas	2018	2020	2025	2030	2035	2040	2050	2060	2070
EAST (South)	103	1,547	4,839	7,716	10,271	12,704	19,320	26,574	31,477
NASSAU EAST	1,554	2,211	3,742	5,087	6,288	7,268	9,009	10,756	12,589
NASSAU WEST	6,190	6,478	7,097	7,649	8,159	8,595	9,357	10,102	10,875
NORTH (North)	1,069	1,113	1,229	1,325	1,412	1,489	1,658	1,861	3,901
WEST (North)	8,039	8,953	11,657	15,827	20,784	28,984	47,115	67,928	93,131
TOTAL	**16,955**	**20,302**	**28,565**	**37,604**	**46,913**	**59,041**	**86,459**	**117,221**	**151,973**

Table 18. Single-family Housing Projections for Expansion Areas

Future Expansion Areas	2018	2020	2025	2030	2035	2040	2050	2060	2070
EAST (South)	32	614	1,937	3,090	4,113	5,088	7,700	10,588	12,535
NASSAU EAST	559	818	1,420	1,948	2,420	2,806	3,491	4,179	4,900
NASSAU WEST	2,234	2,345	2,585	2,798	2,996	3,165	3,460	3,748	4,047
NORTH (North)	388	404	449	485	518	548	613	690	1,470
WEST (North)	2,880	3,108	3,757	4,909	6,284	9,121	15,174	21,935	28,911
TOTAL	**6,093**	**7,290**	**10,147**	**13,231**	**16,332**	**20,728**	**30,439**	**41,139**	**51,863**

Table 19. Multifamily Housing Projections for Expansion Areas

Future Expansion Areas	2018	2020	2025	2030	2035	2040	2050	2060	2070
EAST (South)	7	7	7	7	7	7	7	7	7
NASSAU EAST	51	51	51	51	51	51	51	51	51
NASSAU WEST	164	164	164	164	164	164	164	164	164
NORTH (North)	23	23	23	23	23	23	23	23	23
WEST (North)	256	380	782	1,263	1,833	2,209	3,242	4,597	7,382
TOTAL	**500**	**625**	**1,026**	**1,507**	**2,077**	**2,453**	**3,486**	**4,841**	**7,626**

Table 20. Commercial Heated Square Foot Projections for Expansion Areas

Future Expansion Areas	2018	2020	2025	2030	2035	2040	2050	2060	2070
EAST (South)	10,271	154,919	484,488	772,574	1,028,405	1,272,028	1,934,405	2,660,801	3,151,712
NASSAU EAST	155,550	221,339	374,720	509,365	629,569	727,743	902,038	1,076,961	1,260,534
NASSAU WEST	619,777	648,637	710,555	765,864	816,898	860,613	936,898	1,011,458	1,088,831
NORTH (North)	107,080	111,477	123,100	132,650	141,330	149,128	166,029	186,323	390,561
WEST (North)	804,960	896,410	1,167,196	1,584,726	2,081,064	2,902,051	4,717,472	6,801,367	9,324,854
TOTAL	**1,697,637**	**2,032,783**	**2,860,059**	**3,765,179**	**4,697,266**	**5,911,563**	**8,656,842**	**11,736,910**	**15,216,492**

Table 21. Industrial Heated Square Foot Projections for Expansion Areas

Future Expansion Areas	2018	2020	2025	2030	2035	2040	2050	2060	2070
EAST (South)	9,222	139,089	434,984	693,634	923,324	1,142,054	1,736,751	2,388,925	2,829,676
NASSAU EAST	139,656	198,723	336,432	457,319	565,241	653,383	809,870	966,919	1,131,735
NASSAU WEST	556,449	582,361	637,952	687,609	733,429	772,677	841,167	908,109	977,576
NORTH (North)	96,138	100,087	110,522	119,096	126,889	133,890	149,064	167,285	350,654
WEST (North)	722,710	804,817	1,047,934	1,422,801	1,868,424	2,605,525	4,235,449	6,106,415	8,372,056
TOTAL	**1,524,175**	**1,825,076**	**2,567,823**	**3,380,459**	**4,217,308**	**5,307,529**	**7,772,301**	**10,537,652**	**13,661,697**

Table 22. Institutional Heated Square Foot Projections for Expansion Areas

Future Expansion Areas	2018	2020	2025	2030	2035	2040	2050	2060	2070
EAST (South)	5,088	76,737	239,985	382,685	509,407	630,083	958,183	1,317,993	1,561,160
NASSAU EAST	77,050	109,637	185,613	252,308	311,849	360,478	446,813	533,459	624,389
NASSAU WEST	306,999	321,294	351,964	379,361	404,640	426,294	464,080	501,013	539,339
NORTH (North)	53,041	55,219	60,976	65,706	70,006	73,869	82,240	92,293	193,460
WEST (North)	398,726	444,025	578,156	784,974	1,030,828	1,437,494	2,336,739	3,368,969	4,618,946
TOTAL	**840,903**	**1,006,913**	**1,416,693**	**1,865,033**	**2,326,730**	**2,928,217**	**4,288,055**	**5,813,727**	**7,537,294**

The Baseline Water Demand Forecast

The spatially disaggregated water demand forecast by neighborhood is estimated by multiplying the demographic units of the neighborhood by the corresponding sector water use factor. The monthly water use factors result in a neighborhood sector water demand forecast by month. As the number of sector *drivers,* or number units, changes over time the resulting estimated water demand changes. Note that for the CII irrigation sector, the CII irrigation volume by neighborhood is assumed to increase over time in proportion to the combined CII water use of the neighborhood.

The estimate of future water demand derived from the base period water use factors is referred to as the ***baseline*** water demand forecast. As indoor water use fixtures have become more water efficient over time due to national water fixture standards, newer homes and businesses are more water efficient. The impact of the national fixture standards on water use is referred to as "passive savings." An alternate water demand forecast that incorporates improved water efficiency in future construction is identified as the "**passive**" forecast.

The baseline water demand forecast assumes that future weather conditions will be similar to the average weather conditions during the time period from which the base period water use factors are derived. Another alternative is to adjust the baseline forecast for drier and hotter or wetter and cooler conditions. It is assumed that indoor water use remains the same under each weather scenario. Therefore, the outdoor portion of estimated water use under average weather conditions is increased by a factor of 1.11 to reflect water demand under dry weather conditions and decreased by a factor of 0.83 to reflect water demand under wet weather conditions as determined by the analysis of variation in annual average demand from 2009 to 2018.

As water use estimates by sector and neighborhood are aggregated, a non-revenue (NRW) volume is calculated assuming NRW as 10.3 percent of total demand to account for distribution system losses.

Results of the Microsoft Excel forecast model are transferred into an ArcGIS database for use with distribution hydraulic models.

Table 23 summarizes the baseline water demand forecast by grid. This demand includes potable uses, metered reclaimed water use, non-revenue water volumes and service to future expansion areas. The demand forecast is shown for the average weather, dry weather and wet weather scenarios. **Figure 23** illustrates the forecast for the three weather scenarios relative to historic water use which is JEA well production plus metered reclaimed water sales.

Table 23. Baseline Forecast by Grid in MGD, including NRW and Expansion Areas

	Mayport	Nassau	North	Palm Valley	Ponce De Leon	Ponte Vedra	South	Total
AVERAGE								
Base Year	0.04	4.44	44.35	0.42	0.49	1.55	72.31	123.62
2020	0.04	4.74	46.33	0.45	0.50	1.56	74.42	128.04
2025	0.04	5.47	51.37	0.51	0.53	1.56	78.61	138.10
2030	0.04	6.17	56.15	0.55	0.55	1.57	81.55	146.58
2035	0.05	6.75	60.66	0.56	0.55	1.57	83.94	154.08
2040	0.05	7.21	64.84	0.57	0.55	1.57	85.79	160.58
2050	0.05	8.06	73.26	0.57	0.55	1.57	89.40	173.45
2060	0.05	8.87	80.69	0.57	0.55	1.57	92.24	184.54
2070	0.05	9.70	87.69	0.57	0.55	1.57	94.54	194.67
DRY								
Base Year	0.04	4.76	47.00	0.46	0.54	1.69	77.29	131.77
2020	0.04	5.08	49.12	0.49	0.55	1.69	79.53	136.50
2025	0.04	5.86	54.50	0.56	0.58	1.70	84.00	147.24
2030	0.05	6.61	59.62	0.60	0.60	1.70	87.13	156.30
2035	0.05	7.23	64.44	0.61	0.60	1.70	89.68	164.32
2040	0.05	7.73	68.91	0.62	0.60	1.71	91.65	171.26
2050	0.05	8.63	77.96	0.62	0.60	1.71	95.51	185.07
2060	0.05	9.50	85.91	0.62	0.60	1.71	98.54	196.93
2070	0.05	10.39	93.39	0.62	0.60	1.71	100.99	207.75
WET								
Base Year	0.04	3.95	40.26	0.36	0.43	1.34	64.63	111.01
2020	0.04	4.22	42.03	0.39	0.44	1.35	66.52	114.98
2025	0.04	4.87	46.53	0.44	0.46	1.35	70.28	123.97
2030	0.04	5.49	50.79	0.47	0.48	1.36	72.92	131.54
2035	0.04	6.01	54.81	0.48	0.48	1.36	75.07	138.25
2040	0.04	6.42	58.54	0.49	0.48	1.36	76.73	144.06
2050	0.04	7.17	65.99	0.49	0.48	1.36	79.97	155.50
2060	0.05	7.89	72.62	0.49	0.48	1.36	82.51	165.39
2070	0.04	8.63	78.89	0.49	0.48	1.36	84.56	174.45

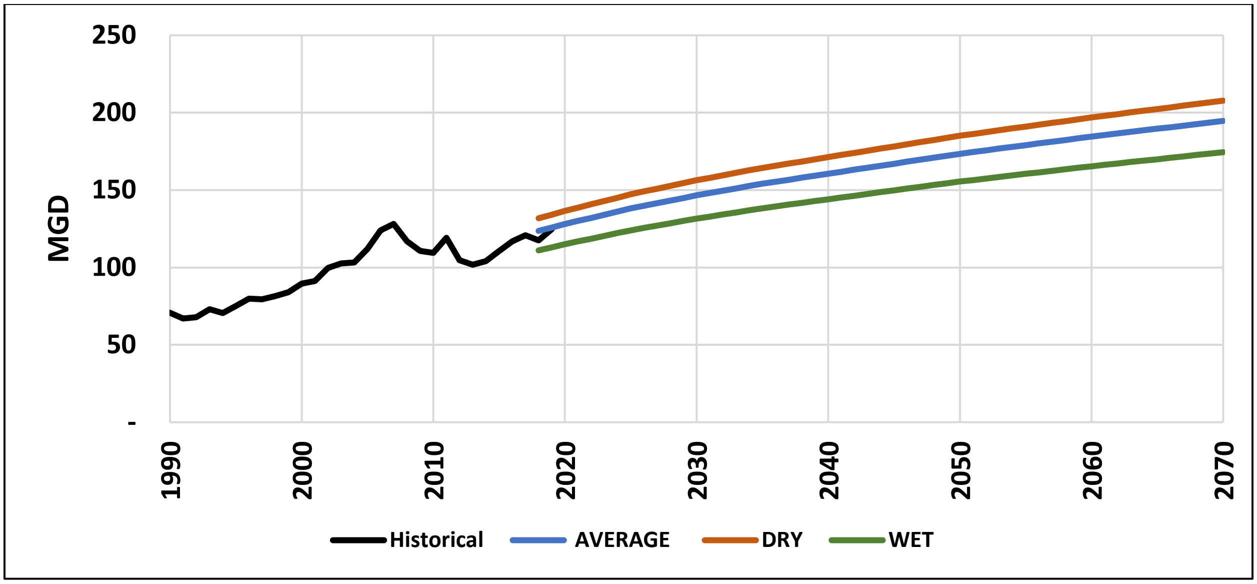

Figure 23. Historic JEA water demand with the Baseline Average, Dry and Wet Weather Forecast Scenarios

Passive Conservation

Indoor water use fixture have become more water efficient over time due to national water fixture standards. Thus, newer homes and businesses have more water efficient fixtures than older construction. The impact of the national fixture standards on water use is referred to as "passive savings."

The National Energy Policy Act of 1992, and amendments, set maximum water flow limits for indoor fixtures such as toilets, urinals, faucets, and showerheads. In addition, the EPA WaterSense and Energy Star program set maximum water use standards for clothes washers. These standards impact all new construction. Note that the current level of water use efficiency as reflected in the base period water use factors incorporates the water use efficiency in construction from the implementation of these standards up to the current time. Thus, the impact of passive savings is only estimated for new construction going forward from the base period. That is, going forward in time from the base period, the average (indoor) water use will decrease as a larger percentage of units have the more efficient fixtures.

Table 24 presents levels of water use efficiency for the affected indoor fixtures for two future time periods. Currently manufacturers are marketing fixtures that perform even more efficiently than required by the national standards in part because some states have enacted state plumbing codes that require more efficient fixture flow rates than those of the national standards. As indicated in Table 23, it is assumed that these more efficient flow rates will become national standards by 2030.

Table 24. Water Efficiency Assumptions for Passive Conservation

Fixture	2018 – 2029 Standard	2030 - 2070 Standard	Metric
Toilet	1.6	1.28	Gallons per flush
Urinal	1.0	0.5	Gallons per flush
Showerhead	2.5	2.0	Gallons per minute
Faucet	2.2	1.6	Gallons per minute
Clothes Washer	6.0	3.5	Gallons per cubic foot

The methodology for calculating the passive savings by end use and sector is described in a subsequent Technical Memorandum. The JEA DSM model developed for this project calculates the changes in per unit gallons per day over time for each sector given the application of the standards in Table 23 to all newly constructed units (i.e., all new growth).

Table 25 shows a comparison of the baseline and passive conservation forecasts for the three weather scenarios, including the expansion areas. Savings from the passive conservation amounts to 2.53 MGD by 2070. Because these savings are achieved in the indoor water use, the savings are the same for all three weather scenarios. **Figure 24** illustrates the baseline and passive forecasts for the three weather scenarios relative to historic water use which is JEA well production plus metered reclaimed water sales.

Table 25. Summary of Baseline and Passive Conservation Forecast

	BASELINE			WITH PASSIVE CONSERVATION		
	AVERAGE MGD	DRY MGD	WET MGD	AVERAGE MGD	DRY MGD	WET MGD
Base Year	123.62	131.77	111.01	123.62	131.77	111.01
2020	128.04	136.50	114.98	127.93	136.38	114.86
2025	138.10	147.24	123.97	137.73	146.87	123.60
2030	146.58	156.30	131.54	146.02	155.75	130.99
2035	154.08	164.32	138.25	153.13	163.37	137.30
2040	160.58	171.26	144.06	159.35	170.03	142.83
2050	173.45	185.07	155.50	171.76	183.38	153.80
2060	184.54	196.93	165.39	182.45	194.84	163.30
2070	194.67	207.75	174.45	192.13	205.22	171.92

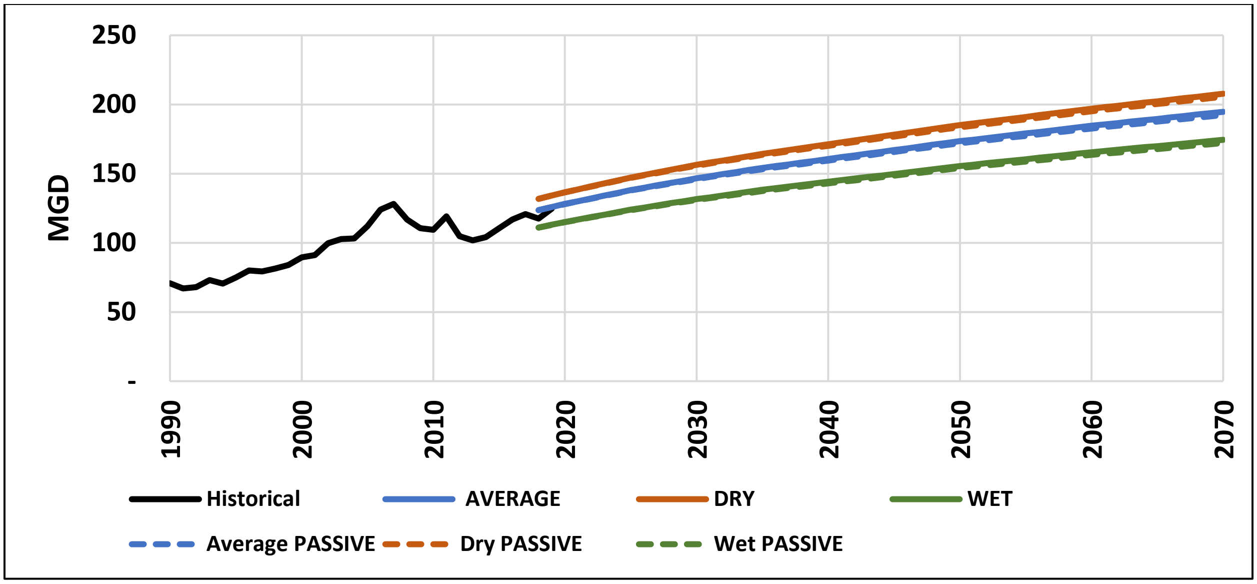

Figure 24. Historic JEA water demand with the Baseline and Passive Average, Dry and Wet Weather Forecast Scenarios

Figures 25 and **26** show the spatial distribution of the passive conservation forecast for the years 2040 and 2070, respectively. **Figure 27** shows the change in water demand from current (base period) use to 2070.

For purposes of reclaimed water supply planning, **Figure 28** shows the spatial distribution of the base period (current) outdoor water demand.

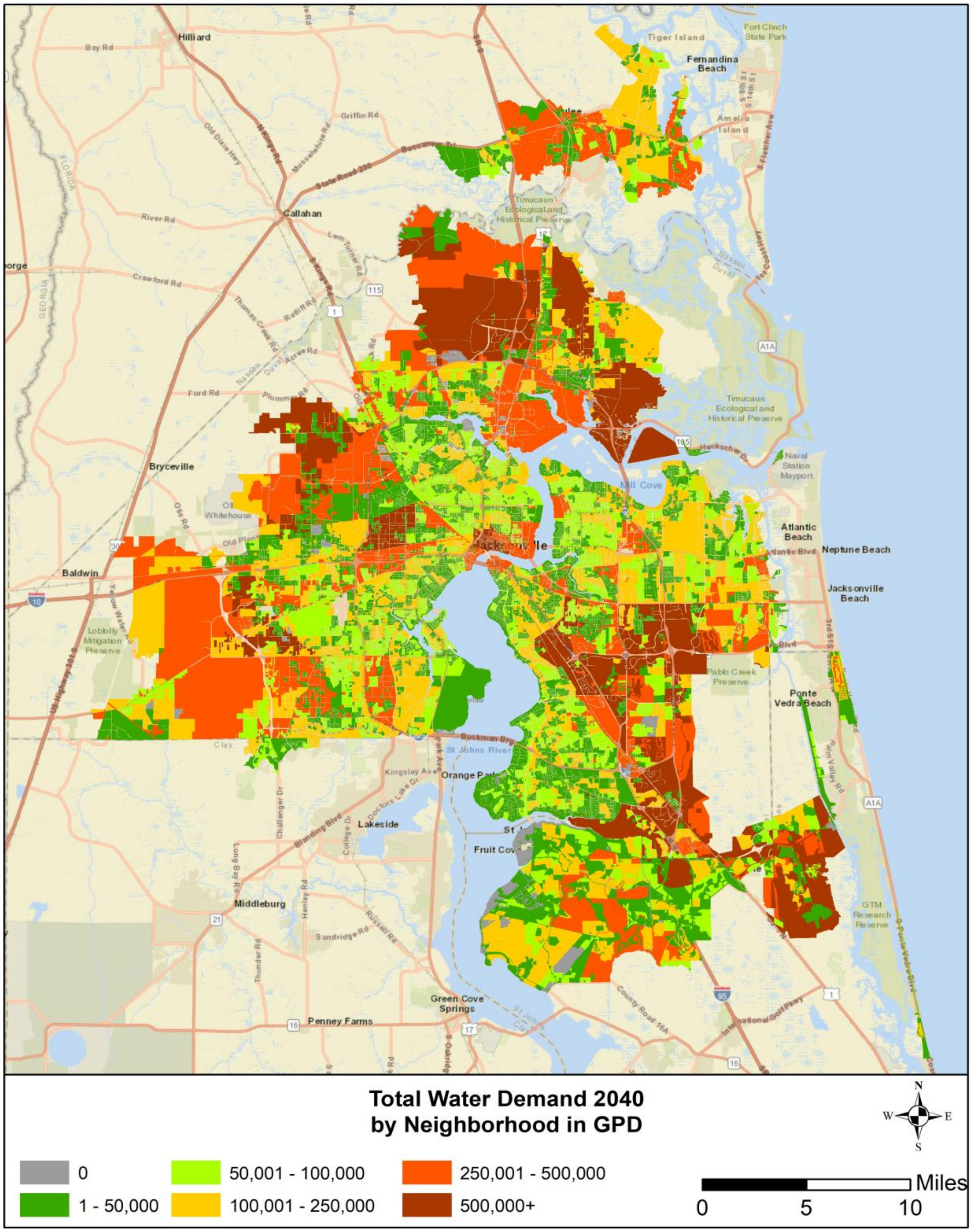

Figure 25. Passive Forecast by Neighborhood for 2040

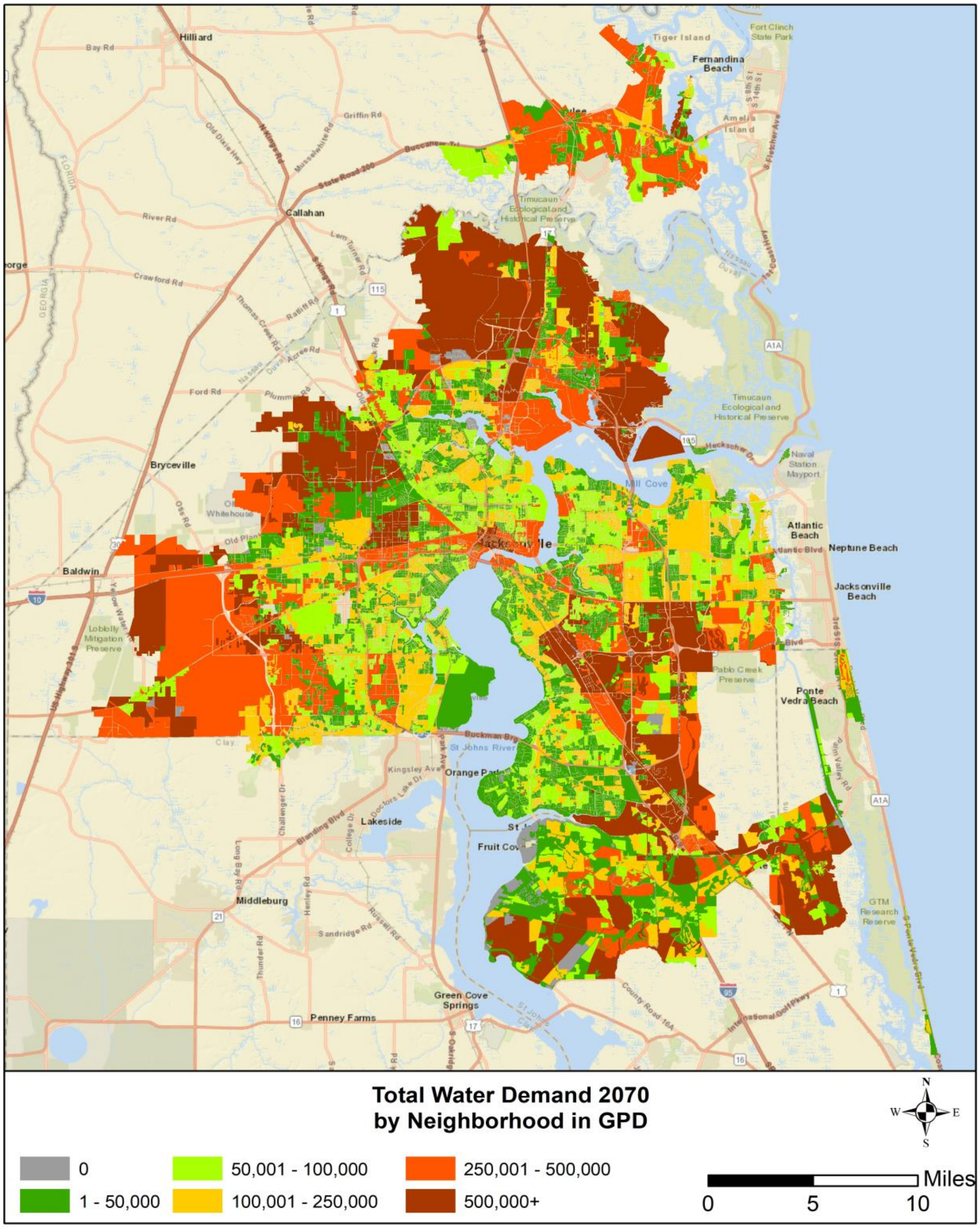

Figure 26. Passive Forecast by Neighborhood for 2070

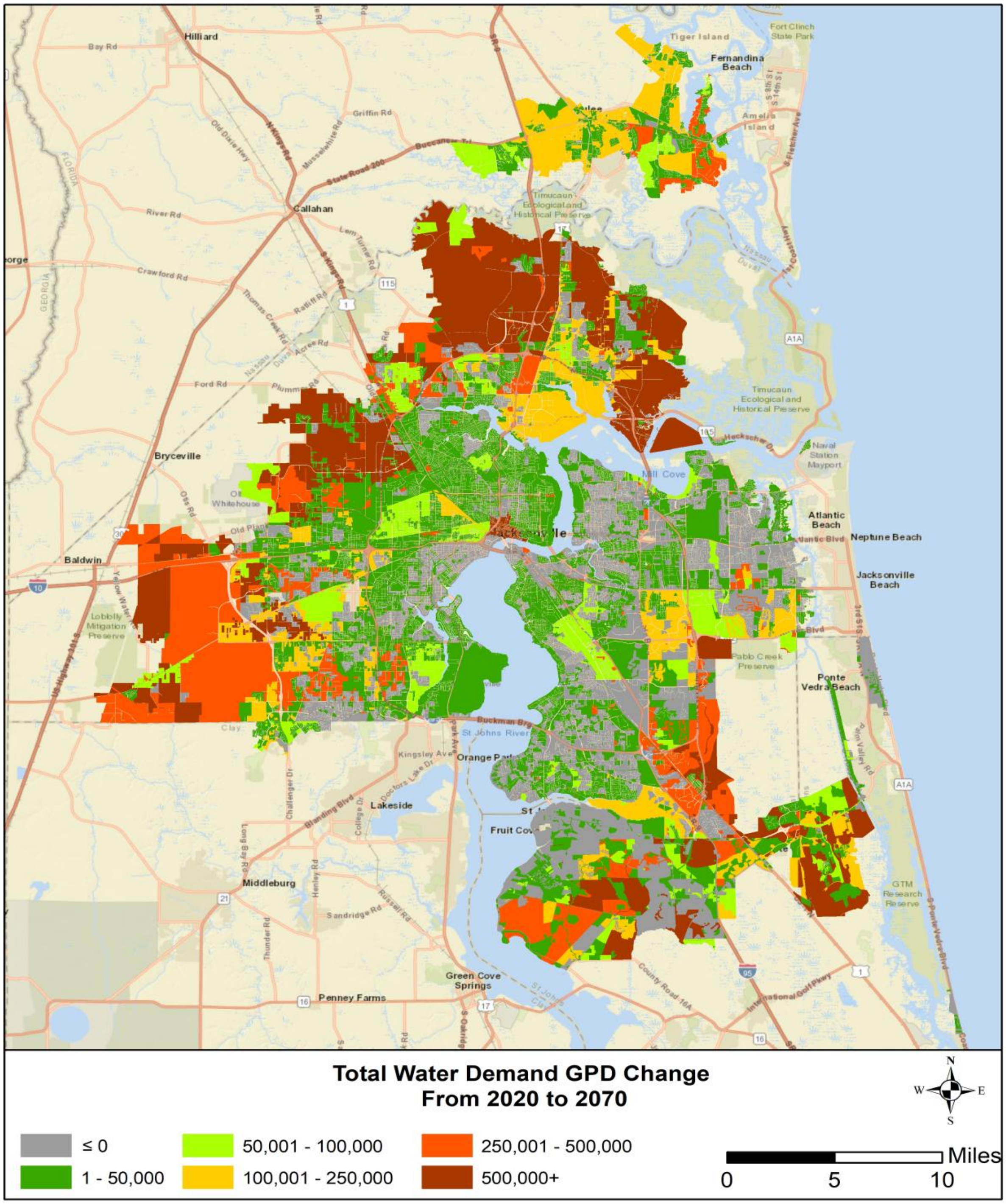

Figure 27. Change in Passive Forecast from 2020 to 2070

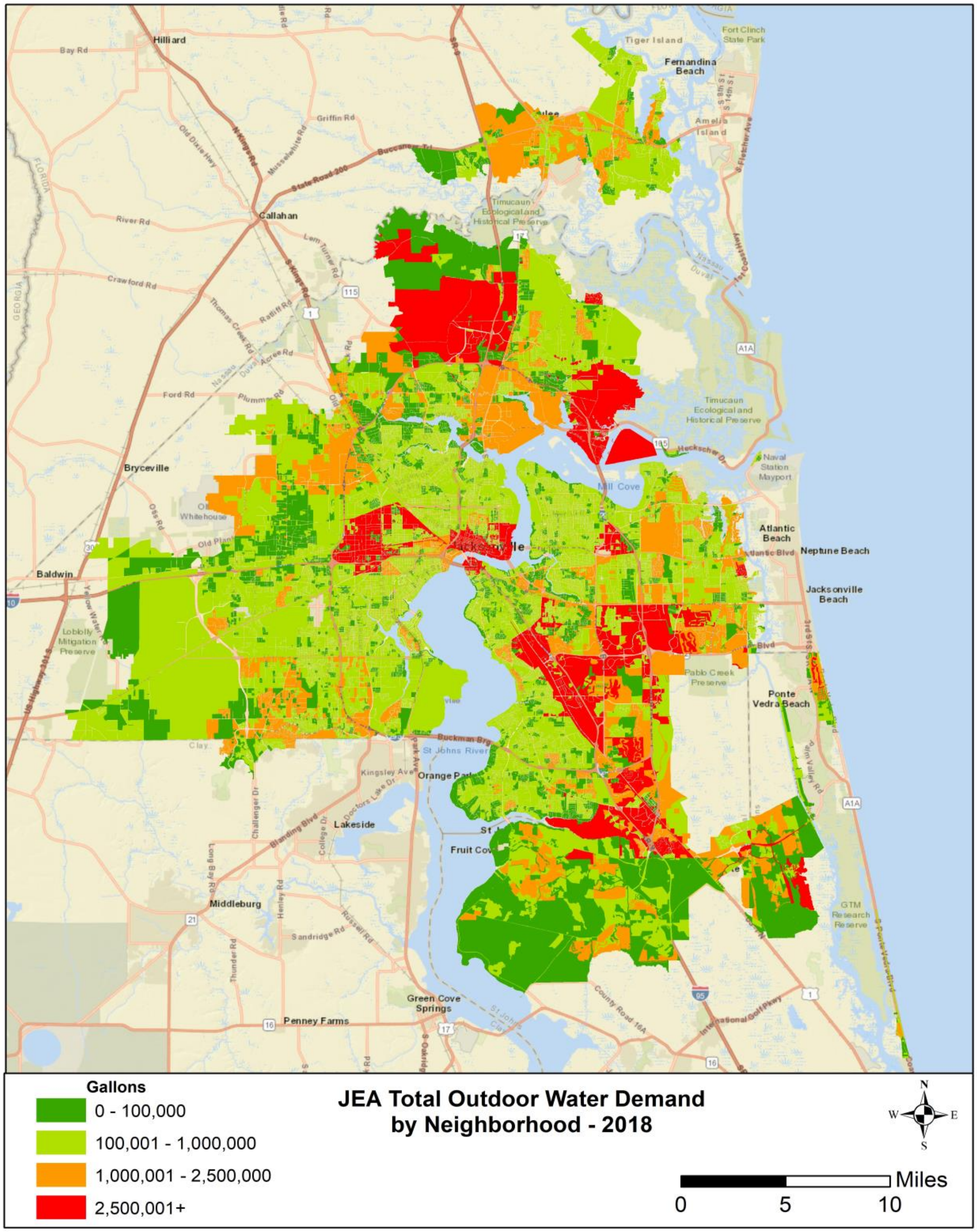

Figure 28. Current Annual Outdoor Water Use by Neighborhood

Spatial Demand by Sub-grid

For the purposes of water supply planning it is necessary to sub-divide the larger North and South grids into sub-grids. As shown in **Figure 29**, the North grid is sub-divided into the Core City, North and West sub-grids. Similarly, the South grid is sub-divided into the Central, Arlington, East and SJC/South sub-grids. Nassau, Mayport, Ponte Vedra, Palm Valley and Ponce de Leon grids remain the same.

Table 26 provides a summary of the passive conservation forecast by sub-grid, which includes the expansion areas.

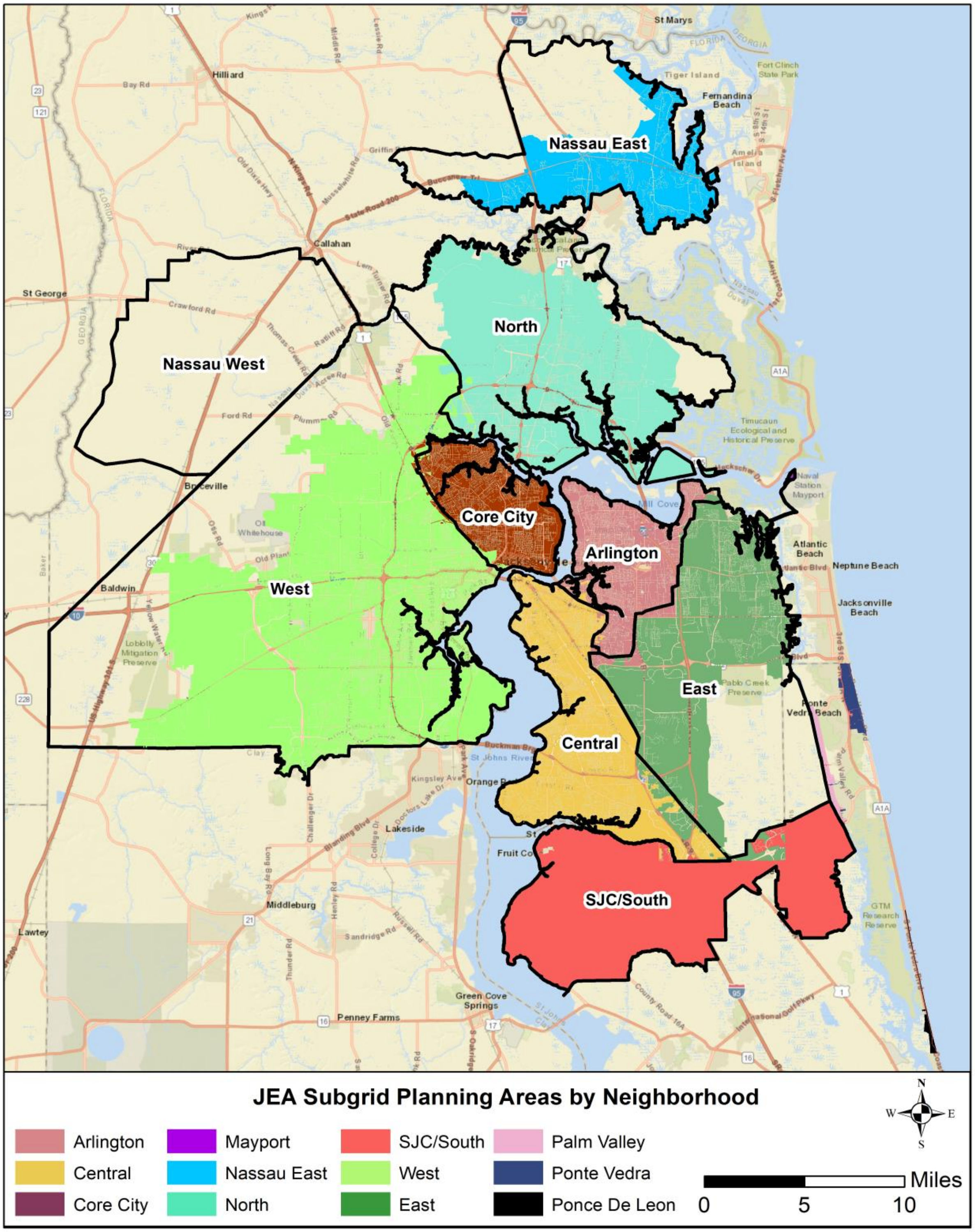

Figure 28. JEA Sub-grids for Supply Planning

Table 26. Passive Conservation Forecast by Sub-grid in MGD

Year	Mayport	Nassau	North Grid	Palm Valley	Ponce de Leon	Ponte Vedra	South Grid	Total
AVERAGE								
Base Year	0.04	4.44	44.32	0.37	0.49	1.44	72.51	123.62
2020	0.04	4.74	46.26	0.40	0.50	1.45	74.54	127.93
2025	0.04	5.46	51.17	0.46	0.53	1.46	78.61	137.73
2030	0.04	6.15	55.82	0.49	0.55	1.46	81.51	146.02
2035	0.05	6.73	60.08	0.50	0.55	1.46	83.77	153.13
2040	0.05	7.18	64.06	0.51	0.55	1.46	85.54	159.35
2050	0.05	8.00	72.18	0.51	0.55	1.46	89.01	171.76
2060	0.05	8.80	79.36	0.51	0.55	1.46	91.72	182.45
2070	0.05	9.61	86.09	0.51	0.55	1.46	93.87	192.13
DRY								
Base Year	0.04	4.76	46.96	0.40	0.54	1.57	77.50	131.77
2020	0.04	5.07	49.04	0.43	0.55	1.57	79.67	136.38
2025	0.04	5.85	54.32	0.50	0.57	1.58	84.01	146.87
2030	0.05	6.59	59.31	0.53	0.60	1.58	87.09	155.75
2035	0.05	7.20	63.90	0.55	0.60	1.58	89.50	163.37
2040	0.05	7.68	68.19	0.56	0.60	1.58	91.38	170.03
2050	0.05	8.57	76.94	0.56	0.60	1.58	95.08	183.38
2060	0.05	9.42	84.66	0.56	0.59	1.58	97.97	194.84
2070	0.05	10.29	91.90	0.56	0.59	1.58	100.25	205.22
WET								
Base Year	0.04	3.96	40.23	0.32	0.43	1.25	64.80	111.01
2020	0.04	4.22	41.95	0.34	0.44	1.25	66.62	114.86
2025	0.04	4.86	46.34	0.39	0.46	1.26	70.24	123.60
2030	0.04	5.47	50.49	0.43	0.48	1.26	72.83	130.99
2035	0.04	5.98	54.28	0.44	0.48	1.26	74.83	137.30
2040	0.04	6.37	57.84	0.44	0.48	1.26	76.40	142.83
2050	0.04	7.10	65.02	0.44	0.48	1.26	79.47	153.80
2060	0.05	7.81	71.41	0.44	0.47	1.26	81.86	163.30
2070	0.04	8.53	77.43	0.44	0.47	1.26	83.74	171.92

Appendix B

Supply Option Fact Sheets

CDM Smith

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IWRP Baseline Water Conservation Option

Category: Water Conservation

Brief Description:

A Demand-Side Management (DSM) Strategy was prepared for JEA as part of the Integrated Water Resources Plan (IWRP) project. This strategy was based on the economic evaluation of 13 DSM measures. The customer targets for the DSM Strategy were based on JEA neighborhoods with certain housing/socioeconomic attributes (e.g., age of home, lot size, and income) for residential measures; and number of certain business establishments for non-residential measures. For residential measures, the DSM Strategy initially assumed that 60% of the customer targets would implement the conservation measure with monetary rebates from JEA over a 5-year period. For non-residential measures, the DSM Strategy assumed a more conservative participation level (10 to 20%) over a 5-year period. These initial target assumptions will be revisited as JEA implements the recommended DSM measures over time. The estimated water savings for the DSM Strategy were not intended to be projections used for the IWRP, as the Strategy is designed to be almost like a pilot program to test the effectiveness of the implementation of DSM measures over an initial 5-year period; while the IWRP represents long-term projections based on full implementation of water supply projects and DSM programs that could likely be implemented over the next 10 to 30 years.

The IWRP Baseline Water Conservation Option was developed based on a more aggressive targeting of customers and longer implementation (10 vs 5 years) of the recommended DSM Strategy (see **Table 1** for comparison).

Table 1. Comparison of Assumed Customer Participation for DSM Measures

DSM Measure	DSM Strategy		IWRP Baseline Water Conservation	
	Assumed Participating Customers	Annual Customer Participation Over 5 Years	Assumed Participating Customers	Annual Customer Participation Over 10 Years
1. SF High Efficiency Toilet Rebate	0	0	0	0
2. SF High Efficiency Toilet Direct Install*	12,000	2,400	16,000	1,600
3. MF High Efficiency Toilet Rebate	0	0	0	0
4. MF High Efficiency Toilet Direct Install*	28,800	5,760	38,000	3,800
5. SF High Efficiency Clothes Washer Rebate	97,800	19,560	141,000	14,100
6. SF High Efficiency Dishwasher Rebate	0	0	0	0
7. SF Low Income Audit/Repairs	0	0	0	0
8. MF Low Income Audit/Repairs	0	0	0	0
9. Green Restaurant Program	125	25	430	43
10. Ice Machine Rebate	150	30	750	75
11. Cooling Tower Cost Sharing	120	24	200	20
12. Landscape Transformation Rebate	0	0	0	0
13. Smart Irrigation Controller Rebate	12,600	2,520	16,000	1,600

* For high-efficiency toilet measures, direct install was chosen over rebates due to greater levels of customer participation and higher assurance of water savings effectiveness.

Expected Water Savings:

Water conservation savings are a function of three variables: (1) participating customers; (2) expected unit water savings per DSM measure; and (3) economic life of DSM measure. **Table 2** presents the expected unit water savings (gallons per day per measure device) and economic life for the DSM measures evaluated in the DSM Strategy. Those DSM measures assumed to be implemented for the Baseline Water Conservation Option are shown in blue bold font in Table 2.

IWRP Baseline Water Conservation Option

Category: Water Conservation

Table 2. Assumed Unit Water Savings and Life for DSM Measures

DSM Measure	Unit Water Savings (gal/day/device)	Economic Life of Measure (years)
1. SF High Efficiency Toilet Rebate	16.0	20
2. SF High Efficiency Toilet Direct Install	**33.1**	**20**
3. MF High Efficiency Toilet Rebate	6.3	20
4. MF High Efficiency Toilet Direct Install	**12.5**	**20**
5. SF High Efficiency Clothes Washer Rebate	**20.4**	**15**
6. SF High Efficiency Dishwasher Rebate	2.7	12
7. SF Low Income Audit/Repairs	21.4	7
8. MF Low Income Audit/Repairs	41.4	7
9. Green Restaurant Program	**738.4**	**7**
10. Ice Machine Rebate	**46.9**	**10**
11. Cooling Tower Cost Sharing	**2,880.0**	**20**
12. Landscape Transformation Rebate	178.0	10
13. Smart Irrigation Controller Rebate	**87.6**	**10**

Blue font indicates measures selected for Baseline Water Conservation Option.

When these unit water savings are multiplied by participating customers for the economic life of the DSM measures, a total expected water savings in million gallons per day (MGD) is derived. As it is commonly expected for similar water conservation programs implemented in the United States, a residual water savings beyond the economic life of the DSM measures can be expected. This is due to most customers replacing their conserving devices at the end of the device's useful life with equally-conserving devices available in the market place without the need for further economic incentives by JEA. **Figure 1** presents the total expected water savings, including the residual savings, over time. The peak water savings is 6.21 MGD in 2030. Based on economic life of the DSM measures, the water savings by 2040 is estimated to be 3.00 MGD. But the residual savings (estimated by taking the difference between 80% of the peak savings and the economic savings) is estimated to be 1.95 MGD in 2040, for a total savings of 4.97 MGD. It is expected that the 4.97 MGD savings holds constant through 2070.

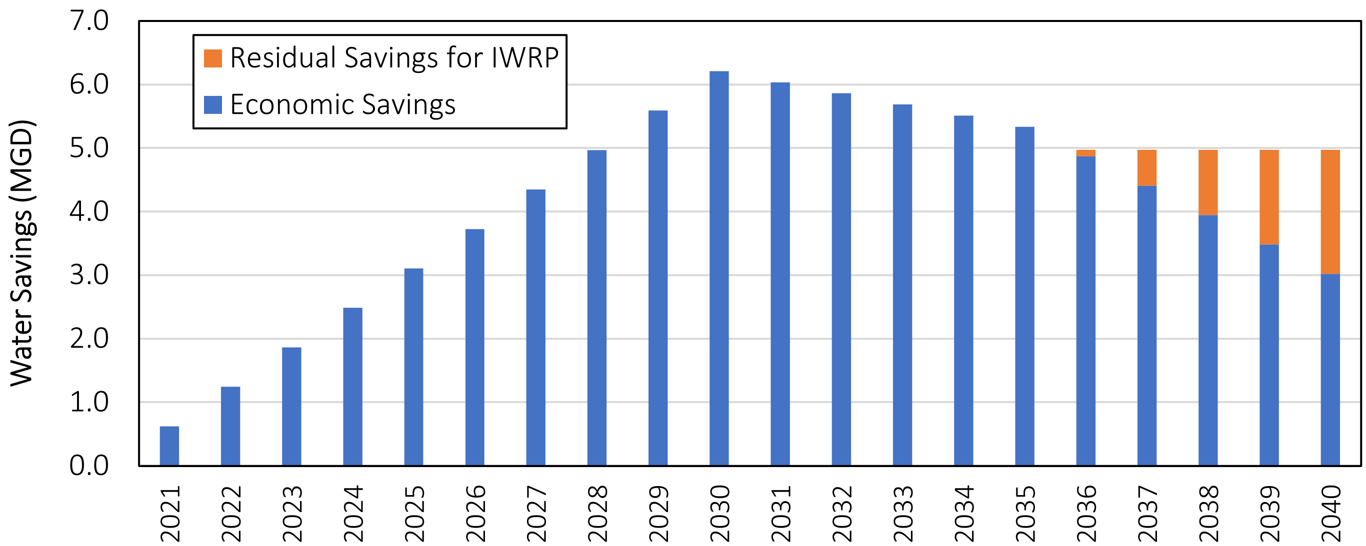

Figure 1. Annual Water Savings for IWRP Baseline Water Conservation

IWRP Baseline Water Conservation Option

Category: Water Conservation

Community Acceptance:

The community acceptance performance measure is qualitative in nature with the scoring based on the best judgement of JEA staff and the consultant team rather than quantitatively through project modeling. The overall score was split into two separate components: community perceived benefits and community concerns. IWRP Baseline Water Conservation received the following scores for each element, which were then averaged into an overall community acceptance score.

Scoring Criteria	1=low degree of perceived benefits by community 5=high degree of perceived benefits by community		1=significant community concerns to be addressed 5=full community support expected		Average Score for Community Acceptance
Supply Options	**Community Perceived Benefits**	**Notes**	**Community Concerns**	**Notes**	
Water Conservation	**5**	This option counts as a credit for JEA's consumptive use permit for groundwater. It also reduces variable water, wastewater and reclaimed operating costs for JEA. In addition, indoor water conservation reduces wastewater flows and discharges. Finally, participating customers would have reduced water and energy bills.	**4**	Voluntary implementation of water conservation, along with financial incentives provided by JEA, would not likely pose community concerns. However, changing water customer behaviors may prove to be somewhat challenging.	**4.5**

Cost:

Costs to JEA for implementing the DSM measures for the Baseline Water Conservation Option include rebates/incentives, vendor costs for direct install programs, administrative costs, public education and marketing costs, and program evaluation costs. As the level of customer participation is higher for the Baseline Water Conservation Option, it is assumed that the costs would be 30% greater than what was assumed for JEA's DSM Strategy. **Table 3** presents the annual costs for the Baseline Water Conservation Option over a 10-year implementation period. The total cost to JEA (with the 30% increase over the DSM Strategy cost estimate) is estimated to be **$70.23 million**.

However, by conserving water JEA would see reduced variable operation costs for water (for all DSM measures), wastewater (for just indoor DSM measures), and reclaimed (for just outdoor DSM measures). The reduced variable operation costs are estimated for the economic life of the DSM measures and total **$26.00 million**, based on JEA's cost of service study. Reduced revenues are not accounted for in the calculation as they are expected to be negligible due to projected growth of future water sales. The net cost to JEA for the Baseline Water Conservation Option is:

$70.23 (total cost) – $26.00 (reduced variable costs) = **$44.23 million** (net cost).

The net unit cost (net cost divided by water savings over economic life of DSM measures) is estimated to be:

$1.31/1,000 gallons.

IWRP Baseline Water Conservation Option

Category: Water Conservation

Table 3. JEA Costs for Implementing Baseline Water Conservation Option

DSM Strategy Cost Categories	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Total
Incentive and Administration Costs ($ millions)											
SF High Efficiency Toilet Direct Install	$0.64	$0.64	$0.64	$0.64	$0.64	$0.64	$0.64	$0.64	$0.64	$0.64	$6.40
MF High Efficiency Toilet Direct Install	$1.14	$1.14	$1.14	$1.14	$1.14	$1.14	$0.00	$0.00	$0.00	$0.00	$6.84
SF High Efficiency Clothes Washer Rebate	$2.54	$2.54	$2.54	$2.54	$2.54	$2.54	$2.54	$2.54	$2.54	$2.54	$25.38
Green Restaurant Program	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09	$0.87
Ice Machine Rebate	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.25
Cooling Tower Cost Sharing	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$4.00
Smart Irrigation Controller Rebate	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$3.68
Sub-total	$5.20	$5.20	$5.20	$5.20	$5.20	$5.20	$4.06	$4.06	$4.06	$4.06	$47.42
Programmatic Costs ($ millions)											
Marketing/Public Education	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$4.00
Program Evaluation	$0.08	$0.08	$0.08	$0.08	$0.38	$0.38	$0.38	$0.38	$0.38	$0.38	$2.60
Sub-total	$0.48	$0.48	$0.48	$0.48	$0.78	$0.78	$0.78	$0.78	$0.78	$0.78	$6.60
Total Costs (Based on DSM Strategy)	**$5.68**	**$5.68**	**$5.68**	**$5.68**	**$5.98**	**$5.98**	**$4.84**	**$4.84**	**$4.84**	**$4.84**	**$54.02**
Total Costs X 1.3 (for Increased Participation)	**$7.38**	**$7.38**	**$7.38**	**$7.38**	**$7.77**	**$7.77**	**$6.29**	**$6.29**	**$6.29**	**$6.29**	**$70.23**

Modeling Assumptions:

Within the model, when the IWRP Baseline Water Conservation is selected it has the following impacts:

- Demands within the model are reduced by the expected water savings. These demands are split between indoor and outdoor demands according to the types of DSM measures. Demand savings are also distributed between subareas with higher savings assigned to future growth areas.
- The total cost for the DSM measures are input into the model. The model also tracks JEA's variable operating costs for the water, wastewater, and reclaimed water system so cost savings from implementing the DSM measures are captured within the model as a benefit that is only applied for water conservation.
- Indoor water conservation will also reduce wastewater generation and discharges.

References:

CDM Smith, "JEA Water Demand-Side Management Strategy." July 2020.

Expanded Water Conservation Option

Category: Water Conservation

Brief Description:

A Demand-Side Management (DSM) Strategy was prepared for JEA as part of the Integrated Water Resources Plan (IWRP) project. This strategy was based on the economic evaluation of 13 DSM measures. The customer targets for the DSM Strategy were based on JEA neighborhoods with certain housing/socioeconomic attributes (e.g., age of home, lot size, and income) for residential measures; and number of certain business establishments for non-residential measures. For residential measures, the DSM Strategy assumed that 60% of the customer targets would implement the conservation measure with monetary rebates from JEA over a 5-year period. For non-residential measures, the DSM Strategy assumed a more conservative participation level (10 to 20%) over a 5-year period. These initial target assumptions will be revisited as JEA implements the recommended DSM measures over time. The estimated water savings for the DSM Strategy were not intended to be projections used for the IWRP, as the Strategy is designed to be almost like a pilot program to test the effectiveness of the implementation of DSM measures over an initial 5-year period; while the IWRP represents long-term projections based on full implementation of water supply projects and DSM programs that could likely be implemented over the next 10 to 30 years.

This Expanded Water Conservation Option for the IWRP is based on a very aggressive targeting of customers and longer implementation (10 vs 5 years) of the recommended DSM Strategy, as well as adding two additional DSM measures (High Efficiency Dishwasher Rebate and Landscape Transformation Rebate). **Table 1** shows a comparison of assumed participating customers between the DSM Strategy and Expanded Water Conservation Option for the IWRP.

Table 1. Comparison of Assumed Customer Participation for DSM Measures

DSM Measure	DSM Strategy		Expanded Water Conservation	
	Assumed Participating Customers	Annual Customer Participation Over 5 Years	Assumed Participating Customers	Annual Customer Participation Over 10 Years
1. SF High Efficiency Toilet Rebate	0	0	0	0
2. SF High Efficiency Toilet Direct Install*	12,000	2,400	18,000	1,800
3. MF High Efficiency Toilet Rebate	0	0	0	0
4. MF High Efficiency Toilet Direct Install*	28,800	5,760	43,000	4,300
5. SF High Efficiency Clothes Washer Rebate	97,800	19,560	145,000	14,500
6. SF High Efficiency Dishwasher Rebate	0	0	80,000	8,000
7. SF Low Income Audit/Repairs	0	0	0	0
8. MF Low Income Audit/Repairs	0	0	0	0
9. Green Restaurant Program	125	25	570	57
10. Ice Machine Rebate	150	30	1,000	100
11. Cooling Tower Cost Sharing	120	24	200	20
12. Landscape Transformation Rebate	0	0	7,000	700
13. Smart Irrigation Controller Rebate	12,600	2,520	18,000	1,800

* For high-efficiency toilet measures, direct install was chosen over rebates due to greater levels of customer participation and higher assurance of water savings effectiveness.

Expected Water Savings:

Water conservation savings are a function of three variables: (1) participating customers; (2) expected unit water savings per DSM measure; and (3) economic life of DSM measure. **Table 2** presents the expected unit water savings (gallons per day per measure device) and economic life for the DSM measures evaluated in the DSM Strategy. Those DSM measures assumed to be implemented for the Expanded Water Conservation Option are shown in blue bold font in Table 2.

Table 2. Assumed Unit Water Savings and Life for DSM Measures

DSM Measure	Unit Water Savings (gal/day/device)	Economic Life of Measure (years)
1. SF High Efficiency Toilet Rebate	16.0	20
2. SF High Efficiency Toilet Direct Install	**33.1**	**20**
3. MF High Efficiency Toilet Rebate	6.3	20
4. MF High Efficiency Toilet Direct Install	**12.5**	**20**
5. SF High Efficiency Clothes Washer Rebate	**20.4**	**15**
6. SF High Efficiency Dishwasher Rebate	**2.7**	**12**
7. SF Low Income Audit/Repairs	21.4	7
8. MF Low Income Audit/Repairs	41.4	7
9. Green Restaurant Program	**738.4**	**7**
10. Ice Machine Rebate	**46.9**	**10**
11. Cooling Tower Cost Sharing	**2,880.0**	**20**
12. Landscape Transformation Rebate	**178.0**	**10**
13. Smart Irrigation Controller Rebate	**87.6**	**10**

Blue font indicates measures selected for Expanded Water Conservation Option.

When these unit water savings are multiplied by participating customers for the economic life of the DSM measures, a total expected water savings in million gallons per day (MGD) is derived. As it is commonly expected for similar water conservation programs implemented in the United States, a residual water savings beyond the economic life of the DSM measures can be expected. This is due to most customers replacing their conserving devices at the end of the device's useful life with equally-conserving devices available in the market place without the need for further economic incentives by JEA. **Figure 1** presents the total expected water savings, including the residual savings, over time. The peak water savings is 8.17 MGD in 2030. Based on economic life of the DSM measures, the water savings by 2040 is estimated to be 3.23 MGD. But the residual savings (estimated by taking the difference between 80% of the peak savings and the economic savings) is estimated to be 3.31 MGD in 2040, for a total savings of 6.54 MGD. It is expected that the 6.54 MGD savings holds constant through 2070.

Expanded Water Conservation Option

Category: Water Conservation

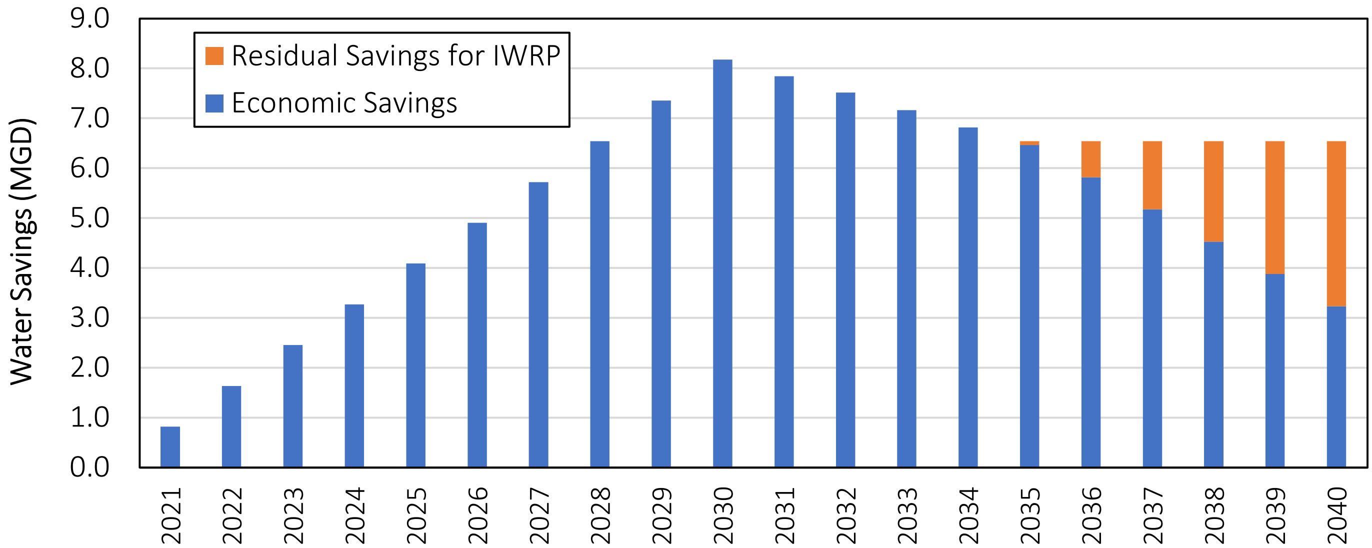

Figure 1. Annual Water Savings for Expanded Water Conservation Option

Community Acceptance:

The community acceptance performance measure is qualitative in nature with the scoring based on the best judgement of JEA staff and the consultant team rather than quantitatively through project modeling. The overall score was split into two separate components: community perceived benefits and community concerns. Expanded Water Conservation received the following scores for each element, which were then averaged into an overall community acceptance score.

Scoring Criteria	1=low degree of perceived benefits by community 5=high degree of perceived benefits by community		1=significant community concerns to be addressed 5=full community support expected		Average Score for Community Acceptance
Supply Options	**Community Perceived Benefits**	**Notes**	**Community Concerns**	**Notes**	
Water Conservation	**5**	This option counts as a credit for JEA's consumptive use permit for groundwater. It also reduces variable water, wastewater and reclaimed operating costs for JEA. In addition, indoor water conservation reduces wastewater flows and discharges. Finally, participating customers would have reduced water and energy bills.	**3**	In order to get to customer participation levels assumed for this expanded water conservation option, it is anticipated that budget-based water pricing would likely be required in addition to financial rebates/incentives. There would likely be some community resistance to these water rate changes.	**4.0**

Expanded Water Conservation Option

Category: Water Conservation

Cost:

Costs to JEA for implementing the DSM measures for the Baseline Water Conservation Option include rebates/incentives, vendor costs for direct install programs, administrative costs, public education and marketing costs, and program evaluation costs. As the level of customer participation is higher for the Baseline Water Conservation Option, it is assumed that the costs would be 50% greater than what was assumed for JEA's DSM Strategy. **Table 3** presents the annual costs for the Baseline Water Conservation Option over a 10-year implementation period. The total cost to JEA (with the 50% increase over the DSM Strategy cost estimate) is estimated to be **$130.02 million**.

However, by conserving water JEA would see reduced variable operation costs for water (for all DSM measures), wastewater (for just indoor DSM measures), and reclaimed (for just outdoor DSM measures). The reduced variable operation costs are estimated for the economic life of the DSM measures and total **$30.33** million, based on JEA's cost of service study. Reduced revenues are not accounted for in the calculation as they are expected to be negligible due to projected growth of future water sales. The net cost to JEA for the Baseline Water Conservation Option is:

$130.02 (total cost) – $30.33 (reduced variable costs) = **$99.69 million** (net cost).

The net unit cost (net cost divided by water savings over economic life of DSM measures) is estimated to be:

$2.39/1,000 gallons.

Table 3. JEA Costs for Implementing Baseline Water Conservation Option

DSM Strategy Cost Categories	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Total
Incentive and Administration Costs ($ millions)											
SF High Efficiency Toilet Direct Install	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72	$7.20
MF High Efficiency Toilet Direct Install	$1.29	$1.29	$1.29	$1.29	$1.29	$1.29	$1.29	$1.29	$1.29	$1.29	$12.90
SF High Efficiency Clothes Washer Rebate	$2.61	$2.61	$2.61	$2.61	$2.61	$2.61	$2.61	$2.61	$2.61	$2.61	$26.10
SF High Efficiency Dishwasher Rebate	$0.64	$0.64	$0.64	$0.64	$0.64	$0.64	$0.64	$0.64	$0.64	$0.64	$6.40
Green Restaurant Program	$0.12	$0.12	$0.12	$0.12	$0.12	$0.12	$0.12	$0.12	$0.12	$0.12	$1.16
Ice Machine Rebate	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.33
Cooling Tower Cost Sharing	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$4.00
Landscape Transformation Rebate	$1.79	$1.79	$1.79	$1.79	$1.79	$1.79	$1.79	$1.79	$1.79	$1.79	$17.85
Smart Irrigation Controller Rebate	$0.41	$0.41	$0.41	$0.41	$0.41	$0.41	$0.41	$0.41	$0.41	$0.41	$4.14
Sub-total	$8.01	$8.01	$8.01	$8.01	$8.01	$8.01	$8.01	$8.01	$8.01	$8.01	$80.08
Programmatic Costs ($ millions)											
Marketing/Public Education	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$4.00
Program Evaluation	$0.08	$0.08	$0.08	$0.08	$0.38	$0.38	$0.38	$0.38	$0.38	$0.38	$2.60
Sub-total	$0.48	$0.48	$0.48	$0.48	$0.78	$0.78	$0.78	$0.78	$0.78	$0.78	$6.60
Total Costs (Based on DSM Strategy)	**$8.49**	**$8.49**	**$8.49**	**$8.49**	**$8.79**	**$8.79**	**$8.79**	**$8.79**	**$8.79**	**$8.79**	**$86.68**
Total Costs X 1.5 (for Increased Participation)	**$12.73**	**$12.73**	**$12.73**	**$12.73**	**$13.18**	**$13.18**	**$13.18**	**$13.18**	**$13.18**	**$13.18**	**$130.02**

Modeling Assumptions:

Within the model, when the Expanded Water Conservation is selected it has the following impacts:

- Demands within the model are reduced by the expected water savings. These demands are split between indoor and outdoor demands according to the types of DSM measures. Demand savings are also distributed between subareas with higher savings assigned to future growth areas.
- The total cost for the DSM measures are input into the model. The model also tracks JEA's variable operating costs for the water, wastewater, and reclaimed water system so cost savings from implementing the DSM measures are captured within the model as a benefit that is only applied for water conservation.

Expanded Water Conservation Option

Category: Water Conservation

- Indoor water conservation will also reduce wastewater generation and discharges.

Innovative Approaches for Increased Water Conservation:

Several cities in the United States have gone further than only offering rebates to incentivize water customers to use water more efficiently. Innovative approaches that can be implemented in conjunction with financial rebates to achieve greater water conservation include:

- Budget-Based Pricing of Water – Water budgets are established for each customer based on lot size, family size, and other attributes, and when water use exceeds these budgets, a higher water rate is applied. This is different from tiered water rates that are applied uniformly regardless of customer attributes.
- AMI with Real-Time Capabilities – Real time water use information (even at an hourly timestep), which can be pushed to customers via cell phone, is a powerful tool that can work with Budget-Based Pricing or alone be implemented to educate customers on water use practices. In addition, it can more quickly identify major leaks within the home or on property that benefits both customers and JEA.
- Local Plumbing Codes and Ordinances – Establishing plumbing codes for high-efficiency toilets and landscape ordinances reducing the amount of certain turf for all new construction can result in significant passive water conservation.

The IWRP report will attempt to quantify how some of these innovative approaches can lead to enhanced water conservation beyond what is estimated with Expanded Conservation.

References:

CDM Smith, "JEA Water Demand-Side Management Strategy." July 2020.

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Expanded Traditional Reclaimed Water

Category: Reuse Water Option

Brief Description:

JEA currently serves retail reclaimed water to customers in the South Grid. In St Johns County, investments have also been made in reclaimed water infrastructure so that as the area develops, reclaimed water use will continue to grow. Within the IWRP, growth of reclaimed water demand within areas already outfitted with reclaimed water infrastructure is referred to as 'committed' reclaimed water and is included within all analyzed alternatives. This supply option looks at further expansion of the South Grid reclaimed water system beyond the current commitments, as well as introduction of new reclaimed water infrastructure into future growth areas in the North Grid and Nassau County. The cost of retrofitting reclaimed water infrastructure into already developed areas was deemed cost prohibitive for this supply option.

Facilities Required:

Facilities required for incorporation of new traditional reclaimed water supplies include:

- Water reclamation facilities producing public access reclaimed quality water.
- Reclaimed water storage to meet peak day demands
- Reclaimed water distribution system
- Pumping infrastructure for supply of water into the reclaimed water distribution system

Key Assumptions:

Within the IWRP analysis, it is assumed that JEA constructs new water reclamation facilities (WRFs) within future growth areas. These facilities are referred to as the Future Airport WRF in the North subgrid of the North Grid, the Future Peterson WRF in the West subgrid of the North Grid, and the Future Nassau West WRF facility in the Nassau West subgrid.

Future growth in indoor water demands within the relevant subgrids were used to project wastewater flows to the new facilities. The Future Airport WRF is assumed to be online in 2028 and flows diverted to this new facility were then subtracted from Cedar Bay WRF's wastewater flow projections. The Future Peterson WRF was assumed to be online in 2035 and flows diverted to this new facility were then subtracted from Southwest WRF's wastewater flow projections. There is currently no wastewater treatment in the Nassau West projected growth area so the Future Nassau West WRF is assumed to be online in 2035 and serve the projected wastewater flows from this subgrid.

Reclaimed water available to be produced from the future WRFs is assumed to be 85 percent of the projected annual wastewater flows.

Within the South Grid, where reclaimed water infrastructure is currently in place, additional expansion of the system is assumed to provide reclaimed water service to all outdoor demands within the St Johns County subgrid as well as all outdoor water demand growth within the east subgrid. Planned expansions of reclaimed water production at South Grid facilities are considered part of all scenarios in serving current commitments. This includes expansions at Arlington East to 12 MGD of reclaimed water production by 2022 and 16 MGD by 2032, Blacks Ford to 9 MGD by 2034 and construction of 6 MGD of reclaimed production capacity at Greenland by 2023.

In the Nassau East subgrid, the demand able to be served by a reclaimed water system was assumed to be half of the growth in projected outdoor demands since some growth would occur as infill in already developed areas and some would be new developments that could be incorporated into a reclaimed water system.

Expanded Traditional Reclaimed Water

Category: Reuse Water Option

Based on JEA experience, as customers either install a designated irrigation meter or are added to the reclaimed water system, their total outdoor water use goes up. Cost may be influencing this behavior as customers do not need to pay a sewerage charge on designated outdoor water use. An additional 80% increase in demand on the reclaimed water system was assumed to account for this change in behavior. So, for every 1 MGD of potable demand that is now served by reclaimed, it is assumed that 1.8 MGD of reclaimed water is utilized to meet the same demand.

Environmental Impacts (Promote Environmental Sustainability):

This option has the environmental benefit of reducing the volume of WRF effluent and loading (i.e. nitrogen) to the St. Johns River by beneficially utilizing the available water for non-potable water supply. This option also has the potential to improve aquifer sustainability as utilization of reclaimed quality water can offset the need for additional groundwater withdrawals.

Community Acceptance:

The community acceptance performance measure is qualitative in nature with the scoring based on the best judgement of JEA staff and the consultant team rather than quantitatively through project modeling. The overall score was split into two separate components: community perceived benefits and community concerns. Expanded traditional reclaimed water received the following scores for each element, which were then averaged into an overall community acceptance score.

Scoring Criteria	1=low degree of perceived benefits by community 5=high degree of perceived benefits by community		1=significant community concerns to be addressed 5=full community support expected		Average Score for Community Acceptance
Supply Options	**Community Perceived Benefits**	**Notes**	**Community Concerns**	**Notes**	
Expanded Reclaimed	5	This option allows for continued expansion of the reclaimed water system and helps reduce discharges to the river. It also matches the right quality of water for the right use and reduces reliance on groundwater.	5	Reclaimed water is currently being served to numerous JEA customers and expansion of this system is expected produce minimal community concerns. All new developers above a threshold are required by ordinance to include purple pipe. Community outreach and education will be required distribute usage to not occur during peak days and times.	5

Water Quality:

In areas where potable water may be needed in addition to reclaimed water to meet peak irrigation demands, JEA must ensure cross connections do not occur.

Yield:

The demand able to be supplied via an expanded reclaimed water system varies over time. The tables below provide the assumed yields for each subgrid over time which offset potable supply as well as the total utilized reclaimed water. The

Expanded Traditional Reclaimed Water

Category: Reuse Water Option

difference between the two tables is the reclaimed demand growth factor of 80% which accounts for increased retail customer use of reclaimed water verse potable supplies. Bulk customer reclaimed water demands and reclaimed water deliveries to SJCUD are not included within the second table and add additional demands to the south grid reclaimed water system. Yield for subgrids within the South Grid are divided into committed reclaimed and expanded reclaimed. In the South Grid and Nassau East, the constraint limiting yield is the demand available to be supplied by the system; whereas, in the North Grid and Nassau West, the constraint limiting yield is the assumed flow available from the future WRFs.

Potable System Demand Offset

Year	S East		S SJC		N North	N West	Nassau West	Nassau East
	Committed	Expanded	Committed	Expanded				
2018	0.50	0.50	6.30	6.30	0	0	0	0
2020	0.50	0.50	6.92	6.92	0	0	0	0
2025	0.86	0.86	8.29	8.60	0	0	0	0.27
2030	1.19	1.27	9.20	13.9	0.12	0	0	0.47
2035	1.42	1.74	10.1	14.6	0.28	0.09	0.15	0.62
2040	1.66	2.21	10.7	15.1	0.46	0.54	0.16	0.74
2050	2.12	3.16	11.9	16.2	0.75	1.38	0.17	0.97
2060	2.49	3.94	12.9	17.0	1.06	2.19	0.19	1.10
2070	2.70	4.42	13.8	17.8	1.27	3.05	0.21	1.22

Reclaimed Water Utilization

Year	S East		S SJC		N North	N West	Nassau West	Nassau East
	Committed	Expanded	Committed	Expanded				
2018	0.50	0.50	6.30	6.30	0	0	0	0
2020	0.50	0.50	7.42	7.42	0	0	0	0
2025	1.15	1.15	9.88	9.88	0	0	0	0.49
2030	1.74	1.89	11.5	19.9	0.21	0	0	0.84
2035	2.16	2.73	13.1	21.3	0.51	0.16	0.27	1.12
2040	2.59	3.58	14.2	22.2	0.82	0.98	0.29	1.34
2050	3.42	5.29	16.4	24.1	1.35	2.48	0.31	1.75
2060	4.08	6.69	18.1	25.6	1.90	3.94	0.34	1.98
2070	4.46	7.56	19.6	27.1	2.29	5.49	0.37	2.2

Cost:

The table below provides estimated capital and O&M costs. Variable O&M costs are dependent on the utilization of the facility and include items such as electricity and process chemicals. Fixed O&M costs represent costs incurred each year. Considerations in developing the costs for the expanded reclaimed water system are highlighted below:

- Costs incurred for construction of the future WRFs are included in the model but are assumed as part of the baseline costs as they would be constructed irrespective of whether the produced reclaimed water would be distributed to customers.
- In determining costs for the reclaimed water distribution system, the costs JEA incurred in building out the current South Grid reclaimed water distribution system were provided by JEA. These costs were brought up to 2019 dollars and converted to a $/gpd value used in developing costs for reclaimed water distribution in additional areas.
- Storage and pumping costs were estimated using three costs from three recent JEA reclaimed water storage and pumping facilities. Averaging the costs for the projects gave a value of $5.9 million per MG tank with pumping. For future systems, it was assumed that 1 MG of storage was needed for every 1 MGD of supply served.

Expanded Traditional Reclaimed Water

Category: Reuse Water Option

- Expansion of the existing south grid reclaimed water system incorporates identified recommended capital costs from the 2016 'SE Regional Reclaimed Water Management Final Report' for the years following 2025.

Option (Potable Offset)	Capital Costs ($M)	Annual O&M Costs at Full Capacity ($M)	O&M Fixed Costs per Year ($M)	O&M Variable Costs per MG
Expanded Reclaimed South Grid (5.72 MGD)	$75.5	$2.6	$1.6	$252
Expanded Reclaimed N North (1.27 MGD)	$27.4	$1.1	$0.9	$252
Expanded Reclaimed N West (3.05 MGD)	$65.3	$2.7	$2.2	$252
Expanded Reclaimed Nassau East (1.22 MGD)	$26.3	$1.1	$0.9	$252
Expanded Reclaimed Nassau West (0.21 MGD)	$4.5	$0.2	$0.1	$252

Model Assumptions:

Within the IWRP model, expanded reclaimed water supply can be selected for any combination of the available subgrids: S East, S SJC, N North, N West, Nassau East, and Nassau West. When selected, the following elements are considered in determining the amount of traditional reclaimed water which is supplied:

- The demand available to be served in a subgrid by traditional reclaimed water is the sum of any committed baseline reclaimed demand and the expanded reclaimed water demand if selected. The annual averages are multiplied by a seasonal pattern to determine monthly reclaimed water demands. The model checks that these monthly reclaimed water demands are not greater than the outdoor water demands within the subgrid.

- An additional demand growth factor of 80% is included within the model to account for customers increasing their water usage when switching from potable to reclaimed water for outdoor water demands.

- The amount of reclaimed water available to be supplied is also constrained by the available flows at the WRFs. Projected flow at each facility is tracked with any on-site reclaimed water use and flow for potable reuse projects subtracted from the available flow. A production ratio of wastewater flow to produced reclaimed water is set within the model and varies by plant between 80 and 95 percent, with most plants set at 85 percent. This means that for every 10-MGD of flow at the WRF, only 8.5 MGD of reclaimed water can be produced.

- The South Grid reclaimed water system is an integrated system with reclaimed water produced at various plants being able to combine to serve the reclaimed water demands. Within the North Grid and Nassau County, only flow from a single plant is available to serve the reclaimed water demand.

References:

Hatch Mott MacDonald (2016) "SE Regional Reclaimed Water Management" DRAFT Final Report. JEA. January 2016.

JEA (2018) "Annual Water Resource Master Plan" JEA Water/Wastewater System Planning. September 2018.

Jones Edmunds (2015) "2015 Alternative Water Supply Facilities Master Plan" JEA. February 2015.

Mott MacDonald (2019) "Technical Memorandum: South Grid Reclaimed Water Additional Modeling and Evaluation" JEA. January 2019.

Distributed Stormwater Collection from FDOT Facilities

Category: Stormwater

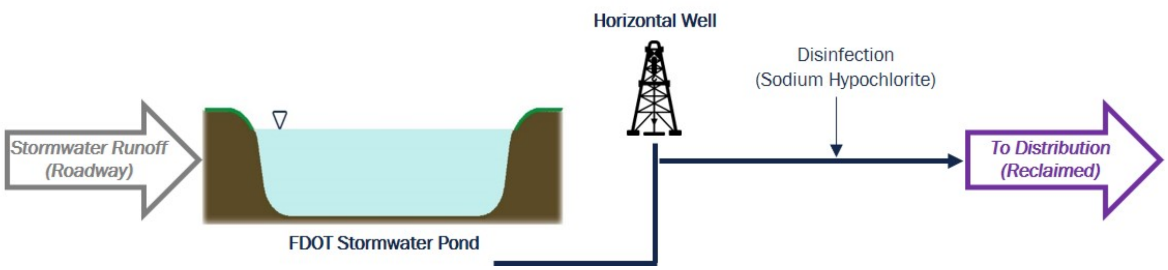
Brief Description:

This option considers augmenting reclaimed water supply by harvesting water from horizontal wells adjacent to Florida Department of Transportation (FDOT) highway stormwater retention ponds in the South Grid. A series of horizontal wells would be installed adjacent to the storm ponds along the FDOT roadways. Harvested stormwater would be filtered through soil matrix, disinfected and pumped into nearby reclaimed water distribution lines.

Facilities Required:

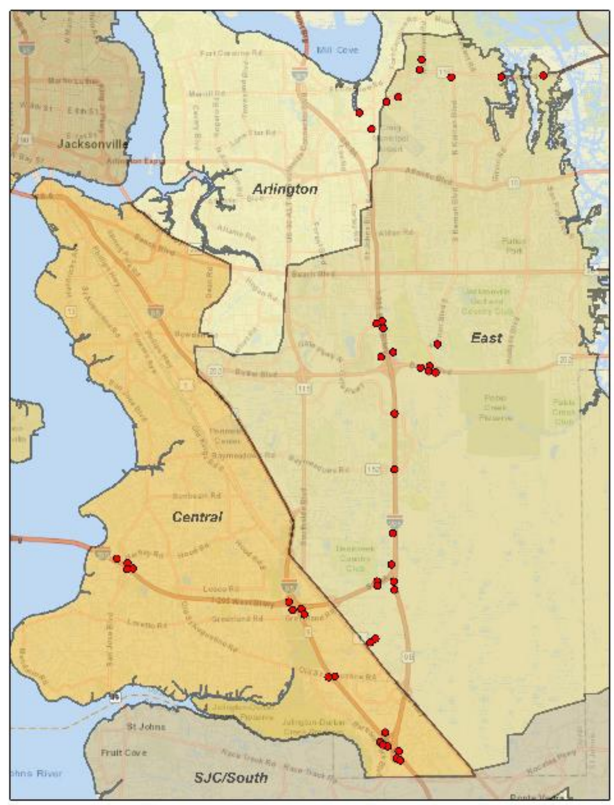
The following facilities would be required as part of this supply option:

- Horizontal well fields adjacent to FDOT stormwater retention ponds
- Sodium hypochlorite disinfection systems
- Transmission piping to nearby reclaimed water system



Key Assumptions:

- This option assumes the stormwater collection facilities are utilized during 6 months of the year when demands on the reclaimed water system are the highest.
- It is assumed that 10 inches of rain runoff are available during the 6 active months, with a 30% recovery. This assumption is consistent with the analysis done by Clay County Utility Authority in their Reclaimed Water Deficit and Augmentation of Reclaimed Water System Projection Study on Long Term Water Supply. However, the reliability of this supply option would be limited in times of drought or reduced rainfall.
- The City of Jacksonville online property map was utilized to identify potential FDOT owned ponds. Over 30 potential ponds were identified covering over 120 acres of surface area. It is assumed that a subset of these ponds would be utilized for this option.
- It is assumed that pumping and treatment facilities would be located within the FDOT property. Allowances were included in the cost estimate to cover items such as delivery access, chemical storage, and electrical and water service.



Distributed Stormwater Collection from FDOT Facilities

Category: Stormwater

Environmental Impacts (Promote Environmental Sustainability):

This option has the potential to improve aquifer sustainability. Water offset by the additional reclaimed supply will help reduce groundwater withdrawals from the UFA. Water quality monitoring would be necessary to prevent roadway contaminants from entering the reclaimed water system and potentially impacting local ecology. A well inventory would need to be completed around each site to study potential impacts of the projects on nearby existing wells.

Water Quality:

Roadway contaminants may be a significant challenge for this alternative water supply option. It is unclear what kind of affects these contaminants may have on the water quality of the runoff, and whether they will be removed from biological treatment within the ponds, filtration through the soil matrix, and chlorination. Pilot studies could provide more insight into this issue. Blending of this new non-potable supply into the current reclaimed system will also require pilot study.

Yield:

This option has the potential to provide approximately 5 MGD of reclaimed water supply assuming around 20 different ponds are connected for an average supply of 0.25 MGD per pond. Although, the potential yield of reclaimed water may be impacted seasonally by dry periods.

Community Acceptance:

The community acceptance performance measure is qualitative in nature with the scoring based on the best judgement of JEA staff and the consultant team rather than quantitatively through project modeling. The overall score was split into two separate components: community perceived benefits and community concerns. Distributed stormwater collection received the following scores for each element, which were then averaged into an overall community acceptance score.

Scoring Criteria	1=low degree of perceived benefits by community 5=high degree of perceived benefits by community		1=significant community concerns to be addressed 5=full community support expected		Average Score for Community Acceptance
Supply Options	**Community Perceived Benefits**	**Notes**	**Community Concerns**	**Notes**	
Distributed Stormwater from FDOT facilities	**4**	Collection of stormwater provides a new non-potable water supply while also providing wet-weather storage and providing receiving water quality benefits. However, it does not reduce discharges to the river.	**4**	While there may be some concerns about contaminants from the roadway, JEA customers would most likely be open to this technology for non-potable uses.	**4**

Distributed Stormwater Collection from FDOT Facilities

Category: Stormwater

Cost:

The table below provides estimated capital and O&M costs for distributed stormwater collected from multiple FDOT facilities. Variable O&M costs are dependent on the utilization of the facility and include items such as electricity and process chemicals. Fixed O&M costs represent costs incurred each year.

Option	Capital Costs ($M)	Annual O&M Costs at Full Capacity ($M)	O&M Fixed Costs per Year ($M)	O&M Variable Costs per MG
Distributed Stormwater Collected from FDOT Facilities	$82.9	$1.6	$0.42	$624

Modeling Assumptions:

Within the model, when distributed stormwater is selected it has the following impacts:

- The yield from distributed stormwater is added into the available reclaimed water supply for the East and Central Subgrids. This supply is also able to be transferred south to the St. Johns County subgrid to meet reclaimed water demands.

Citations:

Avery, Ray O. (2014) "Reclaimed Water Deficit & Augmentation of Reclaimed Water System Projection Study on Long Term Water Supply" Clay County Utility Authority. December 2014.

Gai Consultants (2014) "Technical Memorandum 1: Review of Hydrology Within FDOT Corridor and Environmental Conditions" Clay County Utility Authority; Florida Department of Transportation; St. Johns River Water Management District. February 2014.

Gai Consultants (2012) "Master Development Plan for Keystone Heights Surficial Aquifer and Lake Replenishment Program" Clay County Utility Authority. August 2012.

Jones Edmunds (2015) "2015 Alternative Water Supply Facilities Master Plan" JEA. February 2015.

Taylor Engineering (2016) "Initial Assessment of Alternative Water Supply Options for Clay County Utility Authority" CCUA. January 2016.

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Direct Potable Reuse

Category: Potable Reuse

Brief Description:

In this option, reclaimed water from one of JEA's water reclamation facilities (WRFs) is conveyed to a new Water Purification Facility (WPF) that produces water of potable quality to be utilized as a source of supply to a water treatment plant (WTP). Although purified water is safe for public consumption at the WPF and partially-stabilized with post-treatment chemicals, blending with the groundwater at a WTP utilizes the natural hardness and alkalinity to further stabilize the purified water and enhance its taste to more closely resemble the familiar aesthetics of JEA's Floridan aquifer supply. This supply option is referred to as direct potable reuse (DPR). This option is similar to the aquifer recharge option, indirect potable reuse (IPR), except that the purified water is not injected into the groundwater.

DPR WPFs could be located at several of JEA's WRFs or an alternate location in the service territory. The options currently considered within the IWRP model include: a 11-MGD facility at Southwest WRF, a 10-MGD facility at Buckman WRF, a 10-MGD facility at Arlington East WRF, a 5-MGD facility at Mandarin WRF, a 5-MGD facility at Cedar Bay WRF, and a 1.5-MGD facility at Nassau WRF.

Facilities Required:

Similar to purified water for aquifer recharge, purified water for direct potable reuse (DPR) is provided via a multiple barrier process including microfiltration or ultrafiltration (MF/UF), low pressure reverse osmosis (RO), and an ultraviolet advanced oxidation process (UVAOP) to produce purified water. JEA pilot tested this process for several months in 2017 to 2018 at both the Southwest WRF and Buckman WRF.

Direct potable reuse applications require a higher degree of treatment reliability than aquifer recharge facilities. This is because lapses in treatment at a DPR WPF would not be attenuated via dilution and travel time in a groundwater aquifer, as with the aquifer recharge option. Real-time online monitoring is included throughout the DPR WPF to monitor treatment process integrity and track the quality of the source and purified water prior to blending. Source monitoring includes a targeted industrial pretreatment monitoring program for each WRF, consisting of online monitors deployed throughout each respective collection system watching for illegal or accidental discharges of heavy metals, acids, cyanide, volatile organic compounds (VOCs) and other toxicants. Furthermore, a granular activated carbon (GAC) polishing step is added after UVAOP to attenuate potential transient spikes in organic chemicals from the sewershed, or persistent chemicals, less amenable to removal by RO and UVAOP.

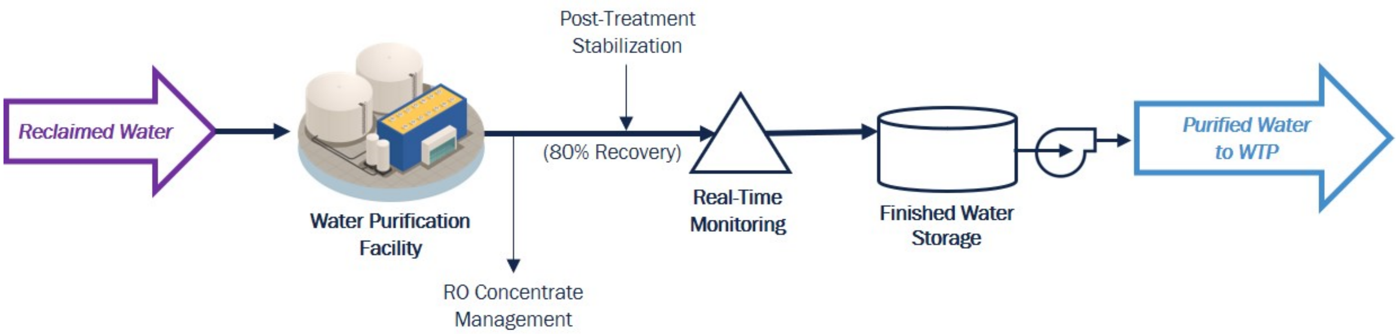
Engineered storage buffer (ESB) tanks have been proposed as one means of holding purified water until water quality and process integrity tests can be completed to verify that the water is safe to be conveyed into the source supply to a WTP. For this option, it is assumed that enough real-time monitoring is provided throughout the WPF to avoid the need to construct an ESB.

Having been treated by reverse osmosis, the purified water will require post-treatment stabilization. This option assumes remineralization by liquid lime addition followed by carbon dioxide addition for pH adjustment while minimizing calcium turbidity. Finally, sodium hydroxide is added to increase finished water pH and alkalinity while minimizing calcium turbidity. Depending on the blending ratio at the WTP and location of the WPF, the chemicals required for post-treatment could be reduced substantially below what is assumed in this fact sheet. An onsite ground storage tank and high service pumps are needed to convey the purified water to the WTP.

For each facility, two alternatives for disposal of RO concentrate were evaluated: 1) via deep well injection or 2) onsite zero liquid discharge via thermal processing with brine concentrators. These two options provide a range of costs of properly managing concentrate. Additional concentrate disposal options such as pumping the concentrate to a separate water reclamation facility could be feasible depending on which combination of treatment facilities is selected for DPR implementation; however, this option is not included in the cost estimates

Direct Potable Reuse

Category: Potable Reuse



Key Assumptions:

- The water purification facility operates at 80% recovery, assuming 94% recovery by MF/UF and 85% recovery by RO. Therefore, approximately 2.0 MGD of concentrate is produced for every 10 MGD of purified water.
- At this time the State of Florida has not established operating permit requirements for potable reuse facilities. For the purpose of the IWRP, water treatment requirements have been applied. Labor at each water treatment facility varies by capacity with facilities greater than 6.5 MGD being Category II Class A Water Treatment Plants requiring staffing by a Class C or higher operator: 24 hours/day for 7 days/week. The lead/chief operator must be Class A. For facilities between 1.0 MGD to 6.5 MGD, Category II Class B Water Treatment Plants, staffing is by a Class C or higher operator: 16 hours/day for 7 days/week. The lead/chief operator must be Class B. (F.A.C. 62-699.310).
- The GAC polishing step after UVAOP has an empty bed contact time of 10 minutes, except for the Buckman WPF where it is 20 minutes, for added conservatism against chemical spikes.
- The following WTPs were paired with each evaluated WPF to evaluate transfer pipeline length and construction costs for conveying purified water to the WTP. Pipelines were sized to achieve a flow velocity of approximately 4 to 5 feet per second, assuming ductile iron. Pipeline costs were estimated using unit prices provided in CDM Smith 2007 installed in an "urban" setting, updated to 2019 dollars.
    - Southwest WPF to Southwest WTP – 25,454 LF of 30" diameter pipeline
    - Arlington East WPF to Arlington East WTP – 21,724 LF of 24" diameter pipeline
    - Mandarin WPF to Community Hall WTP – 14,610 LF of 18" diameter pipeline
    - Cedar Bay WPF to Highlands WTP – 17,000 LF of 20" diameter pipeline
    - Nassau WPF to Nassau WTP – 3,000 LF of 12" diameter pipeline
    - Buckman WPF to Main Street WTP – 15,840 LF of 24" diameter pipeline

Environmental Impacts (Promote Environmental Sustainability):

This option has the potential to improve aquifer sustainability as potable water reuse offsets the need for additional groundwater withdrawals.

This option also has the environmental benefit of reducing the volume of WRF effluent and loading (i.e., nitrogen) to the St. Johns River by beneficially utilizing available supply.

Note, if thermal zero-liquid discharge is utilized as the RO concentrate disposal method, this option becomes much more energy intensive than if deep well injection is utilized.

Water Quality:

The WPF treatment and enhanced monitoring technologies reliably remove pathogens and constituents. Purified water meets all drinking water standards while also removing currently unregulated compounds and contaminants of

Direct Potable Reuse

Category: Potable Reuse

emerging concern (CECs) such as per- and polyfluoroalkyl substances (PFAS), endocrine disrupting compounds (EDCs), pharmaceuticals and personal care products (PPCPs), and antibiotic resistance genes (ARGs). An added GAC polishing step provides protection against chemical spikes in the sewershed, while also potentially enhancing removal of CECs after UVAOP. Chemical post-treatment is provided to produce a stable water.

Yield:

Yields assumed for each plant were developed based on the projected wastewater flows of the plants as well as water supply needs within individual subgrids.

Community Acceptance:

The community acceptance performance measure is qualitative in nature with the scoring based on the best judgement of JEA staff and the consultant team rather than quantitatively through project modeling. The overall score was split into two separate components: community perceived benefits and community concerns. Direct potable reuse received the following scores for each element, which were then averaged into an overall community acceptance score.

Scoring Criteria	1=low degree of perceived benefits by community 5=high degree of perceived benefits by community		1=significant community concerns to be addressed 5=full community support expected		Average Score for Community Acceptance
Supply Options	**Community Perceived Benefits**	**Notes**	**Community Concerns**	**Notes**	
Direct Potable Reuse	**3**	This option provides a new source for potable water and reduces discharges to the river. However, it does not provide the storage benefits of the aquifer which IPR does.	**2**	JEA surveying has shown a portion of the population supports directly using potable reuse instead of putting the high-quality supply back into the aquifer. However, based on the experience of other utilities there will still likely be some significant community concerns. The supply would be post-treated and blended with the current water supply to target a similar or improved water aesthetic.	**2.5**

Cost:

Costing for the option was initially developed around producing 10-mgd of potable supply from the Southwest WRF. Costing for implementing DPR at other potential WRFs was then scaled from the original estimate. WPF costs were compared costs of more than 20 full-scale constructed facilities. The comparison showed that DPR costs with concentrate management via deep injection well were comparable to actual costs of other full-scale projects The tables below provide estimated capital and O&M costs for the two concentrate disposal scenarios, assuming either zero liquid discharge or deep well injection. Variable O&M costs are dependent on the utilization of the facility and include items such as electricity and process chemicals. Fixed O&M costs represent costs incurred each year.

Direct Potable Reuse

Category: Potable Reuse

Concentrate Disposal Alternative 1: Zero Liquid Discharge

Option	Capital Costs ($M)	Annual O&M Costs at Full Capacity	O&M Fixed Costs per Year ($M)	O&M Variable Costs per MG
11-MGD at Southwest WRF	$328.3	$12.1	$4.8	$1,814
10-MGD at Buckman WRF	$308.5	$13.2	$5.4	$2,142
10-MGD Facility at Arlington East WRF	$293.9	$11.2	$4.4	$1,840
5-MGD at Mandarin WRF	$152.2	$5.9	$2.5	$1,859
5-MGD at Cedar Bay	$153.7	$5.9	$2.5	$1,859
1.5-MGD at Nassau	$51.0	$2.4	$1.3	$1,960

Concentrate Disposal Alternative 2: Deep Injection Well

Option	Capital Costs ($M)	Annual O&M Costs at Full Capacity	O&M Fixed Costs per Year ($M)	O&M Variable Costs per MG
11-MGD at Southwest WRF	$122.9	$6.5	$2.8	$910
10-MGD Facility at Buckman WRF	$123.3	$7.4	$3.2	$1,155
10-MGD Facility at Arlington East WRF	$108.6	$5.9	$2.6	$905
5-MGD at Mandarin WRF	$66.1	$3.3	$1.6	$924
5-MGD at Cedar Bay	$67.6	$3.3	$1.7	$924
1.5-MGD at Nassau	$34.8	$1.7	$1.1	$1,028

Modeling Assumptions

When DPR is selected within the IWRP model, the following elements are considered in determining the amount of DPR supply to be utilized:

- The amount of DPR supply utilized will not be greater than the yield of a given facility.
- The amount of DPR supply to be utilized is constrained by the available flow at the WRF. Projected flow at each facility is tracked with any on-site reclaimed water use subtracted from the available flow. A recovery ratio of 80 percent for DPR is assumed, meaning that for every 10-MGD of flow at the WRF, only 8.0-MGD of purified water can be produced.
- Utilization of DPR is also constrained to not serve greater than 50 percent of the water demand within a subgrid. Arlington East is the only plant within the model able to supply DPR water outside of its local subgrid. In this case,

Direct Potable Reuse

Category: Potable Reuse

DPR water produced at Arlington East can serve demands within both the South Arlington and the South East subgrids.

References:

Jones Edmunds (2015) "2015 Alternative Water Supply Facilities Master Plan" JEA. February 2015.

CDM Smith (2019) "Water Purification Technology Research and Development Project; Phase II Conceptual Plan" JEA. February 2019.

CDM Smith (2018) "Water Purification Technology Phase II and III Cost Evaluation Report" JEA. December 2018.

CDM Smith (2007) "Water Supply Cost Estimation Study" SFWMD. February 2007.

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Indirect Potable Reuse

Category: Potable Reuse

Brief Description:

Indirect potable reuse (IPR) is also referred to as aquifer recharge. In this option, reclaimed water from one of JEA's water reclamation facilities (WRFs) is conveyed to a new water purification facility (WPF) that produces purified water of potable quality. The purified water would be used to directly recharge the Floridan aquifer and result in beneficial reuse credits for the JEA consumptive use permit (CUP), allowing additional proportionate withdrawals in excess of historical CUP limiting conditions.

Aquifer recharge (IPR) WPFs could be located at several of JEA's WRFs or an alternate location in the service territory. The options currently considered within the IWRP model include: a 11-MGD facility at Southwest WRF, a 10-MGD facility at Buckman WRF, a 10-MGD facility at Arlington East WRF, a 5-MGD facility at Mandarin WRF, a 5-MGD facility at Cedar Bay WRF, and a 1.5-MGD facility at Nassau WRF. In all cases, the purified water would be injected into the aquifer through an aquifer recharge well system.

Facilities Required:

Purified water for aquifer recharge is provided via a multiple barrier process including microfiltration or ultrafiltration (MF/UF), low-pressure reverse osmosis (RO), and an ultraviolet advanced oxidation process (UVAOP) to produced purified water. JEA pilot tested this process for several months in 2017 to 2018 at both the Southwest WRF and Buckman WRF.

Aquifer recharge is similar to direct potable reuse but there are a number of benefits of using the aquifer for storage. Water can consistently be purified regardless of potable demands because excess purified water can be stored in the aquifer for future use. The aquifer also provides dilution and time between purified water production and potable use. Online monitoring throughout the IPR WPF monitors treatment process integrity and tracks the quality of the source and purified water prior to aquifer recharge.

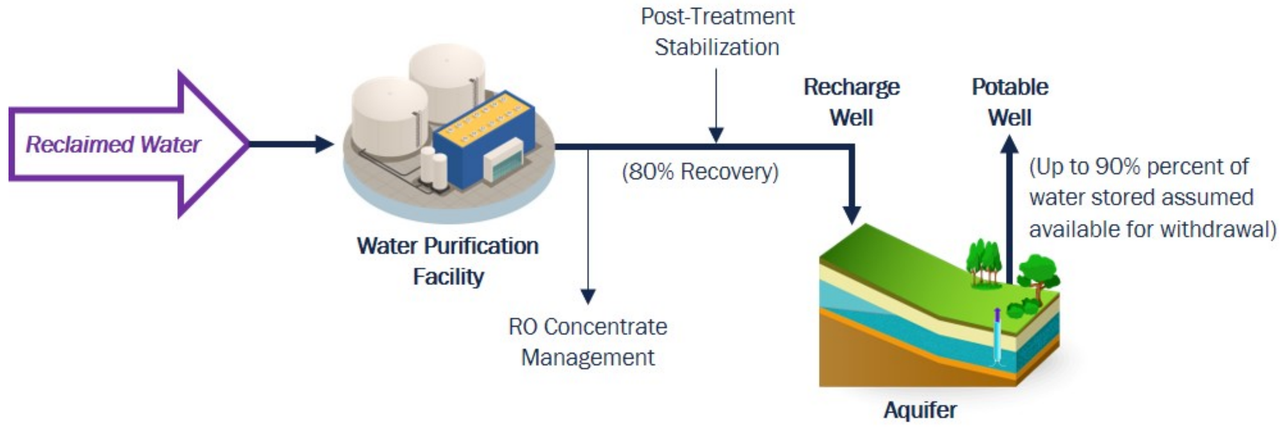
Having been treated by reverse osmosis, the purified water will require post-treatment stabilization before aquifer recharge in the proximity of the WPF. This option assumes remineralization by calcium chloride addition followed by carbon dioxide and sodium hydroxide addition for pH adjustment and alkalinity addition. It is assumed that more costly post-treatment approaches such as deoxygenation via membrane contactors and sodium hydrosulfide (NaHS) are not required, unless the target injection zone is shown to contain arsenopyrite.

For each facility, two alternatives for disposal of RO concentrate were evaluated: 1) via deep well injection or 2) onsite zero liquid discharge via thermal processing with brine concentrators. These two options provide a range of costs of properly managing concentrate. Additional concentrate disposal options such as pumping the concentrate to a separate water reclamation facility could be feasible depending on which combination of treatment facilities is selected for IPR implementation; however, this option is not included in the cost estimates.

Following treatment, the purified water will be injected into the aquifer using an aquifer recharge well system. It is assumed that water could then be withdrawn via JEA's current groundwater wells and conveyed to WTPs.

Indirect Potable Reuse

Category: Potable Reuse



Key Assumptions:

- The water purification facility operates at 80% recovery, assuming 94% recovery by MF/UF and 85% recovery by RO. Therefore, approximately 2.5 MGD of concentrate is produced for every 10 MGD of purified water.
- For the purposes of the IWRP, 90 percent of water stored in the aquifer is assumed to be available for withdrawal when water is stored and then utilized within the same subgrid. When water is stored within one subgrid and extracted from another, 75 percent of the stored supply is assumed to be available for withdrawal. Note, at this time it is not known what the actual recovery rate is that would be permitted and how this may vary by subgrid.

Environmental Impacts (Promote Environmental Sustainability):

Aquifer recharge can provide water quantity and water quality benefits. By using aquifer storage, the need for constructed storage can be reduced. One advantage of using the storage capacity of the aquifer is increased operational flexibility by decoupling of daily purified water production from daily potable water demands. In addition, soil aquifer treatment could provide beneficial removal of pathogens and chemical contaminants through filtration, adsorption, and biological degradation. Aquifer recharge can also provide beneficial dilution. Nevertheless, aquifer hydrogeochemistry in the injection zone should be considered in order to screen for the risk of release of naturally-occurring trace metals such as arsenic, if present.

Post treatment stabilization prior to injection can mitigate in-situ metals release, keeping the purified water pure while in contact with the aquifer. Post-treatment in this option includes limited remineralization, alkalinity addition, and pH stabilization. Additional post-treatment steps such as deoxygenation via membrane contactors and sodium hydrosulfide (NaHS) addition are not included in this option.

This option also has the environmental benefit of reducing the volume of WRF effluent and loading (i.e. nitrogen) to the St. Johns River by beneficially utilizing available supply.

Water Quality:

The WPF treatment and enhanced monitoring technologies reliably remove pathogens and constituents. Purified water meets all drinking water standards while also removing currently unregulated compounds and contaminants of emerging concern (CECs) such as per- and polyfluoroalkyl substances (PFAS), endocrine disrupting compounds (EDCs), pharmaceuticals and personal care products (PPCPs), and antibiotic resistance genes (ARGs). Chemical post-treatment is provided to produce a stable water.

Indirect Potable Reuse

Category: Potable Reuse

Yield:

Yields assumed for each plant were developed based on the projected wastewater flows of the plants as well as water supply needs within individual subgrids.

Community Acceptance:

The community acceptance performance measure is qualitative in nature with the scoring based on the best judgement of JEA staff and the consultant team rather than quantitatively through project modeling. The overall score was split into two separate components: community perceived benefits and community concerns. Purified water for aquifer recharge received the following scores for each element, which were then averaged into an overall community acceptance score.

Scoring Criteria	1=low degree of perceived benefits by community 5=high degree of perceived benefits by community		1=significant community concerns to be addressed 5=full community support expected		Average Score for Community Acceptance
Supply Options	**Community Perceived Benefits**	**Notes**	**Community Concerns**	**Notes**	
Indirect Potable Reuse	4	This option provides a new source for potable water, reduces discharges to the river and helps stabilize groundwater levels. The option also takes advantage of the current JEA groundwater infrastructure plus the storage and treatment benefits of the aquifer.	4	Previous surveying of JEA customers shows they are open to this technology and JEA has a robust Community Education and Outreach program focused on potable reuse. Since stabilized purified water will pass through the Floridan aquifer and be diluted by the existing water source, drinking water aesthetics would be comparable to the current tap water.	4

Cost:

Costing for the option was initially developed around producing 10-mgd of purified water from the Southwest WRF, utilizing quotes from equipment vendors and experience. These costs were scaled from the original estimate and compared against costs for full-scale water purification facilities of varying capacity. WPF costs were compared costs of more than 20 full-scale constructed facilities. The comparison showed that aquifer recharge costs with concentrate management via deep injection well were comparable to actual costs of other full-scale projects. The tables below provide estimated capital and O&M costs for the two concentrate disposal scenarios, assuming either zero liquid discharge or deep well injection. Variable O&M costs are dependent on the utilization of the facility and include items such as electricity and process chemicals. Fixed O&M costs represent costs incurred each year.

Indirect Potable Reuse

Category: Potable Reuse

Concentrate Disposal Alternative 1: Zero Liquid Discharge

Option	Capital Costs ($M)	Annual O&M Costs at Full Capacity ($M)	O&M Fixed Costs per Year ($M)	O&M Variable Costs per MG
11-MGD at Southwest WRF	$310.6	$10.6	$4.3	$1,558
10-MGD at Buckman WRF	$294.9	$10.8	$4.7	$1,670
10-MGD at Arlington East WRF	$284.4	$9.7	$4.0	$1,558
5-MGD at Mandarin	$150.1	$5.1	$2.3	$1,559
5-MGD at Cedar Bay	$150.1	$5.1	$2.3	$1,559
1.5-MGD at Nassau	$50.3	$2.0	$1.2	$1,559

Concentrate Disposal Alternative 2: Deep Injection Well

Option	Capital Costs ($M)	Annual O&M Costs at Full Capacity ($M)	O&M Fixed Costs per Year ($M)	O&M Variable Costs per MG
11-MGD at Southwest WRF	$105.3	$5.3	$2.4	$728
10-MGD at Buckman WRF	$109.6	$5.8	$2.7	$840
10-MGD at Arlington East WRF	$99.1	$5.0	$2.3	$728
5-MGD at Mandarin	$64.1	$2.8	$1.4	$728
5-MGD at Cedar Bay	$64.1	$2.8	$1.4	$728
1.5-MGD at Nassau	$34.4	$1.4	$0.97	$728

Modeling Assumptions

When IPR is selected, at one or multiple facilities, within the IWRP model, the following elements are considered in determining the amount of IPR supply to be stored and then utilized.

- The amount of IPR supply able to be stored within the aquifer is constrained by two elements:
  - Supply is constrained by the yields of the selected facilities.
  - Supply is also constrained by the available flow at the WRF. Projected flow at each facility is tracked with any on-site reclaimed water use subtracted from the available flow. A recovery ratio of 80 percent for IPR is assumed, meaning that for every 10-MGD of flow at the WRF, only 8.0 MGD of purified water can be produced.
- In determining the volume and location for IPR withdrawals within the model, the following logic is utilized:

Indirect Potable Reuse

Category: Potable Reuse

- Priority is first given to the subgrid where the IPR facility is located. If there is a projected supply deficit, IPR water will be utilized within that subgrid to meet demands. It is assumed that within the same subgrid, 90 percent of the water stored via aquifer recharge is available for utilization.

- If there is no immediate projected supply deficit in the local subgrid of the IPR facility, the model next gives priority to other subgrids with immediate supply needs. However, facilities are split so that IPR facilities in the South Grid can only meet demands in South Grid subgrids; while, IPR facilities in the North Grid and Nassau can meet demands only on the north side of the St. Johns River. When IPR water is extracted in a different subgrid than the facility, it is assumed that only 75 percent of the stored water is available for utilization.

- If there are no immediate projected supply deficits in either the local subgrid or surrounding subgrids, the model assumes the stored IPR water is utilized within the local subgrid to offset the need for utilizing JEA's current consumptive use permit for groundwater.

References:

CDM Smith (2019) "Water Purification Technology Research and Development Project; Phase II Conceptual Plan" JEA. February 2019.

CDM Smith (2018) "Water Purification Technology Phase II and III Cost Evaluation Report" JEA. December 2018.

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Brackish Groundwater

Category: Desalination

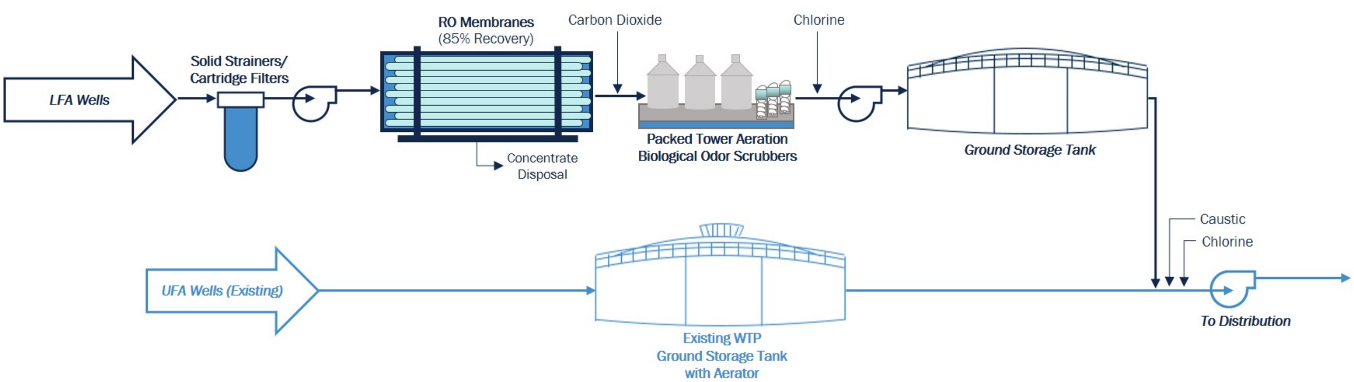
Brief Description:

This option considers developing additional groundwater capacity by treating brackish groundwater in the Fernandina Permeable Zone, located at the base of the Lower Floridan aquifer (LFA), which is typically between 1,900 to 2,500 feet below the surface in the south grid. Brackish groundwater reverse osmosis facilities in Florida typically treat water with salinity in the range from 1,000 milligrams per liter (mg/L) to 6,000 mg/L. While a brackish groundwater layer is not confirmed within the north grid area and Nassau county, the IWRP analysis allows for a brackish groundwater option to be considered within any subgrid.

Facilities Required:

The following are the assumed facilities for delivery and treatment of desalinated brackish groundwater:

- Wells: Assuming approximately 2.5 million gallons per day (MGD) per well with one standby well per facility.
- Pretreatment: steel strainers and cartridge filtration
- Reverse Osmosis (RO): The LFA brackish well water would undergo demineralization using RO membranes. The water then passes through packed tower aeration with pH adjustment to remove dissolved gases such as hydrogen sulfide. Biological odor scrubbers remove hydrogen sulfide from the odorous air.
- Distribution: After hydrogen sulfide removal, the water is then be chlorinated and stored in a reservoir for blending with treated water from an existing WTP. Additional chlorine and pH adjustment (via caustic soda) might be required depending on blending ratios prior to distribution. Groundwater pumpage from the existing UFA wells would be scaled proportionately in response to the operations of the associated RO WTP, to achieve a target blended water quality range to be defined by JEA at the point where the blended waters enter the larger distribution system.
- Process waste: two alternatives for disposal of RO concentrate and biological odor control wastewater were evaluated: 1) via deep well injection or 2) onsite zero liquid discharge via thermal processing with brine concentrators.



Key Assumptions:

- Brackish groundwater is available in sufficient quantity and quality to allow issuance of a water use permit and treatment. A feed water of 3,000 mg/L TDS is assumed. Individual well locations and pipeline routing not identified for each location, but real estate costs and pipelines accounted for with a $500,000 allowance per well.
- Sulfate is the limiting parameter for blending water from the future LFA wells with water from the existing WTPs.
- The RO feed, permeate, and concentrate flows are based on a RO system recovery of 85%, sulfate rejection of 97%, target blended flow (RO permeate + RO bypass) of 10 million gallons per day (MGD). No bypass blending is conducted.

Brackish Groundwater

Category: Desalination

- RO concentrate is disposed either by deep well injection (not confirmed in this region of FL), or by a thermal zero liquid discharge (ZLD) process.
- Groundwater hydrogen sulfide (H_2S) concentration is assumed to be greater than or equal to 3 mg/L, warranting packed tower aeration with pH adjustment per F.A.C. 62-555.315(5)(a).
- Facility is operated continuously so that biological odor scrubbers remain operational.
- The brackish water from the LFA well would require partial demineralization to reduce the chloride and sulfate concentrations to match existing finished water concentrations required for blending with existing product water.

Environmental Impacts (Promote Environmental Sustainability):

Develops a local alternative water supply, brackish groundwater in the Lower Floridan aquifer.

Water Quality:

It is assumed that the brackish water from the future LFA wells would have a total dissolved solids (TDS) of 3,000 mg/L, which is significantly higher than the TDS of the existing UFA wells, which currently provide feedwater to JEA's South Grid WTPs. A number of water quality parameters should be characterized in the LFA wells to help define the parameters of a future RO design, such as sodium, chloride, TDS, temperature, pH, turbidity, calcium, magnesium, alkalinity, total organic carbon, sulfate, fluoride, iron, total silica, manganese, strontium, barium, radionuclides, and sulfides.

Coming from a deep groundwater source, brackish LFA water would be anticipated to be relatively free of pathogens, organic chemical contaminants, and contaminants of emerging concern (CECs). Therefore, the finished water product would be of very high water quality; however, membrane treatment would remove nearly all of the hardness and much of the alkalinity, necessitating stabilization through post-treatment or blending with traditional groundwater supplies.

Deep brackish water can also contain radionuclides such as radium or uranium (Carollo 2009). While RO membranes are highly effective for removal of radionuclides, the presence of radioactive material in the concentrate could be challenging to landfill disposal of solids generated via thermal zero liquid discharge (ZLD). Radionuclide data has not been reviewed for the Lower Florida aquifer in the JEA service area.

Yield:

This alternative has been sized for a variety of yields since the yield analyzed will vary depending on the supply needs of the subgrid and other selected supply options. The site-specific yield of any potential LFA brackish supply would need to be proven using test wells.

Community Acceptance:

The community acceptance performance measure is qualitative in nature with the scoring based on the best judgement of JEA staff and the consultant team rather than quantitatively through project modeling. The overall score was split into two separate components: community perceived benefits and community concerns. Brackish groundwater desalination received the following scores for each element, which were then averaged into an overall community acceptance score.

Brackish Groundwater

Category: Desalination

Scoring Criteria	1=low degree of perceived benefits by community 5=high degree of perceived benefits by community		1=significant community concerns to be addressed 5=full community support expected		Average Score for Community Acceptance
Supply Options	Community Perceived Benefits	Notes	Community Concerns	Notes	
Desalination: Brackish Groundwater	**3**	This option provides a new source of potable water. However, the option continues to rely on groundwater, not providing the environmental benefits of reduced groundwater usage, reduced discharges to the river, or utilization of current JEA groundwater infrastructure.	**3**	This water supply has significantly lower hardness and alkalinity than traditional groundwater supplies and will require blending/stabilization prior to distribution. Brackish groundwater is not a proven source in this area. Concentrate management through locally-unproven deep well concentrate injection or costly and energy-intensive zero liquid discharge could be controversial.	**3**

Cost:

The table below provides estimated capital and O&M costs for brackish groundwater facilities of various yields. Variable O&M costs are dependent on the utilization of the facility and include items such as electricity and process chemicals. Fixed O&M costs represent costs incurred each year.

Concentrate Disposal Alternative 1: Zero Liquid Discharge

Option	Capital Costs ($M)	Annual O&M Costs at Full Capacity ($M)	O&M Fixed Costs per Year ($M)	O&M Variable Costs per MG
Desalination: Brackish Groundwater 2-MGD	$79.3	$2.9	$1.4	$2,033
Desalination: Brackish Groundwater 5-MGD	$164.3	$6.1	$2.4	$2,027
Desalination: Brackish Groundwater 10-MGD	$317.9	$11.8	$4.4	$2,207
Desalination: Brackish Groundwater 15-MGD	$458.2	17.4	$6.3	$2,207

Brackish Groundwater

Category: Desalination

Concentrate Disposal Alternative 2: Deep Injection Well

Option	Capital Costs ($M)	Annual O&M Costs at Full Capacity ($M)	O&M Fixed Costs per Year ($M)	O&M Variable Costs per MG
Desalination: Brackish Groundwater 2-MGD	$53.3	$1.3	$0.9	$572
Desalination: Brackish Groundwater 5-MGD	$78.2	$2.4	$1.4	$572
Desalination: Brackish Groundwater 10-MGD	$132.7	$4.2	$2.2	$572
Desalination: Brackish Groundwater 15-MGD	$174.1	$6.0	$2.9	$572

Modeling Assumptions:

Within the IWRP model, brackish groundwater facilities can be selected for any subgrid. When brackish groundwater is selected, it has the following impacts:

- The yield from any brackish groundwater facilities selected is available to meet demand within that subgrid. Brackish groundwater facilities are prioritized to serve demand after accounting for any traditional reclaimed water usage as well as potable reuse options. However, brackish groundwater is utilized prior to the use of other desalination options and the current consumptive use permit for fresh groundwater supplies.
- Costs for implementing this option are scaled based on the selected yield.

References:

Jones Edmunds (2015) "2015 Alternative Water Supply Facilities Master Plan" JEA. February 2015.

Carollo Engineers (2009) "Water Desalination Concentrate Management and Piloting." South Florida Water Management District. December 2009.

CDM Smith (2013) "Integrated Water Resource Planning Project" JEA. February 2013.

St. Johns River at Shands Bridge

Category: Desalination

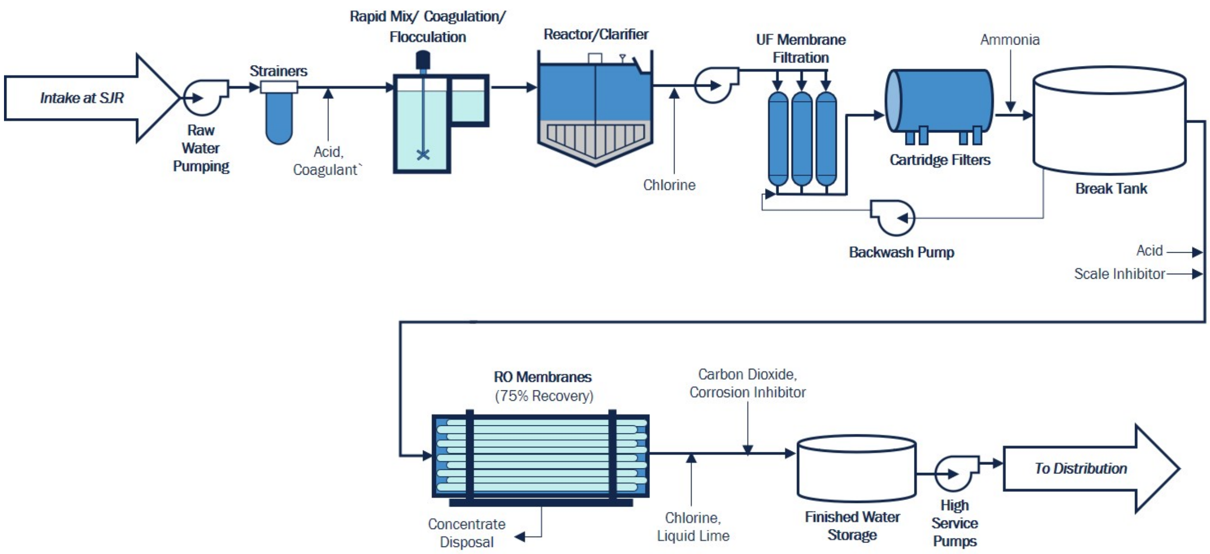
Brief Description:

This option provides an additional potable supply source to supplement the existing groundwater supply source by treating St. Johns River surface water for South Grid potable supply using a low-pressure reverse osmosis (RO) membrane water treatment plant (WTP). The RO WTP facility could be sited in the South Grid near the Shands Bridge at SR 16 in St. Johns County within the JEA water service area and in proximity of future high demand service areas. Finished water would be sent directly to the South Grid distribution system to serve demands within the St. Johns County subgrid. A deep well injection system is currently assumed for concentrate disposal. This option was costed for 10 million gallons per day (MGD); however, costs are scaled within the IWRP model based upon the capacity selected.

Facilities Required:

The following are the assumed facilities for delivery and treatment of desalinated water from the St. Johns River near the Shands Bridge:

- River intake facility and raw water transmission pipeline to the RO WTP.
- Surface water pretreatment: Raw water pumping, strainers, coagulation/flocculation using a ballasted flocculation process, and support processes.
- RO WTP: Ultrafiltration (UF) membranes, cartridge filters, equalization break tank, and support processes, RO feed water conditioning (acid, scale inhibitor) RO membranes, chlorine disinfection (NaOCl), lime remineralization, carbon dioxide (CO_2) addition, corrosion control (PO_4), finished water storage, high service pumping, and support processes.
- Finished water connection(s) to the distribution system.
- Process waste: Backwash waste equalization, gravity thickener, sludge dewatering, and RO concentrate disposal via deep well injection.



St. Johns River at Shands Bridge

Category: Desalination

Key Assumptions:

- Surface water treatment process selection will meet seasonal water quality variations
- TDS of intake water near the Shands Bridge varies seasonally with a median daily salinity of 400 milligrams per liter (mg/L), ranging from 125 mg/L to 5,000 mg/L. Historically, the water has been fresh (below 1,000 mg/L TDS, USGS 2013) for most of the year. Water salinity has been less than 1,500 mg/L for 90% of days over the past 25 years.
- The facility will be operated approximately 90% of the year during periods of lower salinity, and offline during the periods of higher salinity, with a nameplate capacity of 12 MGD for an AADF of 10 MGD.
- The RO treatment system will be designed to attain nameplate capacity for a feed salinity of up to 1,500 mg/L. Feasible production capacity would decline as salinity increased to an upper operating TDS limit.
- The facility would be designed for salinities below 5,000 mg/L in order to reduce capital costs associated with higher rated pressure vessels, reduce the need for duplex steel alloys, and control the size of high-pressure pumps, and associated electrical gear.
- UF membrane recovery rate: 94%
- RO membrane recovery rate: 75 %.
- RO membrane bypass could reduce O&M costs during lower salinity periods; however, the cost estimates assume no bypass.
- RO concentrate disposal: Deep well injection currently assumed, a river discharge would be preferable if could be permitted.
- Land would be available for desalination facilities.

Environmental Impacts (Promote Environmental Sustainability):

This option has the potential to improve aquifer sustainability as desalinated water offsets the need for additional groundwater withdrawals.

Water Quality:

The required treatment facilities would produce water of potable quality. Fresh surface water supplies can be vulnerable to odorous compounds (MIB and geosmin), stormwater runoff (pesticides, herbicides), algal toxins, and other constituents not found in groundwater. Reverse osmosis is capable of removing these and other contaminants of emerging concern (CECs).

Community Acceptance:

The community acceptance performance measure is qualitative in nature with the scoring based on the best judgement of JEA staff and the consultant team rather than quantitatively through project modeling. The overall score was split into two separate components: community perceived benefits and community concerns. Desalination of St Johns River water at the Shands Bridge received the following scores for each element, which were then averaged into an overall community acceptance score.

St. Johns River at Shands Bridge

Category: Desalination

Scoring Criteria	1=low degree of perceived benefits by community 5=high degree of perceived benefits by community		1=significant community concerns to be addressed 5=full community support expected		Average Score for Community Acceptance
Supply Options	**Community Perceived Benefits**	**Notes**	**Community Concerns**	**Notes**	
Desalination: St. Johns River at Shands Bridge	**2**	This option provides a new source of potable water. However, the option does not provide for the environmental benefits of reduced groundwater usage, reduced discharges to the river, or utilization of current JEA groundwater infrastructure.	**2**	Incorporation of this supply will require stabilization and adjustment to achieve a similar quality water. Potential difference in taste could present a community concern. More intrusive facilities including intakes and outfalls along the river as well as significant energy use and environmental impacts from brine discharges could also present community concerns.	**2**

Yield:

The capacity of the treatment plant for this option is assumed to be 10 MGD. The source of water is not considered to be the limiting constraint on the quantity.

Cost:

The table below provides estimated capital and O&M costs. Variable O&M costs are dependent on the utilization of the facility and include items such as electricity and process chemicals. Fixed O&M costs represent costs incurred each year. Note, capital costs are based on a nameplate capacity of 12 MGD, and "full capacity" O&M costs are based on 10 MGD accounting for seasonally high TDS that makes the river water exceed the intended treatment limits of the system.

Option	Capital Costs ($M)	Annual O&M Costs at "Full Capacity" ($M)	O&M Fixed Costs per Year ($M)	O&M Variable Costs per MG
Desalination: St. Johns River at Shands Bridge 10-MGD	$164.1	$7.3	$3.1	$967

Modeling Assumptions:

Within the IWRP model, selecting St. Johns River desalination at Shands Bridge has the following impacts:

- The selected yield for the facility is available to meet demands in the St. Johns County subgrid. The supply is prioritized to serve demand after accounting for any traditional reclaimed water usage as well as potable reuse options and brackish groundwater supplies. However, the desalinated water from this supply option is utilized prior to the current consumptive use permit for fresh groundwater supplies.

St. Johns River at Shands Bridge

Category: Desalination

References:

Jones Edmunds (2015) “2015 Alternative Water Supply Facilities Master Plan” JEA. February 2015.

CDM Smith (2013) “Integrated Water Resource Planning Project” JEA. February 2013

CH2MHill (2008) “JEA Total Water Management Plan”. September 2008.

USGS (2013). “National Brackish Groundwater Assessment.” Infosheet. https://water.usgs.gov/ogw/gwrp/brackishgw/files/brackish_infosheet_v8.pdf (Defines fresh water as TDS<1,000 mg/L)

St. Johns River at NGS Site

Category: Desalination

Brief Description:

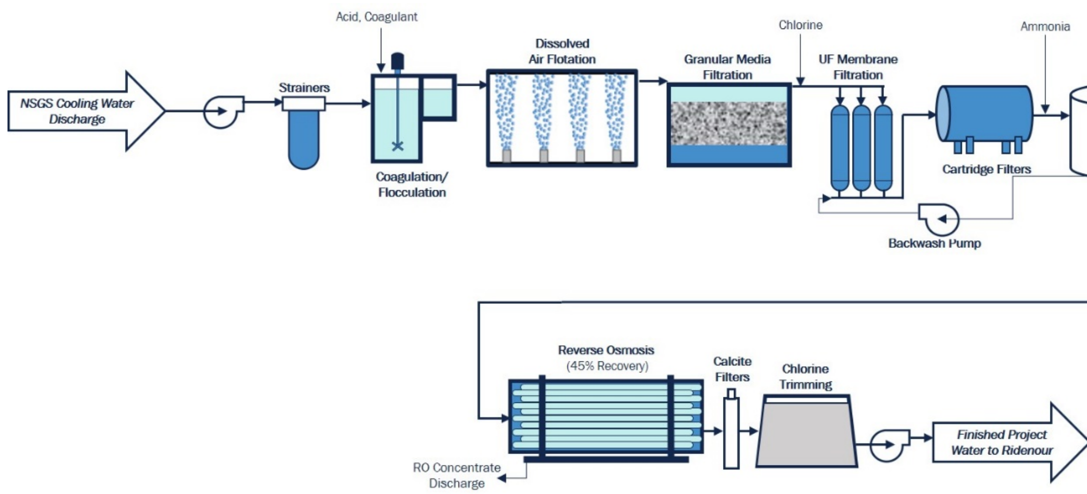
This option provides an additional potable supply source to supplement the existing groundwater supply source. Surface water from the St. Johns River would be treated and desalinated for both North Grid and South Grid potable water supply. The option was costed as a 10-million gallon per day (MGD) reverse osmosis (RO) WTP constructed on the existing Northside (electric power) Generating Station (NGS) site. The source water salt content would be higher than brackish water but lower than seawater. An average total dissolved solids (TDS) of 25,000 milligrams per liter (mg/L) was assumed; however, salinity in the lower St. Johns River is tidally influenced and the potential intraday variability in TDS exceeding 10,000 mg/L would complicate operations. If the NGS does not include storage to stabilize TDS, equalization tanks would stabilize feed water TDS to the water treatment plant (WTP).

The NGS currently discharges approximately 300 MGD of cooling water blowdown (used cooling water) to the St. Johns River. This option considers diverting used cooling water blowdown to the RO WTP for treatment, assuming the temperature is stabilized to between 30°C to 35°C year-round. Thus, additional water supply withdrawal from the St. Johns river would not be required. Finished water from the RO WTP could be utilized in the North Grid or transferred to the South Grid through a new 47,200 linear feet (LF), 42-inch diameter transmission main to Ridenour WTP for distribution. RO concentrate and other process wastewaters would be co-mingled with the NGS cooling water in the discharge canal, downstream of the St. Johns River intake.

Facilities Required:

The following are the assumed facilities for delivery and treatment of desalinated water from the lower St. Johns River:

- Feed Flow Equalization: Two 5-million-gallon ground storage tanks with internal mixing to provide 12 hours of equalization storage to dampen diurnal variations in TDS of lower St Johns River water.
- Raw water pump station and transmission pipeline to the RO WTP.
- Pretreatment: Basket strainers, chemical addition, rapid mix, flocculation, dissolved air flotation, and granular media filtration to remove particles and colloidal matter from the St. Johns River water to prevent fouling of the downstream RO membranes. Chlorine addition prior to UF membranes for biofouling control. Ammonia addition prior to RO to form chloramines for biofouling control.
- RO: Ultrafiltration membranes, high pressure, single-pass seawater RO membrane filtration with energy recovery devices, calcite filters (remineralization), and chlorine disinfection.
- Process waste: Backwash waste equalization, gravity thickener, sludge dewatering and RO concentrate disposal via deep well injection
- Finished Water Transmission: 47,200 LF of 42-inch pipe, including 13,400 LF of directional drilled river crossing.



St. Johns River at NGS Site

Category: Desalination

Key Assumptions:

- Surface water treatment process selection would meet seasonal water quality variations.
- The existing river intake facility would screen river water to remove large debris.
- TDS of intake water would be approximately 25,000 mg/L and fluctuations in TDS would be dampened by potential storage at the NGS.
- RO WTP recovery rate: 45%.
- A second potable water pipeline crossing the St. Johns River would be required. The existing potable water river crossing pipeline does not have capacity to carry the additional supply.
- Land acquisition would not be required. A 10-mgd desalination WTP facility could fit within 2 to 5 acres depending on facility layout. WTP siting would require close coordination with the NGS.

Environmental Impacts (Promote Environmental Sustainability):

RO concentrate disposal is a common concern with desalination projects that will need to be addressed to implement this option. RO concentrate could become a limiting factor in the power plant discharge as desalination facility capacity increases. The surface water discharge will likely require environmental investigation to support an industrial discharge and mixing zone permit being issued by FDEP. The currently proposed concentrate disposal flow (12.2 MGD) is about 4% of the NGS blowdown flow. The Tampa Bay Water Seawater Desalination Facility was designed with concentrate blending as about 2% of power plant cooling water flow (19 MGD into 1,000 MGD). The Carlsbad California Seawater Desalination Facility was designed with concentrate blending as about 18-21% of power plant cooling water flow (54 MGD into 254-304 MGD).

Water Quality:

The source water quality at the intake location is listed below showing the variability of the lower St. Johns River:

- TDS: 11,000–27,500 mg/L (n=9)
- Conductivity: 16,300–40,000 µmhos/cm (n=9)
- Dissolved Oxygen: 5.2–8.62 mg/L (n=9)
- Water Temperature: 59–87 deg F (n=9)

The required desalination and treatment facilities would produce water of potable quality. Boron removal during RO treatment would be an important consideration. Bromide can form trihalomethane disinfection byproducts not removable by air stripping. Surface water supplies can be more vulnerable to odorous compounds (MIB and geosmin), stormwater runoff (pesticides, herbicides), algal toxins, and other constituents not found in groundwater. Reverse osmosis is capable of removing these and other contaminants of emerging concern.

Community Acceptance:

The community acceptance performance measure is qualitative in nature with the scoring based on the best judgement of JEA staff and the consultant team rather than quantitatively through project modeling. The overall score was split into two separate components: community perceived benefits and community concerns. Desalination of St Johns River water at the NGS site received the following scores for each element, which were then averaged into an overall community acceptance score.

St. Johns River at NGS Site

Category: Desalination

Scoring Criteria	1=low degree of perceived benefits by community 5=high degree of perceived benefits by community		1=significant community concerns to be addressed 5=full community support expected		Average Score for Community Acceptance
Supply Options	**Community Perceived Benefits**	**Notes**	**Community Concerns**	**Notes**	
Desalination: St. Johns River at NGS Site	2	This option provides a new source of potable water. However, the option does not provide for the environmental benefits of reduced groundwater usage, reduced discharges to the river, or utilization of current JEA groundwater infrastructure.	2	Incorporation of this supply will require stabilization and adjustment to achieve a similar quality water. Potential difference in taste could present a community concern. More intrusive facilities including intakes and outfalls along the river as well as significant energy use and environmental impacts from brine discharges could also present community concerns.	2

Yield:

The capacity of the treatment plant for this option is assumed to be 10 MGD for costing. A facility up to 30 MGD could be considered, but the ability to blend the RO concentrate with the NGS cooling water discharge would be a limiting factor in sizing the facility larger.

Cost:

The table below provides estimated capital and O&M costs. Variable O&M costs are dependent on the utilization of the facility and include items such as electricity and process chemicals. Fixed O&M costs represent costs incurred each year.

Costs for a potential river crossing to move the supply from the North Grid to the South Grid are also provided.

Option	Capital Costs ($M)	Annual O&M Costs at Full Capacity ($M)	O&M Fixed Costs per Year ($M)	O&M Variable Costs per MG
Desalination: St. Johns River at NGS Site 10-MGD	$161.3	$8.8	$3.5	$1,464
River Crossing	$37.2	$0.99	--	-

St. Johns River at NGS Site

Category: Desalination

Model Assumptions:

Within the IWRP model, selecting St. Johns River desalination at the NGS site has the following impacts:

- The selected yield for the facility is available to meet demands in the N North subgrid. The supply is prioritized to serve demand after accounting for any traditional reclaimed water usage as well as potable reuse options and brackish groundwater supplies. However, the desalinated water from this supply option is utilized prior to the current consumptive use permit for fresh groundwater supplies.
- Supply from the St. Johns River desalination facility can also be directed to the South Grid by selected this sub-option. If selected, the costs for the river crossing are included and supply is also available to serve demand in the S Arlington subgrid.

References:

Jones Edmunds (2015) "2015 Alternative Water Supply Facilities Master Plan" JEA. February 2015.

CDM Smith (2013) "Integrated Water Resource Planning Project" JEA. February 2013

USGS (2020). "Water Data for the Nation." Water Quality Station. ST JOHNS R DAMES POINT BRIDGE AT JACKSONVILLE, FL. https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=302309081333001

Intracoastal Waterway

Category: Desalination

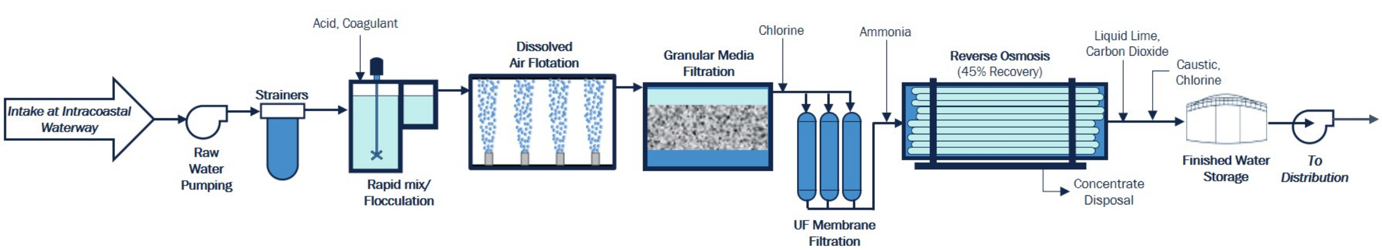
Brief Description:

This option provides an additional source water supply to supplement the existing groundwater supply source. It assumes that surface water from the Intracoastal Waterway would be withdrawn from a location to be determined between St. Mary's River to the north and the George Crady Bridge to the South. Water would be treated and desalinated for potable water supply within the Nassau East grid. Tidally influenced variation in total dissolved solids (TDS) is assumed to be small enough in magnitude to be managed operationally without interrupting the continuous duty of the water treatment plant (WTP). An average TDS of 35,000 milligrams per liter (mg/L) was assumed. This option assumes a reverse osmosis (RO) WTP and was initially sized for 10 million gallons per day (MGD) to be comparative to the sizing of other supply options. However, demand within the Nassau East subgrid is not projected to reach 10 mgd, so the costs are scaled down within the model depending on the size selected for implementation using an exponent of 0.75. Under this assumption, a 2-MGD facility would cost about 60% more per gallon than a 10-MGD facility.

Facilities Required:

The following are the assumed facilities for delivery and treatment of desalinated water from the Intracoastal Waterway to Nassau East:

- Conventional surface water intake from the Intracoastal Waterway to an onshore pump station.
- Pretreatment: Strainers, chemical addition, rapid mix, flocculation, dissolved air flotation, and granular media filtration to remove particles and colloidal matter from the seawater to prevent fouling of the downstream membranes. Chlorine addition prior to UF membranes for biofouling control. Ammonia addition prior to RO to form chloramines for biofouling control.
- Membranes: Ultrafiltration membranes, high pressure, single-pass seawater RO membrane filtration with energy recovery devices, post treatment, and chlorine disinfection.
- Post Treatment: Having been treated by reverse osmosis, the desalinated water will require post-treatment stabilization. This option assumes remineralization by liquid lime addition followed by carbon dioxide addition for pH adjustment while minimizing calcium turbidity. Finally, sodium hydroxide is added to increase finished water pH and alkalinity while minimizing calcium turbidity.
- Process waste: Backwash waste equalization, gravity thickener, sludge dewatering, UF backwash and neutralized chemical cleaning wastes, and RO concentrate disposal via deep well injection. Ferric hydroxide sludge disposed via landfill disposal.
- Finished Water Transmission: Ground storage tank and high service pump station feeding into local distribution system.



Intracoastal Waterway

Category: Desalination

Key Assumptions:

- Seawater would be obtainable through a lower cost intake on the Intracoastal Waterway.
- TDS of intake water assumed to be 35,000 mg/L and relatively stable.
- RO process recovery rate is assumed to be 45%. UF recovery rate is 94%. The combined recovery rates is 42%.
- Real estate near the Intracoastal Waterway will be more costly than many other locations within the service area. A cost of $15 million was assumed based on JEA input.
- A 10-mgd desalination WTP facility could fit within 2 to 5 acres depending on facility layout. A facility area of 5 acres was assumed including storage area.
- Concentrate disposal via deep well injection using two wells.

Environmental Impacts (Promote Environmental Sustainability):

This alternative water supply would offset future demands from the Upper Florida aquifer. Seawater desalination will be challenging to permit in the Jacksonville area, with the intake and concentrate disposal being particularly difficult. The two largest seawater desalination WTPs in the US, Tampa Bay Water and Carlsbad, CA are each co-located with a power plant, taking advantage of the power plant cooling water, and providing a large flow for dilution of the RO WTP concentrate. Offshore concentrate disposal requires diffusers for dispersion and dilution of water to avoid potential impacts to marine life from water with TDS elevated above ambient seawater. This option assumes onshore disposal of concentrate via deep well injection through two wells.

Community Acceptance:

The community acceptance performance measure is qualitative in nature with the scoring based on the best judgement of JEA staff and the consultant team rather than quantitatively through project modeling. The overall score was split into two separate components: community perceived benefits and community concerns. Intracoastal waterway desalination received the following scores for each element, which were then averaged into an overall community acceptance score.

Scoring Criteria	1=low degree of perceived benefits by community 5=high degree of perceived benefits by community		1=significant community concerns to be addressed 5=full community support expected		Average Score for Community Acceptance
Supply Options	**Community Perceived Benefits**	**Notes**	**Community Concerns**	**Notes**	
Desalination: Intracoastal	2	This option provides a new source of potable water. However, the option does not provide for the environmental benefits of reduced groundwater usage, reduced discharges to the river, or utilization of current JEA groundwater infrastructure.	2	Incorporation of this supply will require stabilization and adjustment to achieve a similar quality water. Potential difference in taste could present a community concern. More intrusive facilities including intakes along the waterway as well as significant energy use, the high project cost, and environmental impacts from brine discharges could also present community concerns.	2

Intracoastal Waterway

Category: Desalination

Water Quality:

The required desalination and treatment facilities would produce water of potable quality. Boron removal during RO treatment would be an important consideration. Bromide can form trihalomethane disinfection byproducts not removable by air stripping. Seawater from the Intracoastal Waterway could also be vulnerable to algal blooms and cyanotoxins and lignins or organochlorines from nearby paper mills; however, RO is capable of removing these and other contaminants of emerging concern.

Yield:

While the option is costed at 10 MGD for easier comparison to other desalination option, the typical installation considered within the Nassau East subgrid would be 2.5 MGD based on projected future supply deficits.

Cost:

The table below provides estimated capital and O&M costs. All costs are presented in 2019 dollars, with costs from historical documents being updated to 2019 dollars. Variable O&M costs are dependent on the utilization of the facility and include items such as electricity and process chemicals. Fixed O&M costs represent costs incurred each year.

Option	Capital Costs ($M)	Annual O&M Costs at Full Capacity ($M)	O&M Fixed Costs per Year ($)	O&M Variable Costs per MG
Desalination: Intracoastal Waterway (10 MGD)	$186.7	$10.2	$3.9	$1,742

Modeling Assumptions:

Within the IWRP model, turning on this option has the following impacts:

- The selected yield of the Intracoastal Waterway desalination facility is available to meet demand in the Nassau East subgrid. It is prioritized to serve demand after accounting for any traditional reclaimed water usage as well as other future water supplies that might also be selected (i.e., direct potable reuse, indirect potable reuse, and brackish groundwater). However, the desalinated water serves demand within the model prior to the use of the current consumptive use permit for fresh groundwater supplies.
- Costs for implementing this option are scaled based on the selected yield. A curve for scaling costs is utilized within the model so that the costs are not just a direct ratio of the yield as compared to the developed cost for the 10-MGD facility.

References:

CDM Smith (2007). “Water Supply Cost Estimation Study.” South Florida Water Management District.

Ocean Desalination

Category: Desalination

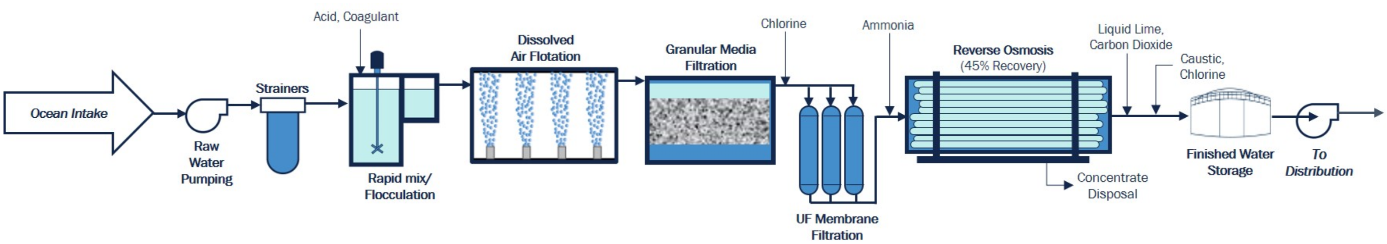
Brief Description:

This option provides an additional source water supply to supplement the existing groundwater supply source. Atlantic Ocean water would be treated and desalinated for potable water supply within the South East subgrid. An average total dissolved solids (TDS) of 35,000 milligrams per liter (mg/L) is assumed. This option assumes a reverse osmosis (RO) water treatment plant (WTP) sized for 10 million gallons per day (MGD).

Facilities Required:

The following are the assumed facilities for delivery and treatment of desalinated seawater to the South East subgrid:

- An open seawater intake and pipeline to onshore pump station. Other intake options such as a sub-seabed infiltration gallery would add additional expense.
- Pretreatment: Strainers, chemical addition, rapid mix, flocculation, dissolved air flotation, and granular media filtration to remove particles and colloidal matter from the seawater to prevent fouling of the downstream membranes. Chlorine addition prior to ultrafiltration (UF) membranes for biofouling control. Ammonia addition prior to RO to form chloramines for biofouling control.
- Membranes: UF membranes, high pressure, single-pass seawater RO membrane filtration with energy recovery devices, post treatment, and chlorine disinfection.
- Post Treatment: Having been treated by RO, the desalinated water will require post-treatment stabilization. This option assumes remineralization by liquid lime addition followed by carbon dioxide addition for pH adjustment while minimizing calcium turbidity. Finally, sodium hydroxide is added to increase finished water pH and alkalinity while minimizing calcium turbidity.
- Process waste: Backwash waste equalization, gravity thickener, sludge dewatering, UF backwash and neutralized chemical cleaning wastes, and RO concentrate disposal via offshore diffuser piping on the ocean floor. RO recovery rate is 45%, with concentrate flow of 12.2 MGD and concentrate TDS of approximately 64,000 mg/L.
- Finished Water Transmission: Ground storage tank and high service pump station feeding into local distribution system.



Key Assumptions:

- New seawater intake and ocean outfall concentrate disposal systems would be required due to the lack of a coastal power plant with which to co-locate. Note, intake and ocean outfall system costs were not site specific but were estimated from general published guidelines (Wetterau et al. 2011) (WateReuse Association 2012).
- TDS of intake water assumed to be 35,000 mg/L and relatively stable.
- RO process recovery rate is assumed to be 45%. UF recovery rate is 94%. Combined recovery rate is 42%.
- The facility would be constructed near the South East Subgrid with piping from high service pump station into nearby transmission mains.
- Real estate near the oceanfront will be more costly than other locations within the service area. Based on JEA input, a land value of $5,000,000/acre was assumed.
- A 10-mgd desalination WTP facility could fit within 2 to 5 acres depending on facility layout. A facility area of 5 acres was assumed including storage area.

Ocean Desalination

Category: Desalination

- While the IWRP model assumes that this option could be constructed within a short enough timeframe to meet initial alternative water supply needs, seawater desalination projects often experience lengthy implementation periods.

Environmental Impacts (Promote Environmental Sustainability):

This alternative water supply would offset future demands from the Upper Florida aquifer. Ocean seawater desalination will be challenging to permit in the Jacksonville area, with seawater intake and concentrate disposal being particularly difficult. The two largest seawater desalination WTPs in the US, Tampa Bay Water and Carlsbad, CA are each co-located with a power plant, taking advantage of the power plant cooling water, and providing a large flow for dilution of the RO WTP concentrate. The most common concerns associated with offshore intakes include cost and mitigating impingement and entrapment of marine life. Offshore concentrate disposal requires diffusers for dispersion and dilution of water to avoid potential impacts to marine life from water with TDS elevated above ambient seawater. Note, the Atlantic Ocean is relatively shallow (about 25 feet deep) for approximately 70 miles offshore, which may limit the rate of dispersion and mixing of concentrate. The region is also a recognized right whale calving area.

Community Acceptance:

The community acceptance performance measure is qualitative in nature with the scoring based on the best judgement of JEA staff and the consultant team rather than quantitatively through project modeling. The overall score was split into two separate components: community perceived benefits and community concerns. Ocean desalination received the following scores for each element, which were then averaged into an overall community acceptance score.

Scoring Criteria	1=low degree of perceived benefits by community 5=high degree of perceived benefits by community		1=significant community concerns to be addressed 5=full community support expected		Average Score for Community Acceptance
Supply Options	**Community Perceived Benefits**	**Notes**	**Community Concerns**	**Notes**	
Desalination: Ocean	2	This option provides a new source of potable water. However, the option does not provide for the environmental benefits of reduced groundwater usage, reduced discharges to the river, or utilization of current JEA groundwater infrastructure.	1	Incorporation of this supply will require stabilization and adjustment to achieve a similar quality water. Potential difference in taste could present a community concern. More intrusive facilities such as intakes and outfalls, high cost, as well as significant energy use could also present community concerns. In addition, ocean desal typically has high visibility along prime beach development and recreation areas.	1.5

Ocean Desalination

Category: Desalination

Water Quality:

The required desalination and treatment facilities would produce water of potable quality. Boron removal during RO treatment would be an important consideration. Bromide can form trihalomethane disinfection byproducts not removable by air stripping. Seawater can also be vulnerable to algal blooms and cyanotoxins; however, RO is capable of removing these and other contaminants of emerging concern.

Yield:

While the option is costed at 10 MGD for easier comparison to other desalination option, it can be sized up or down within the model based on the mix of other supply options being analyzed.

Cost:

The table below provides estimated capital and O&M costs. All costs are presented in 2019 dollars, with costs from historical documents being updated to 2019 dollars. Variable O&M costs are dependent on the utilization of the facility and include items such as electricity and process chemicals. Fixed O&M costs represent costs incurred each year.

Option	Capital Costs ($M)_	Annual O&M Costs at Full Capacity ($M)	O&M Fixed Costs per Year ($M)	O&M Variable Costs per MG
Desalination: Ocean	$329.2	$10.6	$4.6	$1,624

Modeling Assumptions:

Within the IWRP model, turning on this option has the following impacts:

- The selected yield of the ocean desalination facility is available to meet demand in the South East subgrid. It is prioritized to serve demand after accounting for any traditional reclaimed water usage as well as other future water supplies which might also be selected (i.e., direct potable reuse, indirect potable reuse, and brackish groundwater). However, the desalinated water serves demand within the model prior to the use of the current consumptive use permit for fresh groundwater supplies.
- Costs for implementing this option are scaled based on the selected yield. A curve for scaling costs is utilized within the model so that the costs are not just a direct ratio of the yield as compared to the developed cost for the 10-MGD facility.

References:

WateReuse Association (2012). “Seawater Desalination Costs.” White Paper. https://watereuse.org/wp-content/uploads/2015/10/WateReuse_Desal_Cost_White_Paper.pdf

Wetterau, G. et al (2011). “Desalination of Seawater.” AWWA Manual M61. 1st Edition.

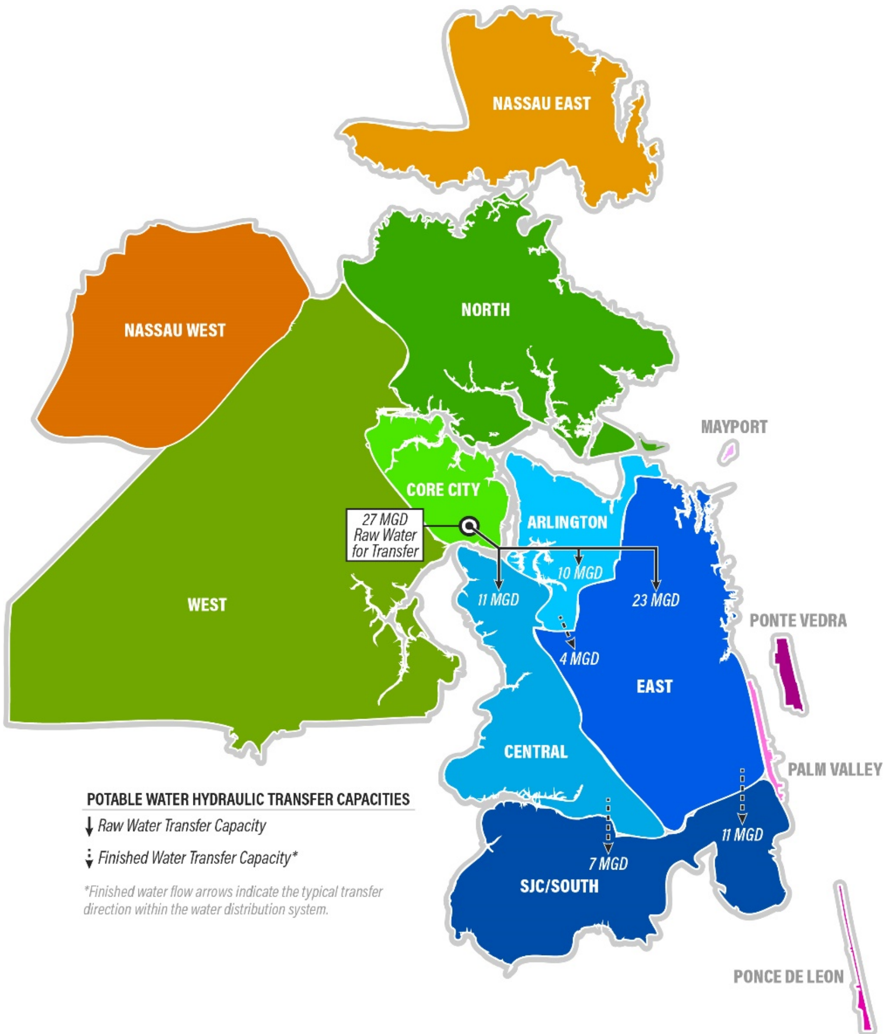
Subgrid Conveyance

Category: Conveyance

Brief Description:

JEA's water system is divided into six distinct service grids with the largest two being the North Grid and the South Grid. Within the IWRP, these major grids were further divided into subgrids based on hydraulic limitations within the distribution systems. JEA does have the capacity to transfer raw water between the North Grid and the South Grid via two transmission mains that cross the St. Johns River. Finished water within the South Grid can also be pumped to neighboring subgrids for distribution. The figure shows the capacity for existing water transfers between subgrids assumed in the IWRP analysis. This supply option looks at additional opportunities for conveying water between subgrids to balance the available supply in one subgrid with unmet demands in another subgrid. The additional conveyance lines considered include:

- Within the North Grid, between the Core City subgrid and the West subgrid (Fairfax WTP to Marietta WTP)
- Within the North Grid, between the Core City subgrid and the North subgrid (Norwood WTP to Highlands WTP)
- Within the North Grid, between the West subgrid and the Nassau West subgrid (Westlake WTP to future growth area)
- Within the South Grid, between the East subgrid and the Central subgrid (Deerwood III WTP to Brierwood WTP)
- A new river crossing from the North Grid's West subgrid to the South Grid's Central subgrid (Southwest WTP to Brierwood WTP)



Facilities Required:

Facilities required for additional conveyance include:

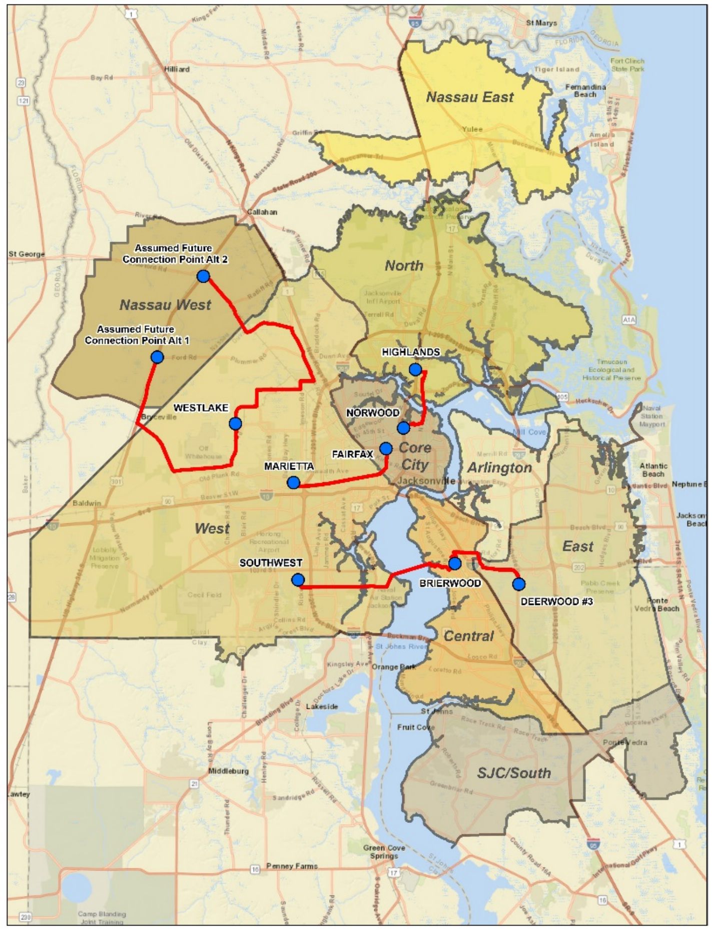
- Pipeline transmission costs including the pipe, casings, appurtenances, and easements
- Transfer pump station

Subgrid Conveyance

Category: Conveyance

Key Assumptions:

While there is an allowance in JEA's current consumptive use permit for groundwater withdrawals to exceed an individual wellfield allocation within a given permit year, this option assumes that a sustained water supply strategy of reducing the withdrawal at one wellfield to then increase production at another wellfield would not be allowable. Thus, this option assumes a new transmission line of finished water from one water treatment plant (WTP) to another. Current utility corridors were followed in determining a potential route between the plants (as shown on the figure). Since there is no current water infrastructure in Nassau West, two potential routes from the Westlake WTP to major intersections within the future service area were calculated and averaged to determine the assumed route length. High service pump capacity to pump the transferred water into the destination service grid was checked at each of the destination facilities.



Environmental Impacts (Promote Environmental Sustainability):

This option makes the most efficient use of the available groundwater supply by providing the flexibility to utilize the water where it is most needed.

Community Acceptance:

The community acceptance performance measure is qualitative in nature with the scoring based on the best judgement of JEA staff and the consultant team rather than quantitatively through project modeling. The overall score was split into two separate components: community perceived benefits and community concerns. Additional conveyance of current groundwater supplies received the following scores for each element, which were then averaged into an overall community acceptance score.

Subgrid Conveyance

Category: Conveyance

Scoring Criteria	1=low degree of perceived benefits by community 5=high degree of perceived benefits by community		1=significant community concerns to be addressed 5=full community support expected		Average Score for Community Acceptance
Supply Options	**Community Perceived Benefits**	**Notes**	**Community Concerns**	**Notes**	
Conveyance	3	The community is comfortable with the use of groundwater and this option builds upon JEA's current groundwater infrastructure through additional conveyance to make use of groundwater supplies where they are needed. However, the option does not reduce discharges to the river or lessen the community's reliance on groundwater.	4	High level of support with some community concerns of over-pumping the aquifer.	3.5

Water Quality:

There should be minimal water quality concerns as this option utilizes the current water supply. This option could increase the average water age in the distribution system, creating challenges with chlorine residual maintenance and disinfection byproduct formation. Booster chlorination stations would be one potential strategy to maintain chlorine residual if required. In tank air-stripping could be used to remove chloroform disinfection byproducts in ground storage tank systems in booster pump stations. However, with the assumption that the water is moving and not sitting in the pipelines, the new lines would only add around an additional day of water age, so the need for additional facilities is not expected.

Yield:

Each of the transmission lines for this option were sized for 2 MGD of supply as an initial yield for analysis except for the river crossing, which is sized for up to 32 MGD but with 10 MGD as a typical expected flow. The 2 MGD is adequate supply to meet demands in Nassau West as well as cover average weather deficits in South Grid Central. Moving additional water between the North Grid subgrids is something that could be explored.

Subgrid Conveyance

Category: Conveyance

Cost:

The table below provides estimated capital and O&M costs. Variable O&M costs are dependent on the utilization of the facility and include items such as electricity and process chemicals. Fixed O&M costs represent costs incurred each year.

Option	Capital Costs ($M)	Annual O&M Costs at Full Capacity ($M)	O&M Fixed Costs per Year ($M)	O&M Variable Costs per MG
North Grid between the Core City and West subgrids	$20.0	$0.37	$0.35	$34
North Grid between the Core City and North subgrids	$17.0	$0.32	$0.30	$40
South Grid between the East and Central subgrids	$16.7	$0.31	$0.29	$38
West subgrid in the North Grid to the Nassau West subgrid	$24.0	$0.42	$0.40	$27
Third River Crossing (North Grid West subgrid to the South Grid Central subgrid)	$147	$3.6	$3.42	$50

Model Assumptions:

Within the IWRP model, any combination of the subgrid conveyance options can be selected. When selected, the following logic is utilized in determining the supply allocation:

- Available groundwater supply from the current consumptive use permit is first utilized to meet demand within the local subgrid.
- If additional permitted withdrawals are available after meeting the local supply, they are assumed to be transferred to the receiving subgrid up to the maximum capacity of the selected line.

References:

CDM (2007) "Water Supply Cost Estimation Study" South Florida Water Management District. February 2007.

JEA (2018) "Annual Water Resource Master Plan" JEA Water/Wastewater System Planning. September 2018.

JEA (2020) "Water Main – Southern (3rd) River Crossing; Preliminary Route Analysis and Preliminary Budget". Updated July 20, 2020.

Appendix C

System Model Inputs

CDM Smith

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System Model Inputs

The following table lists the inputs for the JEA IWRP System Model organized by sector.

Table C-1. IWRP System Model Inputs

Sector	Sector Description	Model Input Available for Modification
Demands	This sector contains the input for determining the total demands to be met within the model. Indoor demands, outdoor demands and a percentage for non-revenue water are all input separately for average weather. Adjustments can then be made for dry weather or wet weather as well as seasonal peaking.	Average Weather ON Dry Weather ON Wet Weather ON Dry Weather Outdoor % Change Wet Weather Outdoor % Change Transfer SJC to SJCUD Potable (per Calendar Year) Transfer SJC to SJCUD Reclaimed (per Calendar Year) Indoor Demands (per Subgrid and Calendar Year) Outdoor Demands (per Subgrid and Calendar Year) Outdoor Peaking (per Month) Annual Average ON NRW %
Wastewater Flows	This sector contains input for tracking wastewater flow projections.	WW Flow Projections (per WRF and Calendar Year) WWTP Permitted Capacity (per WRF and Calendar Year)
DSM Strategy	This sector contains the input for demand side management options. Expected savings are entered for indoor and outdoor demands and then divided amongst the subgrids.	No Conservation ON DSM Baseline Strategy ON DSM Expanded Strategy ON DSM Baseline Strategy Indoor Total (per Calendar Year) DSM Baseline Strategy Outdoor Total (per Calendar Year) DSM Expanded Strategy Indoor Total (per Calendar Year) DSM Expanded Strategy Outdoor Total (per Calendar Year) Subarea DSM Saving Split
Reclaimed Water System	This sector contains inputs for determining the demands and capacities for the reclaimed water system.	Expanded Reclaimed ON (per Subgrid) Reclaim Dry Weather Factor Additional RW Demand Factor Reclaimed Production Capacity (per WRF and Calendar Year) Committed Baseline Reclaimed (per Subgrid and Calendar Year) Expanded Reclaimed Potential (per Subgrid and Calendar Year) North Grid Reclaimed Seasonal Pattern South Grid Reclaimed Seasonal Pattern Nassau Reclaimed Seasonal Pattern Ponte Vedra Reclaimed Seasonal Pattern Ponce de Leon Reclaimed Seasonal Pattern RW to WW Ratio (per WRF) On-Site Reclaim (per WRF) Bulk Reclaimed Use (per Subgrid and Calendar Year) Mandarin Off Site Pumping Restriction Hyd Constraint Central to SJC Reclaimed Hyd Constraint Arlington to East Reclaimed Hyd Constraint East to SJC Reclaimed Base (per Calendar Year) Hyd Constraint East to SJC Reclaimed Expand (per Calendar Year)

Table C-1. IWRP System Model Inputs

Sector	Sector Description	Model Input Available for Modification
CUP Allocation and Transfers	This sector contains inputs for allowable groundwater withdrawals under the CUP as well as transfers between subgrids.	SubGrid Baseline CUP Allocation (per Subgrid) RiverTown WTP CUP Allocation RiverTown WTP Active Year CUP Sensitivity ON CUP Sensitivity % FDEP Permitted Capacity North to South Transfer Raw Water Capacity North to South Transfer Hydraulic Capacity McDuff Transfer Capacity Max North Grid to S Central Transfer Max North Grid to S East Transfer Max East to SJC Transfer Max Central to SJC Transfer Max Arlington to East Finished Water Core City to N West Transfer ON Core City to N West Transfer Capacity MGD Core City to N West Transfer Start Year Core City to N North Transfer ON Core City to N North Transfer Capacity MGD Core City to N North Transfer Start Year N West to Nassau West Transfer ON N West to Nassau West Transfer Capacity MGD N West to Nassau West Transfer Start Year S East to S Central Transfer ON S East to S Central Transfer Capacity MGD S East to S Central Transfer Start Year
Desal Options	This sector includes inputs for the various desalination supply options.	Brackish Groundwater ON (per Subgrid) Brackish Groundwater Capacity MGD (per Subgrid and Calendar Year) Brackish GW Recovery Ratio Intracoastal Desal ON Intracoastal Desal for Nassau East MGD Intracoastal Desal for Nassau East Start Year Intracoastal Desal Phase 2 MGD Intracoastal Desal Phase 2 Start Year Intracoastal Desal Recovery Ratio Ocean Desal to S East ON Ocean Desal S East Capacity MGD Ocean Desal Start Year Ocean Desal Recovery Ratio Lower St Johns River ON Lower St Johns River Capacity MGD Lower St Johns River Start Year Lower St Johns River Phase 2 Capacity MGD Lower St Johns River Phase 2 Start Year Lower St Johns to S Arlington ON Lower St Johns River for S Arlington Capacity MGD Lower St Johns River for S Arlington Start Year Lower St Johns Recovery Ratio

Table C-1. IWRP System Model Inputs

Sector	Sector Description	Model Input Available for Modification
		Upper St Johns River for SJC ON Upper St Johns River for SJC Capacity MGD Upper St Johns River for SJC Start Year Upper St Johns River for N West ON Upper St Johns River for N West Capacity MGD Upper St Johns River for N West Start Year Upper St Johns Recovery Ratio
Stormwater Options	This sector includes inputs for the stormwater supply option.	Stormwater ON Stormwater Capacity MGD Stormwater Start Year
DPR Options	This sector includes inputs for the direct potable reuse supply option.	DPR Blend % DPR Recovery % Cedar Bay DPR ON Cedar Bay DPR Capacity MGD Cedar Bay DPR Start Year Southwest DPR ON Southwest DPR Capacity MGD Southwest DPR Start Year Buckman DPR ON Buckman DPR Capacity MGD Buckman DPR Start Year Buckman DPR to North West ON Buckman to N West Timing (per Calendar Year) Nassau DPR ON Nassau DPR Capacity MGD Nassau DPR Start Year Arlington East DPR ON Arlington East DPR Capacity MGD Arlington East DPR Start Year Mandarin DPR ON Mandarin DPR Capacity MGD Mandarin DPR Start Year
IPR Options	This sector includes inputs for the indirect potable reuse supply option.	IPR Recovery % In Grid IPR Recovery % Other Grid IPR Recovery % Cedar Bay IPR ON Cedar Bay IPR Capacity MGD Cedar Bay IPR Start Year Use Cedar Bay Graph Input Cedar Bay IPR Capacity Graph (per Calendar Year) Southwest IPR ON Southwest IPR Capacity MGD Southwest IPR Start Year Use Southwest Graph Input Southwest IPR Capacity Graph (per Calendar Year) Buckman IPR ON Buckman IPR Capacity MGD Buckman IPR Start Year Nassau IPR ON

Table C-1. IWRP System Model Inputs

Sector	Sector Description	Model Input Available for Modification
		Nassau IPR Capacity MGD Nassau IPR Start Year Arlington East IPR ON Arlington East IPR Capacity MGD Arlington East IPR Start Year Use AE IPR Graph Input AE IPR Capacity Graph (per Calendar Year) Mandarin IPR ON Mandarin IPR Capacity MGD Mandarin IPR Start Year
Cost	This sector includes inputs to calculate the cost-based performance metrics.	Discount Rate Finance Rate Escalation Rate Percent of Capital Financed Finance Life Capital Total Total CUP $M O&M Fixed Total CUP $M per Year O&M Total CUP $ per MG Capital Total WW Existing $M O&M Fixed WW Existing $M per Year O&M WW Existing $ per MG O&M Fixed Committed Reclaimed South Grid $M per Year O&M Var Committed Reclaimed South Grid $ per MG Brackish GW Capital Cost Curve $M Brackish GW O&M Fixed Cost Curve $M Brackish GW O&M Var Cost Curve $ per MG Intracoastal Capital 10 MGD $M Intracoastal O&M 10 MGD $M O&M Var Intracoastal Desal $ per MG Ocean Capital 10 MGD $M Ocean O&M 10 MGD $M O&M Var Ocean Desal $ per MG Lower SJC Capital 10 MGD $M Lower SJR O&M 10 MGD $M Lower SJR River Crossing Capital $M Lower SJR River Crossing O&M Fixed $M O&M Var Lower SJR Desal $ per MG Upper SJR Capital 10 MGD $M Upper SJR O&M 10 MGD $M O&M Var Upper SJR Desal $ per MG Capital Total DPR Cedar Bay $M O&M Fixed DPR Cedar Bay $M per Year O&M Var DPR Cedar Bay $ per MG Capital Total DPR Southwest $M O&M Fixed DPR Southwest $M per Year O&M Var DPR Southwest $ per MG Capital Total DPR Buckman $M O&M Fixed DPR Buckman $M per Year O&M Var DPR Buckman $ per MG

Table C-1. IWRP System Model Inputs

Sector	Sector Description	Model Input Available for Modification
		Capital Total DPR Nassau $M O&M Fixed DPR Nassau $M per Year O&M Var DPR Nassau $ per MG Capital Total DPR Arlington East $M O&M Fixed DPR Arlington East $M per Year O&M Var DPR Arlington East $ per MG Capital Total DPR Mandarin $M O&M Fixed DPR Mandarin $M per Year O&M Var DPR Mandarin $ per MG Capital Total IPR Cedar Bay $M O&M Fixed IPR Cedar Bay $M per Year O&M Var IPR Cedar Bay $ per MG Capital Total IPR Southwest $M O&M Fixed IPR Southwest $M per Year O&M Var IPR Southwest $ per MG Capital Total IPR Buckman $M O&M Fixed IPR Buckman $M per Year O&M Var IPR Buckman $ per MG Capital Total IPR Nassau $M O&M Fixed IPR Nassau $M per Year O&M Var IPR Nassau $ per MG Capital Total IPR Arlington East $M O&M Fixed IPR Arlington East $M per Year O&M Var IPR Arlington East $ per MG Capital Total IPR Mandarin $M O&M Fixed IPR Mandarin $M per Year O&M Var IPR Mandarin $ per MG Capital Total Expanded Reclaimed South Grid $M O&M Fixed Expanded Reclaimed South Grid $M per Year O&M Var Expanded Reclaimed South Grid $ per MG Capital Total Expanded Reclaimed N North $M O&M Fixed Expanded Reclaimed N North $M per Year O&M Var Expanded Reclaimed N North $ per MG Capital Total Expanded Reclaimed N West $M O&M Fixed Expanded Reclaimed N West $M per Year O&M Var Expanded Reclaimed N West $ per MG Capital Total Expanded Reclaimed Nassau East $M O&M Fixed Expanded Reclaimed Nassau East $M per Year O&M Var Expanded Reclaimed Nassau East $ per MG Capital Total Expanded Reclaimed Nassau West $M O&M Fixed Expanded Reclaimed Nassau West $M per Year O&M Var Expanded Reclaimed Nassau West $ per MG Capital Total Stormwater $M O&M Fixed Stormwater $M per Year O&M Var Stormwater $ per MG Capital Total Conveyance Core City to N West $M O&M Fixed Conveyance Core City to N West $M per Year O&M Var Conveyance Core City to N West $ per MG Capital Total Conveyance Core City to N North $M

Table C-1. IWRP System Model Inputs

Sector	Sector Description	Model Input Available for Modification
		O&M Fixed Conveyance Core City to N North $M per Year
		O&M Var Conveyance Core City to N North $ per MG
		Capital Total Conveyance N West to Nassau West $M
		O&M Fixed Conveyance N West to Nassau West $M per Year
		O&M Var Conveyance N West to Nassau West $ per MG
		Capital Total Conveyance S East to S Central $M
		O&M Fixed Conveyance S East to S Central $M per Year
		O&M Var Conveyance S East to S Central $ per MG
		DSM Baseline Levelized Cost
		DSM Expanded Levelized Cost

Appendix D

Demand and Supply Tables

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Modeled Demands per Subgrid – Average Weather

Table D-1. Total Average Weather Demands with Recommended Reclaim

Calendar Year	Mayport	N Core City	N North	N West	Nassau E	Nassau W	Palm Valley	Ponce De Leon	Ponte Vedra	S Arlington	S Central	S East	S SJC	SJCUD Potable	SJCUD Reclaimed	Bulk Reclaimed	Total
2020	0.04	8.8	9.7	27.8	3.9	0.8	0.4	0.5	1.4	11.5	20.6	26.9	16.0	2	0	1.93	132.4
2025	0.04	9.4	11.8	30.0	4.8	0.9	0.5	0.5	1.5	11.8	21.1	28.4	19.0	2.2	0.3	1.93	144.3
2030	0.04	9.5	13.7	32.6	5.6	1.0	0.5	0.5	1.5	11.9	21.4	29.9	23.1	2.25	0.7	1.93	156.2
2035	0.05	9.6	15.3	35.3	6.2	1.1	0.5	0.5	1.5	11.9	21.4	31.2	25.1	2.25	1.1	1.93	164.9
2040	0.04	9.6	16.8	37.8	6.7	1.1	0.5	0.5	1.5	11.9	21.5	32.4	26.4	2.25	1.5	1.93	172.5
2050	0.04	10.4	19.4	42.6	7.6	1.2	0.5	0.5	1.5	11.9	21.5	34.8	29.1	2.25	1.5	1.93	186.8
2060	0.05	10.5	21.9	47.3	8.5	1.3	0.5	0.5	1.5	11.9	21.5	36.8	31.2	2.25	1.5	1.93	199.1
2070	0.05	10.5	23.9	52.2	9.4	1.5	0.5	0.5	1.4	11.9	21.4	37.9	33.2	2.25	1.5	1.93	210.1

Table D-2. Modeled Recommended Reclaimed Water Use Under Average Weather

Calendar Year	Mayport	N Core City	N North	N West	Nassau E	Nassau W	Palm Valley	Ponce De Leon	Ponte Vedra	S Arlington	S Central	S East	S SJC	SJCUD Reclaimed	Bulk Reclaimed	Total
2020	0	0	0	0	0	0	0	0	0	0	0.6	0.5	7.4	0	1.93	10.4
2025	0	0	0	0	0.5	0	0	0	0	0	0.6	1.1	9.9	0.3	1.93	14.3
2030	0	0	0	0	0.8	0	0	0	0	0	0.6	1.9	16.0	0.7	1.93	22.0
2035	0	0	0	0	1.1	0	0	0	0	0	0.6	2.7	17.6	1.1	1.93	25.1
2040	0	0	0	0	1.3	0	0	0	0	0	0.6	3.6	18.7	1.5	1.93	27.7
2050	0	0	0	0	1.6	0	0	0	0	0	0.6	5.3	20.9	1.5	1.93	31.9
2060	0	0	0	0	1.8	0	0	0	0	0	0.6	6.7	22.4	1.5	1.93	35.0
2070	0	0	0	0	2.1	0	0	0	0	0	0.6	7.6	23.1	1.5	1.93	36.7

Table D-3. Potable System Demands per Subgrid Under Average Weather with Recommended Reclaimed

Calendar Year	Mayport	N Core City	N North	N West	Nassau E	Nassau W	Palm Valley	Ponce De Leon	Ponte Vedra	S Arlington	S Central	S East	S SJC	SJCUD Potable	Total
2020	0.04	8.8	9.7	27.8	3.9	0.8	0.4	0.5	1.4	11.5	20.0	26.4	8.6	2	121.9
2025	0.04	9.4	11.8	30.0	4.3	0.9	0.5	0.5	1.5	11.8	20.5	27.3	9.1	2.2	129.9
2030	0.04	9.5	13.7	32.6	4.8	1.0	0.5	0.5	1.5	11.9	20.8	28.1	7.0	2.25	134.2
2035	0.05	9.6	15.3	35.3	5.1	1.1	0.5	0.5	1.5	11.9	20.8	28.4	7.4	2.25	139.8
2040	0.04	9.6	16.8	37.8	5.4	1.1	0.5	0.5	1.5	11.9	20.9	28.8	7.7	2.25	144.8
2050	0.04	10.4	19.4	42.6	6.0	1.2	0.5	0.5	1.5	11.9	20.9	29.5	8.2	2.25	155.0
2060	0.05	10.5	21.9	47.3	6.7	1.3	0.5	0.5	1.5	11.9	20.9	30.1	8.7	2.25	164.1
2070	0.05	10.5	23.9	52.2	7.3	1.5	0.5	0.5	1.4	11.9	20.8	30.3	10.2	2.25	173.3

Modeled Demands per Subgrid – Dry Weather

Table D-4. Total Dry Weather Demands with Recommended Reclaim

Calendar Year	Mayport	N Core City	N North	N West	Nassau E	Nassau W	Palm Valley	Ponce De Leon	Ponte Vedra	S Arlington	S Central	S East	S SJC	SJCUD Potable	SJCUD Reclaimed	Bulk Reclaimed	Total
2020	0.04	9.3	10.4	29.4	4.2	0.9	0.4	0.5	1.6	12.1	21.9	28.7	17.3	2	0	1.93	140.8
2025	0.04	9.9	12.7	31.8	5.1	1.0	0.5	0.6	1.6	12.5	22.5	30.4	20.5	2.2	0.3	1.93	153.4
2030	0.05	10.0	14.7	34.6	6.0	1.1	0.5	0.6	1.6	12.6	22.8	32.0	24.6	2.25	0.7	1.93	165.9
2035	0.05	10.1	16.5	37.4	6.6	1.1	0.5	0.6	1.6	12.6	22.8	33.3	26.7	2.25	1.1	1.93	175.2
2040	0.05	10.1	18.1	40.1	7.2	1.2	0.6	0.6	1.6	12.6	22.9	34.5	28.0	2.25	1.5	1.93	183.2
2050	0.05	11.0	20.9	45.2	8.1	1.3	0.6	0.6	1.6	12.6	22.9	37.1	30.9	2.25	1.5	1.93	198.4
2060	0.05	11.0	23.6	50.2	9.1	1.4	0.6	0.6	1.6	12.5	22.9	39.1	33.0	2.25	1.5	1.93	211.4
2070	0.05	11.1	25.7	55.4	10.0	1.6	0.6	0.6	1.6	12.5	22.8	40.3	35.2	2.25	1.5	1.93	223.1

Table D-5. Modeled Recommended Reclaimed Water Use Under Dry Weather

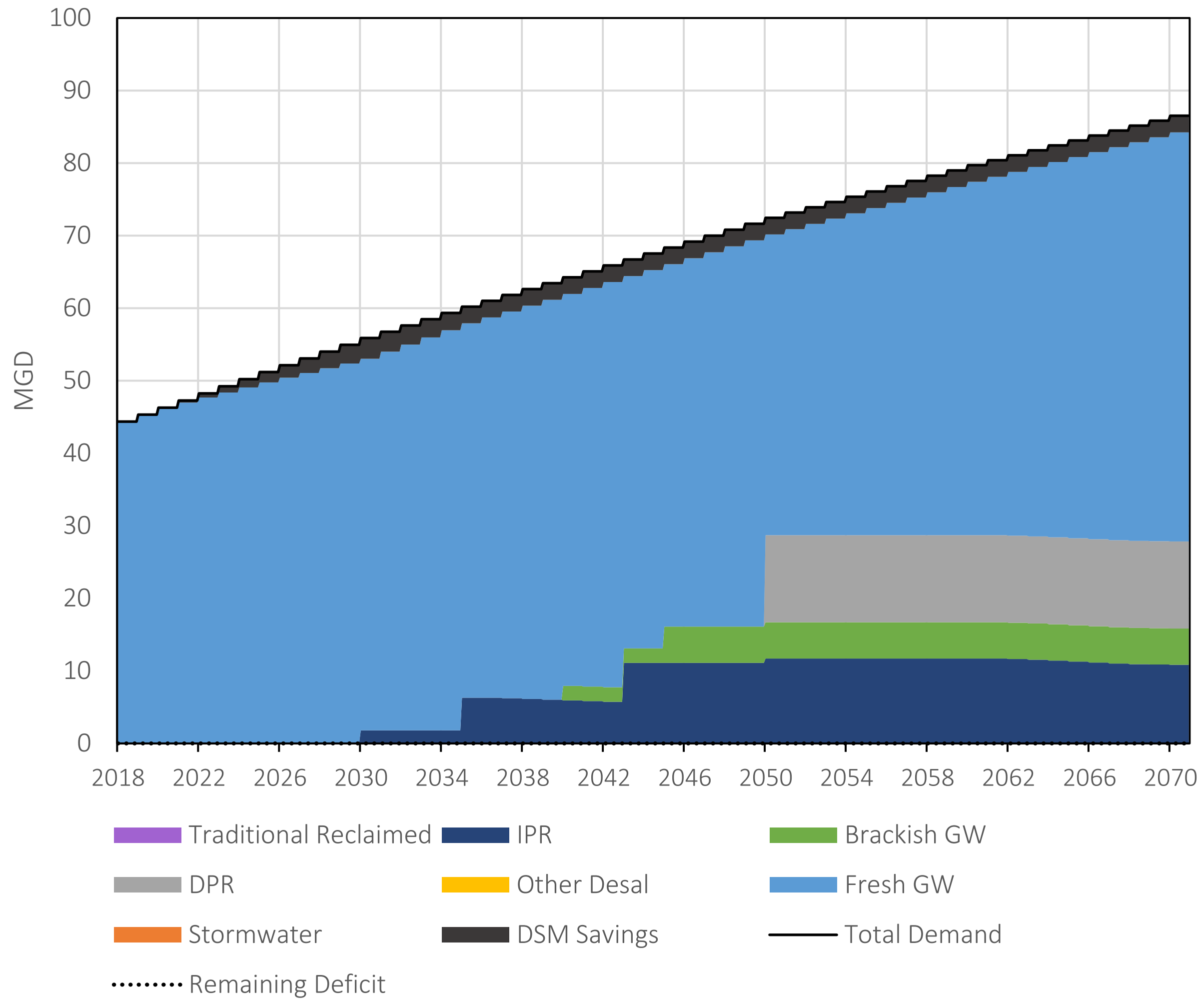
Calendar Year	Mayport	N Core City	N North	N West	Nassau E	Nassau W	Palm Valley	Ponce De Leon	Ponte Vedra	S Arlington	S Central	S East	S SJC	SJCUD Reclaimed	Bulk Reclaimed	Total
2020	0	0	0	0	0	0	0	0	0	0	0.6	0.5	7.4	0	1.93	10.4
2025	0	0	0	0	0.5	0	0	0	0	0	0.6	1.1	9.9	0.3	1.93	14.3
2030	0	0	0	0	0.8	0	0	0	0	0	0.6	1.9	16.0	0.7	1.93	22.0
2035	0	0	0	0	1.1	0	0	0	0	0	0.6	2.7	17.6	1.1	1.93	25.1
2040	0	0	0	0	1.3	0	0	0	0	0	0.6	3.6	18.7	1.5	1.93	27.7
2050	0	0	0	0	1.6	0	0	0	0	0	0.6	5.3	20.9	1.5	1.93	31.9
2060	0	0	0	0	1.8	0	0	0	0	0	0.6	6.7	22.6	1.5	1.93	35.2
2070	0	0	0	0	2.1	0	0	0	0	0	0.6	7.6	23.1	1.5	1.93	36.7

Table D-6. Potable System Demands per Subgrid Under Dry Weather with Recommended Reclaimed

Calendar Year	Mayport	N Core City	N North	N West	Nassau E	Nassau W	Palm Valley	Ponce De Leon	Ponte Vedra	S Arlington	S Central	S East	S SJC	SJCUD Potable	Total
2020	0.04	9.3	10.4	29.4	4.2	0.9	0.4	0.5	1.6	12.1	21.3	28.2	9.9	2	130.4
2025	0.04	9.9	12.7	31.8	4.6	1.0	0.5	0.6	1.6	12.5	21.9	29.2	10.6	2.2	139.0
2030	0.05	10.0	14.7	34.6	5.1	1.1	0.5	0.6	1.6	12.6	22.2	30.1	8.6	2.25	144.0
2035	0.05	10.1	16.5	37.4	5.5	1.1	0.5	0.6	1.6	12.6	22.2	30.5	9.0	2.25	150.0
2040	0.05	10.1	18.1	40.1	5.8	1.2	0.6	0.6	1.6	12.6	22.3	31.0	9.3	2.25	155.5
2050	0.05	11.0	20.9	45.2	6.5	1.3	0.6	0.6	1.6	12.6	22.3	31.8	10.0	2.25	166.6
2060	0.05	11.0	23.6	50.2	7.2	1.4	0.6	0.6	1.6	12.5	22.3	32.4	10.4	2.25	176.2
2070	0.05	11.1	25.7	55.4	7.9	1.6	0.6	0.6	1.6	12.5	22.2	32.8	12.1	2.25	186.4

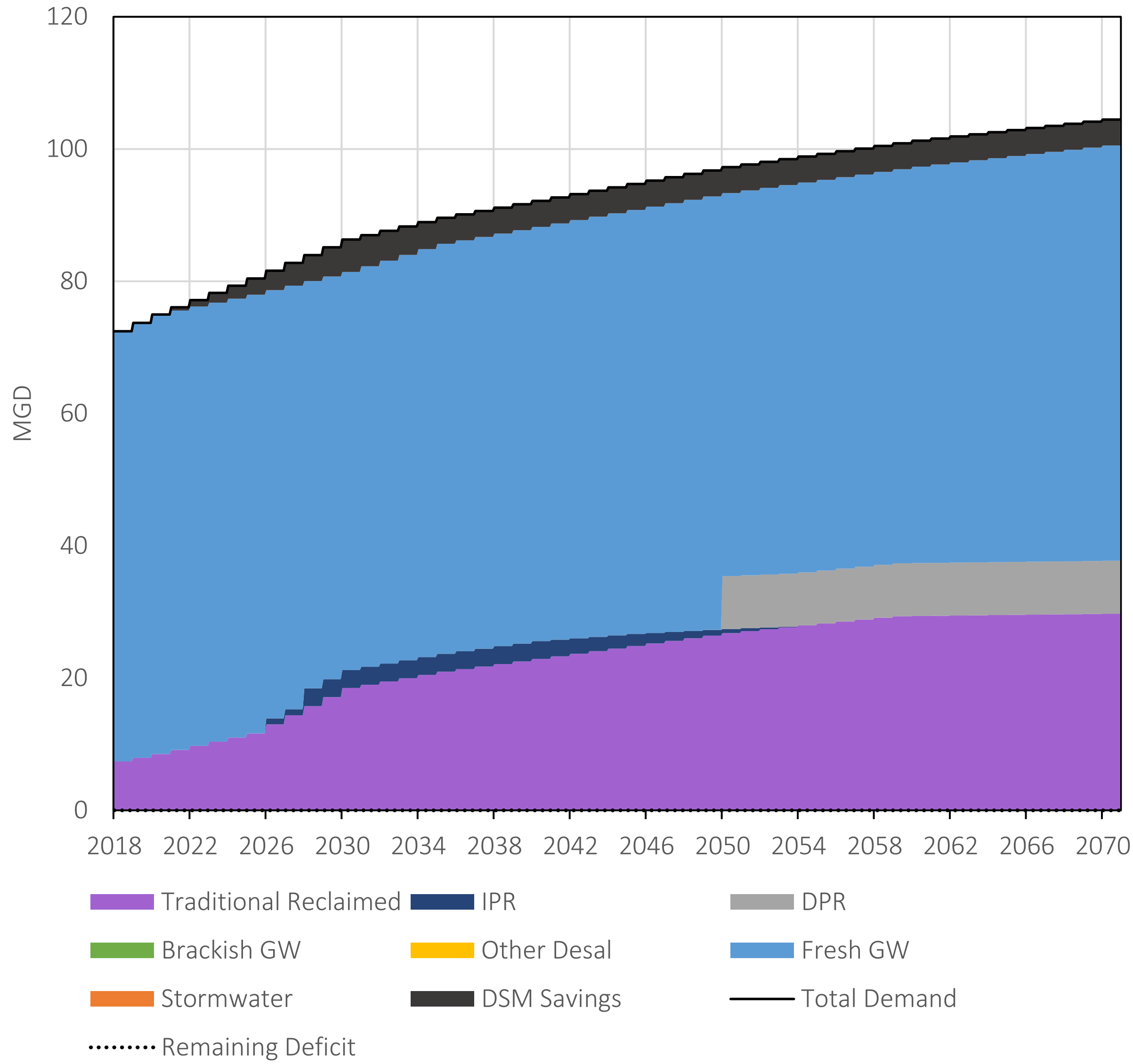
Recommended Supply Options per Grid – Average Weather; Annual Average

North Grid Total



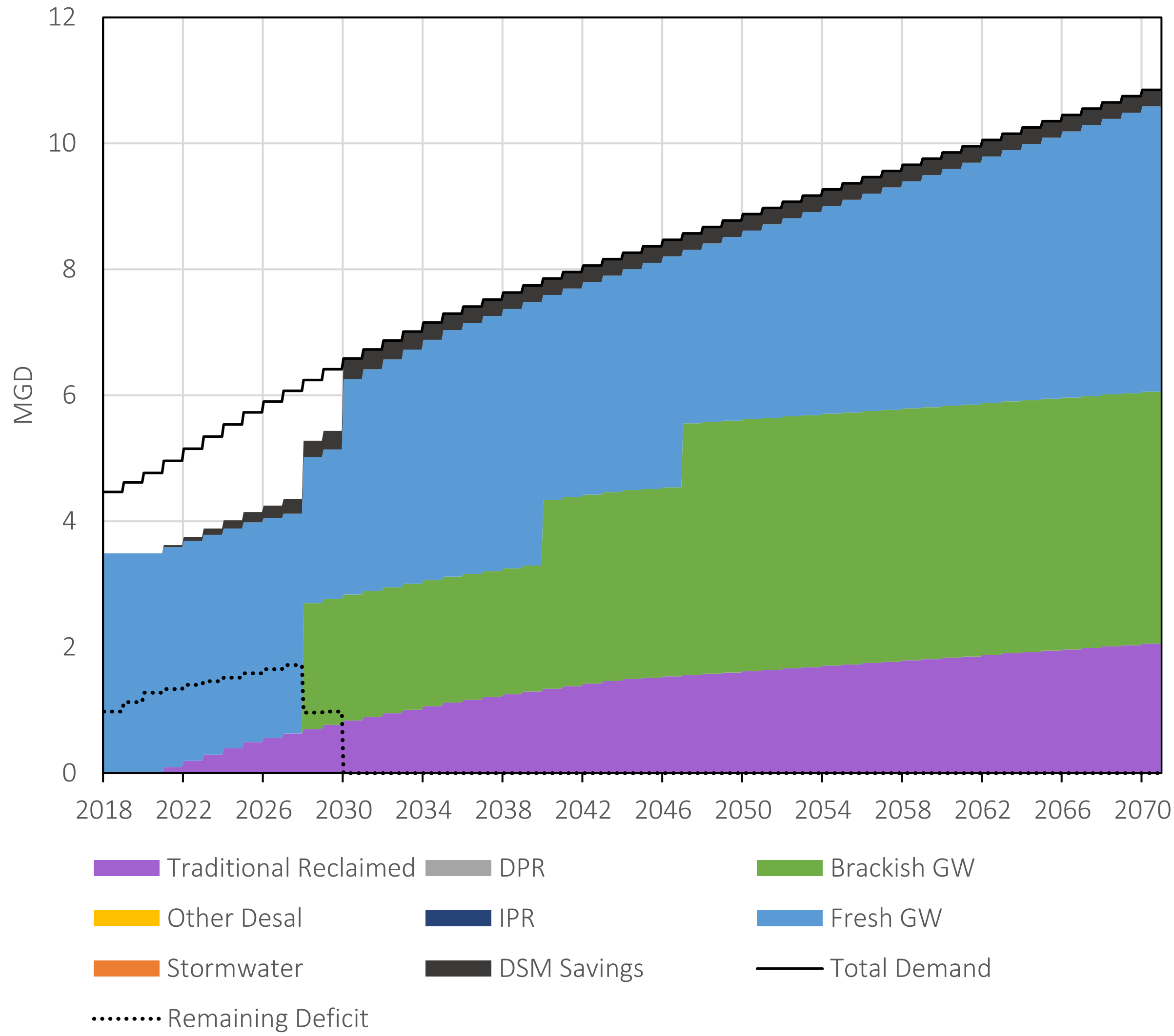
Year	North Grid Demand	DSM Savings	Reclaim	DPR	IPR	Brackish GW	Other Desal	Stormwater	Fresh GW (CUP)	Unserved Demand
2020	46.3	0	0	0	0	0	0	0	46.3	0
2025	51.2	1.4	0	0	0	0	0	0	49.8	0
2030	55.9	2.9	0	0	1.8	0	0	0	51.2	0
2035	60.2	2.3	0	0	6.3	0	0	0	51.6	0
2040	64.3	2.3	0	0	5.9	2	0	0	54.0	0
2050	72.5	2.3	0	12	11.7	5	0	0	41.5	0
2060	79.7	2.3	0	12	11.7	5	0	0	48.7	0
2070	86.5	2.3	0	12	10.8	5	0	0	56.4	0

South Grid Total



Year	South Grid Demand	DSM Savings	Reclaim	DPR	IPR	Brackish GW	Other Desal	Stormwater	Fresh GW (CUP)	Unserved Demand
2020	75.0	0	8.5	0	0	0	0	0	66.5	0
2025	80.4	2.5	11.6	0	0	0	0	0	66.3	0
2030	86.3	4.9	18.5	0	2.7	0	0	0	60.2	0
2035	89.6	3.9	21.0	0	2.7	0	0	0	62.0	0
2040	92.2	3.9	22.9	0	2.7	0	0	0	62.6	0
2050	97.3	3.9	26.8	8	0.6	0	0	0	57.9	0
2060	101.3	3.9	29.4	8	0	0	0	0	59.9	0
2070	104.5	3.9	29.7	8	0	0	0	0	62.8	0

Nassau Grid Total

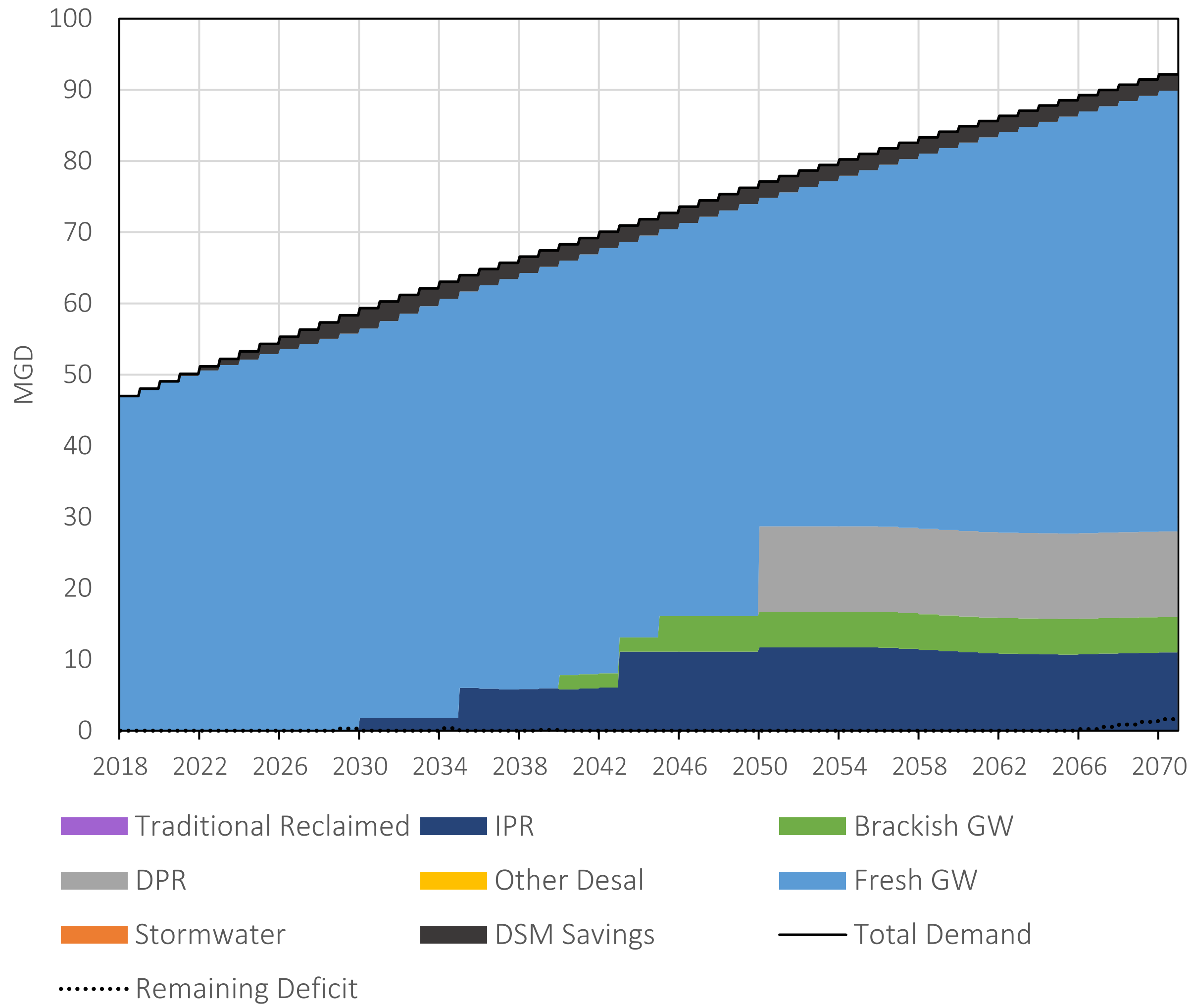


Year	Nassau Grid Demand	DSM Savings	Reclaim	DPR	IPR	Brackish GW	Other Desal	Stormwater	Fresh GW (CUP)	Unserved Demand
2020	4.8	0	0	0	0	0	0	0	3.5	1.3*
2025	5.7	0.2	0.5	0	0	0	0	0	3.5	1.6*
2030	6.6	0.3	0.8	0	0	2.0	0	0	3.4	0
2035	7.3	0.3	1.1	0	0	2.0	0	0	3.9	0
2040	7.9	0.3	1.3	0	0	3.0	0	0	3.3	0
2050	8.9	0.3	1.6	0	0	4.0	0	0	3.0	0
2060	9.9	0.3	1.8	0	0	4.0	0	0	3.8	0
2070	10.8	0.3	2.1	0	0	4.0	0	0	4.5	0

*Modeled demands assume immediate growth within expansion areas in Nassau. The exact timing of this new growth is unknown. Supply options were assumed to be incorporated in 2030 within the IWRP modeling but should correspond to development trends.

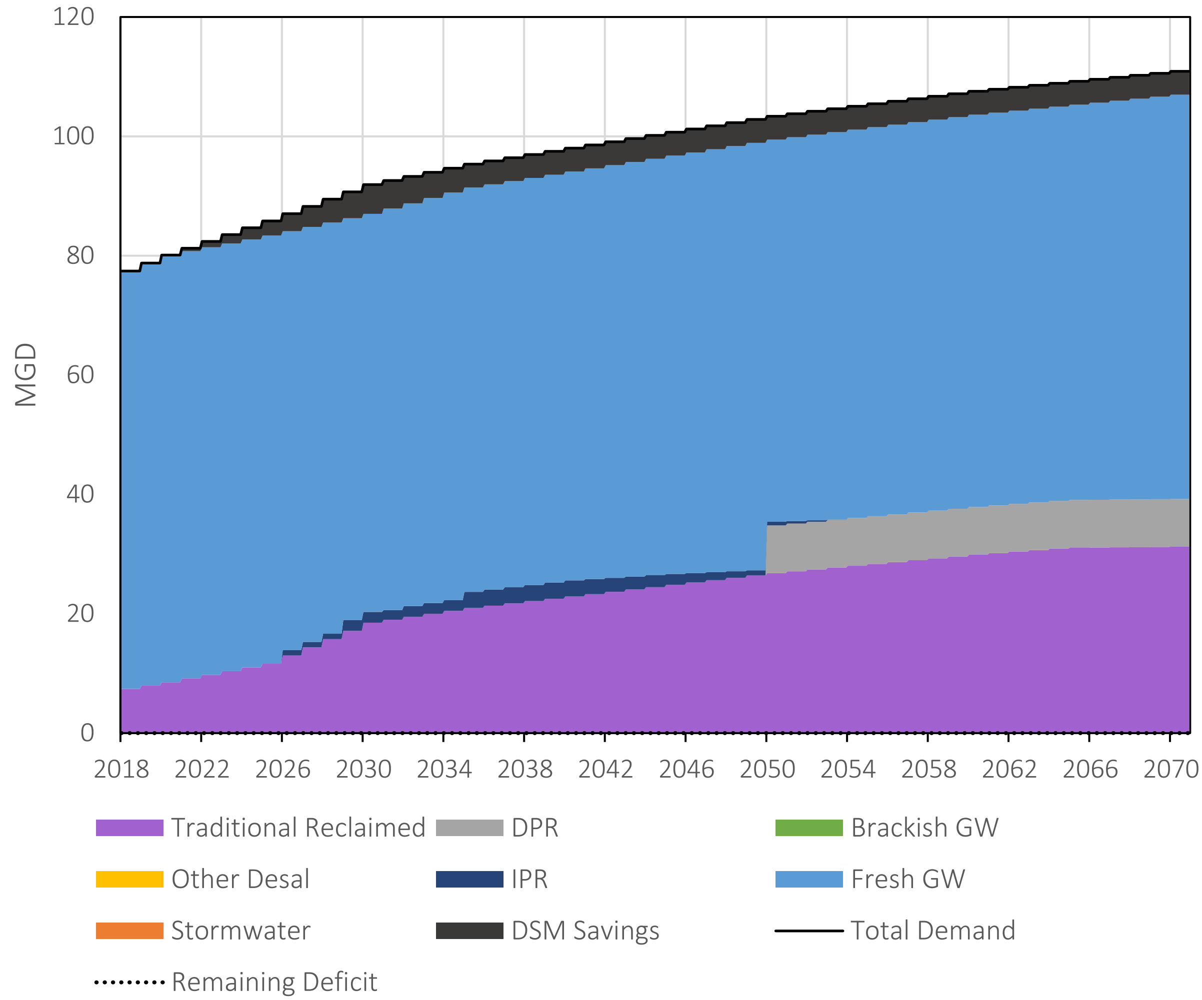
Recommended Supply Options per Grid – Dry Weather; Annual Average

North Grid Total



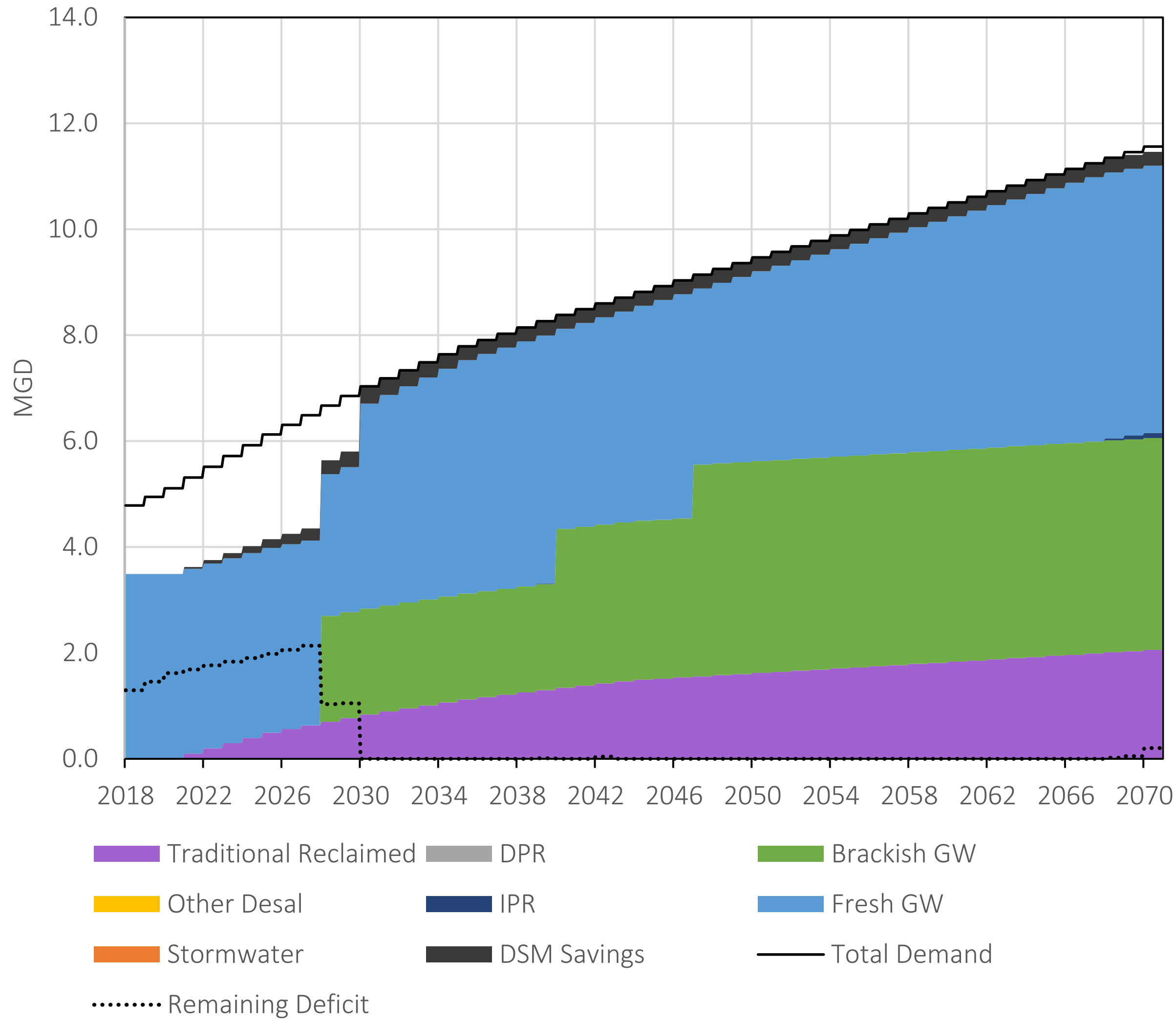
Year	North Grid Demand	DSM Savings	Reclaim	DPR	IPR	Brackish GW	Other Desal	Stormwater	Fresh GW (CUP)	Unserved Demand
2020	49.1	0	0	0	0	0	0	0	49.1	0
2025	54.3	1.4	0	0	0	0	0	0	52.9	0
2030	59.3	2.9	0	0	1.8	0	0	0	54.7	0
2035	64.0	2.3	0	0	6.0	0	0	0	55.7	0
2040	68.3	2.3	0	0	5.8	2	0	0	58.2	0
2050	77.1	2.3	0	12	11.7	5	0	0	46.1	0
2060	84.9	2.3	0	12	11.0	5	0	0	54.6	0
2070	92.2	2.3	0	12	11.0	5	0	0	60.3	1.62

South Grid Total



Year	South Grid Demand	DSM Savings	Reclaim	DPR	IPR	Brackish GW	Other Desal	Stormwater	Fresh GW (CUP)	Unserved Demand
2020	80.1	0	8.5	0	0	0	0	0	71.6	0
2025	85.8	2.5	11.6	0	0	0	0	0	71.7	0
2030	91.9	4.9	18.5	0	2.7	0	0	0	65.8	0
2035	95.3	3.9	21.0	0	2.7	0	0	0	67.8	0
2040	98.0	3.9	22.9	0	2.7	0	0	0	68.5	0
2050	103.4	3.9	26.8	8	0.6	0	0	0	64.0	0
2060	107.6	3.9	29.4	8	0	0	0	0	66.5	0
2070	110.9	3.9	29.7	8	0	0	0	0	69.2	0

Nassau Grid Total

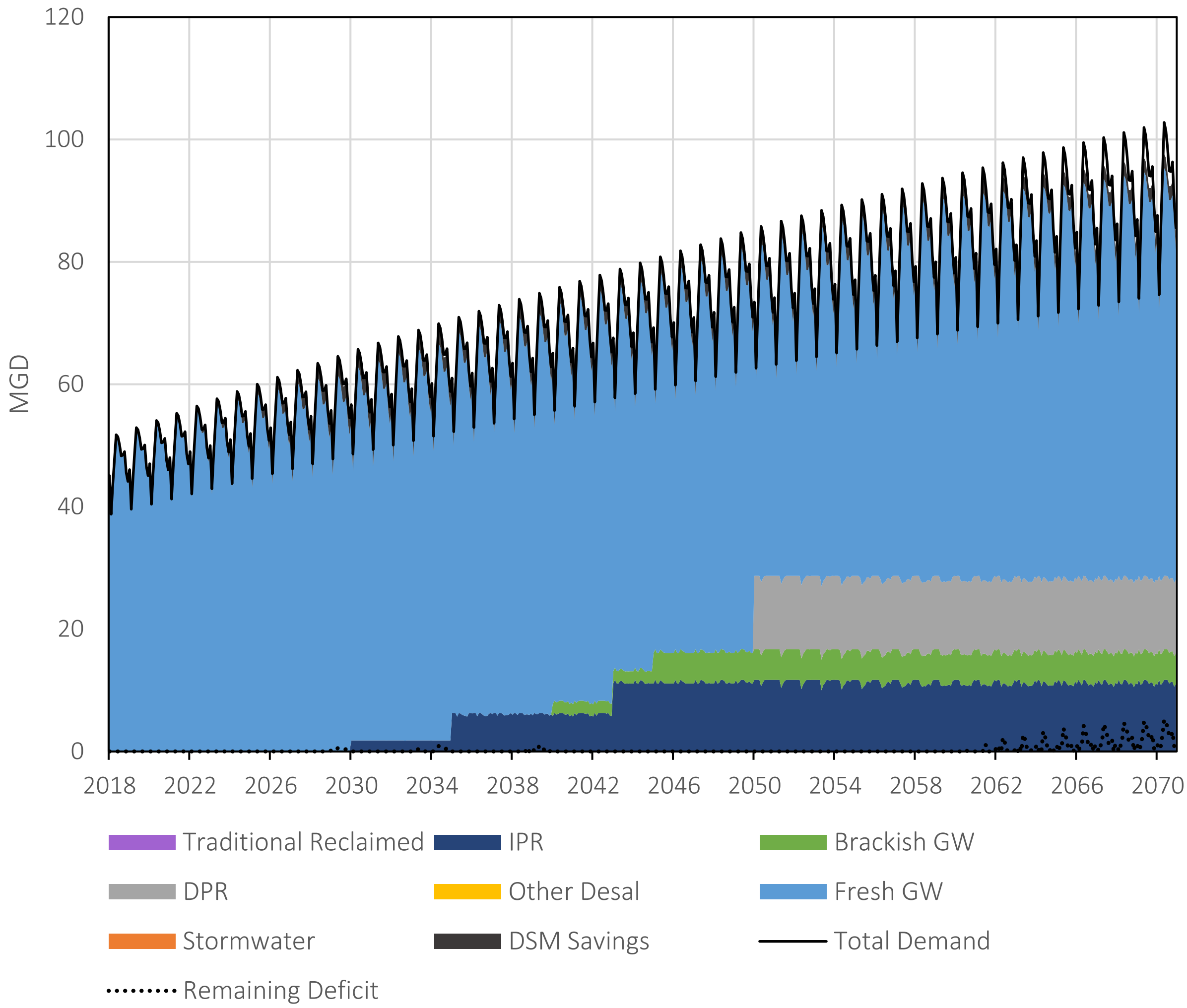


Year	Nassau Grid Demand	DSM Savings	Reclaim	DPR	IPR	Brackish GW	Other Desal	Stormwater	Fresh GW (CUP)	Unserved Demand
2020	5.1	0	0	0	0	0	0	0	3.5	1.6*
2025	6.1	0.2	0.5	0	0	0	0	0	3.5	2.0*
2030	7.0	0.3	0.8	0	0	2.0	0	0	3.9	0
2035	7.8	0.3	1.1	0	0	2.0	0	0	4.4	0
2040	8.4	0.3	1.3	0	0	3.0	0	0	3.8	0
2050	9.5	0.3	1.6	0	0	4.0	0	0	3.6	0
2060	10.5	0.3	1.8	0	0	4.0	0	0	4.4	0
2070	11.6	0.3	2.1	0	0.1	4.0	0	0	5.0	0.2

*Modeled demands assume immediate growth within expansion areas in Nassau. The exact timing of this new growth is unknown. Supply options were assumed to be incorporated in 2030 within the IWRP modeling but should correspond to development trends.

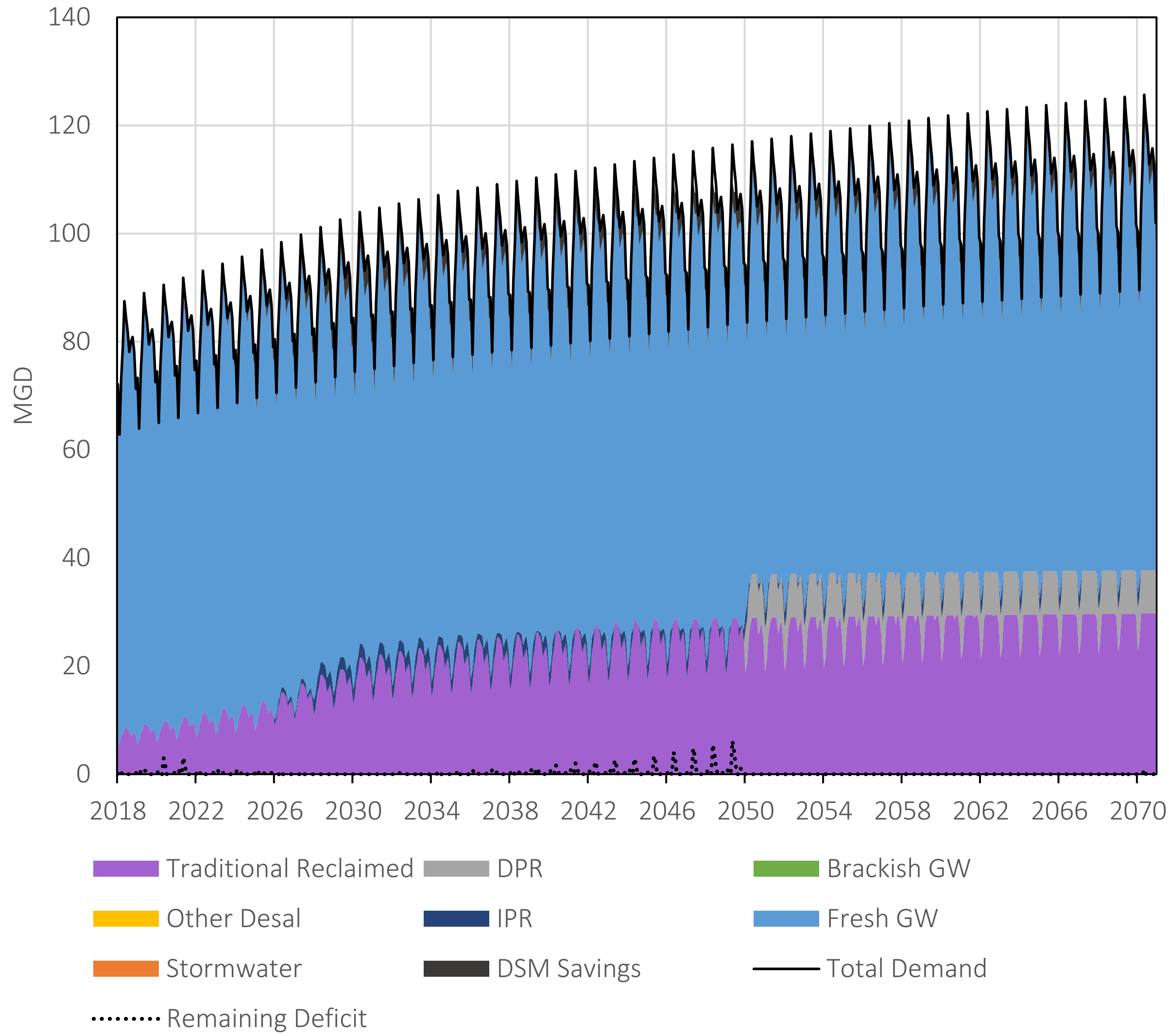
Recommended Supply Options per Grid – Dry Weather; Monthly Pattern

North Grid Total



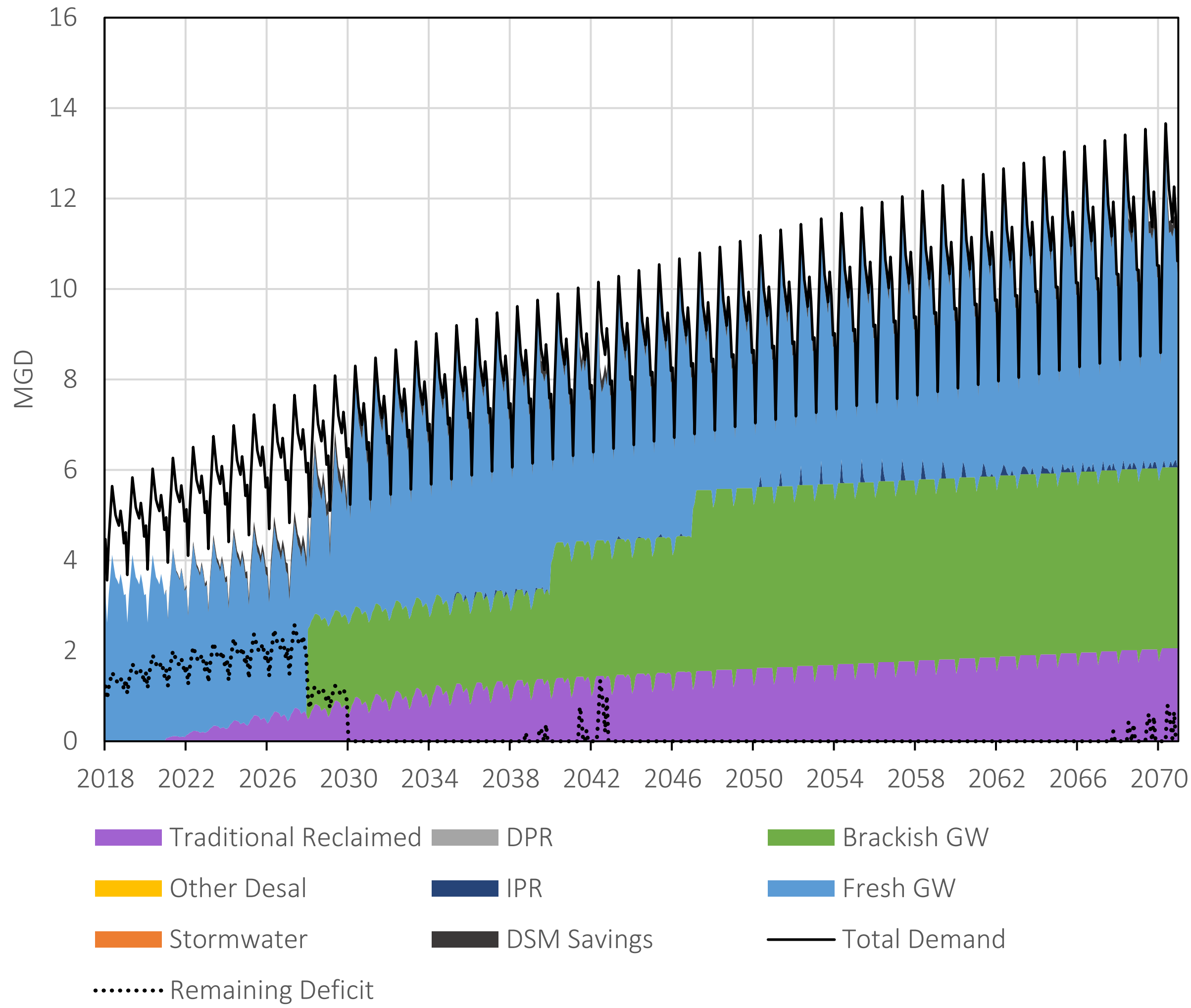
Year	North Grid Max Month Demand	DSM Savings	Reclaim	DPR	IPR	Brackish GW	Other Desal	Stormwater	Fresh GW (CUP)	Unserved Demand
2020	54.1	0	0	0	0	0	0	0	54.1	0
2025	60.0	1.4	0	0	0	0	0	0	58.6	0
2030	65.7	2.9	0	0	1.8	0	0	0	61.0	0
2035	71.0	2.3	0	0	6.3	0	0	0	62.4	0
2040	75.9	2.3	0	0	6	2.0	0	0	65.3	0
2050	85.8	2.3	0	12	11	5.0	0	0	55.8	0
2060	94.6	2.3	0	12	11	5.0	0	0	64.5	0
2070	102.8	2.3	0	12	12	5.0	0	0	64.7	5.2

South Grid Total



Year	South Grid Max Month Demand	DSM Savings	Reclaim	DPR	IPR	Brackish GW	Other Desal	Stormwater	Fresh GW (CUP)	Unserved Demand
2020	90.5	0	9.9	0	0	0	0	0	77.1	2.9
2025	97.0	2.5	13.5	0	0	0	0	0	80.0	0.5
2030	104.0	4.9	21.5	0	2.7	0	0	0	74.9	0
2035	107.9	3.9	24.3	0	1.4	0	0	0	77.5	0.7
2040	111.0	3.9	26.6	0	0	0	0	0	78.2	1.6
2050	117.1	3.9	29.0	8.0	0	0	0	0	76.2	0
2060	121.9	3.9	29.4	8.0	0	0	0	0	80.5	0
2070	125.7	3.9	29.7	8.0	0	0	0	0	83.1	0.9

Nassau Grid Total



Year	Nassau Grid Max Month Demand	DSM Savings	Reclaim	DPR	IPR	Brackish GW	Other Desal	Stormwater	Fresh GW (CUP)	Unserved Demand
2020	6.0	0	0	0	0	0	0	0	3.5	2.5*
2025	7.2	0.2	0.6	0	0	0	0	0	3.5	3.0*
2030	8.3	0.3	1.0	0	0	2.0	0	0	5.0	0
2035	9.2	0.3	1.3	0	0	2.0	0	0	5.6	0
2040	9.9	0.3	1.4	0	0	3.0	0	0	5.2	0
2050	11.2	0.3	1.6	0	0	4.0	0	0	5.1	0
2060	12.4	0.3	1.8	0	0	4.0	0	0	6.0	0
2070	13.7	0.3	2.1	0	0	4.0	0	0	7.3	0

*Modeled demands assume immediate growth within expansion areas in Nassau. The exact timing of this new growth is unknown. Supply options were assumed to be incorporated in 2030 within the IWRP modeling but should correspond to development trends.

Appendix E

Hydraulic Analysis Technical Memorandum

CDM Smith

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Memorandum

To: *Josh Brown*

From: *Stan Plante*

Date: *November 13, 2020*

Subject: *JEA IWRP*
Hydraulic Analysis – Draft

CDM Smith is tasked with developing an Integrated Water Resources Plan (IWRP) for JEA. The IWRP seeks to recommend an optimal path forward for using alternate supply sources for meeting JEA's long-term water needs. As part of the IWRP, a systems model was developed in STELLA (Systems Thinking, Experimental Learning Laboratory with Animation) to test the ability of project options to meet supply needs and other IWRP objectives. The systems model was used to screen combinations of options at a high level, using a monthly simulation time step. As a follow-on to the system model analysis, this technical memorandum is intended to provide additional insight into potential locations for future supply recommendations using a more granular water distribution model based on JEA's hydraulic models.

Model Description

JEA maintains hydraulic models based on the InfoWorks WS platform. Working models were provided to CDM Smith in Fall 2019 and these models formed the basis for the analyses described in this technical memorandum. Working models were provided for the North Grid and South Grid service areas.

The models as provided were based on year 2018 maximum day conditions, with each water treatment plant simplified to provide a maximum flow (based on a simulated flow control valve) at a constant hydraulic grade line.

The models as provided were updated as follows:

- Demands in the models were updated to projected 2040 average day, normal weather conditions by first cross-referencing long range demand projections developed by neighborhood, in support of the IWRP, to hydraulic model junctions, using spatial analysis. The sum of demands/demand type by neighborhood was then distributed to all junctions associated with each neighborhood.

- Two diurnal pattern schemes were evaluated – the original JEA patterns included within the provided models and modified patterns based on the 2040 land use customer types, as derived by CDM Smith from prior projects using automatic metering infrastructure (AMI) data – the CDM Smith patterns result in higher peaks and lower valleys. **Figure 1** shows the two composite patterns, with the JEA pattern repeated to match the CDM Smith week-long pattern. The CDM Smith patterns were applied to stress the transmission/distribution system a little more using the 2040 average demands.

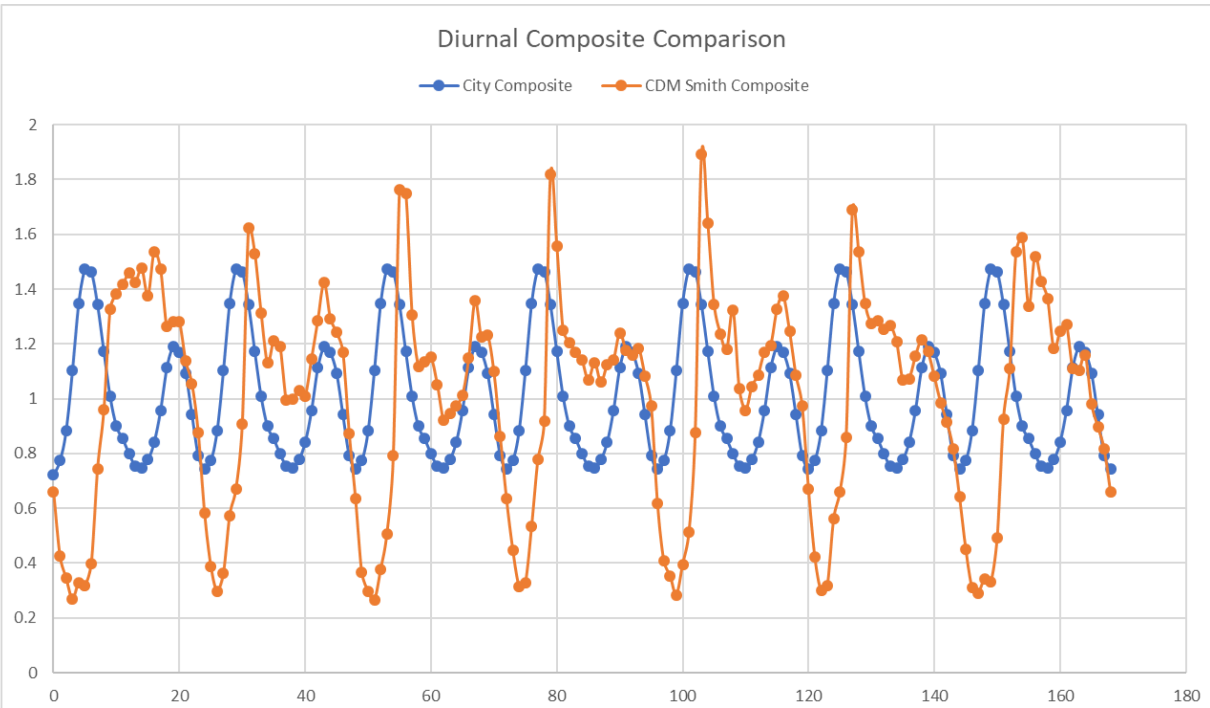

Figure 1: Composite Diurnal Curve Comparison

- The maximum flow was set to the firm pumping capacity for all plants, and the hydraulic grade line (HGL) or head was adjusted to approximate the available head at the firm pumping rate, based on a review of ground storage elevation ranges and pump curves in the model.

- The models were then applied over a 1-week period to identify areas of low pressure (indicating potential preferred locations for siting new supplies) and to review the relative contributions of each plant when competing against all other plants at firm capacity. The purpose of the analysis was to screen potential preferred locations for incorporating indirect potable reuse (IPR) or other new sources. It should be noted that because the total firm capacity is greater than the system-wide grid demands, plants in total will produce less than 100% of firm capacity, especially for average day conditions. The percentages are intended as a relative measure between plants.

- Last, specific plants in Subgrids identified for additional capacity in the IWRP were evaluated farther by increasing the production while maintaining the same HGL derived previously. This step evaluated the capability of individual plants to supply more water without major transmission system improvements and was used to indicate preferred plant sites for incorporating the additional supplies recommended in the IWRP.

North Grid Results

When the 2040 average day, normal weather demands were applied with the composite CDM Smith patterns, low pressure areas were primarily identified in the extreme north of the system, north of I-295. This area is, based on the current hydraulic model, supplied by only three pipes that cross the interstate. Low pressures are particularly noticeable during assumed irrigation periods (early AM), indicating that this should be considered a priority area for alternate irrigation supply delivery.

Table 1 shows the HGL and firm capacity used for each North Grid water treatment plant (WTP). The table also shows the percentage of firm capacity observed at each plant under average (entire simulation) and peak hour conditions.

Table 1: North Grid WTP Settings and Summary Results

WTP	Subgrid	HGL	Firm Pump Capacity (mgd)	% of Firm Capacity into System	
				Average	Peak Hour
Cecil Commerce Center	West	267.6	10.08	72	100
Fairfax	Core City	205.6	7.34	84	100
Highlands	North	194.6	25.20	45	100
Lakeshore	West	198.6	12.96	11	60
Marietta[1]	West	233.6	18.00	49	75
McDuff	West	197.6	17.14	16	60
Northwest[2]	North	194.6	9.79	55	100
Norwood	Core City	191.6	8.64	26	100
Southwest	West	250.6	23.43	54	81
Westlake	West	282.6	1.61	100	100

[1] Marietta model pumps were only indicated to be about 9 mgd firm capacity, but the 18-mgd provided was assumed
[2] Northwest model has no ground storage or pumps, so the same fixed HGL as Highlands was used

The intent of the simulation is not to produce a master plan or consider all of the different options that may be appropriate to alleviate low pressure areas. However, as an indicator of general conditions, the results suggest the following:

- The Lakeshore and McDuff WTPs are indicated to be the weakest relative to average production when all plants are set up to be capable of operating at their firm pumping capacity. This implies that these plants are best suited to peak shaving.
- The Cecil Commerce Center, Fairfax and Westlake WTPs produced the highest average production relative to firm capacity, likely due to high HGL relative to other local plants, and in the case of Cecil Commerce Center and Westlake a more remote location.
- All WTPs except Lakeshore, Marietta, McDuff and Southwest produced 100% of firm capacity at peak hour. Plants producing 100% of firm capacity may be the most appropriate for introduction of additional supply.

Figure 2 shows the minimum pressures observed for the North Grid, occurring due to the morning peak period coincident with irrigation.

As a final step, two Subgrids were evaluated for the potential to introduce additional water resources per the IWRP. The IWRP recommends 5.6 mgd of additional capacity in the North-North Subgrid by 2040, and 2.7 mgd in the North-West Subgrid. Specific plant analyses for each Subgrid are discussed below.

North-North Subgrid

As evidenced in Figure 2, the north end of the existing system is anticipated to become the biggest problem area in the future, due to heavy development. Upon review of the existing system, the issue relates to insufficient transmission capacity to and within the extreme portions of the North-North Subgrid.

There are two WTPs in the Subgrid, Highlands and Northwest. Adding the full 5.6 mgd to either plant or splitting the capacity as a 2.8-mgd increase at both plants, does not overcome the transmission losses in the north end of the system. As a direct comparison, Northwest gives better results, due to its location farther north and west. However, neither option provides sufficient capacity to the areas generally east of US 17. As a result, the following additional alternatives were tested:

- Adding 5.6 mgd capacity at Pecan Park Road and US 17
- Adding 5.6 mgd capacity at Starratt Road and Dunn Creek Road
- Adding 5.6 mgd capacity at New Berlin Road and Yellow Bluff Road
- Adding 5.6 mgd capacity at New Berlin Road and Faye Road
- Adding 5.6 mgd capacity at Faye Road and Alta Drive

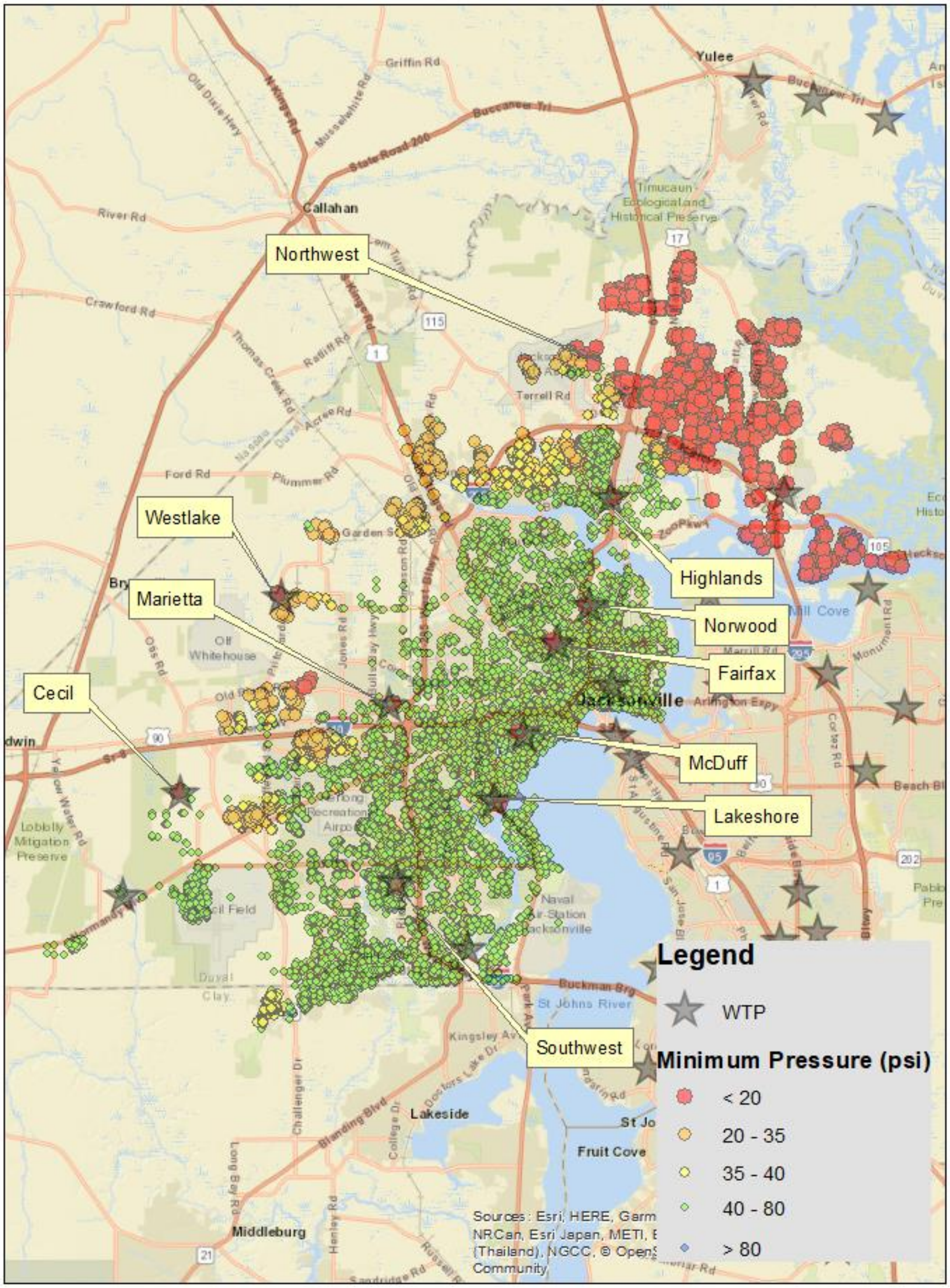

Figure 2: North Grid Minimum Pressure Results – 2040 Average Day Simulation

As with the expanded WTP options, none of these address the whole area, but the most effective of these options is Starratt Road and Dunn Creek Road. Although master planning is not the intent of this exercise, a transmission main was added along Eastport Road/Faye Road from US 17 to Alta Drive. This main was determined to be the largest bottleneck in the area. With this main in place, all options were better, but the Starratt Road and Dunn Creek Road option remained the most favorable. With this combination, only the area around Blount Island and farther east required additional reinforcement. This could likely be enhanced by additional main improvements along Alta Drive and Heckscher Drive, although this was not specifically examined.

A final note of interest is that the very end of the system at Little Marsh Island is not very far from the Beacon Hill WTP in the South Grid, which appears to be underutilized in this analysis based on the South Grid results. Based on a screen, the Beacon Hill WTP can supply the head needed to supply Blount Island if the other options are in place. However, this would require a river crossing.

North-West Subgrid

As opposed to the North-North Subgrid, there are several WTPs in the North-West Subgrid. The North-West Subgrid is recommended for 2.7 mgd of future flow to be generated from the Southwest WRF. The closest WTPs to the Southwest WRF within the North-West Subgrid are Lakeshore and Southwest. Both of these WTPs were screened for the addition of 2.7 mgd and neither provided promising results.

The next two plants out into the system are McDuff and Marietta. Like Lakeshore and Southwest, neither of these plants provided promising results.

The last two plants on the periphery of the North-West Subgrid are Cecil Commerce Center and Westlake. Of the North-West Subgrid WTPs, Westlake is the smallest and most distant plant from the Southwest WRF. Both WTPs are somewhat constrained by transmission connectivity as they use a single line to connect to the larger distribution network. Without transmission improvements, neither plant is effective at moving the additional 2.7 mgd into the system.

However, the full 2.7 mgd can easily be delivered from Westlake if the lines out of the WTP north to Garden Street and south to Old Plank Road are opened (these are closed in the existing model and may not yet be in service). Similarly, the full 2.7 mgd expansion can be achieved from Cecil Commerce Center WTP if a new 24-inch line east to Chaffee Road S is installed, or a 24-inch line north crossing I-10 and then east to the end of the existing system at US 90 (Beaver Street W).

South Grid Results

When the 2040 average day, normal weather demands were applied with the composite CDM Smith patterns, low pressure areas were extensive in an area generally west of US Route 1 and south of University Boulevard. There are a number of closed pipes separating the eastern side of US Route 1 from the western side. As observed within the North Grid, low pressures are particularly noticeable during assumed irrigation periods (early AM). Unlike the North Grid however, the South Grid already has a rather extensive reclaimed irrigation transmission and distribution system. Assuming that this system could supply most of the future projected irrigation, the projected low pressure areas would be much more limited. Therefore, for purposes of this analysis, the irrigation demands were assumed to be supplied from the reclaimed system.

Table 2 shows the assumed HGL and firm capacity used for each South Grid water treatment plant (WTP) in the case with irrigation included. The table also shows the percentage of firm capacity observed at each plant under average (entire simulation) and peak hour conditions.

Table 2: South Grid WTP Settings and Summary Results

WTP[1, 2]	Subgrid	HGL	Firm Pump Capacity (mgd)	% of Firm Capacity into System	
				Average	Peak Hour
Arlington	Arlington	228.7	10.80	39	57
Beacon Hill[3]	Arlington	208.4	3.96	19	45
Brierwood	Central	224.1	19.89	60	100
Community Hall	Central	227.2	12.47	91	100
Deerwood III	East	212.6	33.12	15	30
Greenland	East	217.9	5.76	85	100
Hendricks	Central	187.1	16.57	0	3
Julington Creek Plantation	SJC/South	194.6	8.35	5	63
Lovegrove[3]	Central	225.1	9.00	81	100
Monument	Arlington	235.1	1.63	100	100
Oakridge	East	222.5	11.52	85	100
Ridenour	East	208.1	27.36	24	63
Rivertown[4]	SJC/South	214.0	6.62	31	91
Royal Lakes	East	193.5	5.98	17	96
Southeast[3]	East	208.3	14.40	26	58
St Johns Forest	SJC/South	221.6	3.60	55	100
St Johns North	SJC/South	206.1	1.99	36	100
Woodmere	Arlington	197.5	4.32	8	50

[1] In addition to South Grid WTPs, 7.2 mgd average and 11.1 mgd max was supplied from Main Street at River Oaks
[2] The JEA model additionally included Total Water Master Plan (TWMP) supplies
[3] The HGL as determined from pumps in model was increased to be closer to other plants in area
[4] WTP is under design. Values applied were taken from the preliminary design report

As an indicator of general conditions, the results suggest the following:

- The Community Hall, Greenland, Lovegrove, Monument and Oakridge plants indicated the most potential for additional capacity, producing more than 80% of firm capacity on an average basis.

- The Hendricks WTP is indicated to be the weakest relative to average production when all plants are set up to be capable of operating at their firm pumping capacity. This is likely due to the impact of pumping from Main Street, which in the model is being pumped into the distribution system at River Oaks.

- The Deerwood III WTP may be constrained in part due its large production capacity and proximity to closed lines in the US Route 1 corridor. JEA had suggested that additional water could be moved from the east side to the west side of US Route 1 by opening selected valves. CDM Smith tested one or two options and confirmed that, generally, greater output can be achieved if the west side of US Route 1 is supplemented from the east side.

- All WTPs except Arlington, Beacon Hill, Deerwood III, Hendricks, Julington Creek Plantation, Ridenour, Southeast and Woodmere produced 100% or close to 100% of firm capacity at peak hour. Plants producing 100% of firm capacity are the most appropriate for introduction of additional supply.

Figure 3 shows the South Grid pressures with the irrigation demand removed from the potable water system and assumed to be supplied from the reclaimed system. Minimum pressures are occurring during morning peak demand periods.

As a final step, the most promising plants were evaluated for incorporating additional capacity from the recommended IWRP initiatives. The recommended 2040 projects for the South Grid that were evaluated further include indirect potable reuse (IPR) produced from the Arlington East WRF, totaling 2.7 mgd by 2040. The most beneficial impacts were achieved by adding this capacity at Community Hall or Greenland, with a preference for Greenland based on the most benefit achieved with no other apparent improvements required.

Nassau Grid Discussion

No hydraulic model was made available for the Nassau Grid. However, based on a review of the potable water transmission piping in the grid, and the projected locations of additional development to the year 2040, the centrally located Nassau Regional WTP appears to be a reasonable site for expanded capacity.

In terms of brackish groundwater supply, both the Nassau East and North-North Subgrid are recommended for brackish groundwater development projects. A total of 5 mgd of brackish groundwater is recommended by 2040 and a total of 13 mgd is recommended for the long term. There should be economies of scale available if a suitable site between the Nassau and North systems can be developed to supply both areas. A site in the north end of the north grid that would then convey water to the Nassau Grid, potentially via US 17, may be a good solution.

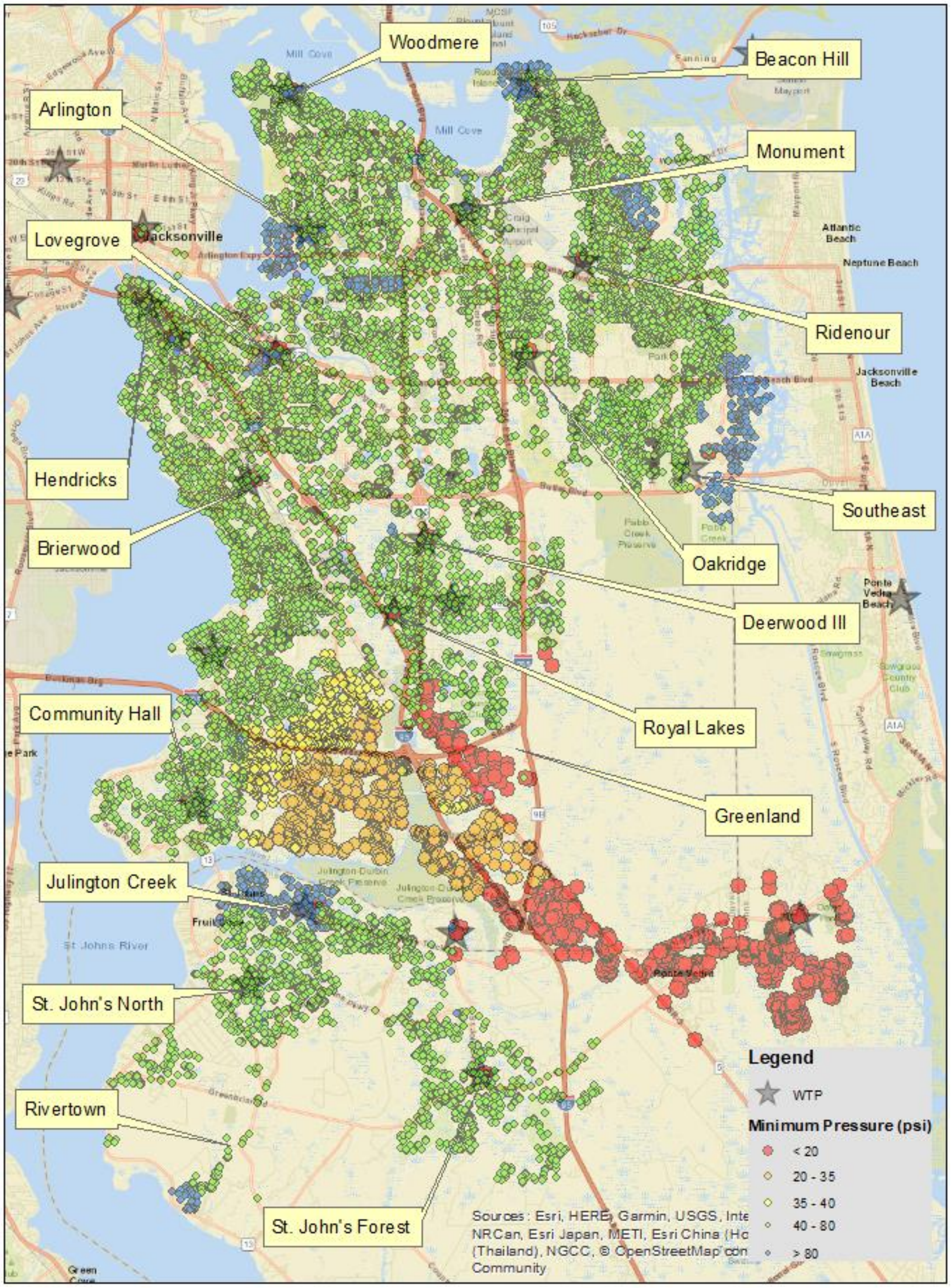

Figure 3
South Grid Minimum Pressure Results with Reduced Irrigation – 2040 Average Day

Conclusions and Recommendations

The hydraulic analyses performed in support of the IWRP and using the JEA hydraulic models corroborate the high-level analyses performed and options screened using the STELLA model. Specific recommendations are:

- In the South Grid, the Greenland WTP is recommended for incorporating additional supply of 2.7 mgd by 2040
- In the North-North Subgrid, any supply increases will need to be supported by enhanced transmission capacity
  - As a single point, the area in the vicinity of Starratt Road and Dunn Creek Road was found to be the most efficient supply site, if no transmission improvements were made
  - With enhanced transmission along Eastport Road/Faye Road, the Highlands WTP would be roughly equivalent to the Starratt Road and Dunn Creek Road location and is recommended to receive indirect potable reuse (IPR) water from Cedar Bay WRF
  - Brackish groundwater development in the North-North Subgrid should be coordinated with similar development in the Nassau Grid to determine whether a single site can supply both grids while achieving economies of scale. This site would ideally be sited in the northern potion of the North Grid
  - If it has not been explored before, re-directing the South Grid Beacon Hill WTP to the extreme eastern point of the North-North Subgrid may warrant further evaluation, as the Beacon Hill WTP appears to be somewhat locked in by other plants, and the area of the North-North Subgrid across the river is the most hydraulic remote from the North Grid as a whole
- In the North-West Subgrid, the Cecil Commerce Center WTP is recommended to receive IPR water from the Southwest WRF. Expanded transmission capacity out of the plant to the east or north will be required to achieve the benefit of the expanded capacity
- In the Nassau Grid, a hydraulic model was not provided, but the Nassau Regional WTP seems to make sense for expanded capacity. As noted above, economies of scale may be achievable by combining projects to serve both the Nassau and North Grids

Appendix F

Eliminate Surface Water Discharge

CDM Smith

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Task 15.2 Technical Memorandum

Engineering Evaluation and Feasibility Level of Design Technical Memorandum (February 2021)

CDM Smith

Memorandum

To: *George Porter, PE, JEA*

From: *CDM Smith*

Date: *August 17, 2020*
Revised September 1, October 13, and October 15, 2020
Final Revision October 19, 2020
Update Submitted February 2021

Subject: *JEA Integrated Water Resource Plan, Task 15.2 - Engineering Evaluation and Feasibility Level of Design for the "Eliminate Surface Water Discharge" Alternative*

Executive Summary

JEA is the eighth largest community-owned utility in the United States and Florida's largest community-owned utility, providing water, sewer, and power services to more than 400,000 customers in the Jacksonville area. Currently, JEA operates 11 water reclamation facilities (WRFs) that handle more than 70 million gallons per day (mgd) of wastewater from the extensive collection system across four counties (Duval, Nassau, Clay, and St. Johns). JEA beneficially reuses nearly 20 mgd of reclaimed water through on-site reuse and by supplying one of the largest interconnected reclaimed water irrigation systems in the state. The remaining volume of highly treated wastewater that is not utilized for reclaimed water is typically discharged to nearby surface waters, including the St. Johns River.

Recently, the Florida Legislature considered proposed legislation (House Bill 715, Senate Bill 1656) that would have imposed strict discharge elimination requirements for treated effluent from domestic water reclamation facilities. While this legislation did not pass in 2020, if similar legislation is passed in the next legislative session, JEA and other Florida utilities could be forced to invest in costly infrastructure under aggressive timelines to reduce or eliminate discharges of treated wastewater to the St. Johns River. JEA requested that CDM Smith conduct a study to evaluate the required new infrastructure and develop planning-level cost estimates associated with eliminating surface water discharges from their WRFs under the proposed legislation. The infrastructure requirements presented herein represent one theoretical scenario of what JEA could do if the Florida Legislature passes a bill requiring elimination of surface water discharges. Since Task 15 was limited in scope, the proposed schedule, quantities, costs, and other factors are subject to change. Furthermore, the requirements of a potential Bill eliminating surface water discharges may differ in certain aspects from the assumptions described herein. If the Florida Legislature adopts such a Bill, we recommend JEA conduct a full and extensive study to determine the feasibility of meeting the enacted requirements, including details of the required improvements, implementation schedule, and impact to rate payers.

For the purpose of this evaluation, backup (intermittent) discharges to surface water under the APRICOT Act are also considered as appropriate. By utilizing backup discharges, the required treatment capacity of the selected alternative(s) could be reduced substantially since peak flows could be handled by backup (intermittent) discharges under the APRICOT Act. In order to be eligible for backup discharges, a WRF must provide advanced wastewater treatment (AWT) for enhanced removal of solids, organics, and nutrients, as well as and high-level disinfection for enhanced inactivation of pathogens.

This Technical Memorandum (TM) evaluated JEA's WRFs considering different approaches to reduce or eliminate surface water discharges. If a facility provides AWT or is upgraded to provide AWT, backup surface water discharges are allowable under the APRICOT Act. Otherwise, it is assumed that discharges would need to be eliminated. Based upon a feasibility-level analysis of JEA's existing and planned WRFs, compliance with a stringent discharge elimination requirement would impose significant costs and challenges.

If legislation of this kind is passed, the following alternatives would be technically feasible, but only at great expense to JEA's ratepayers.

- **Deep Well Injection**: If this alternative is implemented, equalization storage tanks are needed to account for variations in flow at each WRF, resulting in construction of 90 million gallons (MG) in equalization storage tanks. A total of 75 Class I deep injection wells would be required, each extending to depths of more than 2,000 ft. Construction of so many deep wells over many months would cause serious disruption to neighborhoods in the form of noise from drilling rigs and disruptions to roadway crossings from excavation to lay numerous miles of connecting pipelines. Moreover, because of the large quantity of wells needed in such a short period and limited number of capable well drillers in Florida, JEA would be forced to compete with other Florida utilities in turning to out of state resources at a premium cost. Nevertheless, even with the recruitment of numerous out of state drillers, given the inexperience of the drillers with NE Florida hydrogeology and the sheer number of deep wells required, it is doubtful that all 75 wells could be drilled and finished within an allotted 5-year compliance period.

- **Direct Potable Reuse**: This scenario requires extensive upgrades to nearly 114 mgd of installed WRF capacity, to bring JEA's existing WRFs to AWT standards. Upgrades to AWT for the full plant capacity are assumed in order to allow APRICOT backup discharges, reducing the required capacity of direct potable reuse (DPR) facilities. Moreover, 6 new water purification facilities are required with combined production capacity of approximately 45 mgd. The concentrate would be managed through 15 new concentrate disposal wells, similar in construction to the deep injection (Class I) wells described earlier, and their construction would cause similar disruption to neighborhoods. Purified water would be transferred to nearby existing JEA water treatment plants for blending with finished water. The 6 required pipelines conveying a combined 45 mgd of purified water would have total estimated length of nearly 19 miles.

- **Indirect Potable Reuse:** Like the DPR scenario, this requires extensive upgrades to bring JEA's existing WRFs to AWT standards. Upgrades to AWT are assumed in order to allow APRICOT backup discharges, reducing the required capacity of indirect potable reuse (IPR) facilities. Six new water purification facilities with a combined production capacity of 45 mgd and 15 concentrate disposal wells (Class I deep injection wells) are required. Purified water would be conveyed to 31 new recharge wells for injection to the Floridan aquifer.

The following alternatives were studied and found to be incapable of eliminating surface water discharge.

- **Expanded Reclaimed (Insufficient to Eliminate Discharge)**: This scenario evaluated existing irrigation demands not already on JEA's reclaimed system, for potential transfer to reclaimed supply. Extensive upgrades to more than 114 mgd in AWT retrofits are required at JEA WRFs not currently supplying public access reuse. Upgrades to AWT are assumed in order to allow APRICOT backup discharges, reducing the required quantity of expanded reclaimed demand to divert flows from surface water discharge. Even after AWT improvements, there is insufficient reclaimed water demand to meet the systemwide discharge elimination goal.

- **Water Transfer (Insufficient to Eliminate Discharge):** This scenario assumes transfer of reclaimed water to a neighboring utility service area for beneficial reuse. The only potential application identified for this scenario is at Southwest WRF, with a potential water transfer of up to 10 mgd to Clay County Utility Authority (CCUA) for use as reclaimed water. The 10 mgd of demand from CCUA is insufficient to meet discharge elimination criteria since the Southwest WRF peak capacity is up to 48 mgd. Therefore, water transfers would not result in compliance with discharge elimination criteria.

As noted in this assessment, compliance with the provisions of potential legislation to eliminate surface water discharges would require an immense investment from JEA and impose a heavy burden on JEA rate payers. Given the scope of treatment plant upgrades, deep injection wells, land acquisition, pumping, and transmission infrastructure needed in such a short period of time, full compliance by 2027 is a doubtful prospect. Even if JEA competed with other Florida utilities and tried to vigorously mobilize out of state resources at premium cost, it is not reasonable to expect that the necessary work would be completed in time to fulfill requirements by the anticipated 2027 compliance date.

1.0 Introduction

This Technical Memorandum (TM) describes the feasibility-level design of a plan, including alternative scenarios attempting to eliminate surface water discharges of wastewater effluent from JEA's water reclamation facilities (WRFs). CDM Smith Inc. (CDM Smith) will use these design details to develop capital and operation and maintenance cost estimates for JEA's use to estimate rate impacts from implementing a regulation requiring "no surface water discharge," applicable to JEA's water reclamation facilities.

This TM develops this alternative for JEA's Integrated Water Resource Plan assuming the following timetable of future events:

- May 2021: Florida Legislature passes a surface water discharge elimination requirement that is then signed by the Governor
- May 2022: JEA finishes development of a detailed implementation plan (1 year)
- October 2022: Florida Department of Environmental Protection (FDEP) reviews and approves the plan (6 months)
- October 2027: Plan implementation is complete (5 years)

Section 2 estimates the required design flows for discharge elimination improvements associated with each WRF. Section 3 provides an engineering analysis and feasibility-level design of five scenarios for each WRF. These scenarios are 1) deep well injection, 2) expansion of traditional reclaimed water, 3) transfer to other service areas, 4) DPR, and 5) IPR using aquifer recharge. Section 4 provides a summary of the improvements needed to meet discharge elimination requirements under the different scenarios.

2.0 Data Evaluation to Estimate Design Flows of Discharge Elimination Improvements

The purpose of this section is to describe the procedure for estimating the required design flows for discharge elimination improvements associated with each WRF.

2.1 Water Reclamation Facilities and Flows

This section estimates design flows for discharge elimination scenarios, as applicable in 2027, at each of JEA's 11 existing WRFs and 2 future WRFs, listed in **Table 1** and mapped on **Figure 1**. JEA indicated that three existing WRFs and two future WRFs would meet the no surface water discharge requirement via traditional reclaimed water implementation via existing or already planned infrastructure. No improvements are proposed for these five WRFs. These five non-highlighted WRFs in Table 1 are not considered further in this TM. JEA anticipates the remaining eight existing WRFs (highlighted in green) would require improvements to eliminate surface water discharge. Based on feedback from JEA, it was assumed the planned discharges from Nassau and Ponte Vedra WRFs would be considered for the deep well injection scenario only.

Table 1 presents current flows based on approximately 3 years of recent data (June 2017 through May 2020) from each WRF and future flows based upon projected 2027 annual average daily flow (AADF) data and reuse demand provided by JEA. Flow data were not provided by JEA for Ponte Vedra and Nassau WRFs, and water quality data were not provided for Ponte Vedra WRF. Therefore, available data for these facilities were obtained from EPA's Enforcement and Compliance History Online (ECHO) database.

Among the eight WRFs requiring improvements under discharge elimination, six have sufficient flow capacity to handle future 2027 AADF. However, Southwest's 2027 AADF of 13.6 mgd is projected to be at 97 percent (%) of permitted AADF, 14 mgd. Currently, the Southwest WRF is undergoing an expansion to 16 mgd, and the estimated project completion date is in fiscal year 2025. Similarly, Nassau is currently undergoing an expansion to 4.0-mgd permitted ADF.

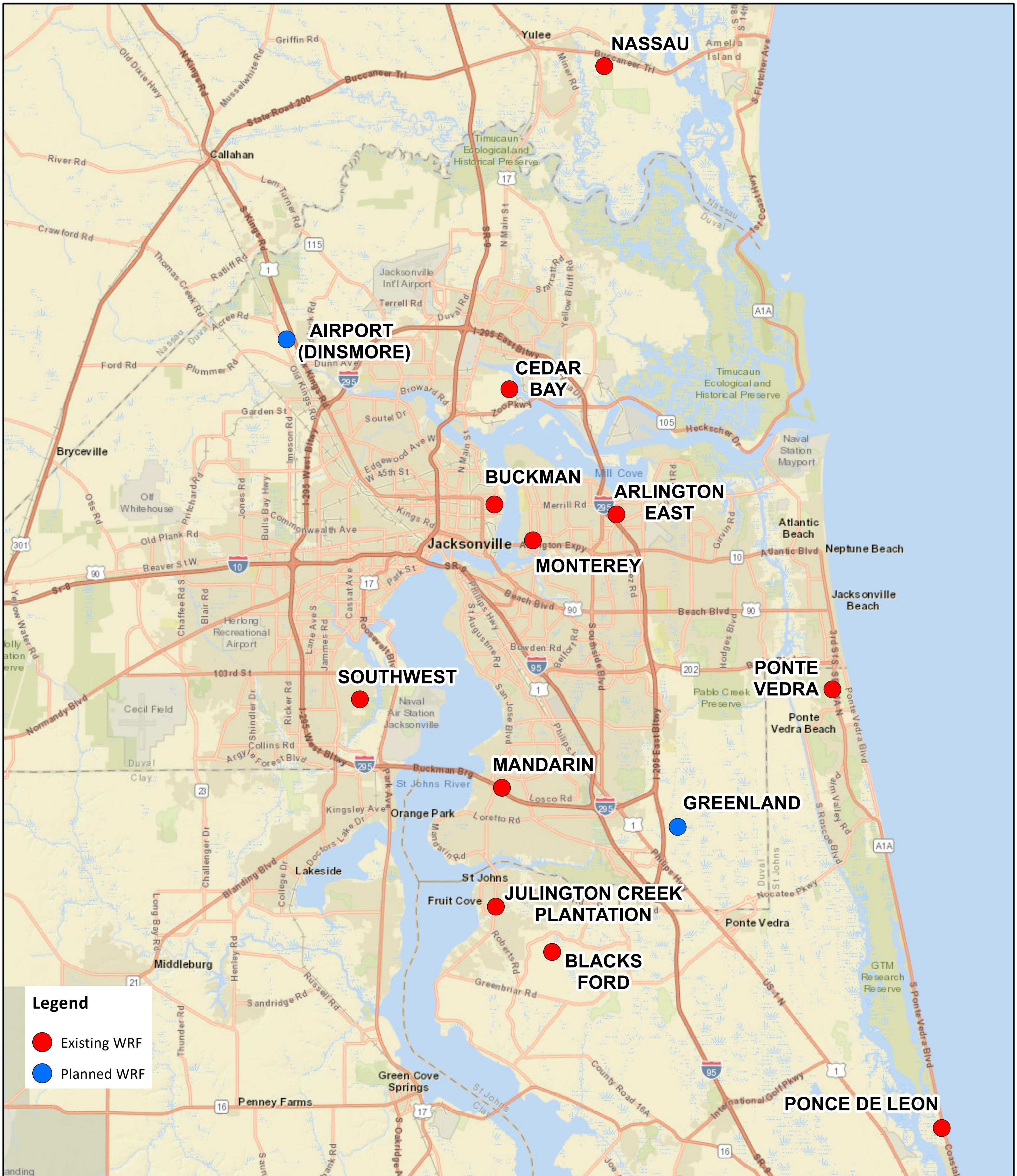
The existing average effluent quality from each WRF over the approximate 3-year period is summarized in **Table 2**. None of these facilities currently provide high level disinfection or meet advanced wastewater treatment (AWT) standards, which include 5-5-3-1 AADF limits for total suspended solids (TSS), Carbonaceous Biochemical Oxygen Demand (CBOD), total nitrogen (TN), and total phosphorus (TP). While several of the facilities listed in Table 2 have partial reuse treatment systems, the effluent quality data shown are representative of the quality currently discharged to surface water. Therefore, if JEA wishes to be eligible for APRICOT backup discharges at any of these WRFs, AWT upgrades would be required for the full permitted flow. The preliminary improvements required for AWT are summarized in **Section 2.3.2**.

Key permit limits were reviewed and compared with historical operating data and EPA's Enforcement and Compliance History Online (ECHO) database. Upon preliminary review of the data, JEA's existing WRFs are generally operating in compliance with current permitted limits. Currently, the existing ultraviolet (UV) disinfection systems at Buckman WRF and Southwest WRF are being upgraded to meet new surface water discharge requirements for enterococci in addition to fecal coliform.

Table 1. Recent and Forecast WRF Flows: Baseline Before Improvements

Location (Grid)	WRF	Permit AADF	Provides AWT?	Recent Flows (7/2017-5/2020)			Forecast Flows (2027)					
				Inflow		MDF/ AADF	Inflow		Outflow			
									Water Reuse (AADF)		Surface Water Discharges (AADF)	
				AADF	MDF		AADF	MDF	Onsite Demand	Offsite Demand (Capacity)	Baseline APRICOT Allowance	Other Discharge to Be Managed
South	**Arlington East**	**25**	-	**16.8**	**36.3**	**2.2**	**21.1**	**45.6**	**1.4**	**1.2 (8.0)**	**N/A**	**19.9**
	Blacks Ford [1]	6	AWT	4.6	5.5	1.2	4.5	5.4	0.1	3.1 (6.0)	1.8	0
	Julington Creek Plantation (JCP)	1	-	N/A	N/A	N/A	0.80	N/A	0.02	0.8 (1.0)	N/A	0
	Mandarin [1]	**8.75**	-	**6.7**	**8.0**	**1.2**	**6.3**	**7.6**	**0.62**	**5.9 (8.75)**	**N/A**	**0.4**
	Monterey	**3.6**	-	**1.6**	**4.5**	**2.8**	**1.7**	**4.8**	**0**	**0**	**N/A**	**1.7**
North	**Cedar Bay**	**10**	-	**5.6**	**8.9 [2]**	**1.6**	**6.8**	**10.8**	**0.48**	**1.3 (5.0)**	**N/A**	**5.5**
	Buckman	**52.5**	-	**25.9**	**62.7 [2]**	**2.4**	**29.3**	**70.9**	**3.54**	**0**	**N/A**	**29.3**
	Southwest	**14**	-	**11.6**	**27.9**	**2.4**	**13.6**	**32.7**	**0.33**	**0**	**N/A**	**13.6**
Small Grids	**Nassau [3]**	**2.0**	AWT	**0.5**	**1.2**	**2.5**	**2.06**	**5.2**	**0.39**	**1.8 (4.0)**	**0.54**	**1.94 [4]**
	Ponce de Leon	0.24	-	N/A	N/A	N/A	0.10	N/A	0.06	N/A	N/A	0
	Ponte Vedra [3]	**0.8**	-	**0.28**	**0.8**	**2.5**	**0.70**	**1.75**	**0**	**0.7 (0.8)**	**N/A**	**0.1 [4]**
Planned WRFs												
South	Greenland	N/A	AWT	N/A	N/A	N/A	2.60	N/A	0.30	2.6 (4.0)	**1.2**	0
North	Airport	N/A	AWT	N/A	N/A	N/A	1.00	N/A	0	0.0 (1.0)	N/A	0
Total							90.6		7.24	**16.3**	**3.9**	**71.6**

AADF – annual average daily flow
MDF – maximum daily flow
mgd – million gallons per day
AWT – advanced wastewater treatment
All flows in mgd
Baseline APRICOT Allowance Estimated Based on 30% of Actual Offsite Reuse Demand
1 Based on projected flows from 11/2018 to 05/2020, when flow was diverted from Mandarin WRF to Blacks Ford WRF. Mandarin's AADF was projected to decrease between 2020 and 2027 due to a portion of the influent flow being directed to the planned Greenland WRF; however, the larger 2020 values were retained for this analysis, assuming no future decline in flow.
2 Single day extreme flow events occurred at Cedar Bay and Buckman in September 2017. These were removed from the analysis for approaches A1 and A2 due to their extreme nature.
3 Data based on best available information from EPA ECHO database, not data provided by JEA. Discharge from these facilities is considered only for the deep well injection scenario.
4 Calculated as future permitted ADF minus forecast AADF.



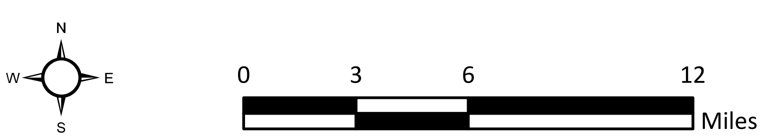


Figure 1.
JEA WRFs Evaluated for Surface Water Discharge Elimination Alternatives (Existing and Planned)

Table 2. Typical Effluent Water Quality of Existing JEA WRFs with Anticipated Impact from Future Discharge Elimination (June 2017-May 2020)*

Location	WRF	Permitted Flow (mgd AADF)	TSS	CBOD	TN	TP	Existing Treatment Processes	Existing AWT?
AWT Requirements (mg/L)			*≤5*	*≤5*	*≤3*	*≤1*		
South Grid	Arlington East	25	**7.8**	**8.4**	**5.2**	0.9	MLE, cloth filter	**No**
	Mandarin	8.75	1.8	2.6	**3.8**	**1.5**	MLE, sand filter	**No**
	Monterey	3.6	**6.7**	2.3	2.7	**3.9**	SBR	**No**
North Grid	Cedar Bay	10	1.9	2.1	**6.0**	**2.1**	MLE	**No**
	Buckman	52.5	**7.1**	2.9	**4.1**	**5.8**	MLE	**No**
	Southwest	14	**8.2**	**5.4**	**3.3**	0.9	Modified Bardenpho	**No**
Small Grid	Ponte Vedra	0.8	0.5**	1.5	**4.1**	**1.6**	SBR, bridge filter	**No**
	Nassau	2	0.6	2.1	1.9	0.4	MBR	Yes

TSS-Total Suspended Solids, CBOD-Carbonaceous Biochemical Oxygen Demand, TN-Total Nitrogen, TP-Total Phosphorus, SBR – sequencing batch reactor, MLE Ludzack-Ettinger Process (MLE), MBR – membrane bioreactor

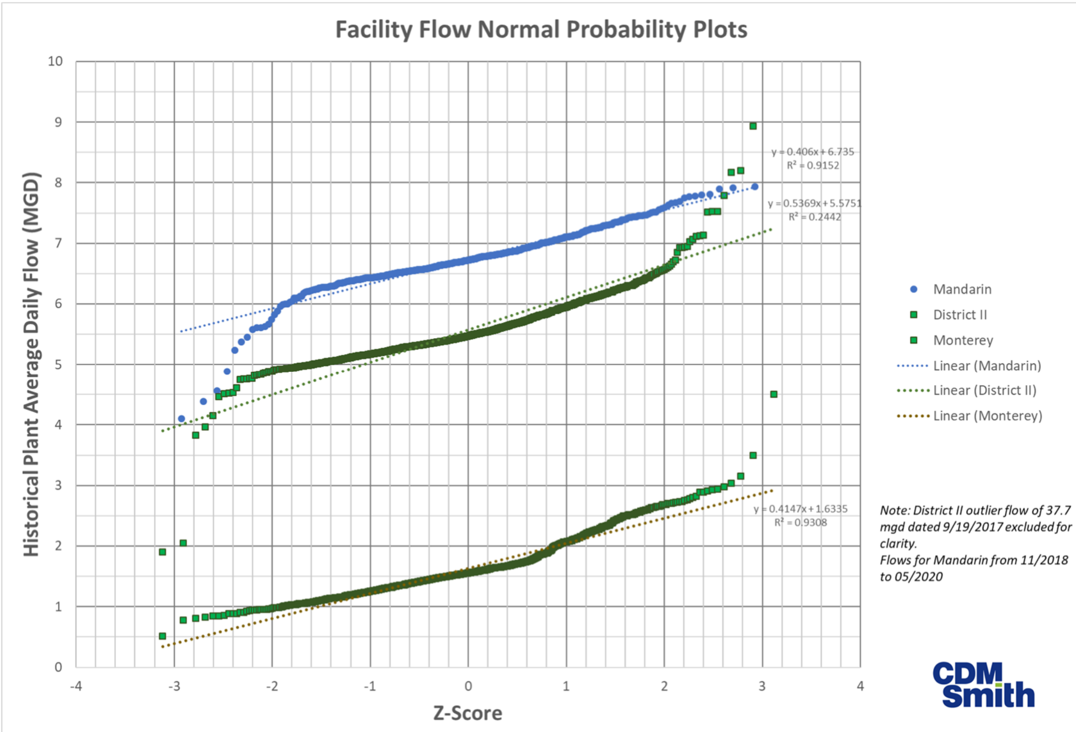
Bolded and underlined values do not meet AWT requirements.

* Facilities listed provide basic-level disinfection. Exact range of dates included varies with facility by about one month. Facilities not listed meet the surface water discharge elimination requirement via traditional reclaimed water implementation.

** Based on median of maximum monthly filtered turbidities. Median used in order to exclude impact of one high value.

Historical daily inflows over the approximate 3-year period were analyzed for each of the 6 WRFs through preparation of normal probability plots to identify potential daily flow outliers **(Figure 2)**. The AADF for each facility was calculated as the arithmetic mean of daily inflows for the facility and is provided in Table 1. The maximum day flow (MDF) was calculated from the maximum daily inflow, except for Cedar Bay and Buckman, which experienced extremely high single day flows in September 2017 near the time when Hurricane Irma and Hurricane Maria increased precipitation in Jacksonville. For Cedar Bay, the original maximum day flow of 37.7 mgd from 9/19/17 was replaced with the second highest daily flow, 8.9 mgd. For Buckman, the original maximum day flow of 105.73 mgd from 9/11/17 was replaced with the second highest daily flow of 62.7 mgd. The analysis period for Blacks Ford and Mandarin begins in November 2018, to reflect the flow transfer from Mandarin to Blacks Ford after the Blacks Ford plant expansion was completed. The MDF/ADF ratio was calculated for each facility and ranged from 1.2 to 2.8. Looking ahead to future flows, a 2027 MDF was estimated for each facility by multiplying the 2027 AADF by the MDF/ADF ratio, Table 1. In this TM, the 2027 MDF is considered in the sizing of certain improvement scenarios, prior to consideration of equalization storage tanks.

Forecast water reuse demand in 2027 for both on-site reuse at each WRF and off-site reuse was also provided by JEA and is shown in Table 1. Onsite reuse was considered a closed loop because on-site reuse is continuously returned to the treatment process, thus not contributing to the facility inflow or deducting from the facility effluent flow. Offsite reuse flows were assumed to be constant year round without variations in demand. This is consistent with the findings of an irrigation demand analysis later in this TM (Section 3), which found little seasonal impact on irrigation demands.



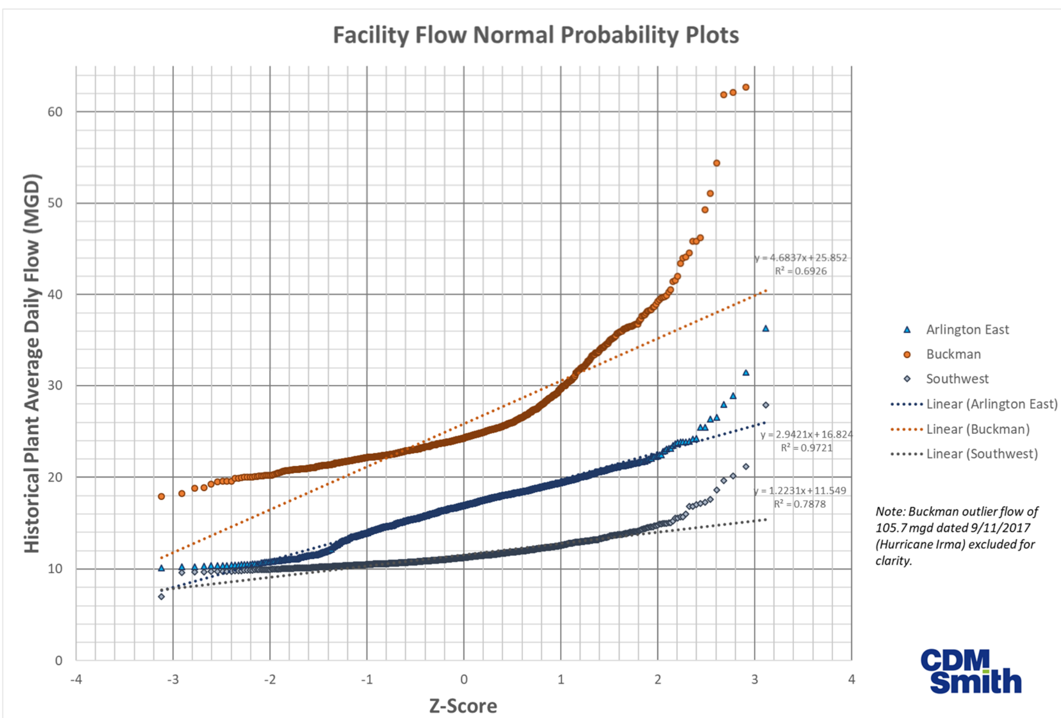


Figure 2. Facility Flow Normal Probability Plots

Surface water discharges for each WRF were estimated as AADFs by taking the inflow and subtracting off-site reuse demand. Among the six WRFs evaluated, only Nassau provides AWT and therefore is eligible for backup discharges through the APRICOT Act. The APRICOT Act (Florida Statute Section 403.086) allows for permitting of backup discharges for public access reuse systems to surface water when the WRF provides AWT and high-level disinfection. Identifying the unmanaged surface water discharges as AADFs is informative, but not sufficient for planning the design of improvements under discharge elimination scenarios, since the elimination of all discharges would require facilities able to handle not only the average flow, but also variations in daily flow as discussed in Sections 2.2 and 2.3.

2.2 Assumed Surface Water Discharge Elimination Criteria

This section describes the assumptions used to size the required capacity of discharge elimination improvements. This TM assumes that the following approaches for handling WRF effluent would comply with a potential surface water discharge elimination law.

- Elimination of surface water discharges for non-AWT facilities.
- Deep well injection is the only surface water discharge elimination alternative considered for Ponte Vedra and Nassau. In the case of Nassau, a backup APRICOT discharge is allowed.
- Partial elimination of surface water discharges with the following allowable backup discharge from AWT facilities:
    - Backup "APRICOT" discharge[1] of reclaimed water to surface water limited to 30% of the permitted reuse capacity on an annual basis, provided the reclaimed water meets AWT, which requires high-level disinfection[2] and 5-5-3-1 mg/L annual average requirements for TSS, CBOD, TN, and TP concentrations, respectively. Note within this TM, backup discharges are limited to 25% of permitted reuse capacity, to reflect the uncertainty associated with wastewater daily inflows.
    - None of the discharge elimination scenarios will be applied to Blacks Ford because JEA is in the process of converting the existing backup wetland discharge to an APRICOT Act discharge, which is assumed to be allowed under the proposed legislation. Thus, Blacks Ford will meet the surface water discharge elimination requirement.

Among the scenarios considered, it is assumed that different improvements would have the following impacts on permitted reuse capacity (and by implication the allowable backup "APRICOT" discharge):

[1] Section 403.086(7), F.S.
[2] Rule 62-600.440 (5).

- Scenarios neither expanding the permitted reuse capacity nor increasing the allowable backup discharge
  - Deep well injection (Section 3.1)
  - Transfer to other service areas (Section 3.2)
- Scenarios expanding the permitted reuse capacity and increasing allowable backup discharge
  - Expansion of traditional reclaimed water[3] (Section 3.3)
  - Direct potable reuse (Section 3.4)
  - Indirect potable reuse using aquifer recharge (Section 3.4)

2.3 Estimation of Required Design Flows for Discharge Elimination Improvements

Three years of daily WRF influent flows were evaluated at each WRF to estimate the required design flow of discharge elimination improvements, using one of the following three approaches:

- Approach A: No AWT Upgrades with Discharge Elimination
  - A1. Without Use of Equalization Storage
  - A2. With Use of Equalization Storage
- Approach B: AWT Upgrades and Allowance for APRICOT Backup Discharges

The results of these simulations are shown in **Table 3** for 2017-2020 data. An equalization sizing model (not shown) was developed, simulating the use of an equalization tank against historical daily flows for each WRF to determine the beneficial reduction in flows attainable with various sizes of equalization storage. In general, increasing equalization storage provided beneficial, but diminishing reductions in the required receiving facility capacities. Therefore, a standard equalization storage volume of 50% of the maximum daily flow was provided for each facility, and the required capacity for discharge elimination was varied until surface water discharges across the entire simulation period totaled zero. Flows and equalization storage volumes from the baseline simulation are scaled up to 2027 in **Table 4** by multiplying each value by $\frac{AADF_{2027}}{AADF_{2017-2020}}$ at each respective WRF. Site-specific approaches were used to analyze flows at Nassau and Ponte Vedra WRFs, because the flow data were not provided, and these facilities were considered for the deep well injection alternative only. For Nassau and Ponte Vedra, the current ADF was multiplied by an assumed peaking factor of 2.5 to estimate the current MDF. JEA provided the projected ADF for 2027, and the same peaking factor of 2.5 was used to estimate the 2027 MDF. The flow capacity with equalization (under A2) was based upon the facility's future permitted ADF.

[3] Note, it is assumed for this analysis that APRICOT credit for reclaimed water is based on actual demand and not on reclaimed system capacity which often greatly exceeds actual demand.

Note, Mandarin's AADF was projected to decrease between 2020 and 2027 due to a portion of the influent flow being directed to the planned Greenland WRF; however, the larger 2020 values were retained for this analysis, assuming no future decline in flow. The approach used to develop these capacities is described in the following paragraphs.

Table 3. Simulated Treatment and Storage Requirements for Baseline Flows (2017-2020)

Location (Grid)	WRF	Permitted Flow (mgd AADF)	Approach A No AWT Upgrades			Approach B AWT Upgrades	
			A1. No EQ Storage (Treat MDF)	A2. Build EQ Storage (Store 50% of MDF)		Permitted Reuse System Combined Capacity (mgd)	Backup Discharge AADF (@25%) (mgd)
			Flow Capacity (mgd)	*Storage Volume (MG)*	Flow Capacity (mgd)		
South	Arlington East	25	**36.3**	18.2	**27.2**	**13.7**	3.4
	Mandarin	8.75	**8.0**	4.0	**7.2**	**6.0**	1.5
	Monterey	3.6	**4.5**	2.25	**3.4**	**1.4**	0.34
North	Cedar Bay	10	**8.9**	4.5	**7.3**	**4.5**	1.1
	Buckman	52.5	**62.7**	31.4	**47.0**	**20.7**	5.2
	Southwest	14	**27.9**	14.0	**20.9**	**9.2**	2.8
Small	Nassau	2.0	**1.2**	0.6	**2.0**	**-**	-
	Ponte Vedra	0.8	**0.8**	0.4	**0.8**	**-**	-

Table 4. Simulated Treatment and Storage Requirements for Forecast Flows (2027)

Location (Grid)	WRF	Permitted Flow (mgd AADF)	Approach A No AWT Upgrades			Approach B AWT Upgrades	
			A1. No EQ Storage (Treat MDF)	A2. Build EQ Storage (Store 50% of MDF)		Permitted Reuse System Combined Capacity (mgd)	*Backup Discharge AADF (@25%) (mgd)*
			Flow Capacity (mgd)	*Storage Volume (MG)*	Flow Capacity (mgd)		
South	Arlington East	25	**45.6**	*22.9*	**34.2**	**17.2**	*4.3*
	Mandarin	8.75	**8.0**	*4.0*	**7.2**	**6.0**	*1.5*
	Monterey	3.6	**4.8**	*2.4*	**3.6**	**1.5**	*0.4*
North	Cedar Bay	10	**10.8**	*5.5*	**8.9**	**5.5**	*1.3*
	Buckman	52.5	**70.9**	*35.5*	**53.2**	**23.4**	*5.9*
	Southwest	14	**32.7**	*16.4*	**24.5**	**10.8**	*3.3*
Small	Nassau	4.0	**5.2**	2.6	**4.0**	**-**	-
	Ponte Vedra	0.8	**1.75**	0.9	**0.8**	**-**	-

2.3.1 Approach A: No AWT Upgrades with Discharge Elimination

Approach A eliminates surface water discharges by designing the discharge management alternative to capture the WRF maximum daily flow, thus avoiding surface water discharges to the St. Johns River. This is the approach used herein for identifying required capacity for deep well injection facilities and transfers to other service areas.

Approach A1 entails a design of improvements based on the 2027 forecast MDF, without any inter-day equalization storage. To simplify analysis for planning purposes, this TM limits the flow analysis to exclude peak hourly flows and associated intraday equalization. Note, for this simplified conceptual design analysis, detailed design of conveyance piping and pumpage associated with the equalization tanks was not included. As discussed in Section 2.2, the maximum single daily flows at Buckman and Cedar Bay were judged outliers from a normal probability plot, and removed from the analysis for Approach A, and replaced by the second largest daily flow.

For Approach A2, the outlier days were excluded from analysis and equalization storage was provided for treated WRF effluent, sized to 50% of the MDF in circular, prestressed ground storage tanks. For example, at Arlington East the MDF was 36.3 mgd, therefore 18.2 million gallons (MG) of equalization storage was provided. This equalization (EQ) tank capacity was subsequently used in a spreadsheet analysis model to identify the minimum required treatment capacity to eliminate surface water discharges over the approximate 3-year period of data, accounting for storage of flows in the equalization tank. The deep well injection and water transfer scenarios rely on Approach A2, assuming the use of equalization storage.

Providing equalization storage for plant effluent equal to 50% of the MDF reduced the required treatment inflow capacity by 10 to 25% relative to the MDF. Four of the 6 WRFs showed a 25% reduction in required capacity (Arlington East, Monterey, Buckman, and Southwest). The other 2 of the 6 WRFs showed a 10% reduction in capacity (Mandarin) and 18% reduction in required capacity (Cedar Bay) with provision of equalization storage.

2.3.2 Approach B: AWT Upgrades and Allowance for Backup Discharges

This approach upgrades all the facilities in Table 3 to provide AWT for the permitted WRF capacity, thus enabling each facility to take advantage of the APRICOT backup discharge provision. This approach slashes the required capacity of discharge elimination improvements by about 50 to 69% relative to MDF, depending on the WRF. This is the approach used herein for identifying capacity required for expansion of reclaimed water, direct potable reuse, and indirect potable reuse by aquifer recharge.

This TM does not include a detailed evaluation of requirements to upgrade to AWT at each facility; however, a high-level assessment was performed for each WRF to evaluate the potential land area requirements associated with AWT upgrades. Multiple factors[4] can impact the feasibility of retrofitting an existing plant, including aeration basin size and configuration, clarifier capacity, type of aeration system, sludge processing units, and operator skills. This assessment concluded the upgrades associated with AWT improvements could be achieved within the existing plant footprint/JEA-owned parcel, without the need for additional land acquisition. For the purpose of this TM, it was assumed the additional nitrogen removal required for AWT could be achieved by adding a carbon source to the secondary anoxic zone or through the addition of deep-bed denitrifying filters. Phosphorous removal could be achieved through the addition of a metal coagulant salt such as alum or ferric chloride, prior to secondary clarification. Filters would be required for TSS removal. Of the seven JEA WRFs listed in Table 2 without AWT, three facilities (Southwest, Monterey, and Ponte Vedra) could be retrofitted to operate as 4-stage Bardenpho (i.e., secondary anoxic zone after aerobic zone). New filters would be required at Southwest and Monterey for TSS removal. Substantial new tankage would be required at the Arlington East, Buckman, and Cedar Bay WRFs for the addition of deep-bed denitrifying filters and chemical systems for enhanced phosphorous removal. It was assumed the existing sand filters at Mandarin could be retrofitted to operate as deep-bed denitrifying filters. Conceptual land area estimates associated with these upgrades are provided in Section 3.5. Note, additional evaluations of JEA's water reclamation facilities would be needed in order to more accurately estimate the improvements associated with AWT upgrades.

The required capacity of the reuse system with AWT improvements and allowed backup discharges was sized using a daily inflow spreadsheet analysis similar to that used in Approach A, except that the equalization storage was set to zero and cumulative discharge to surface water was calculated by adding up the daily discharges over the approximate 3-year period. Reuse system capacity was adjusted until surface water discharges equaled 25% of permitted reuse system capacity. Offsite reclaimed water capacity was based on demands only. Potable reuse facilities' capacity was based on inflow.

Permitted reuse system capacity was set to allow discharges at 25% of system capacity instead of the full 30% of discharges allowed under APRICOT to reflect the uncertainty inherent in the utilization of backup discharge volumes. Equalization storage volumes were set to 0 MG because the use of backup discharges greatly attenuated peak flows, thereby requiring impractically large equalization storage to attain additional benefit.

3.0 Feasibility Level Design of Discharge Elimination Scenarios

This section includes description of feasibility level design criteria for the following five discharge elimination scenarios as applicable to each of the six WRFs under consideration for discharge elimination.

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[4] USEPA 2007, "Biological Nutrient Removal Processes and Costs." Fact Sheet. June 2007. https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=60000G2U.TXT

- Deep Well Injection (Section 3.1)
- Expansion of Traditional Reclaimed (Section 3.2)
- Transfer to Other Service Areas (Section 3.3)
- Direct and Indirect Potable Reuse (Section 3.4)
- Land Area Required for Each Alternative (Section 3.5)

3.1 Deep Well Injection

The intent of deep well injection is for the injected fluid to remain confined in an aquifer's storage zone indefinitely, with no upward vertical migration into drinking water aquifers. For the purposes of this TM, deep well injection is considered a viable alternative for each WRF to eliminate surface water discharges, although this approach has not yet been utilized in the Jacksonville area. A stand-alone report was prepared to focus on this portion of the TM, and is included as **Appendix A**. In Florida, FDEP permits six types of injection wells. Class I wells are typically used to inject secondary-treated effluent into an aquifer with good confinement above the injection zone beneath the lowermost underground source of drinking water (USDW). The USDW is defined as groundwater with a TDS concentration of less than or equal to 10,000 mg/L. No Class I deep-injection wells exist in northern Florida – the closest Class I well is located approximately 140 miles south of Jacksonville at the Sykes Creek WRF in Brevard County. Little is known about the deep subsurface geological conditions below the USDW, but construction of a deep well could still be a viable option in the Jacksonville area. Extensive hydrogeologic exploration (drilling) and testing of potential test well locations can assist with site selection.

The evaluation of deep well injection for JEA's WRFs involved characterization of groundwater quality present in deep zones of the aquifer beneath the WRFs. More specifically, groundwater quality characterization was performed to determine the lowest limit of the USDW below which injection of treated effluent may be feasible. This was evaluated on a case by case basis for each WRF.

Six of JEA's 8 WRFs with excess reclaimed water capacity, as identified in Table 1, are located in Duval County. Ponte Vedra WRF is located in St. Johns County and Nassau WRF is in Nassau County. St. Johns County is listed as a county with carbonate aquifer chemistry requiring high-level disinfection prior to deep well injection in accordance with the federal rule 40 CFR 176. Duval County and Nassau County are not included on that list. Since Ponte Vedra is located in St. Johns County, high-level disinfection (which it already provides) would be required for deep well injection. For the purpose of this evaluation, it was assumed that no additional treatment process upgrades would be required for the deep well injection scenario.

Based on the groundwater quality characterization presented in Appendix A, two zones of the aquifer were identified for potential reclaimed water disposal associated with JEA's WRFs – the Fernandina Permeable Zone (FPZ) and Lawson Limestone. Several factors such as insufficient water quality data and unknown drilling depths add to uncertainty in the development of deep wells in north Florida. The injection zones and rates presented in Table 5 were assumed to be most feasible. Arlington East was assumed to be able to access the FPZ with a capacity of 2 mgd per well. All other WRFs were assumed to go to the Lawson Limestone with a capacity of 2 mgd per well. Actual capacities would need to be better defined after review of data from exploratory well drilling. Table 5 also presents the total number of wells estimated to be required to allow for disposal of the flow required to eliminate discharge as calculated in Approach A and deducting the off-site reclaimed water demand.

While each injection well only occupies a limited footprint, the need to space out and connect all injection wells via pipelines would be particularly challenging for some WRFs. Ideally, injection wells should be located at least 1,000 feet apart to avoid interference within the injection zone and avoid inefficiency associated with higher pumping pressures. Construction of deep injection wells can take several months, generating significant noise in residential neighborhoods, and creating addition disruption during trenching and excavation and laying of connecting pipelines. This may be most difficult near Buckman, where an estimated 28 injection wells along a 5.1-mile pipeline corridor would be required. Moreover, there are not enough drilling rigs in the state of Florida to complete this number of injection wells in 5 years. Due to the large quantity of wells needed in such a short period and limited number of capable well drillers in the state, JEA would be forced to turn to out of state resources at a premium cost. Nevertheless, even with the recruitment of numerous out of state drillers, given the inexperience of the drillers with NE Florida hydrogeology and the sheer number of deep wells required, it is doubtful that all 65 wells could be drilled and finished within the assumed 5-year period allotted for compliance.

Table 5. Application of Deep Well Injection for Discharge Elimination in 2027 at Each WRF

Location (Grid)	WRF	Injection Zone[1]	Equalization Tank Storage Volume (MG)	Flow Receiving Capacity Needed (mgd)	Offsite Reuse Demand (mgd)	Deep Well Capacity Required (mgd)	Injection Wells Required (ea)	Injection Well Corridor Distance (Miles)[2]
South	Arlington East	FPZ	**22.9**	34.2	1.2	33.0	**18**	3.4
	Mandarin	Lawson	**4.0**	7.2	5.9	1.3	**2**	0.4
	Monterey	Lawson	**2.4**	3.6	0	3.6	**3**	0.4
North	Cedar Bay	Lawson	**5.5**	8.9	1.3	7.6	**5**	0.8
	Buckman	Lawson	**35.5**	53.2	0	53.2	**28**	5.1
	Southwest	Lawson	**16.4**	24.5	0	24.5	**14**	2.5
Small	Nassau	Lawson	**2.6**	4.0	1.8	4.0	**3**	0.4
	Ponte Vedra	Lawson	**0.9**	0.8	0.7	1.0	**2**	0.2

[1] The estimated drilling depth to reach the high TDS aquifer ranges from 1,990 feet below land surface (BLS) to 2,126 feet BLS at each WRF. Source: Williams, L.J., and Kuniansky, E.L. 2016. Revised hydrogeologic framework of the Floridan aquifer system in Florida and parts of Georgia, Alabama, and South Carolina (ver 1.1, March 2016): U.S. Geological Survey Professional Paper 1807, 140 p., 23 pls, http://dx.doi.org/10.3133/pp1807.)

[2] Length required for injection well pipeline corridor was based on 1,000-ft spacing between each deep injection well

3.2 Expansion of Traditional Reclaimed

Over the past 20 years, JEA has made significant investments in expanding their reclaimed water system, which currently provides more than 5 mgd of on-site reuse and provides an additional 15 mgd of reclaimed water to customers across the service territory. Public access reuse standards in Florida are outlined in 62-610 F.A.C., entitled "Reuse of Reclaimed Water and Land Application." At a minimum, these requirements include secondary treatment, filtration for TSS removal, and meeting the high-level disinfection criterion for fecal coliform as specified in 62-660.440 F.A.C ("Disinfection.")

Of the JEA WRFs evaluated for this project, eight produce public access reclaimed water and three existing WRFs produce non-public access reclaimed water used strictly at the WRF and/or within a restricted area, as shown in Table 1. Only one facility, Monterey WRF, does not currently produce reclaimed water. Cedar Bay (District II) provides reclaimed water to St. Johns Power Park (industrial reuse). Upgrades including addition of tertiary filtration and high-level disinfection would be required to meet public access reuse standards at Southwest, Buckman, Arlington East, Monterey, and Cedar Bay.

JEA continues to focus on projects to expand reclaimed water use in areas of future growth to offset aquifer demands to the extent economically, environmentally, and technologically feasible. To support an analysis of reclaimed system expansion, JEA provided customer billing data for each year from 2016 to 2019. The billing data included all types of customer billing. For analysis purposes, sewer only and deduct meters were removed.

The total irrigation demand based on specific irrigation meters was tabulated for each year and found to range from 18.4 to 23.5 mgd during the time frame analyzed, 2016 to 2019. The 2018 year was selected for further study since it represented the minimum irrigation to reclaimed volume that might be achieved. The primary focus was on irrigation meters because these are already separate meters that may be more easily retrofitted than a single meter used for both indoor and outdoor water.

3.2.1 Data Sources

CDM Smith utilized the following data to evaluate the "expansion of traditional reclaimed water" alternative:

- JEA 2018 monthly billing data as a service point shapefile. The 2018 water billing data shapefile included the service point location for existing water meters, the water use type for each meter (e.g., residential water, residential irrigation, commercial irrigation, etc.), and the 2018 monthly water consumption (measured in gallons).
- JEA water system GIS coverages, primarily "WaterMain.shp" that included the existing water main pipe diameter and length.
- Duval County neighborhood boundary polygon shapefile.

- Reclaimed water transmission main shapefile that included existing, planned, and potential reclaimed water transmission pipes.

3.2.2 Analysis

The general procedure described below was used to analyze the 2018 billing data along with the existing water main, neighborhood, and reclaimed water main shapefiles to identify and prioritize potential reclaimed water retrofit areas. The purpose of the process was to identify specific neighborhoods/properties that currently have irrigation water meters and to quantify the irrigation meter density and 2018 irrigation water use for each neighborhood. In addition, the approximate distance to existing reclaimed water transmission mains and the total length of existing water mains within each neighborhood were calculated. This exercise was performed so that neighborhoods could be prioritized to reap incremental benefits earlier as part of an overall conversion approach.

1. An annual average value (gallons per day) was calculated for each service point based on the monthly consumption data.
2. The 2018 service point shapefile was intersected with the neighborhood shapefile in GIS to generate a new point shapefile which includes the consumption data, meter type (i.e., residential irrigation), and neighborhood. Attribute data for the intersected shapefile was processed in a spreadsheet to calculate the total irrigation water use and the number of irrigation meters within each neighborhood. Neighborhoods with no existing irrigation meters were not considered for the remainder of the evaluation.
3. The neighborhood polygons with existing irrigation were grouped based on the neighborhood code (NBHD_COD) attribute field. Most of the neighborhoods have a neighborhood code that includes an integer and two-digit decimal value (e.g., 117200.01, 117200.02, etc.) These neighborhoods were grouped together based on the integer value and assigned a new neighborhood group code (NBHD_Group, i.e., 117100). This step helped to create more contiguous neighborhood areas within a single neighborhood or merge adjacent neighborhoods together, and reduced the universe of neighborhoods to evaluate from over 2,000 to about 500, with about 300 of those containing irrigation meters.
4. For each neighborhood group, the total area, total average daily irrigation water use, and total number of irrigation meters were recalculated. In addition, the meter density (i.e., meters per area) was also calculated.
5. The straight-line distance from each neighborhood to the nearest reclaimed water transmission main was determined in a GIS spatial analysis. The existing water main shapefile was intersected with the neighborhood shapefile in GIS to identify the water mains associated with each neighborhood. The attribute data for the intersected shapefile were processed in a spreadsheet to calculate the total length for each diameter water main located within a given neighborhood. Then, the total length for each 12-inch diameter pipe

and smaller pipe was calculated for each neighborhood group. These data were used as an estimate of the length and size of reclaimed water mains required to retrofit a neighborhood.

6. The data generated from the above procedures were compiled in a spreadsheet to summarize the following information for each neighborhood group: total area, approximate distance to existing reclaimed water main, total average irrigation (gallons per day), total count of irrigation meters, irrigation meter density, total inch-diameter miles of existing water main, and total existing length of 0.75- to 12-inch water mains.

Figure 3 shows a map of all neighborhood groups with irrigation meters, color-coded by the 2018 total irrigation demand. Since there is also outdoor water use that is not specifically tied to irrigation meters, it is prudent to estimate what the additional potential might be for conversion to reclaimed water. The total billed demand to water uses that is not captured in reclaimed or irrigation meters was estimated to be about 76 mgd for 2018, based on the billing data provided. There was not a strong seasonal component to this data, suggesting that much of the outdoor water use is occurring year round. Based on summary information provided from JEA, the total estimated outdoor use that might be converted to reclaimed water is an additional 18 mgd for the 2018 year, or about the same amount as the irrigation water. This water use occurs both within the 305 neighborhood groups that contain irrigation meters and in 193 additional neighborhood groups that do not.

Demands from each neighborhood were then allocated to the nearest of the seven WRFs having a discharge elimination requirement within each neighborhood's grid. Demands in 2027 are assumed to be the same as they were in 2018. **Table 6** compares the combined reuse attainable for each WRF assuming maximum expansion of the reclaimed system to serve residential and commercial irrigation demands from the closest WRF.

Based on this analysis, among the seven WRFs, expanded reclaimed water is not a feasible method of meeting the discharge elimination requirement for five of the seven WRFs, even with APRICOT backup discharges. Monterey WRF falls short of the reuse demand needed (1.5 mgd) by a mere 0.2 mgd; however, this could be remedied by diverting some demand to Monterey from the Arlington East service area. The first iteration of this analysis found insufficient demand near Arlington East to take what would need to be taken to eliminate surface water discharges. Conversely, there is excess demand near the Mandarin, without enough WRF capacity. Therefore, the analysis was repeated and excess demand from Mandarin was shifted to being served by Arlington East. Even with the flow transfer, the reclaimed water demand shortfall at Arlington East (6.0-mgd) is too great to be mitigated. Mandarin may have sufficient potential irrigation demand to make expanded reclaimed a technically feasible discharge elimination option; however, the cost to construct the necessary conveyance infrastructure to serve this demand, especially in crowded built-out neighborhoods, may be substantial.

Table 6. Application of Expanded Reclaimed for Discharge Elimination in 2027 at Each WRF

Location (Grid)	WRF	JEA Projected 2027 Reclaimed Demand (mgd)	Irrigation Demand Not Connected to Reclaimed (mgd)		Combined Reuse Demand After Max Expansion (mgd)	Demand Needed to Reduce Discharge to Goal (mgd)	Could Expanded Reclaimed Meet DE Goal?	Shortfall (mgd)
			Residential	Commercial				
South	Arlington East	1.2	2.33	3.39	11.2	17.2	Goal missed	**6.0**
	Mandarin	5.9	1.85	3.73	6.0 [1]	6.0	Meets goal	-
	Monterey	0	0.42	0.88	1.30	1.5	Goal missed	**0.2**
North	Cedar Bay	1.3	0.55	0.67	2.52	5.5	Goal missed	**2.98**
	Buckman	0	0.13	0.97	1.1	23.4	Goal missed	**22.3**
	Southwest	0	0.85	0.93	1.78	10.8	Goal missed	**9.02**

[1] The combined reuse demand closest to Mandarin was 11.48-mgd. The analysis was repeated, with the excess 5.48 mgd demand near Mandarin shifted to being served by Arlington East

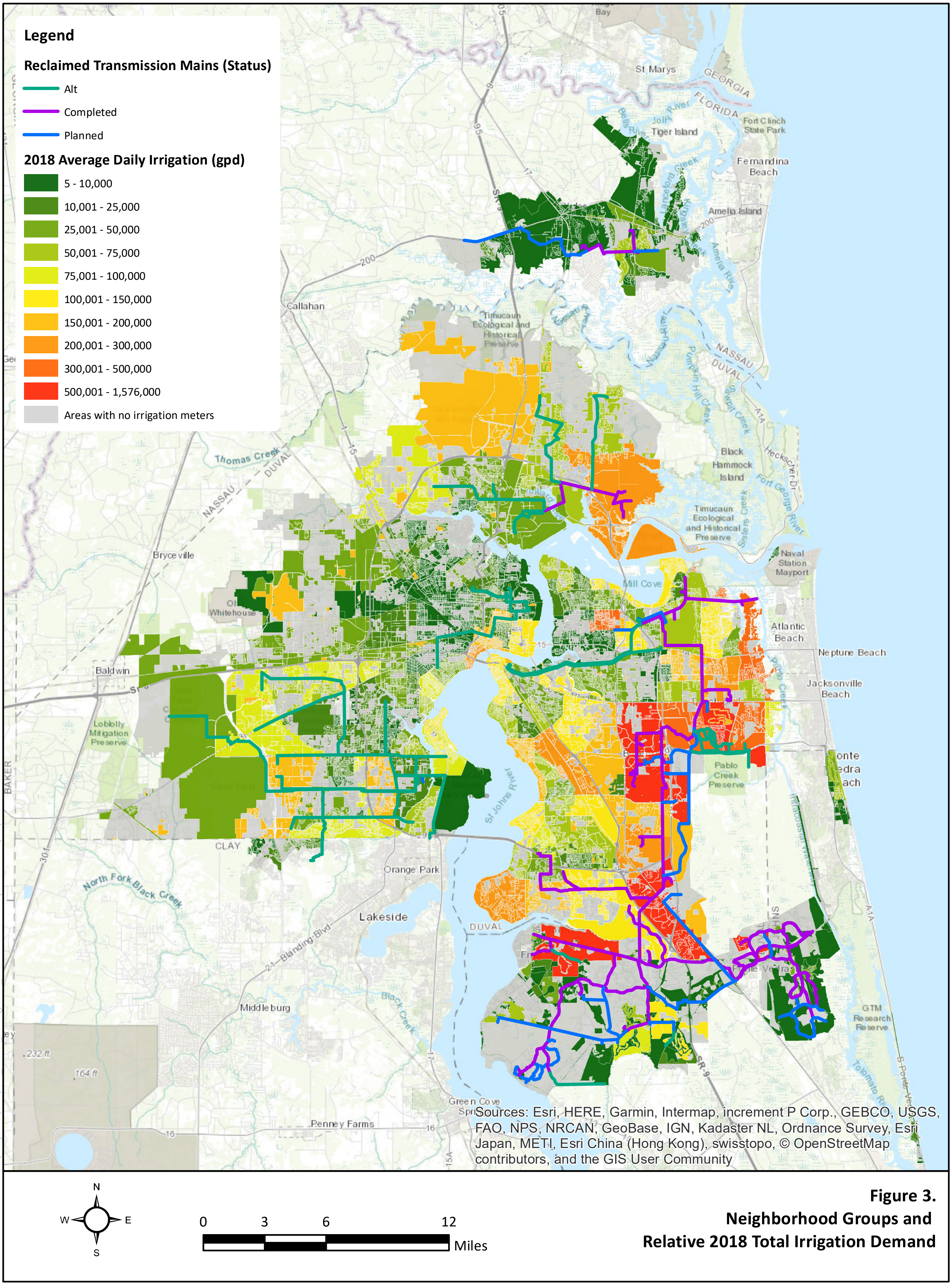

Figure 3.
Neighborhood Groups and Relative 2018 Total Irrigation Demand

3.3 Transfer to Other Service Areas

This alternative consists of conveying reclaimed water from an existing JEA WRF to a different utility's service area to use for public access irrigation. This alternative was considered for locations outside of JEA's service territory that are experiencing high residential growth, that are not currently supplied with reclaimed water or do not have enough reclaimed water capacity to meet projected demand. Currently, JEA does not transfer excess reclaimed water to any other service areas.

For this evaluation, JEA provided initial direction on existing WRFs and background on related discussions with nearby local utilities. For this to be a viable surface water discharge elimination alternative, an agreement between JEA and the receiving utility would need to be in place. The receiving utility would need to accept a minimum volume of water on a daily basis.

Based upon discussions with JEA, this alternative for eliminating surface water discharges is only being considered for one existing JEA WRF. Within the Southwest WRF service area, preliminary discussions are underway for JEA to provide CCUA with reclaimed water to help supplement their reclaimed water system to meet residential demand. This project could provide 5 to 10 mgd of reclaimed water to CCUA, serve as an additional revenue source to JEA, and offset the volume of water currently discharged by Southwest WRF to the St. Johns River. However, extensive treatment upgrades for Southwest WRF would be required to meet public access reuse standards, an approximately ten-mile booster pumping and pipeline network would need to be constructed, and additional measures still would be needed to dispose of the remaining average 6- to 11-mgd balance of the discharge volume that is ordinarily conveyed to the St. Johns River.

Assuming that JEA does not upgrade Southwest's 14-mgd facility to AWT, the same flow requirements applicable to deep well injection would apply to this water transfer, requiring 16.4 MG of equalization storage and 24.5 mgd of baseline flows to the other service area.

Conversely, assuming a 10-mgd baseline water transfer to CCUA, a minimum required equalization volume could be estimated for discharge elimination. Over the 3-year simulation period 3.4 billion gallons of storage would be required to eliminate discharges when water transfers are 10 mgd. However, even this large volume is not tenable since water levels were increasing steadily over the 3-year simulation, indicating that a 10-mgd diversion flow is too low for any size of storage to function effectively as equalization.

3.4 Potable Reuse (Direct and Indirect)

Potable reuse involves conveyance of reclaimed water to a newly constructed water purification facilities (WPF) that produces water of potable quality to either 1) be blended with finished water at an existing JEA water treatment plant (an approach known as DPR), or 2) be recharged directly into the Floridan aquifer, resulting in beneficial reuse credits for the JEA CUP (an approach known as IPR by aquifer recharge). For these two scenarios (DPR and IPR), it is assumed that the full AADF capacity of each WRF would be upgraded to AWT in order to allow JEA to be eligible for backup discharges, while also limiting the required WPF intake capacity and associated costs. Without

AWT, the IPR/DPR facility would need to be sized for MDF or larger to achieve “discharge elimination” without backup discharges. For example, without AWT upgrades at Arlington, the IPR/DPR facility needs to have an intake capacity of at least 45.6 mgd. AWT allows cutting the IPR/DPR facility intake capacity by 63%, which is a more cost-effective approach. Moreover, while AWT is not required for IPR or DPR, it would have an additional benefit of providing better removal of trace organic compounds and pathogens. For example, the FDEP protozoa database shows that Crypto and Giardia levels were about 30% lower in nitrifying facilities that effectively removed chemical biological oxygen demand (CBOD)[5].

Table 7 and **Table 8** summarize the DPR and IPR options by WRF.

A combined water recovery of 80% is assumed for both DPR and IPR via aquifer recharge, assuming that 20% of the inflow becomes concentrate to be disposed via deep well injection to the same aquifers for each WRF, and with the same injection capacities, as identified in the deep well injection discussion, with one standby well and associated monitoring wells included. The treatment train for either DPR or IPR includes ultrafiltration (UF), reverse osmosis (RO), and advanced oxidation with UV (UV-AOP), to provide multiple treatment barriers and pathogen removal, along with addition of post-treatment chemicals to stabilize the finished water pH, calcium, and alkalinity.

Both DPR and IPR would have unique treatment components. For DPR only, the final purified water would undergo a final polishing step using granular activated carbon (GAC) in conjunction with additional advanced online water quality analyzers, prior to conveyance to a nearby JEA drinking water facility. Special permit negotiations will likely be required to ensure JEA maintains enough flexibility in their well withdrawal capacity under the DPR scenario. For IPR, the final purified water would be injected into a region of the Floridan aquifer used for water supply. JEA would be able to receive beneficial reuse credits for their CUP if aquifer recharge is implemented. The number of recharge wells required per site is based on previous JEA drinking water well projects and assumes a 2.0-mgd capacity per recharge well. This scenario would also include four adjacent monitoring wells installed at each site.

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[5] MacNevin, D., & Zornes, G. 2020. “Health Risks from Protozoa in Potable Reuse: Implications of Florida’s Dataset.” *AWWA Wat. Sci.* 2020; e1199. https://doi.org/10.1002/aws2.1199. In Press as of 10/12/2020

Table 7. Application of Direct Potable Reuse for Discharge Elimination in 2027 at Each WRF

Location	WRF	AWT Upgrade	Target Permitted Reuse Capacity (mgd)	Existing Offsite Reuse Demand (mgd)	DPR Feed Capacity Required (mgd)	Concentrate Disposal Flow (mgd)	Concentrate Injection Wells Required (ea) [2]	Purified Water Production (mgd)	Potential WTP for Blending	Approx. Transfer Pipeline Distance (miles)
South	Arlington East	Add AWT	17.2	1.2	16.0	3.2	Three (3)	12.8	Arlington East	4.1
	Mandarin [1]	Add AWT	6.0	5.9	0.1	0.02	Two (2)	0.08*	Comm. Hall	2.8
	Monterey	Add AWT	1.5	0	1.5	0.3	Two (2)	1.2	Arlington	0.7
North	Cedar Bay	Add AWT	5.5	1.3	4.2	0.8	Two (2)	3.4	Highlands	3.2
	Buckman	Add AWT	23.4	0	23.4	4.7	Three (3)	18.7	Main Street	3.0
	Southwest	Add AWT	10.8	0	10.8	2.2	Three (3)	8.6	Southwest	4.8

[1] While DPR can allow for compliance with discharge elimination scenarios at these facilities, the amount of purified water produced is low compared to the investments required for implementation.
[2] Based on 2.0-mgd capacity per well, with one backup well at each location

Table 8. Application of Indirect Potable Reuse by Aquifer Recharge for Discharge Elimination in 2027 at Each WRF

Location	WRF	AWT Upgrade	Target Permitted Reuse Capacity (mgd)	Existing Offsite Reuse Demand (mgd)	IPR Feed Capacity Required (mgd)	Concentrate Disposal Flow (mgd)	Concentrate Injection Wells Required (ea) [2]	Purified Water for Recharge (mgd)	Recharge Wells Required (ea) [2]
South	Arlington East	Add AWT	17.2	1.2	16.0	3.2	Three (3)	12.8	Eight (8)
	Mandarin [1]	Add AWT	6.0	5.9	0.1	0.02	Two (2)	0.08*	Two (2)
	Monterey	Add AWT	1.5	0	1.5	0.3	Two (2)	1.2	Two (2)
North	Cedar Bay	Add AWT	5.5	1.3	4.2	0.8	Two (2)	3.4	Three (3)
	Buckman	Add AWT	23.4	0	23.4	4.7	Three (3)	18.7	Ten (10)
	Southwest	Add AWT	10.8	0	10.8	2.2	Three (3)	8.6	Six (6)

[1] While IPR can allow for compliance with discharge elimination scenarios at these facilities, the amount of purified water produced is low compared to the investments required for implementation.
[2] Based on 2.0-mgd capacity per well, with one backup well at each location

There are currently no regulations for potable reuse in Florida. However, in June 2020 Florida Governor Ron DeSantis signed Senate Bill 712, which deems reclaimed water as a water source for public water systems. The bill also requires FDEP to initiate rule revisions by the end of 2020 for potable reuse based on the recommendations of the Potable Reuse Commission's Framework Report. This is an important step forward towards the safe, regulated availability of DPR as a water supply option in Florida. However, FDEP has not yet permitted a DPR facility and the regulatory planning horizon is still uncertain. For the purpose of this evaluation, it was assumed DPR regulations would be in place by 2027 and appropriate permits for both the purified water and the concentrate could be obtained for each WRF where this alternative is utilized.

3.5 Land Area Required for Each Alternative

A conceptual-level assessment was performed for each WRF to evaluate the potential land area requirements associated with each discharge elimination alternative and results are presented in **Table 9**. For the injection wells (deep-wells and recharge wells), it was assumed each well occupies a 0.5-acre parcel and each monitoring well requires a 0.25-acre parcel. The pipeline corridor connecting each well would be located in existing easements or rights-of-way near roads; therefore, no additional land is required for the pipeline portion. Area requirements for the water purification facilities were estimated based on 3 acres required per 10 mgd of capacity. Using the estimates, a review of the available land area at each WRF was conducted, along with surrounding parcels. For the DPR, IPR, and deep well injection alternatives, additional land acquisition would be required for the Mandarin, Monterey, Buckman, and Ponte Vedra WRFs. This assessment concluded that the upgrades associated with AWT improvements could be achieved within the existing plant footprint/JEA-owned parcel, without the need for additional land acquisition.

Table 9. Approximate Land Area Requirements Associated with Each Discharge Elimination Alternative

Location Grid	WRF	Permitted Flow (mgd AADF)	Land Area Required (Acres)				Nearby JEA-owned Parcel Area (Acres)	Additional Land Purchase Required? (Yes/No)
			AWT Upgrades [1]	DWI	IPR	DPR [2]		
South	Arlington East	25	0.4	24.2	19.6	9.6	69	No
	Mandarin	8.75	0.25 [3]	4.3	NA	NA	0	**Yes**
	Monterey	3.6	0.1	4.6	8.6	4.6	0	**Yes**
North	Cedar Bay	10	0.2	6.4	10.4	5.4	19.5	No
	Buckman	52.5	0.8	29.9	24.2	12.2	0	**Yes**
	Southwest	14	0.2	22.7	15	7	100	No
Small	Ponte Vedra	0.8	0.1	3.4	NA	NA	0	**Yes**

WRF – Water Reclamation Facility, AADF – Annual Average Daily Flow, DWI – Deep Well Injection; IPR – Indirect Potable Reuse, DPR – Direct Potable Reuse, NA – Not Applicable

[1] Assumes 0.015 acre/mgd upgrade required for addition of deep-bed/denitrifying filters and tankage associated with enhanced nitrogen and phosphorous removal

[2] The pipeline corridor to convey water to selected WTP(s) would be in existing easements or rights-of-way near roads; therefore, no additional land is required for the pipeline portion.

[3] Estimated area for new tankage associated with enhanced nitrogen and phosphorous removal (assumes existing sand filters can be retrofitted)

4.0 Summary of Improvements Required for Discharge Elimination Under Different Scenarios

Passage of a wastewater discharge elimination requirement in Florida would require substantial investment in new infrastructure to comply. If the Florida Legislature adopts this requirement, we recommend JEA conduct a full and extensive study to determine the feasibility of meeting the enacted requirements, including details of the required improvements, implementation schedule, and impact to rate payers. **Table 10** summarizes the feasibility level design criteria associated with the implementation of five potential alternative discharge elimination scenarios. A combination/hybrid scenario will be developed.

A review of available property information was performed for each WRF to evaluate the potential land area requirements associated with each discharge elimination alternative. For the DPR, IPR, and deep well injection alternatives, additional land acquisition would be required for the Mandarin, Monterey, Buckman, and Ponte Vedra WRFs. In addition to requiring additional property, the construction of deep injection wells and recharge wells would proceed slowly, causing significant impacts to the surrounding community. The upgrades associated with AWT improvements could be achieved within the existing plant footprint/JEA-owned parcel, without the need for additional land acquisition.

Advanced wastewater treatment status of an WRF allows a facility to utilize APRICOT backup discharge credits. When AWT was active, backup discharges were limited to 25% of the total permitted reuse capacity, instead of the full 30% to provide some conservatism for uncertainty in inflows. Permitted reuse capacity for calculation of backup discharges was based on off-site reclaimed water demand (not capacity) plus the intake capacity of any potable reuse facilities (assuming full utilization).

Since neither of the following options would result in an increased APRICOT backup discharge, no AWT upgrades are assumed for the following scenarios: 1) Deep Well Injection, or 2) Water Transfer. Since all the following scenarios result in an increased APRICOT backup discharge reducing the required reclaimed water demand and required water purification facility capacities, AWT upgrades are assumed for the following scenarios: 1) Expanded Reclaimed, 2) Direct Potable Reuse, and 3) Indirect Potable Reuse Scenarios. Note, when AWT retrofits are assumed, the full flow (AADF) of each WRF is upgraded. A detailed assessment of AWT upgrade requirements was not performed at each WRF. It is assumed that the upgrade could be accomplished largely through retrofits of existing infrastructure with some expanded construction potentially being required.

Following is a summary of each discharge elimination scenario's potential applicability to meet a potential discharge elimination requirement:

- **Deep Well Injection**: This scenario assumed discharge elimination, with no backup discharges. Equalization storage tanks were constructed to reduce the number of wells required, with tankage sized to capture 50% of the maximum daily flow at each WRF, result in construction of 90 MG in equalization storage tanks. A total of 75 deep injection wells are required constructed, each extending to depths of more than 2,000 ft BLS, assuming Class I disposal wells are feasible to the Fernandina Permeable Zone (FPZ) (2 mgd each, Arlington East only) or the Lawson Limestone (2 mgd each, all other WRFs). This total assumes one backup disposal well for each WRF and associated monitoring wells. While the individual deep wells require a negligible amount of land, the construction of so many deep wells over many months could cause serious disruption to neighborhoods in the form of noise from drilling rigs and disruptions to roadway crossings from excavation to lay numerous miles of connecting pipelines.

- **Expanded Reclaimed (Insufficient to Eliminate Discharge)**: This scenario evaluated existing irrigation demands not already on JEA's reclaimed system for potential transfer to reclaimed supply. Irrigation demands were evaluated by neighborhood and then grouped by closest WRF in the same Grid in need of expanded reclaimed to mitigate surface water discharges. A total of 113.85 mgd in AWT retrofits at 6 facilities are included to maximize backup discharges and minimize the required expanded reclaimed volume. Even after AWT improvements, expanded reclaimed cannot meet the systemwide discharge elimination goal, only provided a maximum demand of 23.9 mgd, which falls short of the 64.4 mgd target demand needed, even with backup discharge credits from AWT upgrades.

  Not considering the cost and feasibility of adding the full irrigation demands to the reclaimed service area, there appears to be sufficient irrigation demand near Mandarin to meet the associated discharge elimination requirements at those facilities. Monterey did not comply with the discharge requirement, facing a 0.2-mgd demand shortfall; however, shifting demand from Arlington East could alleviate this shortfall. Nevertheless, there is insufficient irrigation demand for expanded reclaimed to result in discharge elimination compliance at Arlington East, Cedar Bay, Buckman, and Southwest.

- **Water Transfer (Insufficient to Eliminate Discharge):** This scenario assumes transfer of reclaimed water to a neighboring utility service area for beneficial reuse. The only potential application identified for this scenario is at Southwest WRF, with a potential water transfer of up to 10 mgd to CCUA for use as reclaimed water. Southwest does not currently provide tertiary filtration and high-level disinfection to produce reclaimed water for Public Access Reuse. No additional treatment is assumed by JEA prior to transfer to CCUA. Since no AWT upgrades are assumed, the discharge elimination criteria are the same as with deep well injection, namely 24.5 mgd of demand when 16.5 MG of equalization storage is provided. The 10 mgd of demand from CCUA is insufficient to meet discharge elimination criteria since 24.5 mgd of demand is needed from Southwest when 16.4 MG of equalization storage is provided. Therefore, water transfers would not result in compliance with discharge elimination criteria.

- **Direct Potable Reuse:** This scenario assumes construction of 113.85 mgd (AADF) in AWT improvements among the 6 WRFs in Table 10 currently without AWT. Six water purification facilities are constructed with combined production capacity of 44.7 mgd. These facilities are operated as base-loaded facilities at 100% utilization. Water recovery is 80%, resulting in a combined 11.2 mgd of concentrate handled by 15 concentrate disposal wells. Concentrate disposal wells are similar in construction to the deep injection wells described earlier and their construction would cause similar disruption to neighborhoods.

Purified water would be transferred to nearby existing JEA WTPs for blending with finished water. Special permit negotiations will likely be required to ensure JEA maintains enough flexibility in their well withdrawal capacity under the DPR scenario. The 6 required pipelines conveying a combined 44.7 mgd of purified water would have total estimated length of nearly 19 miles. The WPF at Mandarin had a trivial production capacity—0.08 mgd—required to meet the associated discharge elimination requirement. While such an option could meet the discharge requirement at Mandarin, it would be too small of a facility to be practical. One potential option could be to divert excess reclaimed water flows from the Mandarin region of the collection system to the Arlington WRF.

- **Indirect Potable Reuse:** This scenario assumes construction of 113.85 mgd (AADF) in AWT improvements among the 6 WRFs in Table 10 currently without AWT. Upgrades to AWT are assumed in order to allow APRICOT backup discharges, reducing the required capacity of indirect potable reuse facilities. Six water purification facilities are constructed with combined production capacity of 44.7 mgd. These facilities are operated as base-loaded facilities at 100% utilization. Water recovery is 80%, resulting in a combined 11.2 mgd of concentrate handled by 15 concentrate disposal wells. Concentrate disposal wells are similar in construction to the deep injection wells described earlier and their construction would cause similar disruption to neighborhoods.

  Purified water would be transferred to 31 recharge wells for injection to the Floridan aquifer. One water supply benefit of aquifer recharge is JEA would receive CUP credits for the water used for aquifer recharge. Construction of these recharge wells would proceed more rapidly than deep wells but would still cause disruption to surrounding neighborhoods. The WPF at Mandarin had a trivial production capacity, 0.08 mgd, required to meet the associated discharge elimination requirement. While such an option could meet the discharge requirement at Mandarin, it would be too small of a facility to be practical. One potential option could be to divert excess reclaimed water flows from the Mandarin region of the collection system to the Arlington WRF.

Table 10. Feasibility Level Design Criteria for Six Scenarios to Eliminate Surface Water Discharges at Select JEA WRFs in 2027

Location	WRF	Upgrade to AWT? (Capacity in AADF)	Scenarios for Discharge Elimination in 2027					
			Deep Well Injection *(Table 5)*	Expanded Reclaimed *(Table 6)*	Water Transfers	Direct Potable Reuse *(Table 7)*	Indirect Potable Reuse *(Table 8)*	Combo/ Hybrid
South	Arlington East	No AWT	EQ Tanks (22.9 MG) 18 Wells (33.0 mgd)	-[1]	No Customer	-[2]	-[2]	TBD
		Retrofit for AWT (25 mgd)	-[3]	Insufficient Demand 11.2 mgd Max 17.2 mgd Target		Water Purification Facility (12.8 mgd) 3 Conc. Disposal Wells (3.2 mgd) 4.1 Mile Pipeline to Arlington East WTP	Water Purification Facility (12.8 mgd) 3 Conc. Disposal Wells (3.2 mgd) 8 Recharge Wells (12.8 mgd)	
	Mandarin	No AWT	EQ Tanks (4.0 MG) 2 Wells (1.3 mgd)	-[1]	No Customer	-[2]	-[2]	TBD
		Retrofit for AWT (8.75 mgd)	-[3]	Enough Demand 6.0 mgd Max 6.0 mgd Target		SMALL CAPACITY FACILITY Water Purification Facility (0.08 mgd) 2 Conc. Disposal Wells (0.02 mgd) 2.8 Mile Pipeline to Community Hall WTP	SMALL CAPACITY FACILITY Water Purification Facility (0.08 mgd) 2 Conc. Disposal Wells (0.02 mgd) 2 Recharge Wells (0.8 mgd)	
	Monterey	No AWT	EQ Tanks (2.4 MG) 3 Wells (3.6 mgd)	-[1]	No Customer	-[2]	-[2]	TBD
		Retrofit for AWT (3.6 mgd)	-[3]	Nearly Enough Demand 1.3 mgd Max 1.5 mgd Target		Water Purification Facility (1.2 mgd) 2 Conc. Disposal Wells (0.3 mgd) 0.7 Mile Pipeline to Arlington WTP	Water Purification Facility (1.2 mgd) 2 Conc. Disposal Wells (0.3 mgd) 2 Recharge Wells (1.2 mgd)	
North	Cedar Bay	No AWT	EQ Tanks (5.5 MG) 5 Wells (7.6 mgd)	-[1]	No Customer	-[2]	-[2]	TBD
		Retrofit for AWT (10 mgd)	-[3]	Insufficient Demand 2.52 mgd Max 5.5 mgd Target		Water Purification Facility (3.4 mgd) 2 Conc. Disposal Wells (0.8 mgd) 3.2 Mile Pipeline to Highlands WTP	Water Purification Facility (3.4 mgd) 2 Conc. Disposal Wells (0.8 mgd) 3 Recharge Wells (3.4 mgd)	
	Buckman	No AWT	EQ Tanks (35.5 MG) 28 Wells (53.2 mgd)	-[1]	No Customer	-[2]	-[2]	TBD
		Retrofit for AWT (52.5 mgd)	-[3]	Insufficient Demand 1.1 mgd Max 23.4 mgd Target		Water Purification Facility (18.7 mgd) 3 Conc. Disposal Wells (4.7 mgd) 3.0 Mile Pipeline to Main Street WTP	Water Purification Facility (18.7 mgd) 3 Conc. Disposal Wells (4.7 mgd) 10 Recharge Wells (18.7 mgd)	
	Southwest	No AWT	EQ Tanks (16.4 MG) 14 Wells (24.5 mgd)	-[1]	Insufficient Demand to Comply 10 mgd Max to CCUA 24.5 mgd Target	-[2]	-[2]	TBD
		Retrofit for AWT (14 mgd)	-[3]	Insufficient Demand 1.78 mgd Max 10.8 mgd Target	-[3]	Water Purification Facility (8.6 mgd) 3 Conc. Disposal Wells (2.2 mgd) 4.8 Mile Pipeline to Southwest WTP	Water Purification Facility (8.6 mgd) 3 Conc. Disposal Wells (2.2 mgd) 6 Recharge Wells (8.6 mgd)	
Small	Nassau	AWT	EQ Tanks (2.6 MG) 3 Wells (4.0 mgd)	-[5]	-[5]	-[5]	-[5]	-[5]
	Ponte Vedra	No AWT	EQ Tanks (0.9 MG) 2 Wells (1.0 mgd)	-[5]	-[5]	-[5]	-[5]	-[5]
Combined Improvements for Scenario			***No AWT Retrofits*** ***EQ Tanks (90 MG)*** ***75 Wells (128.2 mgd)***	***113.85 mgd AWT Retrofits*** ***23.9 mgd Max Demand*** ***64.4 mgd Target***	***No AWT Retrofits*** ***CCUA Reports 10 mgd Max Demand*** ***24.5 mgd Target***	***113.85 mgd AWT Retrofits*** ***6 DPR WPFs (44.7 mgd)*** ***15 Conc. Disposal Wells (11.2 mgd)*** ***6 Pipelines to WTPs (18.6 miles)***	***113.85 mgd AWT Retrofits*** ***6 IPR WPFs (44.7 mgd)*** ***15 Conc. Disposal Wells (11.2 mgd)*** ***31 Recharge Wells (43.8 mgd)***	***TBD***

Key		
	Pink	*Not Compliant or Practical*
	Yellow	*Marginal Compliance*
	Green	*Compliant with Discharge Requirement[4]*
	Grey	*Not Considered*

Notes: [1]-Expanded Reclaimed not considered without AWT since AWT enables APRICOT backup discharges, reducing required reclaimed demand.
[2]-Potable reuse not considered without AWT since AWT enables APRICOT backup discharges, reducing required facility capacity, infrastructure, and capital costs
[3]-AWT upgrades not considered with deep well injection or water transfers since APRICOT does not give provide any backup discharge credit for these scenarios.
[4]-While this initial screening may suggest some options are technically feasible for meeting the discharge elimination related goals, this does not consider project costs and other implementation factors that may complicate implementation of the scenario.
[5]- Deep well injection was the only surface water discharge elimination alternative considered for this WRF

Appendix A

Deep Well Injection Scenario Technical Memorandum provided by Liquid Solutions Group

TECHNICAL MEMORANDUM

To:	Shayne Wood, P.E., BCEE	**Date:**	August 31, 2020
From:	Oscar Vera, Ph.D., P.E., D.WRE Roberto Denis, P.E., D.WRE	**Reference:**	JEA IWRP - Wastewater Deep Injection Well Disposal Option
Subject:	**Elimination of JEA Wastewater Discharges Deep Injection Well Disposal Option**		

EXECUTIVE SUMMARY

JEA is currently evaluating reclaimed water disposal options to eliminate surface water discharges into the St. Johns River. One of the alternate options considered is the use of deep injection wells to dispose of wastewater below the Underground Source of Drinking Water.

This memorandum presents a conceptual evaluation of deep injection well disposal for nine JEA's Wastewater Treatment Facilities forecasted to produce excess reclaimed water through 2027. This study identifies two potential subsurface injection zones based on an assessment of the hydrogeology and groundwater quality. These two zones are: the Fernandina Permeable Zone, which is the lowermost productive zone of the Lower Floridan aquifer, and the Lawson Limestone, which is below the Lower Floridan aquifer. Total Dissolved Solids concentration in these injection zones have been reported to range from about 10,000 mg/L in the shallower zone to about 200,000 mg/L in the deepest one.

While disposing wastewater into the Fernandina Permeable Zone has the advantage of lower injection pressures, lower costs, and alternative water supply benefits, this option may only be feasible at one wastewater treatment plant utilizing current treatment processes. For the majority of sites, where existing wastewater quality would require injection into the Lawson Limestone, both capital and operating costs would be substantially higher.

As noted in this assessment, the potential costs for the required injection wells are over $650 million. These costs are substantially affected due to a number of factors including the number of wells required, the spatially-distributed nature of the wastewater flows, the potential drilling issues encountered at these depths, and the limited number of drillers capable of such construction. Furthermore, these costs do not consider potential wastewater treatment modifications or land acquisition costs.

Introduction

JEA produces approximately 80 million gallons (MG) of wastewater water each day. Wastewater that is not beneficially reused is discharged into the St. Johns River (JEA, 2020). JEA is currently evaluating alternate wastewater disposal options to eliminate surface water discharges.

One of the alternate disposal options considered is the use of deep injection wells (DIWs). In Florida, DIWs are used to dispose municipal and non-hazardous wastes (e.g., wastewater) below the Underground Source of Drinking Water (USDW). At locations where hydrogeologic conditions are suitable, and where other disposal methods are not possible or may cause contamination, subsurface injection below all USDWs is considered a viable and lawful disposal method in Florida (Florida Department of Environmental Protection [FDEP], 2020a).

This memorandum presents a conceptual evaluation of DIWs for wastewater disposal at nine JEA wastewater treatment facilities (WWTFs). These WWTFs are forecasted to produce excess wastewater through 2027. This study identifies potential subsurface injection zones based on an assessment of the hydrogeology and groundwater quality present at the location of the WWTFs.

JEA's WRFs And Groundwater Quality

The nine WWTFs that define the focus of this study are located in east Nassau County, north central, central, and south central Duval County, and in north St. Johns County, as shown in **Figure 1**. These WWTFs are forecasted to produce a surplus of wastewater through 2027 as shown in **Table 1**. As such, DIW disposal options were considered to eliminate surface water discharges to the St. Johns River from these facilities.

The evaluation of DIWs for JEA's WWTFs involved characterization of groundwater quality present in deep zones of the aquifer beneath the WWTFs. More specifically, groundwater quality characterization is required to determine the lowest limit of the USDW below which injection of wastewater may be feasible. The FDEP defines an USDW as an aquifer that supplies drinking water for human consumption, and it has a total dissolved solids (TDS) concentration of less than 10,000 milligrams per liter (mg/L) (FDEP, 2020b).

The estimated altitude of the 10,000 mg/L TDS surface (i.e., base of the USDW) under JEA's WWTFs is presented in **Table 2**. As depicted by Williams and Kuniansky (2016), the base of the USDW appears to be located consistently at an elevation of about -2,000 ft.-NGVD29 across the nine WWTFs. In fact, the 10,000 mg/L TDS surface is relatively "flat" or uniform inside the study area, varying from about -1,900 ft.-NGDVD29 in north St. Johns County to about -2,150 ft.-NGDVD29 in Nassau County, as shown in **Figure 2**.

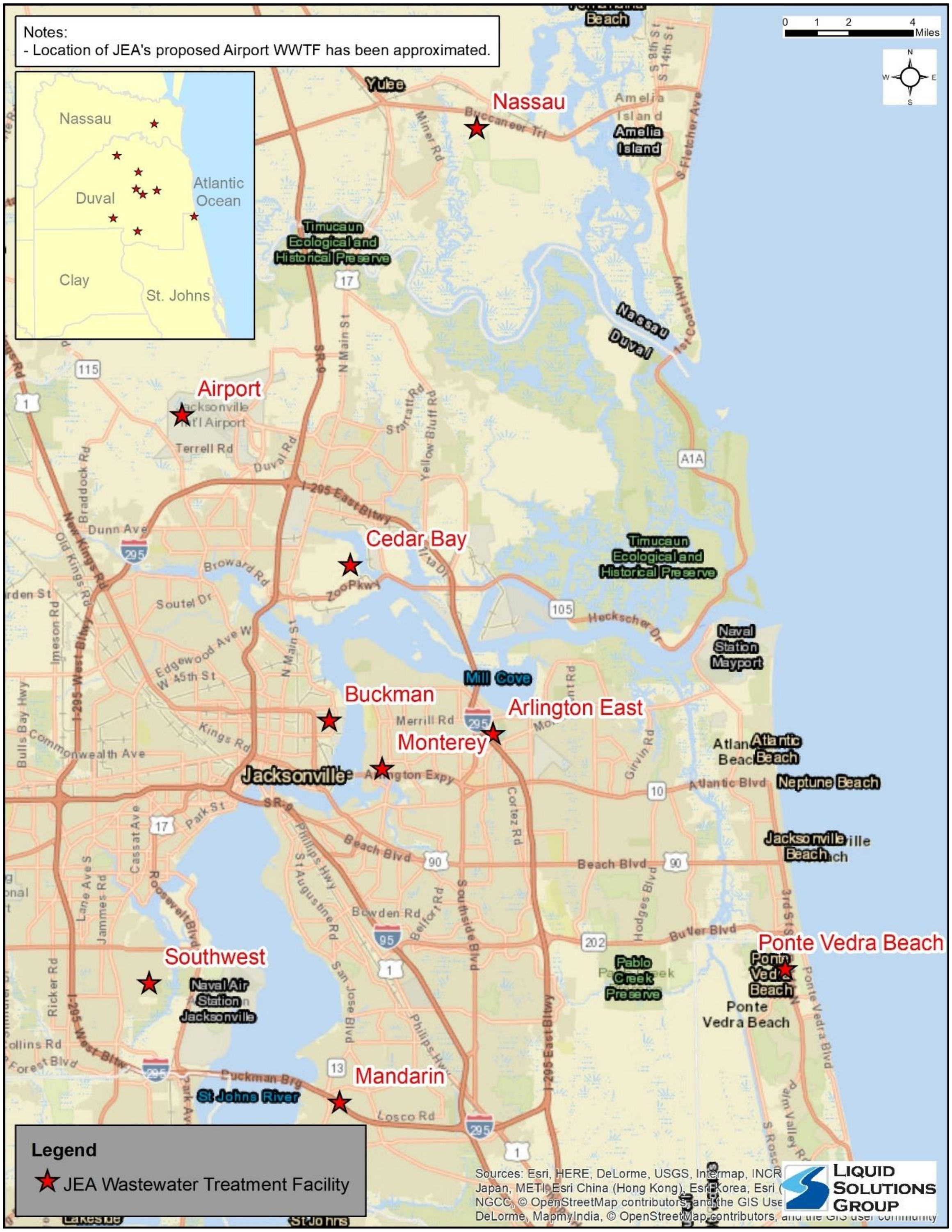

Figure 1. JEA's WWTFs Evaluated for Potential DIW Disposal.

Table 1. Projected Wastewater Capacity Deficits at JEA WWTFs

WWTF	Projected Flows in 2027 (mgd AADF)	Committed Uses in 2027 (mgd AADF)	Capacity Deficit in 2027 (mgd AADF)
Arlington East	21.1	0.0	21.1
Buckman	29.3	0.0	29.3
Cedar Bay	6.8	1.3	5.5
Future Airport	1.0	0.0	1.0
Mandarin	6.3	5.9	0.4
Monterey	1.7	0.0	1.7
Nassau	2.06	2.34	1.94**
Ponte Vedra Beach	0.7	0.7	0.1**
Southwest	13.6	0.3	13.3
Totals	82.56	10.54	74.34

** - Calculated as future permitted ADF minus forecast AADF.

Table 2. Estimated Altitude of the 10,000 mg/L TDS Surface Under JEA's WWTFs

WWTF Name	Elevation, ft.-NGVD29[a,b,c]
Airport	-2,126
Arlington East	-2,050
Buckman	-2,061
Cedar Bay	-2,103
Mandarin	-1,992
Monterey	-2,046
Nassau	-2,155
Ponte Vedra Beach	-2,048
Southwest	-2,006
Minimum	-2,155
Maximum	-1,992
Average	-2,065

Notes:
a. ft.= Foot.
b. NGVD29 = National Geodetic Vertical Datum of 1929.
c. Source: Williams and Kuniansky, 2016.

The distribution of TDS concentration below land surface (bls) was also investigated. Estimating TDS at various depths not only assists with identifying potential injection zones under JEA's WWTFs, but also helps define the level of pre-treatment required (if any) prior to injection. Furthermore, changes in TDS concentration affects the density of the receiving groundwater, which modifies estimated injection pressures and costs associated with the DIW disposal option.

Figure 3 shows TDS concentrations sampled inside a deep groundwater monitoring well located at JEA's Arlington East WWTF. This well is also known as Well D-3060 (USGS Site 302052081323201). Well D-3060 was constructed in 1982, and it was drilled to a depth of about 2,112 ft. (Brown et al., 1985).

The bottom of the well coincides with the base of the Floridan Aquifer System (FAS) (i.e., bottom of the LFA); as depicted by Williams and Kuniansky (2016), and as shown in **Figure 4**.

TDS concentrations associated with Well D-3060 have been sampled at depths between 1,920 ft. and 2,126 ft. bls., based on data retrieved from the St. Johns River Water Management District (SJRWMD) database. As shown in **Figure 4**, this depth interval includes the bottom zone of the LFA or Fernandina Permeable Zone (FPZ), and (potentially) a semi-confining unit below the FPZ. Based on **Figure 3**, it is inside this depth interval that TDS concentrations have been observed to exceed the 10,000 mg/L threshold, ranging from 13,590 mg/L to 20,700 mg/L, and averaging approximately 16,400 mg/L from 2003 through 2009. These site specific water quality data show the USDW as potentially shallower than 1,920 ft. bls which differs slightly from the regional conceptualization documented in **Figure 4**.

There is insufficient local water quality data available below the FPZ. However, Tetra Tech (2014) have reported TDS concentrations in excess of 100,000 mg/L within the Cedar Keys Formation and the Lawson Limestone for studies conducted in Central Florida. This estimation matches a range of TDS concentrations between 35,000 mg/L and 200,000 mg/L reported by Hovorka et al. (2003) for the lower Cedar Keys and upper Lawson Dolomites in Central and South Florida.

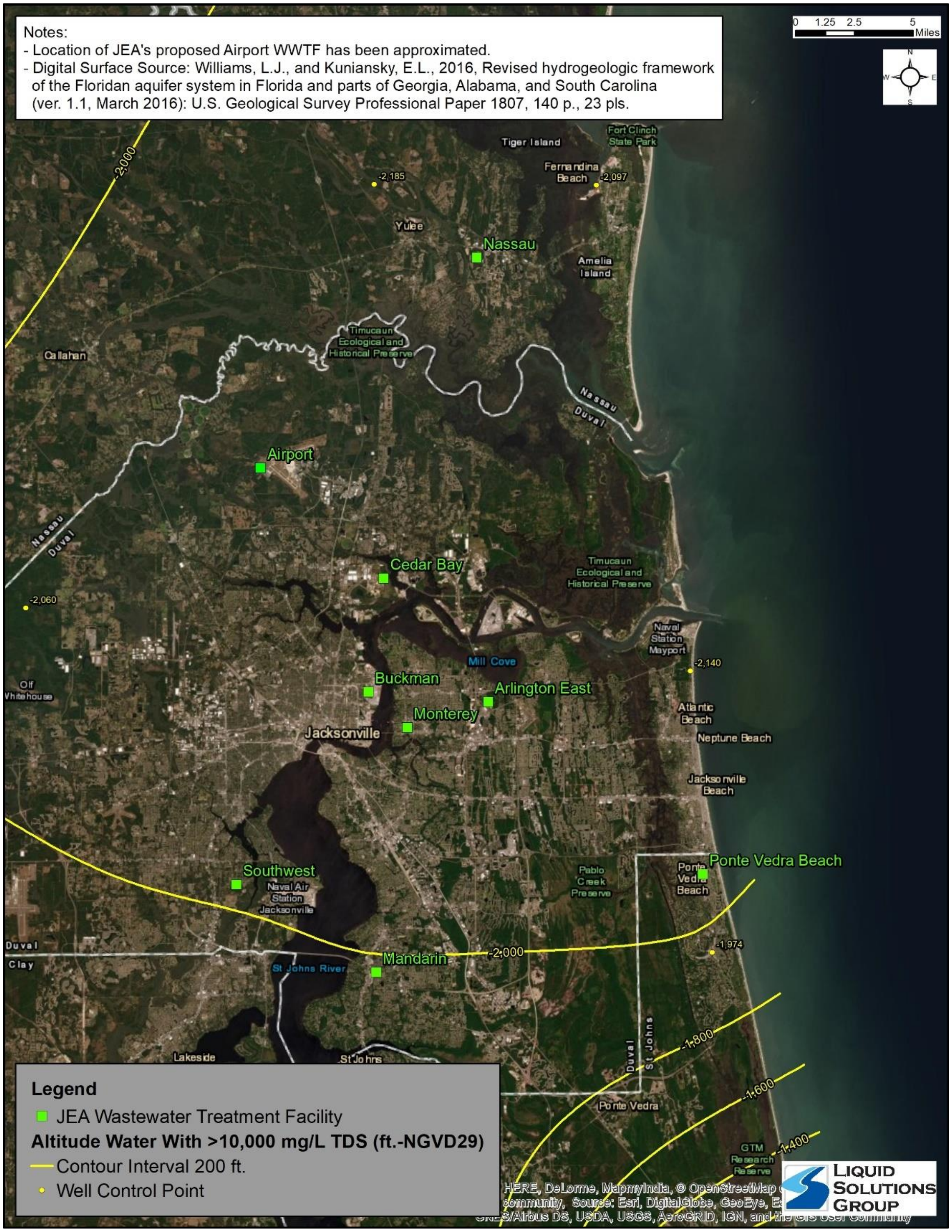

Figure 2. Estimated Altitude of the 10,000 mg/L TDS Surface (Base of the USDW).

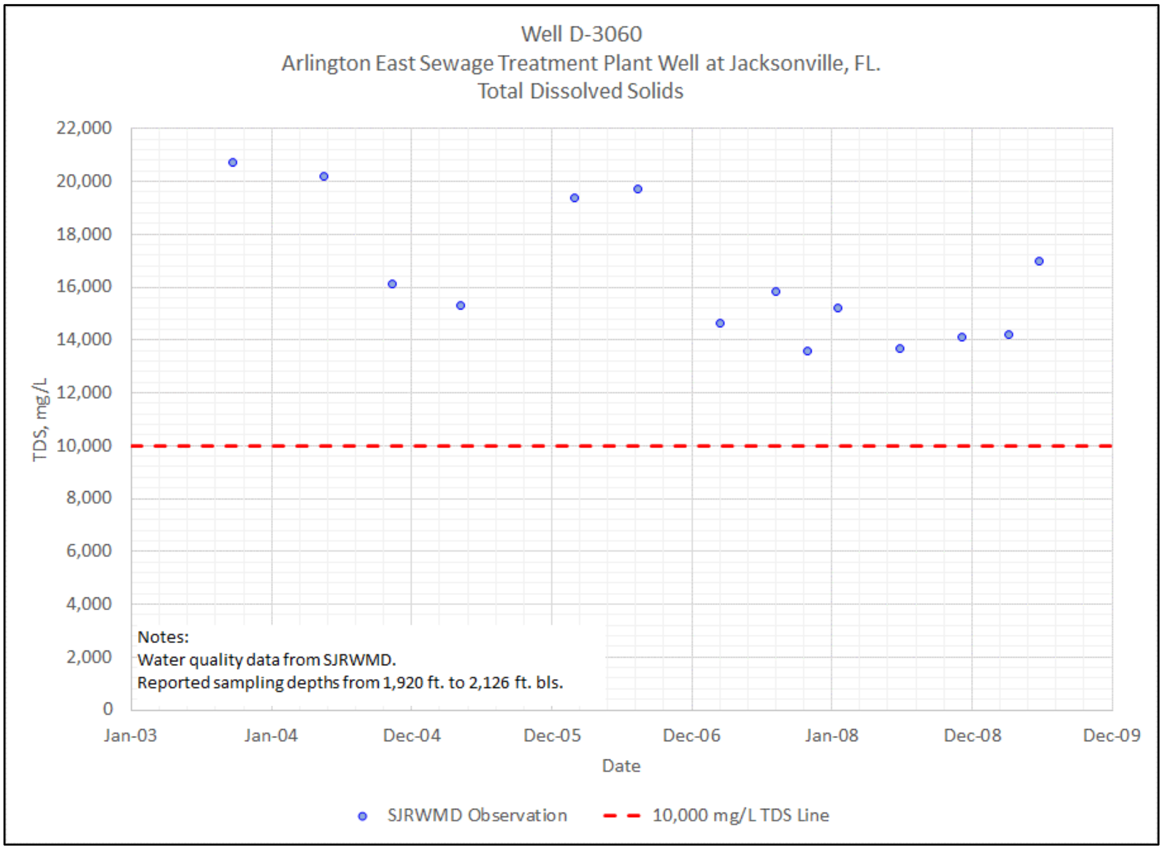

Figure 3. Groundwater TDS Concentration Distribution at Well D-3060.

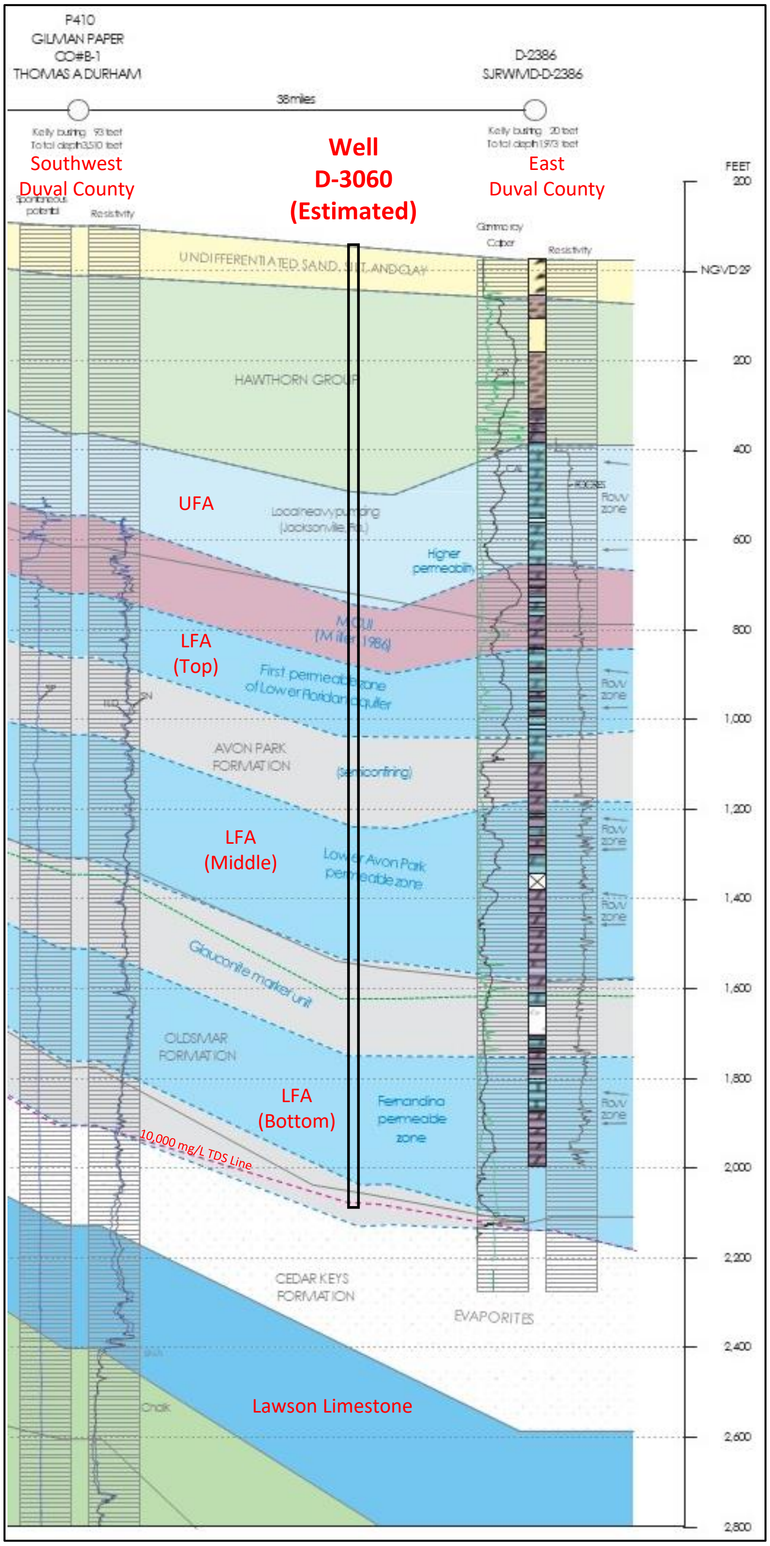

Figure 4. General East-Southwest Cross-Section in Duval County (Modified from Williams and Kuniansky, 2016).

Aquifer Injection Zones

Based on the groundwater quality characterization presented above, two zones of the aquifer have been identified for potential wastewater DIW disposal associated with JEA's WWTFs. These two zones are: the FPZ and the Lawson Limestone.

Figure 5 and **Figure 6** show the estimated top and bottom elevation of the FPZ, respectively. Similar to the estimated TDS surface presented in **Figure 2**, the location (altitude) of the FPZ is relatively uniform across JEA's WWTFs, varying less than 100 ft. from average elevation.

The Lawson Limestone is located beneath the Cedar Keys Formation. Available hydrogeologic data for this formation is very limited. However, Hovorka et. al (2003) presented a map showing the estimated depth to the top of the Lawson Limestone in the vicinity of JEA's WWTF. The estimated "depth-to-top" digital surface is shown in **Figure 7**. At the location of JEA's WWTF, the Lawson Formation is located between about -2,200 ft. and -2,500 ft. bls. These estimated depths correlate well with the elevations presented in **Figure 4**, as estimated by Williams and Kuniansky (2016). Also, based on **Figure 4**, the thickness of the Lawson Limestone is estimated to be at least 400 ft.

Table 3 summarizes the estimated location of both the FPZ and the Lawson Limestone under JEA's WWTFs.

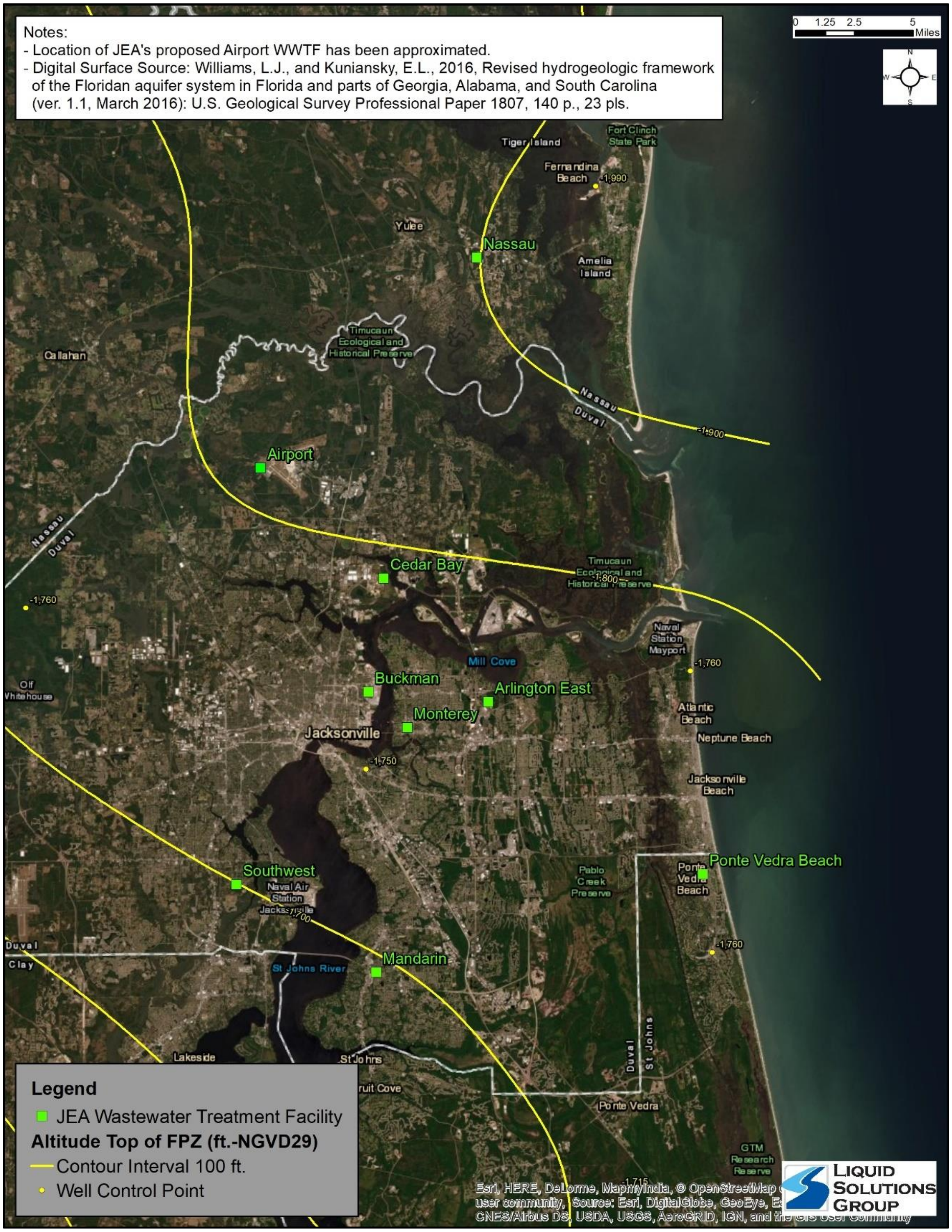

Figure 5. Estimated Top Surface Elevation of the FPZ.

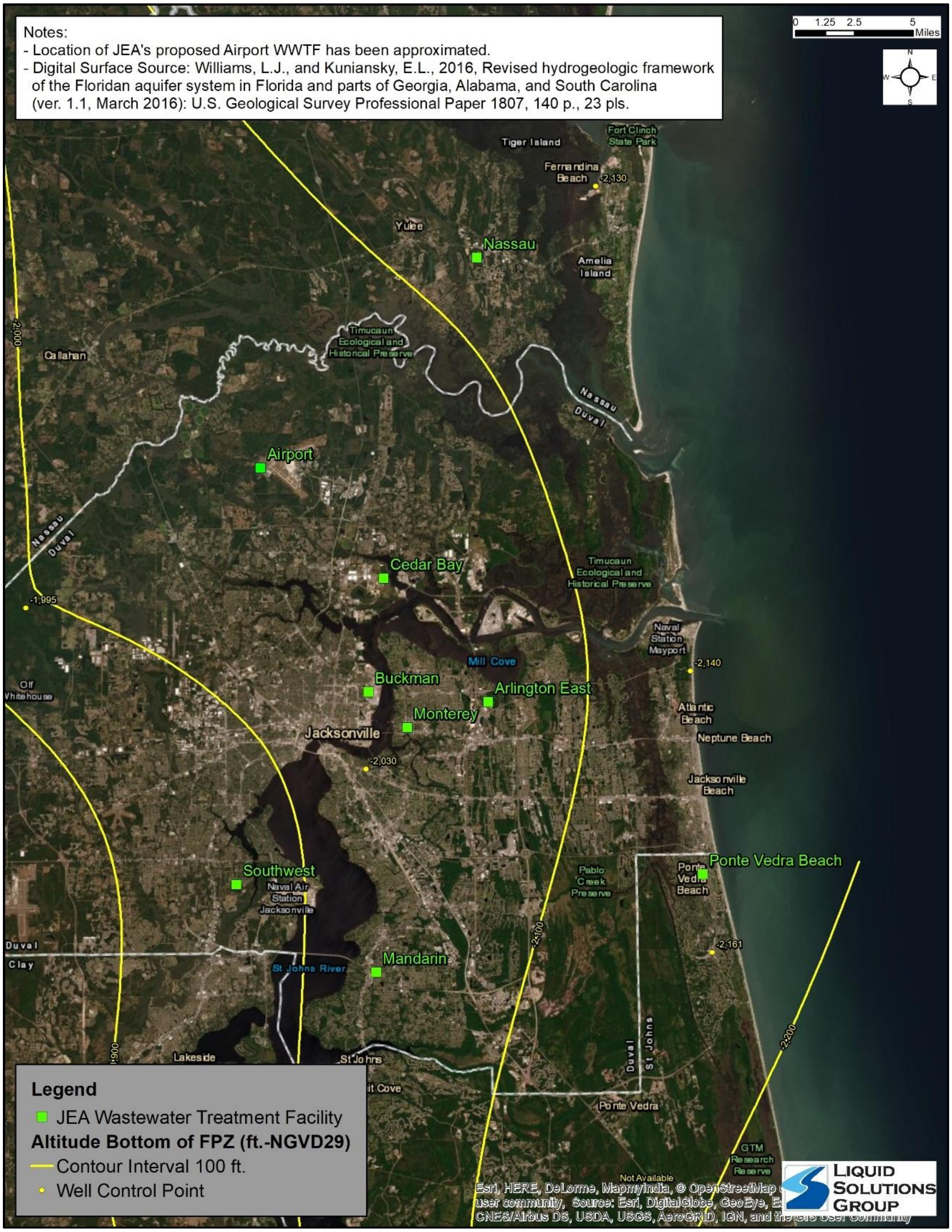

Figure 6. Estimated Bottom Surface Elevation of the FPZ.

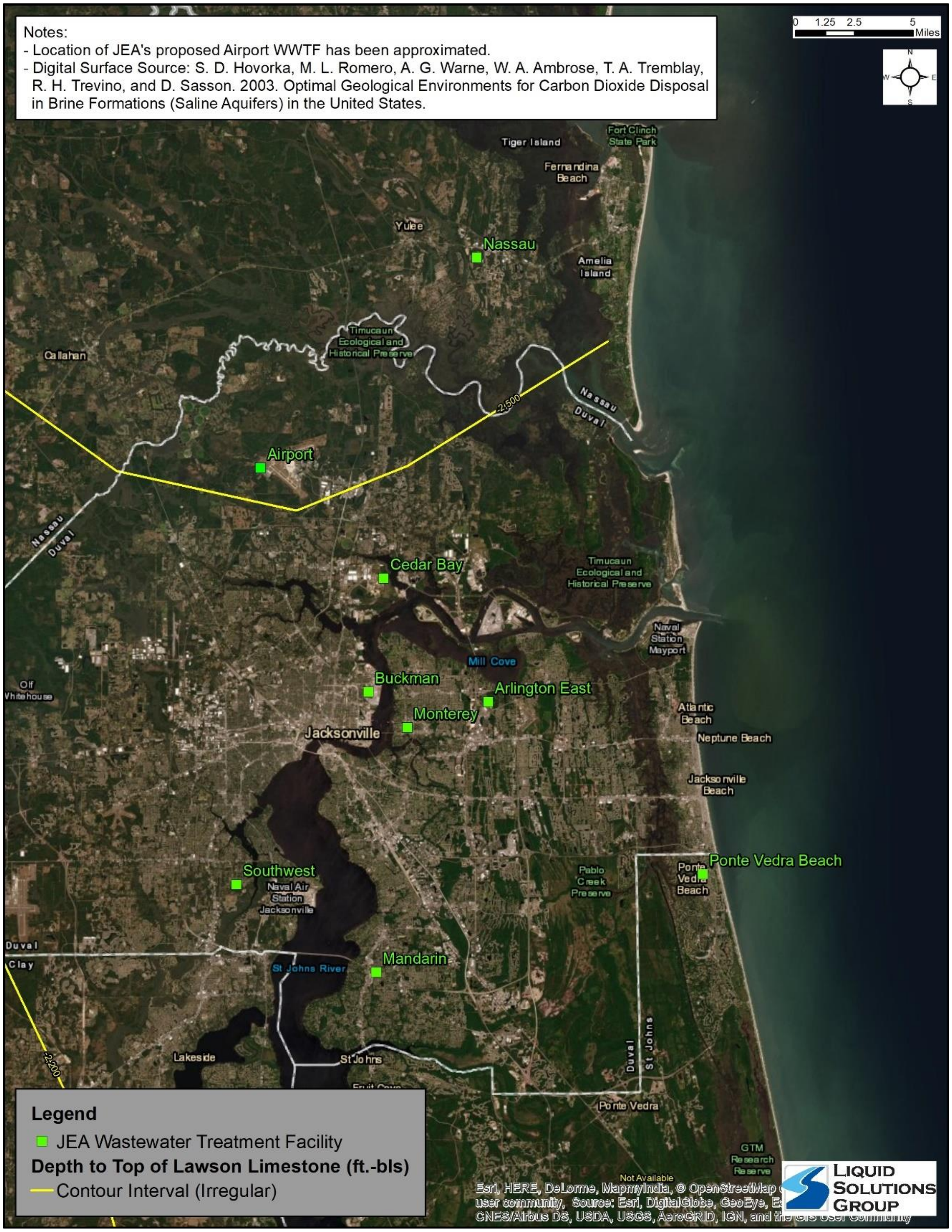

Figure 7. Estimated Depth to Top of Lawson Limestone.

Table 3. Estimated Altitude of the FPZ and Lawson Limestone Under JEA's WWTFs

WWTF Name	FPZ Top Elevation (ft.-NGVD29)[a]	FPZ Bottom Elevation (ft.-NGVD29)[a]	Lawson Limestone Top Elevation (ft.-NGVD29)[a]	Lawson Limestone Bottom Elevation (ft.-NGVD29)[a]
Airport	-1,806	-2,057	Approximately -2,300 to -2,500	Approximately -2,700 to -2,900
Arlington East	-1,750	-2,065		
Buckman	-1,762	-2,033		
Cedar Bay	-1,788	-2,054		
Mandarin	-1,692	-2,032		
Monterey	-1,754	-2,042		
Nassau	-1,901	-2,111		
Ponte Vedra Beach	-1,753	-2,154		
Southwest	-1,698	-1,966		
Minimum	-1,901	-2,154	-2,500	-2,700
Maximum	-1,692	-1,966	-2,300	-2,900
Average	-1,767	-2,057	-2,400	-2,600

Notes:
a. Source: Williams and Kuniansky, 2016.

Hydrogeologic Uncertainty

Characterization of the two aquifer zones identified for potential wastewater DIW disposal, as described previously in this memorandum, are based on a limited amount of hydrogeologic data available, especially data associated with the Lawson Limestone. As such, preliminary design of infrastructure and/or cost estimations associated with the potential injection of wastewater into any of these two zones will have a significant level of uncertainty.

For instance, Tetra Tech (2014) documented that injection into low permeability formations, such as the Lawson Limestone, can lead to turbulent (non-laminar) flow that creates back pressure. This effect would result in a significant amount of additional wellhead pressure (i.e., more than 100% of the normally expected pressure). Hence, acidization of the borehole may be required to increase the permeability of the rock matrix. Based on data gathered from an injection well located at the Tampa Electric Company Polk (TEC) Power Station (PPS), acidization of the injection zone could result in a pressure reduction of up to about 75% relative to pre-stimulation conditions.

In reference to the FPZ, the variability of transmissivity of this potential injection zone can be estimated using hydraulic conductivity data from the North Florida Southeast Georgia Groundwater (NFSEG) Model (SJRWMD and Suwannee River Water

Management District [SRWMD], 2019), coupled with the elevations (thickness) presented in **Table 3**. Estimated transmissivities in the FPZ at the location of JEA's WWTFs are shown in **Table 4**.

Table 4. Estimated FPZ Transmissivity Under JEA's WWTFs

WWTF Name	**FPZ Thickness (ft.)[a]**	**FPZ Hydraulic Conductivity (ft./d)[b]**	**FPZ Transmissivity ($ft.^2/d$)[c]**
Airport	251	96	24,096
Arlington East	315	115	36,225
Buckman	271	110	29,810
Cedar Bay	266	104	27,664
Mandarin	340	107	36,380
Monterey	288	115	33,120
Nassau	210	81	17,010
Ponte Vedra Beach	401	114	45,714
Southwest	268	99	26,532
Minimum	210	81	17,010
Maximum	401	115	45,714
Average	290	105	30,728

Notes:
a. Source: Williams and Kuniansky, 2016.
b. Hydraulic conductivity in feet per day, from SJRWMD and SRWMD (2019).
c. Calculated by multiplying FPZ thickness by FPZ hydraulic conductivity.

Based on the values presented in **Table 4**, it appears that the transmissivity of the FPZ may be relatively lower in north Duval County near JEA's Airport and Cedar Bay WWTFs, and relatively higher in south Duval County and north St. Johns County near JEA's Mandarin WWTF. The potential variation in transmissivity is due to a corresponding change in the estimated thickness of the FPZ.

From the hydrogeologic characterization and uncertainties presented above, the FPZ and the Lawson Limestone have advantages and disadvantages as potential wastewater injection zones.

Injecting wastewater into the FPZ has the advantage of reduced wellhead pressure, resulting from a shallower zone, potential larger transmissivity, and lower TDS concentrations, relative to the Lawson Limestone. Though sufficient confinement above the injection zone to inhibit upward migration of injected fluids into a shallower USDW must be demonstrated during the permitting process, use of the FPZ could require additional regulatory oversight.

Conversely, injecting wastewater into the Lawson Limestone could provide a more robust long-term injection option due to the substantial higher level of confinement above the injection zone. However, the infrastructure and operational costs associated with injecting into the Lawson Limestone are notably higher due to the need of deeper wells, substantially higher TDS concentration in the native groundwater, and expected lower transmissivities.

An additional benefit of injecting wastewater into the FPZ is the potential drawdown mitigation in the UFA as discussed below. A portion of the potentiometric head increases in the LFA resulting from injection operations is also expected to reflect in the UFA. These increases would provide enough drawdown offsets for JEA to partially or fully recover the injected water as an alternative water supply (AWS) option in the UFA, while still complying with stringent Minimum Flow and Levels (MFLs) proposed for water bodies within JEA's groundwater withdrawal area of influence. Drawdown mitigation in the UFA will likely not occur by injecting into the Lawson Limestone though.

Potential Water Supply Benefits

As described above, an additional consideration in the selection of an injection zone for wastewater DIW disposal is the potential water supply benefit achieved by offsetting drawdowns in the UFA or at regional water resources features, such as minimum flow and level (MFL) water bodies, as a result of aquifer recharge in the LFA.

Injecting wastewater into the FPZ (lowest permeable zone of the LFA) has the potential to allow JEA to recover the injected water, partially or fully, as an AWS option in the UFA. Injection in the FPZ would increase the potentiometric head in the LFA which would mitigate drawdowns resulting from a corresponding additional groundwater withdrawal in the UFA. Furthermore, these drawdowns offsets are expected to be sufficient to comply with stringent MFLs currently proposed by both the SJRWMD and the SRWMD in the Keystone Heights and the Lower Santa Fe River systems. These MFLs could represent constraints to JEA's groundwater use in the future.

A groundwater simulation using the North Florida Southeast Georgia (NFSEG) regional groundwater model was performed to show the potential benefit of aquifer recharge into the FPZ. The scenario evaluated was the injection of 1 million gallons per day (MGD) of wastewater into the FPZ (Model Layer 7) at the location of JEA's Greenland WWTF. The objective of the test evaluation was to predict an estimated potentiometric head "rebound" in the UFA (Model Layer 3) per unit rate of injection. Results from the preliminary simulation are shown in **Figure 8**.

As shown in **Figure 8**, injecting 1 MGD of wastewater into the FPZ at the location of JEA's Greenland WWTF has the potential to produce up to 0.06 ft. of rebound in the UFA. Furthermore, potentiometric head rises in the UFA are expected to extend beyond Duval County, fully intersecting several neighbor counties. Results from the preliminary evaluation also show that JEA would be able to recover 100 percent of the injected water through AWS wells in the UFA, while still complying with proposed MFLs in the SJRWMD and the SRWMD.

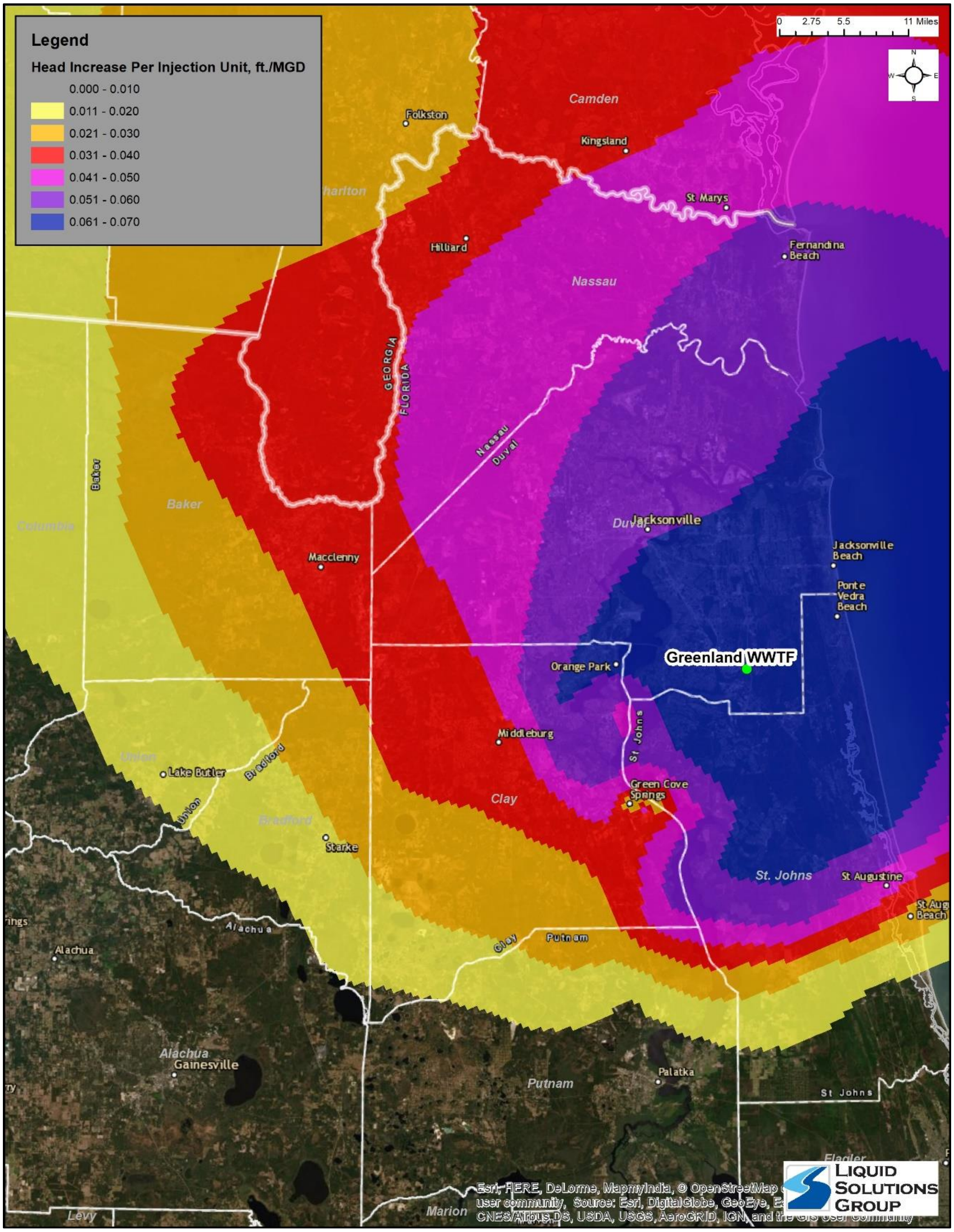

Figure 8. Simulated UFA Potentiometric Rise Resulting From Injecting 1 MGD of Wastewater into the FPZ at JEA's Greenland WWTF.

Opinion of Costs

As discussed above, there are several factors that contribute uncertainty to the development of costs for an option to eliminate surface water discharge of wastewater by DIW. However, in order to develop an estimate of the costs for this option several assumptions were made and are documented herein.

The injection zones and rates presented in **Table 5** were assumed to be feasible. **Table 5** also presents the total number of wells assumed to be required to allow for disposal of excess wastewater in 2027. **Table 6** presents estimated unit costs for various components required for this option and provides more detail on the DIW well designs assumed. These assumptions were used to develop the total costs presented in **Table 7.**

As presented, the total costs for this option are significant and over $650 million. It is important to note that these potential costs exclude land acquisition, pumping and transmission costs, so the total cost will be significantly higher. These costs are substantially affected due to a number of factors including the number of wells required, the spatially-distributed nature of the wastewater flows, and the potential drilling issues encountered at these depths. In order to increase the certainty of these costs, primary efforts should be focused on better understanding the hydrogeology and feasibility of injection below in the Floridan aquifer (i.e., the Lawson Limestone).

Table 5. Assumed Injection Zone and IWs Required

WWTF	Injection Zone	Capacity Deficit in 2027 (mgd AADF)	Number of Injection Wells Required in 2027
Arlington East	FPZ	21.1	12
Buckman	Lawson	29.3	16
Cedar Bay	Lawson	5.5	4
Future Airport	Lawson	1.0	2
Mandarin	Lawson	0.4	2
Monterey	Lawson	1.7	2
Nassau	Lawson	1.94	2
Ponte Vedra Beach	Lawson	0.1	2
Southwest	Lawson	13.3	8
Totals		74.34	50

Notes:
1. FPZ injection wells assumed to have 2 mgd capacity
2. Lawson Limestone injection wells assumed to have 2 mgd capacity
3. Required number of wells assumes that 1 redundant well is required at each WWTF

Table 6. Opinion of Probable Cost for Injection Wells System Components

Injection Well Component	Construction Cost	Engineering and Permitting (20%)	Construction Hydrogeologic Supervision (20%)	Contractor Overhead and Profit (15%)	Total Cost
Injection well (steel) constructed into the lower portion of the Lower Floridan aquifer (Fernandina). Open hole from approximately 2,000 ft bls to 2,200 ft bls. Assumed capacity of 2 mgd.	$ 6,000,000	$ 1,200,000	$ 1,200,000	$ 900,000	**$ 9,300,000**
Injection well (FRP) constructed into the Lawson Limestone formation. Total depth estimated at 3,000 ft bls. Assumed capacity of 2 mgd.	$ 9,000,000	$ 1,800,000	$ 1,800,000	$ 1,350,000	**$ 13,950,000**
Dual zone (Fernandina/LFA) monitor well. One well assumed for each 5 injection wells.	$ 1,000,000	$ 200,000	$ 200,000	$ 150,000	**$ 1,550,000**

Notes:
1. Fernandina zone injection well costs based on SJRWMD cost estimating tool developed for the Central Florida Water Initiative Regional Water Supply Plan.
2. Lawson Limestone injection well costs based on Tetra Tech, 2014
3. Costs designed to achieve *The Association for the Advancement of Cost Engineering International* (AACE), Class 4 Estimate level. A Class 4 Estimate is considered a “Concept Evaluation” level, with an expected accuracy range of -30% to +50%.

Table 7. Opinion of Total Injection Well and Monitor Well Costs for DIW Disposal Option

WWTP	Opinion of Cost for Injection/Monitor Wells
Arlington East	$116,250,000
Buckman	$229,400,000
Cedar Bay	$ 57,350,000
Future Airport	$ 29,450,000
Mandarin	$ 29,450,000
Monterey	$ 29,450,000
Nassau	$ 29,450,000
Ponte Vedra Beach	$ 29,450,000
Southwest	$114,700,000
Total	$664,950,000

Notes:
1. Costs do not include land acquisition
2. Costs do not include transmission, pumping or treatment changes
3. Costs designed to achieve *The Association for the Advancement of Cost Engineering International* (AACE), Class 4 Estimate level. A Class 4 Estimate is considered a "Concept Evaluation" level, with an expected accuracy range of -30% to +50%.

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Task 15.3 Conceptual Cost Estimating Factsheet

Deep Well Injection

CDM Smith

Deep Well Injection

Integrated Water Resource Plan

Eliminate Surface Water Discharge Alternative

Brief Description:

This fact sheet summarizes the improvements needed to meet a potential wastewater discharge elimination requirement at JEA's water reclamation facilities (WRF) by disposal of excess treated wastewater via deep injection wells to suitable underground injection zones with intact low permeability confining layers, preventing the upward vertical migration of injected fluids. The intent is for the injected reclaimed water to remain in the aquifer's injection zone indefinitely, with no upward vertical migration into underground sources of drinking water (USDW). An aquifer with total dissolved solids (TDS) less than 10,000 milligrams per liter (mg/L) is classified as a USDW. Florida Department of Environmental Protection allows deep injection wells, as long as the aquifer zone targeted for injection does not contain a USDW and has adequate overlying confining layers to prevent upward migration of injected wastewater into a USDW.

Groundwater TDS generally increases with increasing depth – in the Jacksonville area, the depth of the 10,000 mg/L TDS boundary is estimated at more than 2,000 ft below land surface (bls). However, knowledge of local hydrogeology at this depth is scarce since few wells in Northeast Florida have been drilled to this depth. Further hydrogeologic exploration (drilling) and testing of potential test well locations would be required to validate the feasibility of deep well injection in Northeast Florida.

Facilities Required:

The capacity requirements for this discharge elimination scenario are based upon the projected 2027 annual average daily flow (AADF) data and reuse demand provided by JEA. Equalization tanks are required at each WRF to account for variations in flow. For this scenario, tankage was sized to capture 50 percent (%) of the maximum daily flow at each WRF. Each equalization tank is accompanied by a pump station sized for the maximum deep injection well capacity, along with one redundant deep injection well for each WRF.

To dispose of the excess reclaimed water production from JEA's WRFs via deep well injection, the following infrastructure improvements are required:

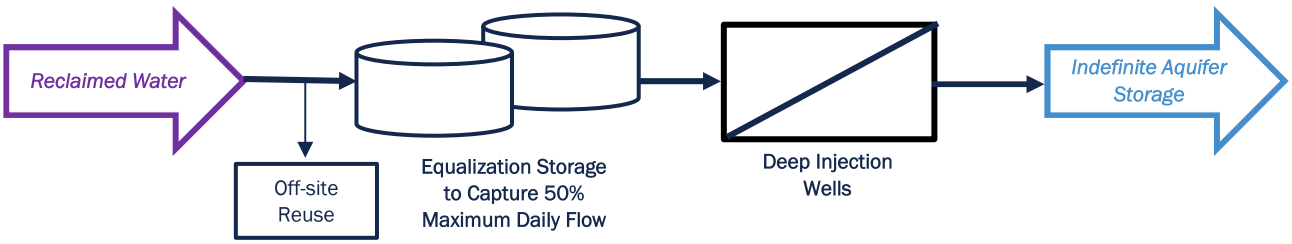
- Equalization storage tanks and pump stations at each WRF, with a combined capacity of 91 million gallons.
- 75 new deep injection wells.
- Construction of eight injection well pipeline corridors with a combined length of 13 miles.

While each well occupies a limited footprint (approximately 0.5 acres/well) the injection wells would be located approximately 1,000 feet apart to avoid interference within the injection zone and inefficiencies associated with higher pumping pressures. The spacing requirement may be especially challenging for WRFs in developed areas, including Buckman WRF, where 28 injection wells along a 5-mile pipeline corridor would be required. Moreover, construction of deep injection wells can take 10-12 months each, generating significant noise in residential neighborhoods and disruption associated with trenching, excavation, and laying of connecting pipelines.

Deep Well Injection

Integrated Water Resource Plan

Eliminate Surface Water Discharge Alternative



Key Assumptions:

- Based on current regulations, injected wastewater effluent will meet secondary treatment requirements. Note, specific geographies in Florida are required to meet high level disinfection treatment prior to injection.
- Injection wells in will discharge up to 2 million gallons per day (mgd) each to the Fernandina Permeable Zone (Arlington East only) or Lawson Limestone (all other WRFs) located approximately 2,500-3,000 feet bls. The unit cost is $10 million per injection well, including the expense of associated monitoring wells, and pipeline installation.
- Equalization tank construction costs were estimated using a cost model based on prestressed concrete tank bid tabulations (CDM Smith 2007) and cross-checked with bids from recent JEA tank projects.
- When the total equalization tank storage requirement exceeded 10 million gallons (MG), costs were developed assuming that equalization would be provided by multiple tanks of equal size.
- Power consumption costs were developed assuming annual injectate flows equal to the WRF's AADF minus offsite reuse demand, and a uniform deep well injection pressure of 175 pounds per square inch, with an 80% wire to water efficiency for the injection pumps. Deep well injection pressures were estimated considering the salinity, depth, and permeability of the target injection zone.

Cost:

As noted in the table below, the potential capital costs for the required injection wells are nearly $1.5 billion, with an annual O&M cost of nearly $11.9 million dollars. While the 75 wells have a combined injection capacity of 150 mgd, because of variability in flows, less than approximately 50% (72.4 mgd) of this capacity would be used on an average annual basis.

Injection well costs are substantially affected because of a number of factors, including the number of wells required, the spatially-distributed nature of the reclaimed water flows, the potential drilling issues encountered at more than 2,000 feet bls, and the limited number of drillers capable of such construction. Furthermore, because of the large quantity of wells needed in such a short period and limited number of capable well driller in the state, JEA would be forced to turn to out-of-state resources at a premium cost. Nevertheless, even with recruitment of out of state drillers, it is doubtful that all 75 wells could be drilled and finished within the assumed 5-year period allotted for compliance. It is recommended that JEA conduct a full extensive study to determine the feasibility and details of the potential implementation schedule and how it impacts rate payers.

Amortizing the capital costs at 2.5% over a 30-year period, would result in $71.1 million in annual expense in 2019 dollars. Therefore, the total combined annual impact of the improvements described herein would total an estimated $83 million/yr.

Deep Well Injection

Integrated Water Resource Plan

Eliminate Surface Water Discharge Alternative

Eliminate Surface Water Discharges via Deep Well Injection (DWI)

WRF	Equalization Tanks and Storage Volume (MG) [1]	Maximum Daily Flow to Deep Well Injection (mgd)	Injection Wells Required (each) [2]	Injection Well Corridor Length (miles) [3]	AADF Deducting Off-site Reuse (mgd)	Capital Cost ($M) [4]	Annual O&M Cost ($M) [4]
Arlington East	Three (3) 7.5 MG Tanks	33.0	18	3.4	19.9	$355	$3.0
Mandarin	One (1) 4 MG Tank	1.3	2	0.4	0.4	$45	$0.3
Monterey	One (1) 2.5 MG Tank	3.6	3	0.4	1.7	$60	$0.4
Cedar Bay	One (1) 5.5 MG Tank	7.6	5	0.8	5.5	$98	$0.8
Buckman	Four (4) 9 MG Tanks	53.2	28	5.1	29.3	$557	$4.5
Southwest	Two (2) 8.5 MG Tanks	24.5	14	2.5	13.6	$275	$2.2
Nassau	One (1) 2.5 MG Tank	4.0	3	0.4	1.94	$59	$0.4
Ponte Vedra	One (1) 1 MG Tank	1.0	2	0.2	0.1	$40	$0.2
TOTAL	**14 EQ Tanks 91 MG Storage**	**128.2**	**75**	**13.2**	**72.4**	**$1,488**	**$11.9**

WRF – Water Reclamation Facility; DWI – Deep Well Injection; EQ- Equalization; MG – Million Gallon; mgd – million gallons per day; AADF – Annual Average Daily Flow; O&M – Operations and Maintenance; $M - Millions

[1] Equalization tank capacity sized to capture 50% of the WRF's maximum daily flow

[2] Includes one redundant injection well at each WRF and associated monitoring wells

[3] Assumes 1,000-ft spacing between injection wells

[4] Costs have been adjusted to 2019 dollars

References:

CDM Smith (2020) "Integrated Water Resource Plan, Task 15.2 Memorandum" JEA. October 2020.

CDM Smith (2019) "Water Purification Technology Research and Development Project; Phase II Conceptual Plan" JEA. February 2019.

CDM Smith (2018) "Water Purification Technology Phase II and III Cost Evaluation Report" JEA. December 2018.

CDM Smith (2007) "Water Supply Cost Estimation Study" SFWMD. February 2007.

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Liquid Solutions Group (2020) "Elimination of JEA Wastewater Discharges Deep Injection Well Disposal Option" CDM Smith. August 2020.

Task 15.3 Conceptual Cost Estimating Factsheet

Direct Potable Reuse

CDM Smith

Direct Potable Reuse

Integrated Water Resource Plan

Eliminate Surface Water Discharge Alternative

Brief Description:

This factsheet summarizes the improvements needed to meet a potential wastewater discharge elimination requirement at JEA's water reclamation facilities (WRFs) by construction of new direct potable reuse (DPR) water purification facilities (WPFs). In this scenario, reclaimed water from a JEA WRF is conveyed to a new WPF that produces water of potable quality to be blended with finished water from an existing JEA water treatment plant (WTP). Alternatively, the purified water could be used to augment the groundwater supply upstream of a WTP; however, this approach was not used because it may require upgrades to the WTP capacity and changes to the existing treatment processes. The DPR scenario also assumes baseline improvements at each WRF to bring the reclaimed water quality to advanced water treatment (AWT) standards, reducing required WPF capacity by allowing for backup (intermittent) discharges permitted under the 1994 APRICOT Act.

Although purified water is safe for public consumption at the WPF and partially-stabilized, blending with the finished water at an existing WTP allows for the natural hardness and alkalinity in those sources to further stabilize the purified water and enhance its taste to more closely resemble the familiar aesthetics of JEA's Floridan aquifer supply. This supply option is referred to as DPR. This option is similar to the aquifer recharge option, indirect potable reuse (IPR), except that the purified water undergoes an additional polishing treatment step and is blended with the finished water from an existing WTP and transmitted to distribution, instead of being injected into the aquifer for recharge purposes.

Facilities Required:

The capacity requirements for this discharge elimination scenario are based upon the projected 2027 annual average daily flow (AADF) data and reuse demand provided by JEA. Implementing the DPR scenario requires construction of 105 million gallons per day (mgd) in AWT improvements at JEA's five existing WRFs currently without AWT. In addition, five new WPFs would be constructed with a combined production capacity of 45 mgd. The remaining flow of approximately 60 mgd is planned to be distributed for off-site reuse, discharged to a surface water body as allowable by APRICOT, or disposed of via concentrate injection wells. Purified water for DPR is provided via a multiple barrier process including microfiltration or ultrafiltration (MF/UF), low pressure reverse osmosis (RO), ultraviolet advanced oxidation process (UVAOP), and granular activated carbon (GAC) as a final polishing step to produce purified water. JEA pilot tested this process (except for GAC) for several months in 2017-2018 at both the Southwest WRF and Buckman WRF. The purified water would be partially stabilized through calcium addition and pH adjustment and transferred to a nearby existing JEA WTP for blending with finished water. The 5 required pipelines conveying approximately 45 mgd of purified water would have a total estimated length of nearly 16 miles, with most of the pipelines extending about 3-5 miles.

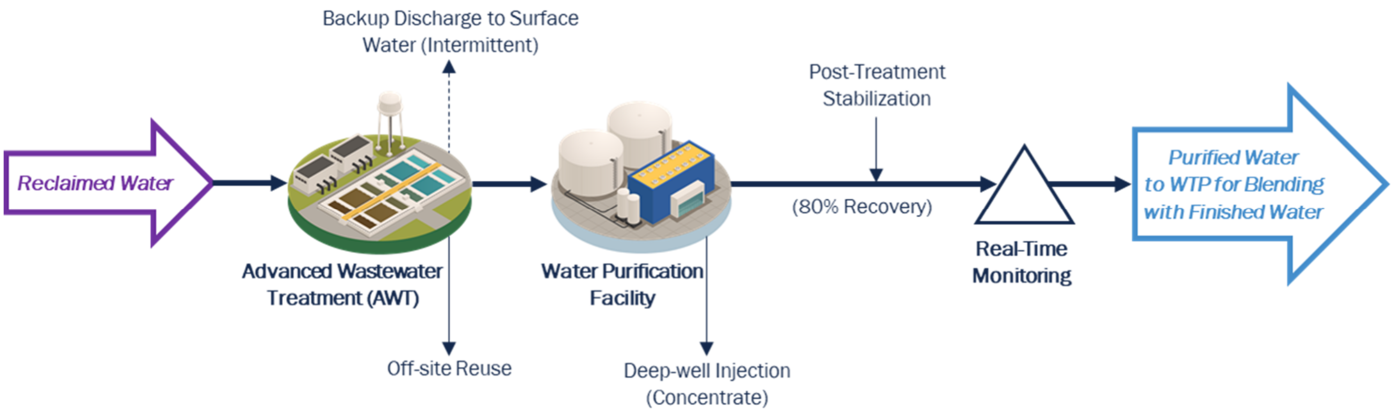
Concentrate (i.e., brine) is a byproduct of the RO process, and the five new WPFs would produce a combined 11 mgd of concentrate that would be managed by 13 new concentrate disposal wells likely installed in the Lawson aquifer, and associated monitoring wells. The concentrate disposal wells have an assumed capacity of 2 mgd each, with one backup well for each WRF. Concentrate disposal wells would each extend to depths of more than 2,000 ft, assuming Class I disposal wells are feasible in the Jacksonville area. Although none currently exist and little is known about the hydrogeology in Northeast Florida, these disposal wells are used throughout South Florida. Further hydrogeologic exploration (drilling) and testing of potential test well locations would be required to validate the feasibility of deep well injection in Northeast Florida.

Direct Potable Reuse

Integrated Water Resource Plan

Eliminate Surface Water Discharge Alternative

Given the scope of treatment plant upgrades and new infrastructure required for the DPR alternative, a review of available land area and property values surrounding each WRF was conducted. For the DPR alternative, additional land acquisition would be required around Mandarin, Monterey, Buckman, and Ponte Vedra WRFs to accommodate the new WPF and deep injection wells. It was assumed the pipeline corridor connecting each well would be located in existing easements or rights-of-way near roads; therefore, no additional land is required for the pipeline portion. While the individual deep wells require a negligible amount of land (approximately 0.5 acres/well), the construction of so many deep wells over many months could cause serious disruption to neighborhoods in the form of noise from drilling rigs and disruptions to roadway crossings from excavation to lay numerous miles of connecting pipelines. Four monitoring wells are also required near the deep injection wells and are assumed to require 0.25 acres/well.



Water Quality:

The WPF treatment and enhanced monitoring technologies reliably remove pathogens and other undesirable constituents. Purified water meets all drinking water standards while also removing currently unregulated compounds and contaminants of emerging concern (CECs) such as per- and polyfluoroalkyl substances (PFAS), endocrine disrupting compounds (EDCs), pharmaceuticals and personal care products (PPCPs), and antibiotic resistance genes (ARGs). An added GAC polishing step provides protection against chemical spikes in the sewershed, while also potentially enhancing removal of CECs and low molecular weight organic compounds after UVAOP. Chemical post-treatment, through calcium addition and pH adjustment, and blending at an existing WTP, is utilized to produce a stabilized finished water ready for distribution.

Cost:

Costs for the DPR option were estimated using the same planning-level cost spreadsheet tool developed for the IWRP project factsheets and reviewed by JEA. The table below presents capital and O&M costs for the DPR alternative, summarized by WRF and adjusted to 2019 dollars. The projected capital cost for JEA to implement DPR systemwide is nearly $636 million, not including the costs of associated AWT upgrades described below. O&M costs assume 100% utilization of the facility and include items such as electricity and process chemicals, along with routine maintenance costs incurred each year. O&M costs for associated AWT upgrades are listed in a separate table below. If the wastewater discharge elimination legislation passes, it is recommended that JEA conduct a full extensive study to determine the feasibility and details of potential implementation schedules and how they impact rate payers.

Eliminate Surface Water Discharge Alternative

Implementation of a wastewater discharge elimination requirement with an aggressive implementation schedule would likely inflate capital costs further by straining locally available construction contractor capacity, requiring the use of out-of-state contractors at a premium price.

Eliminate Surface Water Discharges via Direct Potable Reuse (DPR)

WRF	DPR WPF Capacity (MGD)	Concentrate Injection Wells Required (each) [1]	WTP Transfer Pipeline Distance (miles)	Capital Cost ($M) [2]	Annual O&M Cost ($M) [2]
Arlington East	12.8	3	4.1	$163	$7.5
Monterey	1.2	2	0.7	$55	$1.6
Cedar Bay	3.4	2	3.2	$78	$2.7
Buckman	18.7	3	3.0	$212	$13.1
Southwest	8.6	2	4.8	$129	$5.5
TOTAL	**44.7**	**12**	**16**	**$636**	**$30.4**

MGD – million gallons per day; WRF – Water Reclamation Facility; DPR – Direct Potable Reuse; WPF – Water Purification Facility; WTP – Water Treatment Plant; $M – Millions; O&M – Operations and Maintenance

[1] Each well has a 2-mgd capacity. Includes one redundant injection well at each WRF and associated monitoring wells

[2] Costs have been adjusted to 2019 dollars

In addition to the costs associated with the DPR WPFs, the following advanced wastewater treatment upgrade and O&M costs would be incurred to allow JEA to utilize backup discharges to surface water permitted under the APRICOT Act, while still meeting the wastewater discharge elimination requirement. The benefit of backup discharges would be that the required capacity of the WPFs could be reduced substantially since peak flows could be handled by backup (intermittent) discharges under the APRICOT Act. The capital cost for AWT upgrades was estimated assuming a unit price of $10.80 per gallon per day capacity (Harper et al. 2008) to perform the upgrades, and an added O&M cost of $0.80 per thousand gallons treated (CDM Smith 2007, FWEAUC 2010). Note the capital cost of AWT improvements as well as the added O&M were both calculated against the AADF capacity of each WRF and adjusted to 2019 dollars.

Direct Potable Reuse

Integrated Water Resource Plan

Eliminate Surface Water Discharge Alternative

Advanced Wastewater Treatment Upgrade Costs (DPR)

WRF	Capacity in AADF (MGD)	Capital Cost ($M)	Annual O&M Cost ($M)
Arlington East	25	$269.8	$7.3
Monterey	3.6	$38.9	$1.1
Cedar Bay	10	$107.9	$2.9
Buckman	52.5	$566.7	$15.3
Southwest	14	$151.1	$4.1
TOTAL	**105.1**	**$1,134**	**$30.7**

MGD – million gallons per day; WRF – Water Reclamation Facility; DPR – Direct Potable Reuse; AADF – Annual Average Daily Flow; O&M – Operations and Maintenance; $M – Millions

Implementation of the five DPR WPFs and associated AWT upgrades described in this fact sheet would have an estimated combined capital cost of $1.8 billion, with an annual increase of $68.5 million in O&M costs. Amortizing the capital costs at 2.5% over a 30-year period, would result in $84.5 million in annual expense in 2019 dollars. Therefore, the total combined annual impact of the improvements described herein would total, $153 million/yr.

The proposed schedule, quantities, costs, and other factors are subject to change. Furthermore, the requirements of a potential Bill eliminating surface water discharges may differ in certain aspects from the assumptions described herein. If the Florida Legislature adopts such a Bill, JEA should conduct a full and extensive study to determine the feasibility of meeting the enacted requirements, including details of the required improvements, implementation schedule, and impact to rate payers.

Combined Cost Associated with AWT Upgrades and DPR WPF Facilities

WRF	Improvements	Capital Cost ($M)	Annual O&M Cost ($M)
Arlington East	12.8 MGD DPR 25 MGD AWT	$433	$16.4
Monterey	1.2 MGD DPR 3.6 MGD AWT	$94	$2.9
Cedar Bay	3.4 MGD DPR 10 MGD AWT	$186	$6.3
Buckman	18.7 MGD DPR 52.5 MGD AWT	$778	$32.5
Southwest	8.6 MGD DPR 14 MGD AWT	$280	$10.5
TOTAL	**44.7 MGD DPR** **105.1 MGD AWT**	**$1,771**	**$68.5**

AWT – Advanced Wastewater Treatment; DPR – Direct Potable Reuse; WPF – Water Purification Facility; WRF – Water Reclamation Facility; O&M – Operations and Maintenance; $M – Millions; MGD – million gallons per day

References:

CDM Smith (2020) "Integrated Water Resource Plan, Task 15.2 Memorandum" JEA. October 2020.

CDM Smith (2019) "Water Purification Technology Research and Development Project; Phase II Conceptual Plan" JEA. February 2019.

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Liquid Solutions Group (2020) "Elimination of JEA Wastewater Discharges Deep Injection Well Disposal Option" CDM Smith. August 2020.

Task 15.3 Conceptual Cost Estimating Factsheet

Indirect Potable Reuse

CDM Smith

Indirect Potable Reuse

Integrated Water Resource Plan

Eliminate Surface Water Discharge Alternative

Brief Description:

This factsheet summarizes the improvements needed to meet a potential wastewater discharge elimination requirement at JEA's water reclamation facilities (WRFs) with construction of new indirect potable reuse (IPR) water purification facilities (WPFs). In this scenario, reclaimed water from a JEA WRF is conveyed to a new WPF that produces water of potable quality. The purified water would be used to directly recharge the Floridan aquifer and assumes JEA would receive beneficial reuse credits for the JEA consumptive use permit (CUP), allowing additional proportionate withdrawals in excess of historical CUP limiting conditions. During the project planning and permitting phase, JEA could demonstrate that aquifer recharge in this area would be beneficial to the region, resulting in CUP credits. This scenario assumes baseline improvements at each WRF to bring the reclaimed water quality to advanced water treatment (AWT) standards, reducing required WPF capacity by allowing for backup (intermittent) discharges to surface waters under the 1994 APRICOT Act. This supply option is referred to as indirect potable reuse (IPR) using aquifer recharge.

Facilities Required:

The capacity requirements for this discharge elimination scenario are based upon the projected 2027 annual average daily flow (AADF) data and reuse demand provided by JEA. Implementing the IPR scenario requires construction of 105 million gallons per day (mgd) in AWT improvements among five JEA WRFs currently without AWT. Five new WPFs would be constructed with a combined production capacity of 45 mgd. The remaining flow of approximately 60 mgd is planned to be distributed for off-site reuse, discharged to a surface water body as allowable by APRICOT, or disposed of via concentrate injection wells. Purified water for IPR is provided via a multiple barrier process including microfiltration or ultrafiltration (MF/UF), low-pressure reverse osmosis (RO), ultraviolet advanced oxidation process (UVAOP), and post-treatment stabilization. Online monitoring throughout the IPR WPF monitors treatment process integrity and tracks the quality of the source and purified water prior to aquifer recharge. JEA pilot tested this process (except for aquifer recharge) for several months in 2017-2018 at both the Southwest WRF and Buckman WRF.

Indirect potable reuse could be achieved by the construction of a total of 29 Floridan aquifer recharge wells, spread across all WPF locations. The number of recharge wells required per facility was based on previous JEA drinking water well projects and assumes a 2.0-mgd capacity per recharge well. This scenario would also include a total of eight adjacent monitoring wells installed at each injection well and concentrate disposal well site. Aquifer recharge is similar to direct potable reuse but there are several benefits of using the aquifer for storage. Water can be continually purified, as received from the WRF, regardless of potable demands because excess purified water can be stored in the aquifer for future use. The aquifer also provides dilution, aquifer treatment, and travel time between purified water production and potable use.

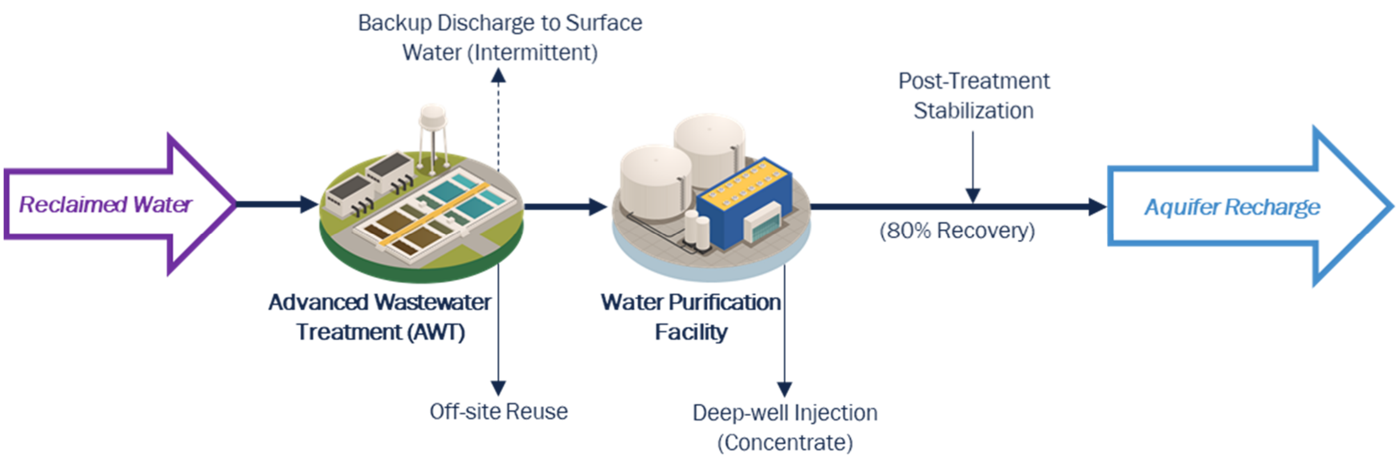
Concentrate (i.e., brine) is a byproduct of the RO process, and the five new WPFs would produce a combined 11 mgd of concentrate that would be managed by 13 new concentrate disposal wells likely installed in the Lawson aquifer, and associated monitoring wells. Concentrate disposal wells would each extend to depths of more than 2,000 ft, assuming Class I disposal wells are feasible in Northeast Florida, although none currently exist and little is known about the hydrogeology. Deep injection wells are more widely used throughout South Florida. Further hydrogeologic exploration (drilling) and testing of potential test well locations would be required to validate the feasibility of deep well injection in Northeast Florida.

Indirect Potable Reuse

Integrated Water Resource Plan

Eliminate Surface Water Discharge Alternative

Given the scope of treatment plant upgrades and new infrastructure required for the IPR alternative, a review of available land area and property values surrounding each WRF was conducted. For the IPR alternative, additional land acquisition would be required around Mandarin, Monterey, Buckman, and Ponte Vedra WRFs to accommodate the new WPF, aquifer recharge wells, and deep injection wells. It was assumed the pipeline corridor connecting each well would be located in existing easements or rights-of-way near roads; therefore, no additional land is required for the pipeline portion. While the individual deep wells require a negligible amount of land (approximately 0.5 acres/well), the construction of so many deep wells over many months could cause serious disruption to neighborhoods in the form of noise from drilling rigs and disruptions to roadway crossings from excavation to lay numerous miles of connecting pipelines.



Indirect Potable Reuse

Integrated Water Resource Plan

Eliminate Surface Water Discharge Alternative

Water Quality:

The WPF treatment and enhanced monitoring technologies reliably remove pathogens and other undesirable constituents. Purified water meets all drinking water standards while also removing currently unregulated compounds and contaminants of emerging concern (CECs) such as per- and polyfluoroalkyl substances (PFAS), endocrine disrupting compounds (EDCs), pharmaceuticals and personal care products (PPCPs), and low molecular weight organic compounds. Post-treatment is provided through calcium addition and pH adjustment to produce a stable water for aquifer recharge.

Cost:

Costs for the IPR option were estimated using the same planning-level cost spreadsheet tool developed for the IWRP project factsheets and reviewed by JEA. The table below presents capital and O&M costs for the IPR alternative, summarized by WRF and adjusted to 2019 dollars. The projected capital cost for JEA to implement IPR systemwide is nearly $663 million, with an annual O&M cost of nearly $25.5 million. O&M costs assume 100 percent (%) utilization of the facility and include electricity and process chemical costs, along with routine maintenance costs incurred each year. O&M costs for associated AWT upgrades are listed in a separate table below. If the wastewater discharge elimination legislation passes, it is recommended that JEA conduct a full extensive study to determine the feasibility and details of potential implementation schedules and how it impact rate payers.

Implementation of a wastewater discharge elimination requirement with an aggressive implementation schedule would likely inflate capital costs further by straining locally available construction contractor capacity, requiring the use of out-of-state contractors at a premium price.

Eliminate Surface Water Discharges via Indirect Potable Reuse (IPR)

WRF	IPR WPF Capacity (mgd)	Concentrate Injection Wells Required (ea.) [1]	Aquifer Recharge Wells Required (ea.) [1]	Capital Cost ($M) [2]	Annual O&M Cost ($M) [2]
Arlington East	12.8	3	8	$173	$6.6
Monterey	1.2	2	2	$60	$1.4
Cedar Bay	3.4	2	3	$80	$2.4
Buckman	18.7	3	10	$227	$10.5
Southwest	8.6	2	6	$123	$4.6
TOTAL	**44.7**	**12**	**29**	**$663**	**$25.5**

WRF - Water Reclamation Facility; IPR - Indirect Potable Reuse; WPF - Water Purification Facility; $M – Millions; MGD – million gallons per day; ea. - each

[1] Each well has a 2-mgd capacity. Includes one redundant injection well at each WRF and associated monitoring wells

[2] Costs have been adjusted to 2019 dollars

In addition to the costs associated with the IPR WPFs, the following advanced wastewater treatment upgrade and O&M costs would be incurred to allow JEA to utilize backup (intermittent) surface water discharges permitted under the APRICOT Act, while still meeting the wastewater discharge elimination requirement. The benefit of backup discharges would be that the required capacity of the WPFs could be reduced substantially since peak flows could be handled by backup discharges. The capital cost for AWT upgrades was estimated assuming a unit price of $10.80 per gallon per day capacity (Harper et al 2008) to perform the upgrades, and an added O&M cost of $0.80 per thousand gallons treated (CDM Smith 2007, FWEAUC 2010). Note the capital cost of AWT improvements as well as the added O&M were both calculated based on the AADF capacity of each WRF and adjusted to 2019 dollars.

Eliminate Surface Water Discharge Alternative

Advanced Wastewater Treatment Upgrade Costs (IPR)

WRF	Capacity in AADF	Capital Cost ($M)	Annual O&M Cost ($M)
Arlington East	25	$269.8	$7.3
Monterey	3.6	$38.9	$1.1
Cedar Bay	10	$107.9	$2.9
Buckman	52.5	$566.7	$15.3
Southwest	14	$151.1	$4.1
TOTAL	**105.1**	**$1,134**	**$30.7**

MGD – million gallons per day; WRF – Water Reclamation Facility; IPR – Indirect Potable Reuse; AADF – Annual Average Daily Flow; O&M – Operations and Maintenance; $M – Millions

Implementation of the five IPR WPFs and associated AWT upgrades described in this factsheet would have an estimated combined capital cost of $1.8 billion, with an annual increase of $63.7 million in O&M costs. Amortizing the capital costs at 2.5% over a 30-year period, would result in $86.3 million in annual expense in 2019 dollars. Therefore, the total combined annual impact of the improvements described herein would total $150 million/yr.

The proposed schedule, quantities, costs, and other factors are subject to change. Furthermore, the requirements of a potential Bill eliminating surface water discharges may differ in certain aspects from the assumptions described herein. If the Florida Legislature adopts such a Bill, JEA should conduct a full and extensive study to determine the feasibility of meeting the enacted requirements, including details of the required improvements, implementation schedule, and impact to rate payers.

Combined Cost Associated with AWT Upgrades and IPR WPF Facilities

WRF	Improvements	Capital Cost ($M)	Annual O&M Cost ($M)
Arlington East	12.8 MGD DPR 25 MGD AWT	$443	$15.5
Monterey	1.2 MGD DPR 3.6 MGD AWT	$99	$2.7
Cedar Bay	3.4 MGD DPR 10 MGD AWT	$188	$5.9
Buckman	18.7 MGD DPR 52.5 MGD AWT	$794	$29.9
Southwest	8.6 MGD DPR 14 MGD AWT	$274	$9.6
TOTAL	**44.7 MGD DPR** **105.1 MGD AWT**	**$1,797**	**$63.7**

AWT – Advanced Wastewater Treatment; DPR – Direct Potable Reuse; WPF – Water Purification Facility; WRF – Water Reclamation Facility; $M – Millions; O&M – Operations and Maintenance; MGD – million gallons per day

References:

CDM Smith (2020) "Integrated Water Resource Plan, Task 15.2 Memorandum" JEA. October 2020.

CDM Smith (2019) "Water Purification Technology Research and Development Project; Phase II Conceptual Plan" JEA. February 2019.

CDM Smith (2018) "Water Purification Technology Phase II and III Cost Evaluation Report" JEA. December 2018.

CDM Smith (2007) "Water Supply Cost Estimation Study" SFWMD. February 2007.

FWEAUC (2010). "Costs of Utilities and their Ratepayers to Comply with EPA Numeric Nutrient Criteria for Freshwater Dischargers." November, 1, 2020. Prepared by Roderick D. Reardon, Carollo Engineers.

Harper, S.R.; Coleman, D.; Tobocman, D.; Wilkinson, D.; and Bender, L. (2008). "Analysis of Nutrient Removal Costs in the Chesapeake Bay Program and Implications for the Mississippi-Atchafalaya River Basin." Proceedings of WEFTEC 2008. Water Environment Federation, Alexandria, VA.

Jones Edmunds (2015) "2015 Alternative Water Supply Facilities Master Plan" JEA. February 2015.

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Task 15.3 Conceptual Cost Estimating Factsheet

Expanded Traditional Reclaimed Water

CDM Smith

Expanded Traditional Reclaimed Water

Integrated Water Resource Plan

Eliminate Surface Water Discharge Alternative

Brief Description:

This factsheet summarizes the reclaimed water infrastructure improvements needed to meet a potential wastewater discharge elimination requirement at JEA's water reclamation facilities (WRFs) by expanding JEA's existing traditional reclaimed water network. JEA continues to focus on projects to expand reclaimed water use in areas of future growth to offset aquifer demands to the extent economically, environmentally, and technologically feasible.

This scenario evaluated converting existing irrigation demands not currently connected to JEA's reclaimed water system and transferring those customers to reclaimed supply. This scenario also assumed baseline improvements at each WRF to bring the reclaimed water quality to advanced wastewater treatment (AWT) standards. This approach allows backup (intermittent) discharges permitted under the 1994 APRICOT Act, thus reducing the required quantity of expanded reclaimed demand needed to divert flows from surface water discharge. Based upon analysis of JEA's reclaimed water demands, even with the backup discharges allowed with AWT improvements, there is insufficient reclaimed water demand to meet JEA's systemwide discharge elimination goal alone. Therefore, this alternative would need to be considered in conjunction with another strategy to effectively eliminate surface water discharges across JEA's service territory.

Facilities Required:

Expanding traditional reclaimed water requires construction of 114 million gallons per day (mgd) in AWT improvements among the six JEA WRFs currently without AWT. However, even with AWT improvements, there is insufficient reclaimed water demand to meet the discharge elimination goal. If this alternative were implemented at select facilities, the infrastructure improvements required for incorporation of new traditional reclaimed water supplies include:

- Water reclamation facilities producing AWT water with high-level disinfection (114-mgd of capacity improvements)
- Reclaimed water storage to meet peak day demands
- Reclaimed water distribution system
- Pumping infrastructure for supply of water into the reclaimed water distribution system

Key Assumptions:

- JEA provided monthly customer billing data for each year from 2016 to 2019. The billing data included all types of customer billing. For analysis purposes, sewer only and deduct meters were removed, and the primary focus was on irrigation meters.
- The capacity requirements for this discharge elimination scenario are based upon the projected 2027 annual average daily flow (AADF) data and reuse demands provided by JEA.
- The irrigation meter billing data, along with maps of JEA's existing water main, neighborhood, and reclaimed water main network, were used to identify and prioritize potential reclaimed water retrofit areas.
- Costs assume $28.00 per foot of pipe per inch of diameter. For example, a 4-inch pipe would cost $112 per foot to install.
- A ratio of pipe material cost to total project cost of 50 percent (%) was used. In other words, if the pipe cost based on total diameter and length is $1 million, the total project cost was assumed to be $2 million.
- Added reclaimed water O&M costs include equipment repair and maintenance at 0.5% of capital cost annually. electricity costs assuming flow equal to the reuse service capacity added, pumped at 30 pounds per square inch distribution pressure with an 80% wire to water efficiency.

Expanded Traditional Reclaimed Water

Integrated Water Resource Plan

Eliminate Surface Water Discharge Alternative

Water Quality:

This scenario assumes baseline improvements at each WRF to bring the reclaimed water quality AWT standards, thus reducing the required reuse system capacity by allowing for backup (intermittent) discharges, permitted under the 1994 APRICOT Act. In addition to meeting AWT standards, each plant must also provide high-level disinfection in accordance with Florida's public access reuse standards included in 62-610, F.A.C., entitled "Reuse of Reclaimed Water and Land Application." At a minimum, these requirements include secondary treatment, filtration for suspended solids removal, and meeting the high-level disinfection criterion for fecal coliform, as specified in Section 62-660.440, F.A.C ("Disinfection."). To meet public access reuse standards, WRF upgrades typically include addition of tertiary filtration and high-level disinfection.

Cost:

Using billing data and maps provided by JEA, existing irrigation demands from each neighborhood were allocated to the nearest of the six JEA WRFs having a discharge elimination requirement. A map of the existing irrigation demands and the pipelines to serve them is shown in Figure 1. The table below compares the combined reuse attainable for each WRF assuming maximum expansion of the reclaimed system to serve residential and commercial irrigation demands from the closest WRF. Even with allowable backup discharges after AWT improvements, expanded reclaimed cannot meet the systemwide discharge elimination goal: maximum annual average irrigation demand is projected at 18.3 mgd, which falls short of the 64.4-mgd target demand needed.

Only the Mandarin WRF has sufficient projected future reuse demand, 11.5 mgd, to meet the requirement for discharge elimination, 6 mgd. The first iteration of this analysis found insufficient demand near Arlington East to take what would be needed to eliminate surface water discharges. Therefore, the analysis was repeated and excess demand from Mandarin was shifted to being served by Arlington East. Even with the flow transfer, the reclaimed water demand shortfall at Arlington East (6.0 mgd) is too great to be mitigated. Mandarin may have sufficient potential irrigation demand to make expanded reclaimed a technically feasible discharge elimination option; however, the cost to construct the necessary conveyance infrastructure to serve this demand, especially in crowded built-out neighborhoods, is substantial. Should the legislation pass, it is recommended that JEA conduct a full extensive study to determine the feasibility and details of the potential implementation schedule and how it will impact rate payers.

The costs shown in the table below are based on expanding the irrigation grid near each WRF to serve the full projected future reuse demand, except for Mandarin, which has enough demand to meet the discharge requirement. Therefore, the grid expansion near Mandarin is limited to that required to meet the discharge elimination goal.

Mandarin WRF service area is expected to grow beyond 0.4-mgd shortfall after 2027, however, for the purposes of this memo, AWT upgrades and expansion of the reclaimed system are assumed to achieve full compliance by 2027. It should also be noted that Monterey did not comply with the discharge requirement, facing a 0.2-mgd demand shortfall; however, shifting demand from Arlington East could alleviate this shortfall. Nevertheless, there is insufficient irrigation demand for expanded reclaimed to result in discharge elimination compliance at Arlington East, Cedar Bay, Buckman, and Southwest. As noted in the table, the cost to construct the necessary conveyance infrastructure to serve an added 18.3 mgd of demand, especially in crowded built-out neighborhoods, is substantial, totaling approximately $4.8 billion.

Expanded Traditional Reclaimed Water

Integrated Water Resource Plan

Eliminate Surface Water Discharge Alternative

Eliminate Surface Water Discharges via Expansion of Reclaimed Water (Insufficient to Eliminate Discharge)[1]

WRF	Projected Future Reuse Demand (mgd)	Demand Needed to Reduce Discharge to Goal (mgd)	Could Expanded Reclaimed Meet DE Goal?	Shortfall (mgd)	Reuse Service Capacity Added (mgd)	Capital Cost ($M)	Annual O&M Cost ($M)
Arlington East	11.2	17.2	Goal missed	6.0	11.2	$1,800	$10.9
Mandarin	**6.0[2]**	**6.0**	**Meets goal**	-	**0.4**	**$95**	**$0.6**
Monterey	*1.3*	*1.5*	*Nearly Meets Goal*	*0.2*	*1.3*	*$545*	*$3.3*
Cedar Bay	2.5	5.5	Goal missed	2.98	2.5	$698	$4.2
Buckman	1.1	23.4	Goal missed	22.3	1.1	$795	$4.8
Southwest	1.8	10.8	Goal missed	9.02	1.8	$828	$5.0
TOTAL	**23.9**	**64.4**	-	**40.5**	**18.3**	**$4,762**	**$28.7**

WRF – Water Reclamation facility; mgd – million gallons per day; DE – Discharge Elimination; $M – Millions; O&M – Operations and Maintenance

[1]Flows presented in table are based on annual average daily flows

[2]The combined reuse demand closest to Mandarin was 11.5-mgd. The analysis was repeated, with the excess 5.48 mgd demand near Mandarin shifted to being served by Arlington East

In addition to the costs associated with the expansion of reclaimed water, the following advanced wastewater treatment upgrade and O&M costs would be incurred to allow JEA to utilize backup (intermittent) discharges, permitted under the APRICOT Act. The benefit of backup discharges would be that the required capacity of the WPFs could be reduced substantially since peak flows could be handled by backup discharges. The capital cost for AWT upgrades was estimated assuming a unit price of $10.80/gal (Harper et al 2008) to perform the upgrades, and an added O&M cost of $0.80/kgal treated (CDM Smith 2007, FWEAUC 2010). Note the capital cost of AWT improvements as well as the added O&M were both calculated against the AADF capacity of each WRF and adjusted to 2019 dollars.

Advanced Wastewater Treatment Upgrade Costs

WRF	Capacity in AADF (mgd)	Capital Cost ($M)	Annual O&M Cost ($M)
Arlington East	25	$269.8	$7.3
Mandarin	8.75	$94.4	$2.6
Monterey	3.6	$38.9	$1.1
Cedar Bay	10	$107.9	$2.9
Buckman	52.5	$566.7	$15.3
Southwest	14	$151.1	$4.1
TOTAL	**113.85**	**$1,229**	**$33.2**

WRF – Water Reclamation Facility; AADF – Annual Average Daily Flow; mgd – million gallons per day; $M – Millions; O&M – Operations and Maintenance

Expanded Traditional Reclaimed Water

Integrated Water Resource Plan

Eliminate Surface Water Discharge Alternative

Expansion of reclaimed water distribution and implementation of associated AWT upgrades described in this factsheet would have an estimated combined capital cost of nearly $6.0 billion, with an annual increase of $69.3 million in O&M costs. Amortizing the capital costs at 2.5% over a 30-year period would result in $286.2 million in annual expense in 2019 dollars. Therefore, the total combined annual impact of the improvements described herein would total an estimated $356 million/yr. Nevertheless, despite this great expense and all the efforts described herein to maximize the use of reclaimed water for irrigation, this approach alone would fail to meet the surface water discharge elimination requirement.

Combined Cost Associated with AWT Upgrades and Expanded Reclaimed Service

WRF	Improvements	Capital Cost ($M)	Annual O&M Cost ($M)
Arlington East	Add 11.2 mgd Irrigation Service 25 mgd AWT	$2,069	$19.8
Mandarin	Add 0.4 mgd Irrigation Service 8.75 mgd AWT	$189	$3.7
Monterey	Add 1.3 mgd Irrigation Service 3.6 mgd AWT	$584	$4.6
Cedar Bay	Add 2.5 mgd Irrigation Service 10 mgd AWT	$806	$7.8
Buckman	Add 1.1 mgd Irrigation Service 52.5 mgd AWT	$1,362	$23.5
Southwest	Add 1.8 mgd Irrigation Service 14 mgd AWT	$980	$10.0
TOTAL	**Add 18.3 mgd Irrigation Service 114 mgd AWT**	**$5,991**	**$69.3**

AWT – Advanced Wastewater Treatment; WRF – Water Reclamation Facility; $M – Millions; O&M – Operations and Maintenance; mgd – million gallons per day

References:

CDM Smith (2020) "Integrated Water Resource Plan, Task 15.2 Memorandum" JEA. October 2020.

CDM Smith (2007) "Water Supply Cost Estimation Study" SFWMD. February 2007.

FWEAUC (2010). "Costs of Utilities and their Ratepayers to Comply with EPA Numeric Nutrient Criteria for Freshwater Dischargers." November 1, 2020. Prepared by Roderick D. Reardon, Carollo Engineers.

Harper, S.R.; Coleman, D.; Tobocman, D.; Wilkinson, D.; and Bender, L. (2008). "Analysis of Nutrient Removal Costs in the Chesapeake Bay Program and Implications for the Mississippi-Atchafalaya River Basin." Proceedings of WEFTEC 2008. Water Environment Federation, Alexandria, VA.

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Jones Edmunds (2015) "2015 Alternative Water Supply Facilities Master Plan" JEA. February 2015.

Mott MacDonald (2019) "Technical Memorandum: South Grid Reclaimed Water Additional Modeling and Evaluation" JEA. January 2019.

Task 15.3 Conceptual Cost Estimating Factsheet

Water Transfer

CDM Smith

Water Transfer

Integrated Water Resource Plan

Eliminate Surface Water Discharge Alternative

Brief Description:

This fact sheet summarizes the improvements needed to meet a potential wastewater discharge elimination requirement at JEA's water reclamation facilities (WRFs) by conveying excess treated wastewater effluent to a different utility's service area. This alternative was considered for locations outside JEA's service territory that are experiencing high residential growth, and are not currently supplied with reclaimed water, or do not have enough reclaimed water capacity to meet projected demand. Currently, JEA does not transfer excess reclaimed water to any other service area.

The only potential project identified for this scenario is at Southwest WRF, with a potential water transfer of up to 10 million gallons per day (mgd) to Clay County Utility Authority (CCUA) for use as reclaimed water after treatment at a facility constructed by CCUA to provide tertiary filtration and high level disinfection to meet public access reuse standards. Southwest WRF does not currently provide tertiary filtration and high-level disinfection to produce reclaimed water for Public Access Reuse. No additional treatment is assumed by JEA beyond the current treatment provided prior to transfer to CCUA. Since no allowable backup discharges are assumed, the discharge elimination criteria require 24.5 mgd of transfer capacity to handle the peak flow when 16.4 million gallons (MG) of equalization storage is provided. The 10 mgd of demand from CCUA is insufficient to meet discharge elimination criteria since 24.5 mgd of demand is needed from Southwest when 16.4 MG of equalization storage is provided. Therefore, water transfers would not result in compliance with discharge elimination criteria for the Southwest WRF or the overall JEA WRF system. This alternative would need to be considered in conjunction with another strategy to effectively eliminate surface water discharges across JEA's service territory.

Facilities Required:

Based upon discussions with JEA, the water transfer alternative for eliminating surface water discharges is only being considered for JEA Southwest WRF. If this alternative were implemented, the required infrastructure improvements include:

- Construction of 16.4 MG of equalization storage.
- Approximately 10 miles of pipeline and a booster pumping network to convey flow from Southwest WRF to a CCUA connection point.
- Projected demand from CCUA only accounts for 5 to 10-mgd; however, 24.5 mgd of baseline flows elsewhere are required.
    - Additional measures would be still needed to dispose of the remaining balance of the discharge volume that is ordinarily conveyed to the St. Johns River.

Water Transfer

Integrated Water Resource Plan

Eliminate Surface Water Discharge Alternative

Cost:

The table below presents the estimated capital and O&M cost for water transfer to CCUA, adjusted to 2019 dollars. The capital cost is comprised of a new pumping station, piping, and land acquisition. The assumed pipeline cost is $18/inch/linear foot, based on recent pipeline installation data provided by JEA as part of the expanded reclaimed scenario. This cost does not include disposal of the remaining balance of the discharge volume that is ordinarily conveyed to the St. Johns River. If the proposed wastewater discharge elimination bill passes, it is recommended that JEA conduct a full extensive study to determine the feasibility and details of potential implementation schedules and how it impacts rate payers.

Eliminate Surface Water Discharges via Water Transfers (Insufficient to Eliminate Discharge)

WRF	Max Transfer (MGD)	WTP Transfer Pipeline Distance (miles)	Capital Cost ($M)	Annual O&M Cost ($M)
Southwest	10	10.3	$74	$0.5

References:

CDM Smith (2020) "Integrated Water Resource Plan, Task 15.2 Memorandum" JEA. October 2020.

CDM Smith (2019) "Water Purification Technology Research and Development Project; Phase II Conceptual Plan" JEA. February 2019.

CDM Smith (2018) "Water Purification Technology Phase II and III Cost Evaluation Report" JEA. December 2018.

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Jones Edmunds (2015) "2015 Alternative Water Supply Facilities Master Plan" JEA. February 2015.

Task 15.4 Technical Memorandum

Technical Memorandum for “Eliminate Surface Water Discharge” Alternative (February 2021)

CDM Smith

Memorandum

To:	*George Porter, PE, JEA*
From:	*CDM Smith* *Chris Cerreta, Anna Ness, P.E., Shayne Wood, P.E., BCEE*
Date:	*November 3, 2020* *Updated November 18, 2020* *Updated November 24,2020* *Updated February 2021*
Subject:	*JEA Integrated Water Resource Plan, Task 15.4 – Technical Memorandum for "Eliminate Surface Water Discharge" Alterative*

1.0 Introduction

As part of JEA's Integrated Water Resource Plan (IWRP), CDM Smith Inc. (CDM Smith) developed planning alternatives that attempt to eliminate surface water discharges of wastewater effluent from JEA's water reclamation facilities (WRFs). This task was prompted by the possibility that the Florida Legislature may, in the near future, implement legislation that would impose strict discharge elimination requirements for treated effluent from JEA's WRFs. Although legislation with these types of provisions was proposed in the early 2020 legislative session, associated language was removed prior to passage of a pared-down versions of the bills (House Bill 715, Senate Bill 1656).

The infrastructure requirements and planning-level cost estimates presented herein represent one theoretical scenario of what JEA could do if the Florida Legislature passes a bill requiring elimination of surface water discharges. Feasibility-level alternatives were developed by CDM Smith and presented in the "Engineering Evaluation and Feasibility Level of Design for the 'Eliminate Surface Water Discharge' Alternative Memorandum" (Task 15.2), and in the subsequent "Conceptual Cost Estimating and Documentation Factsheets" (Task 15.3).

Since Task 15 was limited in scope, the proposed schedule, quantities, costs, and other factors are subject to change. Furthermore, the requirements of a potential Bill eliminating surface water discharges may differ in certain aspects from the assumptions described herein. If the Florida Legislature adopts such a Bill, CDM Smith recommends JEA conduct a full and extensive study to determine the feasibility of meeting the enacted requirements, including details of the required improvements, implementation schedule, and impact to rate payers.

The purpose of this memorandum is to summarize the development of these planning-level alternatives for JEA to eliminate surface water discharges from its WRFs. The six discharge elimination alternatives considered for this evaluation include:

- Deep Well Injection
- Expansion of Traditional Reclaimed Water
- Water Transfers
- Direct Potable Reuse
- Indirect Potable Reuse
- Hybrid: A mix of the above alternatives, picking the most favorable alternative for each WRF, considering technical feasibility and cost for each WRF. The feasible implementation timeline for the hybrid scenario is estimated at 15 to 20 years.

This memorandum provides a summary of capital and operations and maintenance (O&M) costs in 2019 dollars for each discharge elimination alternative, including costs associated with Advanced Wastewater Treatment (AWT) upgrades, where required, and land acquisition. All annualization of capital costs is calculated assuming a 30 year-life of improvements and a 2.5 percent (%) discount rate. Also included is a summary of a final "hybrid" option that utilizes a variety of alternatives to ultimately achieve discharge elimination. For the hybrid option, it was assumed the implementation timeline is 15 to 20 years to account for projected growth in JEA's reclaimed water service territory through new development. Discharge elimination under the hybrid scenario still requires an immense investment in new infrastructure, totaling an estimated **$1.3 billion (B) in capital cost,** and an additional **$27 million (M) per year for O&M. The total annualized expense to JEA would be $88 M per year**.

The hybrid scenario was assumed to be implemented over the next 15 to 20 years because the elimination of surface water discharges is likely not practicable by the anticipated 2027 compliance date suggested by the timeframe included in the draft legislation. Because of the large quantity of wells, pipelines, and water purification facilities needed in such a short period and the limited number of capable well drillers in Florida, JEA would be forced to compete with other Florida utilities and turn to out of state resources at a premium cost. Nevertheless, even with the recruitment of numerous out of state drillers and construction companies, given the inexperience of the drillers with Northeast Florida hydrogeology and the sheer number of new facilities and pipelines required, it is unlikely that design and construction could be finished within an allotted 5-year compliance period.

It should be noted that some information provided in this memo, independent of the final "hybrid" option discussed in Section 3, differs from what was presented in the previous task 15.2 memo. Following discussion with JEA and consideration of the previously submitted draft version of this memo (November 3, 2020), the expanded reclaimed water capacity at Mandarin WRF was decreased from 6.0 mgd to 0.4 mgd. This change was made to account for 5.9 mgd of reclaimed demand already installed in the Mandarin service area that was previously overlooked.

2.0 Costs and Requirements to Eliminate Surface Water Discharges

This section briefly describes each discharge elimination alternative and identifies the major capital and O&M cost components for each alternative. The costs presented in this section are based on 2027 projected flows, and do not take in to account anticipated growth in JEA's service territory presented in the "hybrid" scenario (**Section 3.0**).

2.1 Deep Well Injection (DWI)

This alternative would achieve wastewater effluent discharge elimination by disposal of excess reclaimed water via deep injection wells to confined underground injection zones. The total capital cost of implementing only DWI to achieve discharge elimination at all JEA WRFs evaluated is approximately $1.5B. The total annual O&M cost associated with implementation of DWI is approximately $11.9M. The combined annualized expense to JEA would total $83M per year. This alternative provides no potable water supply benefits to JEA.

Assuming the feasibility of injection in the proposed zones, the DWI alternative is technically capable of handling the flows required to meet the proposed discharge elimination requirement. However, actual construction of a systemwide DWI alternative would be costly and slow, particularly at the large WRFs needing large volumes of water storage tankage and dozens of costly injection wells with interconnecting pipelines and right-of-way requirements.

Requirements associated with this alternative include equalization tanks for treated effluent at each WRF to equalize peaks in flow above the combined wellfield injection capacity, an associated pumping station, and several deep injection wells. For the purpose of this evaluation, it was assumed that no additional treatment process upgrades would be required for the DWI scenario, based on current DWI regulations in Federal Rule 40 CFR 176. However, neighboring St. Johns County is listed as a county with carbonate aquifer chemistry requiring high-level disinfection (HLD) prior to DWI. If this alternative is selected for implementation, additional permitting discussions with Florida Department of Environmental Protection (FDEP) would be advisable before proceeding with DWI to confirm that HLD would indeed not be required in Duval County.

Groundwater quality characterization described in the Task 15.2 memorandum concluded that two zones of the aquifer may be used for reclaimed water disposal – the Fernandina Permeable Zone (FPZ) and the Lawson Limestone. Several other factors such as water quality data and unknown drilling depths add to the uncertainty in development of deep wells in north Florida, as no such wells currently exist locally.

Significant capital cost items and assumptions for the DWI scenario include:

- Deep injection wells – Assumed 75 injection wells at $10M for each well in accordance with "Deep Injection Well Disposal Option Memorandum" provided by Liquid Solutions Group. Each injection well has a capacity of 2 million gallons per day (mgd); a redundant well and monitoring wells provided at each location.

- Equalization storage tanks – 91 million gallons (MG) of storage are required. Costs are assumed using linear interpolation with given manufacturer capital costs for a variety of tank sizes.

- Pipeline connecting injection wells – Assumed 13 miles of 12-inch pipe at $400 per linear foot and 1,000 feet of separation between each well.

The total annual O&M cost associated with implementation of DWI is approximately $11.9 M. Significant annual O&M cost items and assumptions include:

- Equipment repair and maintenance – Assumed to be 0.5% of the total capital cost.

- Miscellaneous operations and analytical expenses.

- Electricity – Includes electricity required for injection wells and equalization tank pumps. Cost is based on total DWI capacity.

2.2 Advanced Wastewater Treatment (AWT)

Although not a sole alternative for complete wastewater effluent discharge elimination, upgrading JEA's WRFs to provide AWT is a critical component for all discharge elimination alternatives, excluding DWI. AWT provides enhanced removal of solids, organics, and nutrients, as well as high-level disinfection, beyond what is currently required at municipal wastewater plants. In return for the improvements in water quality, AWT facilities are allowed to make backup discharges to surface water. For the purpose of this evaluation, it was assumed backup (intermittent) discharges to surface water could be permitted under the 1994 APRICOT Act (Florida Statute Section 403.086) when AWT measures are in place.

The capital cost for AWT upgrades was estimated assuming a unit price of $10.80 per gallon per day capacity[1] to perform the upgrades, and an added O&M cost of $0.80 per thousand gallons treated[2,3]. Note that the capital cost of AWT improvements as well as the added O&M were both calculated against the average annual daily flow (AADF) capacity of each WRF and adjusted to 2019 dollars. Upgrading JEA's WRFs to AWT and taking advantage of APRICOT discharges reduces the

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[1] Harper, S.R.; Coleman, D.; Tobocman, D.; Wilkinson, D.; and Bender, L. (2008). "Analysis of Nutrient Removal Costs in the Chesapeake Bay Program and Implications for the Mississippi-Atchafalaya River Basin." Proceedings of WEFTEC 2008. Water Environment Federation, Alexandria, VA.
[2] FWEAUC (2010). "Costs of Utilities and their Ratepayers to Comply with EPA Numeric Nutrient Criteria for Freshwater Dischargers." Prepared by R.D. Reardon, Carollo Engineers.
[3] CDM Smith (2007) "Water Supply Cost Estimation Study" SFWMD. February 2007.

overall capacity needed for the discharge elimination alternatives, reducing the capital cost associated with building new infrastructure (cost estimates are provided in **Section 2.8**).

2.3 Expansion of Traditional Reclaimed

This alternative was considered for discharge elimination through expansion of JEA's existing reclaimed water system to meet projected 2027 irrigation water demands. Based upon a review of JEA's existing and projected reclaimed water demands, there is insufficient reclaimed water demand to meet the systemwide discharge elimination goal using this approach alone. This alternative can capture an additional 18.0 mgd of reclaimed water demand in addition to the 8.4 mgd already assumed. A total of 64.4 mgd of demand is required to eliminate surface water discharge, of which only 16.7 mgd can be disposed of via allowable APRICOT discharges. Nevertheless, for discussion purposes, this alternative, as developed herein, maximizes the use of reclaimed water for irrigation to meet projected demands, even though it is not sufficient to meet the discharge elimination requirement. If JEA implemented the expanded reclaimed water alternative to reduce surface water discharges to the extent possible using projected 2027 demands, the total capital cost would be approximately $6.0B. The total annual O&M cost associated with implementation of expanded reclaimed is approximately $69.3M. The combined annualized expense to JEA would total $356M per year. Expansion of traditional reclaimed could provide a water supply benefit to JEA by offsetting future demand increases for potable water from irrigation.

Requirements associated with this alternative include AWT upgrades at all WRFs, reclaimed water storage to meet peak day demands, reclaimed water distribution piping, and increased pumping infrastructure. AWT upgrades are required to take advantage of backup (intermittent) surface water discharges during periods of high flow and low reclaimed water demand.

Significant capital cost items and assumptions include the following:

- Reclaimed Water Pipelines – Includes neighborhood level piping and transmission piping from WRF to existing neighborhoods. Assumes $28 per foot of pipe per inch of diameter, based on recent pipeline installation data for developed neighborhoods provided by JEA.
- Allowances for yard piping, electrical site work, contractor overhead and profit, insurance, construction contingency, and other items.
- AWT upgrades – Extensive upgrades are required at JEA WRFs not currently providing AWT. During periods with a low reclaimed water demand, it was assumed the backup (intermittent) APRICOT surface water discharge would be used.
- System connections – An average connection cost of $400 per service connection was assumed, derived from reviewing JEA published water connection rates for residential and commercial meters.

Significant annual O&M cost items and assumptions include:

- O&M associated with AWT upgrades – coagulant addition, modified aeration, filtration, high-level disinfection, and other items.
- Equipment repair and maintenance – Assumed to be 0.5% of the total capital cost.
- Electricity – Cost is based on total increase in expanded reclaimed capacity of 18.0 MGD.

2.4 Water Transfers

This alternative was evaluated for potential elimination of wastewater discharges by conveying excess reclaimed water effluent to an adjacent utility's reclaimed water +service area. Water transfers alone are not sufficient to achieve discharge elimination. The only potential project identified for this scenario is at Southwest WRF, with a potential water transfer of up to 10 mgd to Clay County Utility Authority (CCUA) for use as reclaimed water. Requirements for this alternative include construction of 16 MG of equalization storage, approximately 10 miles of pipeline and a booster pumping network to convey flow to the CCUA connection point.

The total capital cost of implementing the 10-mgd water transfer to CCUA from JEA's Southwest WRF is approximately $74M. The total annual O&M cost associated with implementation of the water transfer alternative is approximately $0.5M. The combined annualized expense to JEA would total $4M per year. Significant capital cost items and assumptions include:

- 16 MG of equalization storage tanks and transfer pump station.
- Pipeline – Cost for approximately 10-mile conveyance pipeline is $18 per inch per linear foot, based on recent pipeline installation data provided by JEA as part of the expanded reclaimed scenario.

Significant annual O&M cost items and assumptions include:

- Equipment repair and maintenance – Assumed to be 0.5% of the total capital cost.
- Electricity – Cost is based on 10 mgd of flow capacity.

2.5 Direct Potable Reuse (DPR)

The DPR alternative would achieve wastewater effluent discharge elimination by construction of a DPR water purification facility (WPF) at each of JEA's WRFs with interconnecting piping to a nearby existing JEA WTP for blending with traditional groundwater supplies. Planning-level costs for this supply option were initially developed based on a detailed cost estimate for 10 mgd of potable supply from the Southwest WRF, utilizing quotes from equipment vendors and experience. Costing for implementing DPR at other potential WRFs was then scaled from the original estimate according to flow. The total capital cost of implementing DPR only at each JEA WRF to achieve discharge elimination is approximately $1.8B. The total annual O&M cost associated with the DPR alternative is approximately $68.5M. The combined annualized expense to JEA would total $153M per year. While this alternative may be technically feasible, there is likely not enough existing potable water demand and potable water distribution system capacity near each new WPF to accept the additional purified water without further potable water distribution system upgrades.

Requirements associated with this alternative include AWT upgrades at five existing WRFs currently without AWT, construction of five new WPFs, and construction of concentrate disposal wells to properly dispose of brine that is produced as part of the treatment process at each WPF.

The total capital cost of implementing DPR at each JEA WRF to achieve discharge elimination is approximately $1.8B. Significant capital cost items and assumptions include:

- AWT upgrades – Extensive upgrades are required at JEA WRFs not currently providing AWT. During periods with a low reclaimed water demand, it was assumed the backup (intermittent) APRICOT surface water discharge would be used.
- WPF facility construction – 45 mgd of WPF capacity is required. Assumes construction of five new WFPs using a multi-barrier treatment train consisting of ultrafiltration, reverse osmosis, advanced oxidation and granular activated carbon, with associated online monitoring equipment. Note that WPF capacity refers to the purified water capacity assuming 80% recovery for direct and indirect potable reuse.
- Concentrate injection wells – Construction of 13 concentrate injection wells is required. Assumed $10M for each well in accordance with the "Deep Injection Well Disposal Option Memorandum" provided by Liquid Solutions Group. Each injection well has a capacity of 2 mgd; each location is provided with one redundant well and associated monitoring wells.
- Pipeline connections to nearest WTP – Construction of 5 major pipelines is required to convey a total of 45 mgd of purified water. The total estimated length of pipelines is nearly 16 miles, with most extending between 3 to 5 miles.

The total annual O&M cost associated with implementation of DPR is approximately $68.5M. Significant annual O&M cost items and assumptions include:

- O&M associated with AWT upgrades – coagulant addition, modified aeration, filtration, high-level disinfection, and other items.
- Chemicals – Includes chemicals needed for WPF treatment and is based on total WPF capacity.
- Equipment repair and maintenance – Assumed to be 0.5% of the total capital cost.
- Electricity – Cost is based on total DPR capacity.

2.6 Indirect Potable Reuse (IPR)

The IPR alternative would achieve wastewater effluent discharge elimination by treating reclaimed water to drinking water standards through construction of new WPFs. Planning level costs for this supply option were initially developed based on a detailed cost estimate for 10 mgd of potable supply from the Southwest WRF, utilizing quotes from equipment vendors and experience. Costing for implementing IPR at other potential WRFs was then scaled from the original estimate according to flow. The total capital cost of implementing IPR at each JEA WRF to achieve discharge elimination is approximately $1.8B. The total annual O&M cost associated with implementation of the IPR alternative is approximately $63.7M. The combined annualized expense to JEA would total $150M per year. This alternative would provide a water supply benefit to JEA.

In the IPR scenario, rather than blend directly with finished water from JEA's WTPs, WPF effluent would be used to directly recharge the Floridan aquifer, used as a water supply. The main advantage of IPR over DPR is the ability to utilize the aquifer as storage, instead of sending purified water directly to the potable water distribution system. IPR provides increased operational flexibility by decoupling recharge of purified water from groundwater pumpage. Requirements associated with this alternative include AWT upgrades at five existing WRFs currently without AWT, construction of five new WPFs, construction of aquifer recharge wells, and construction of concentrate disposable wells to properly dispose of brine that is produced as part of the treatment process at the WPF facility.

The total capital cost of implementing IPR at each JEA WRF to achieve discharge elimination is approximately $1.9B. Significant capital cost items and assumptions include:

- AWT upgrades – Extensive upgrades are required at JEA WRFs not currently providing AWT. During periods with a low reclaimed water demand, it was assumed the backup (intermittent) APRICOT surface water discharge would be used.
- WPF facility construction – 45 mgd of WPF capacity is required. Assumes construction of five new WPFs using a multi-barrier treatment train consisting of ultrafiltration, reverse osmosis, and advanced oxidation, along with associated online monitoring equipment.
- Concentrate injection wells – Construction of 13 concentrate injection wells is required. Assumed $10M for each well in accordance with the "Deep Injection Well Disposal Option Memorandum" provided by Liquid Solutions Group. Each injection well has a capacity of 2 mgd; each location is provided with one redundant well and associated monitoring wells.
- Aquifer recharge and monitoring wells – Assumes $10M for each recharge well and an additional $0.5M for each monitoring well.

Significant cost items and assumptions include:

- Electricity – Cost is based on total IPR capacity.

- Equipment repair and maintenance – Assumed to be 0.5% of the total capital cost.
- Chemicals – Includes chemicals needed for WPF treatment and is based on total WPF capacity.
- O&M associated with AWT upgrades – Includes coagulant addition, modified aeration, filtration, high-level disinfection, and other items.

This alternative is deemed a plausible option at large WRFs and offers beneficial reuse credits for JEA's Consumptive Use Permit (CUP), which would allow additional proportionate future withdrawals. Additional groundwater modeling to demonstrate regional benefits and discussions with FDEP are recommended if this alternative is selected for future implementation.

2.7 Land Acquisition Costs

A subset of the above discharge elimination alternative costs is land acquisition required for each alternative. A review of available property surrounding each WRF was conducted. For example, additional land area would be needed for the WPF facility (3 acres per 10-mgd WPF capacity), deep injection wells (0.5 acres each), concentrate wells (0.5 acres each), monitoring wells, equalization tanks, and AWT upgrades (chemical addition, deep-bed filters, and other items). It was assumed the pipeline corridor connecting each well would be located in existing easements or rights-of-way near roads; therefore, no additional land is required for the pipeline portion. It was concluded that upgrades associated with AWT improvements could be achieved within the existing plant footprint; however, additional land would be needed for the other aforementioned infrastructure improvements. To estimate the cost of additional property acquisition, the prices of adjacent properties close to each WRF were obtained through the Duval County property appraiser website, and ultimately used to calculate an average land cost in dollars per acre. It should be noted that land acquisition costs accounted for less than 10% of the overall capital cost for each discharge elimination alternative.

2.8 Summary

A summary table of capital and annual O&M costs associated with each discharge elimination alternative at each WRF is presented in **Table 2-1**. The total annualized costs are also presented, calculating the annualized capital costs assuming a 30-year period and 2.5% discount rate. Note, these costs are based on discharge elimination in the near future and are different from the hybrid costs presented in Section 3.0, which are phased to occur over a longer timeline to account for projected growth in JEA's reclaimed water service territory.

Table 2-1. Cost for Surface Water Discharge Alternatives ($M or $M per yr)

WRF	Cost	Alternatives that Could Meet the Requirement			Alternatives that Could Not Meet the Requirement *	
		AWT Upgrades and DPR	AWT Upgrades and IPR	DWI	AWT Upgrades and Expanded Reclaimed	Water Transfer
Arlington East	Capital	$433	$443	$355	$2,069	-
	O&M	$16.4	$15.5	$3.0	$19.8	-
Mandarin	Capital	-	-	$45	$189	-
	O&M	-	-	$0.3	$3.7	-
Monterey	Capital	$94	$99	$60	$584	-
	O&M	$2.9	$2.7	$0.4	$4.6	-
Cedar Bay	Capital	$186	$188	$98	$806	-
	O&M	$6.3	$5.9	$0.8	$7.8	-
Buckman	Capital	$779	$794	$557	$1,362	-
	O&M	$32.5	$29.9	$4.5	$23.5	-
Southwest	Capital	$280	$274	$275	$980	$74
	O&M	$10.5	$9.6	$2.2	$10.0	$0.5
Nassau	Capital	-	-	$59	-	-
	O&M	-	-	$0.4	-	-
Ponte Vedra	Capital	-	-	$40	-	-
	O&M	-	-	$0.2	-	-
TOTAL SYSTEM WIDE	Capital	$1,771	$1,797	$1,488	$5,991	$74
	O&M	$68.5	$63.7	$11.9	$69.3	$0.5
	Total Annual**	$153	$150	$83	$356	$4.0

Blank cells indicate alternative was not considered for analysis, based on feedback from JEA and previous recommendations.
*Insufficient reclaimed water demand to meet discharge elimination requirement
** Annual Impact of Capital Cost at 2.5% discount rate for 30 years.

3.0 Hybrid Option for Surface Water Discharge Elimination

If JEA is required to eliminate surface water discharge of wastewater effluent, a combination of the alternatives mentioned above would be required to achieve this goal. The proposed hybrid option described below uses indirect potable reuse, deep well injection, expanded reclaimed water, and intra-JEA wastewater transfers. This recommended hybrid option was developed through consideration of capital costs, potable water demands, reclaimed water demands, technical feasibility, and discussion with JEA. The hybrid option, as developed at each WRF, is described in the following sections.

3.1 Implementation Schedule

The 2027 timeline for surface water discharge elimination is not feasible. The projected timeline for the hybrid option described herein is 15 to 20 years (2035 to 2040). The shortest technically feasible implementation timeline is approximately 12-15 years (2032 to 2035) for the deep injection well improvements, based on 10-12 months of construction per well, and 5 well drilling companies mobilized in Jacksonville at the same time. Moreover, several challenges are associated with this approach: permitting, driller capability and availability, and unknown hydrogeological conditions at nearly 3,000 feet below land surface. In an attempt to meet stringent schedule requirements, the possibility of retrofitting injection wells to become aquifer recharge wells was evaluated but considered unreliable due to the inability of methods to dependably “plug” deep injection wells and uncertain local geology. The implementation schedule for the overall JEA Integrated Water Resource Program (IWRP) is approximately 50 years (through 2070), which is based on projected potable water demands and does not include complete surface water discharge elimination from WRFs.

3.2 Arlington East WRF

Indirect potable reuse by aquifer recharge is the selected discharge elimination alternative for Arlington East WRF under the hybrid option. The plant has a permitted AADF of 25 mgd. For the hybrid option, it was assumed the flow currently conveyed to Monterey WRF (1.7-mgd AADF) would instead be treated at Arlington East. Around 2030, the reclaimed water demand from new growth within the South Grid increases substantially, up to the planned reclaimed production capacity of 12-mgd. Given the flow diversion from Monterey WRF and the increased reclaimed water demand of 12 mgd, the required volume of surface water discharge to eliminate from Arlington East under the “hybrid” scenario is 7.2-mgd ADF. During the project planning and permitting phase, JEA could demonstrate that aquifer recharge in this area would be beneficial to the region, resulting in CUP credits.

Potable reuse was selected as the most viable alternative since the difficulty of DWI increases at high flows, as greater investment is required for equalization storage, pipelines, deep injection wells, and associated rights of way and easements. IPR was selected over DPR given the WRF’s location in the South Grid, where aquifer recharge may be beneficial. Implementation of the IPR alternative at Arlington East requires a capital investment of approximately $270M, associated with 25 MGD of advanced wastewater treatment upgrades and construction of a 5.8 MGD IPR WPF.

3.3 Mandarin WRF

Expansion of reclaimed water is the selected discharge elimination alternative for Mandarin WRF under the hybrid option. Discharge elimination at Mandarin WRF will be achieved through reclaimed water demand growth in the South Grid over the next 15-20 years. With a projected AADF in 2027 of 6.3 mgd, Mandarin WRF is expected to serve 5.9 mgd of reclaimed water via the existing treatment and distribution system. Beyond 2027, the projected reclaimed water demand from new growth in the South Grid within the proposed implementation window of 15-20 years is expected to be sufficient to use the remaining 0.4 mgd of effluent conveyed via extension of the existing reclaimed water distribution system.

The increase in reclaimed water demand will occur organically through new development in the region; therefore, retrofitting existing neighborhoods with new reclaimed water distribution piping is not needed under the “hybrid” scenario. Consequently, it was assumed implementation of this alternative will not require costly retrofits to existing neighborhoods or plant improvements, and therefore, can be achieved over the next 15-20 years with no significant added capital or O&M cost to JEA.

3.4 Monterey WRF

An intra-JEA wastewater transfer is the selected discharge elimination alternative for Monterey WRF under the hybrid option. All untreated wastewater that is ordinarily conveyed to Monterey WRF will be diverted instead to Arlington East WRF. Discussions with JEA indicated that Monterey WRF could be phased out over time because of its small capacity, limited treatment technology, and available capacity at nearby Arlington East WRF to accept flows. Monterey WRF has a forecasted 2027 AADF of 1.7 mgd and requires that 100% of this flow be managed given the lack of reuse demand in the area and the level of existing treatment provided, which does not allow for APRICOT discharges.

Given that the Monterey WRF will be eliminated in the future, it is not technically feasible to implement costly discharge elimination alternatives. Instead, JEA’s interconnected collection system can convey water that is typical sent to Monterey WRF to Arlington East WRF. For the purpose of this analysis, it was assumed this transfer of wastewater can be achieved without upgrades to JEA’s wastewater conveyance system or treatment improvements at Monterey WRF. Therefore, it was assumed that this transfer can be achieved without significant capital or O&M cost to JEA.

3.5 Cedar Bay WRF

Indirect potable reuse by aquifer recharge is the selected discharge elimination alternative for Cedar Bay WRF under the hybrid option. The plant has a permitted AADF of 10 mgd, with 5.5 mgd of flow currently projected to discharge in the St. Johns River in 2027.

Although the capital cost associated with DWI is less than that of both potable reuse options, IPR was chosen given the assumed CUP benefits associated with aquifer recharge in this region. The recharge location should be placed considering where increased withdrawals are planned. During the project planning and permitting phase, JEA could demonstrate that aquifer recharge in this area would be beneficial to the region, resulting in CUP credits. Implementation of the IPR alternative at Cedar Bay WRF requires a capital investment of approximately $188M, associated with 10 MGD of advanced wastewater treatment upgrades and construction of a 3.4 MGD IPR WPF.

3.6 Buckman WRF

Deep well injection is the selected discharge elimination alternative for Buckman WRF under the hybrid option. The plant is located near downtown Jacksonville and is JEA's largest WRF, with a permitted AADF of 52.5 mgd. Buckman does not currently serve any off-site reuse customers, and the projected surface water discharge flow that must be managed is approximately 30 mgd AADF.

Given the high cost of AWT upgrades and low projected population growth in the area, potable reuse was eliminated from consideration. Buckman WRF is located in a highly urbanized location with little room for expansion. Given the large volume of effluent to be managed, need for operational flexibility, and land availability constraints, the recommended discharge elimination approach is DWI.

The capital investment required for DWI at Buckman WRF is approximately $557M, associated with construction of 36 MG of equalization storage tanks, 18 deep injection wells, pumping system upgrades, and a new pipeline corridor. It should also be noted that purchase of additional land for deep injection wells is required, which may be challenging in the highly urbanized area.

3.7 Southwest WRF

A composite discharge elimination alternative is selected for Southwest WRF under the hybrid option. The plant has a permitted AADF of 14 mgd with a planned expansion to 16-mgd AADF, and does not currently serve any off-site reuse customers. The first part of this alternative is indirect potable reuse by aquifer recharge with a 4.6 MGD WPF. The second part of this alternative provides for transfer of 5-mgd of reclaimed water to Clay County for reuse.

Implementation of IPR at Southwest WRF is unique among all the other WRFs described herein, since Southwest WRF would not require AWT upgrades because periods of peak flow could be attenuated using equalization storage for the water transfer pump station. Southwest WRF is located in the West sub-grid of JEA's North Grid water service territory, where potable water demands are anticipated to increase. During the project planning and permitting phase, JEA could demonstrate that aquifer recharge in this area would be beneficial to the region, resulting in CUP credits.

The reclaimed water not used for aquifer recharge would be diverted for transfer to a neighboring utility, the Clay County Utility Authority (CCUA). Given uncertainties associated with reliance on an outside organization accepting reclaimed water during periods of low customer reclaimed water demand, this memo assumes CCUA would accept 5-mgd of flow on a daily basis. Note, Southwest WRF currently provides secondary treatment and basic level disinfection. Therefore, CCUA would need to provide additional treatment to meet public access reuse standards.

Implementation of the IPR and water transfer projects related to Southwest WRF requires a capital investment of approximately $167M. The capital cost for IPR is $93M for a 4.6 MGD WPF and associated infrastructure. The capital cost associated with the water transfer option totals $74M for equalization storage tanks, a water transfer pump station, and a 10-mile pipeline to Clay County.

3.8 Nassau WRF

A composite discharge elimination alternative is selected for Nassau WRF under the hybrid option. This composite alternative was developed in recognition of the current low reclaimed water demand near Nassau, while taking advantage of potential increases in reclaimed associated with future population growth in the service area. The first part of this alternative is construction of deep injection wells. The second part of this alternative includes expansion of the existing reclaimed water distribution system. The plant currently provides AWT and is being expanded by JEA to a permitted capacity of 4.0 mgd through an ongoing design and construction project.

Implementation of DWI would require construction of three new deep injection wells and equalization storage tanks to eliminate discharges within the 15-20 year time frame before future reclaimed demand becomes available. The cost of constructing neighborhood-level piping and individual customer connections for reclaimed water in areas of new growth was not considered in this evaluation. Implementation of DWI at Nassau requires a capital investment of approximately $59M.

In the hybrid option, expansion of traditional reclaimed is assumed to occur near Nassau WRF beyond the 15-20 year time frame, given the forecasted population growth and subsequent expected growth in reclaimed water demand. Until reclaimed water demand increases, DWI is recommended for Nassau given the WRF's small capacity, low reclaimed water demand, and isolation from the rest of JEA's reclaimed water system.

3.9 Ponte Vedra WRF

Deep well injection is the selected discharge elimination alternative for Ponte Vedra WRF under the hybrid option. The plant has a permitted capacity of 0.8 mgd and requires management of 0.1 mgd of additional reclaimed water effluent following consideration of off-site reuse demands.

Because of the small volume of effluent to be managed, DWI was the only considered alternative for this plant. Since the Ponte Vedra WRF is isolated and far removed from the rest of the collection system grid, a reclaimed water transfer to Arlington East was judged unfeasible, given the need for long pipelines and a costly river crossing to convey the small flow. Implementation of potable reuse would require AWT upgrades and construction of a WPF facility, which would not be the most economically feasible option for just 0.1 mgd of treatment. Similarly, expansion of traditional reclaimed water would likely require substantial upgrades to the existing system located in an urban area, which would again be an inefficient method for managing 0.1 mgd of flow. Implementation of the DWI alternative at Ponte Vedra requires a capital investment of approximately $40M. It should be noted that 2 deep injection wells are needed to meet FDEP requirements for 1 redundant well, which essentially doubles the capital cost for this alternative. If this requirement could be waived for normal operating conditions, then 1 well would be sufficient to handle all excess effluent at the plant, and cost would be reduced significantly.

4.0 Conclusion

A summary table of the hybrid option for wastewater effluent surface water discharge elimination is shown below in **Table 4-1**. The hybrid option selects effective and technically feasible alternatives for each plant, with planned implementation over the next 15-20 years. Discharge elimination under the hybrid scenario requires an immense investment in new infrastructure, totaling an estimated **$1.3B in capital cost,** adding approximately **$27M per year in O&M cost. The total annualized cost impact to JEA for these improvements would be $88M per year.** As mentioned in this assessment, compliance with provisions of potential legislation to eliminate surface water discharges would require an immense investment from JEA and impose a heavy burden on JEA's rate payers, including an estimated 357,000 water customers and 279,000 sewer customers[4]. Resource availability and competition from neighboring utilities further complicates the matter and adds to the investment needed to achieve compliance.

cc: David MacNevin, PhD, PE (CDM Smith)

[4] JEA (accessed November 2020); "About JEA"; https://www.jea.com/about

Table 4-1. Recommendation to Eliminate Surface Water Discharges (Hybrid Approach, Implementation Time 15 to 20 Years)

Location (Grid)	WRF	Discharge to Be Managed (mgd)	Requirements to Eliminate Surface Water Discharges Under the Hybrid Scenario				
			Recommended Alternative	Upgrades to AWT Required?	Justification	New Infrastructure Required	Costs ($M)
South	Arlington East	7.2	Indirect Potable Reuse + Reclaimed Water Growth	Yes	▪ Regional aquifer system may benefit from recharge in this area. ▪ Around 2030, the reclaimed water demand from new growth within the South Grid increases substantially, up to the planned reclaimed production capacity of 12-mgd. ▪ All flow (untreated wastewater) from Monterey WRF's collection system is conveyed to Arlington East.	▪ AWT upgrades (25 MGD) to allow for APRICOT discharges ▪ Construction of WPF with 7.2-mgd capacity ▪ Construction of 2 concentrate injection wells and associated monitoring wells ▪ Construction of 3 aquifer recharge wells ▪ New development in JEA's South Grid to accept 12-mgd reclaimed water (cost incurred by others, not included in capital and O&M)	▪ Capital: $270 ▪ Annual O&M: $12.5
	Mandarin	0.4	Reclaimed Water Growth	No	▪ The projected reclaimed water demand from new growth in the South Grid increases within the feasible. implementation window of 15 to 20 years. ▪ This new reclaimed water demand from the South Grid will utilize available flow from Mandarin WRF.	▪ None - New development in JEA's South Grid to accept remaining 0.4-mgd reclaimed water (cost incurred by others, not included in capital and O&M)	▪ Capital: $0 ▪ Annual O&M: $0
	Monterey	1.7	Water Transfer to Arlington East	No	▪ Phase out Monterey WRF over time. ▪ Monterey only provides secondary treatment and basic-level disinfection. ▪ Arlington East has treatment capacity to accept the flow from Monterey.	▪ None – assume Monterey WRF will be phased out over time ▪ JEA's interconnected collection system can convey water that is typically sent to Monterey to Arlington East, instead.	▪ Capital: $0 ▪ Annual O&M: $0
North	Cedar Bay	5.5	Indirect Potable Reuse	Yes	▪ Utilize aquifer for storage (not enough potable water demand in area for DPR). ▪ Added benefit of using groundwater at plants where needed instead of needing to pipe DPR.	▪ AWT upgrades (10 MGD) to allow for APRICOT discharges ▪ Construction of WPF with 4.2-mgd capacity ▪ Construction of 2 concentrate injection wells and associated monitoring wells ▪ Construction of 3 aquifer recharge wells	▪ Capital: $188 ▪ Annual O&M: $5.9
	Buckman	29.3	Deep Well Injection	No	▪ Deep well injection with equalization storage offers operational flexibility during times of peak flow. ▪ Given the high cost of AWT upgrades and low projected population growth in the area, potable reuse not favorable for this location. ▪ Limited land area around Buckman WRF is available for construction of WPFs, AWT upgrades, and other items.	▪ Construction of 36 MG of equalization storage tanks ▪ Construction of 18 deep injection wells and pumping system upgrades ▪ New pipeline corridor (approximately 5 miles) connecting deep injection wells ▪ Purchase additional land for deep injection wells (assumed pipeline corridor would be located in existing easements)	▪ Capital: $557 ▪ Annual O&M: $4.5
	Southwest	13.6	Indirect Potable Reuse + Water Transfer	No	▪ Utilize aquifer for storage (not enough potable water demand in area for DPR) ▪ Conveying reclaimed water to CCUA is beneficial reuse of the water (assumes CCUA will accept 5-mgd) ▪ AWT upgrades are not required – it was assumed equalization storage for water transfer pump station could be used during peak flow events.	▪ Construction of WPF with 4.6-mgd capacity ▪ Construction of 2 concentrate injection wells and associated monitoring wells ▪ Construction of 4 aquifer recharge wells ▪ New pipeline (approximately 10 miles) and booster pumping network to convey flow from Southwest WRF to a CCUA connection point.	▪ Capital: $167 ▪ Annual O&M: $3.6
Small	Nassau	1.9	Deep Well Injection + Reclaimed Water Growth	No	▪ Deep well injection with equalization storage offers operational flexibility during times of peak flow and low reclaimed water demand ▪ Nassau already provides AWT ▪ Long term savings associated with predicted increase in regional reclaimed demand	▪ New development in Nassau County to accept reclaimed water (cost incurred by others, not included in capital and O&M) ▪ Construction of one 2.5 MG equalization storage tank ▪ Construction of 3 deep injection wells	▪ Capital: $59 ▪ Annual O&M: $0.4
	Ponte Vedra	0.1	Deep Well Injection	No	▪ Only alternative considered ▪ Small volume of water to eliminate	▪ Construction of one 0.1 MG equalization storage tank ▪ Construction of 2 deep injection wells and pump system upgrades ▪ Purchase of additional land	▪ Capital: $40 ▪ Annual O&M: $0.2
	TOTAL	72.4	-	-	-	-	▪ **Capital: $1,300** ▪ **Annual O&M: $27** ▪ **Total Annual: $88**

Prepared by

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