

TAYLOR ENGINEERING, INC.



Initial Assessment of Alternative Water Supply Options for Clay County Utility Authority

FINAL REPORT

January 2016

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Clay County Utility Authority**

Final Report

Prepared for

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by

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Introduction

Clay County Utility Authority (CCUA) tasked Taylor Engineering with providing an initial assessment of potential alternative water supply (AWS) options that can be used to supplement CCUA’s fresh groundwater and reclaimed water supplies currently used to meet its customers’ water supply needs.

This initial assessment provides, for review and further consideration by CCUA, the following: (1) framework for AWS development; (2) identification of water supply options with planning level cost estimates; (3) a comparison of options; and (4) recommended next steps in developing long-term sustainable AWS options.

1.0 Framework for Sustainable Water Supplies/AWS Development

CCUA is committed to sustainable water supplies for the future. In October 2015, CCUA’s Board of Supervisors approved an AWS surcharge expressly for the purpose of developing and implementing AWS to supplement the current fresh groundwater supplies and reclaimed water supplies available to CCUA. A framework for sustainable water supplies is proposed as follows:

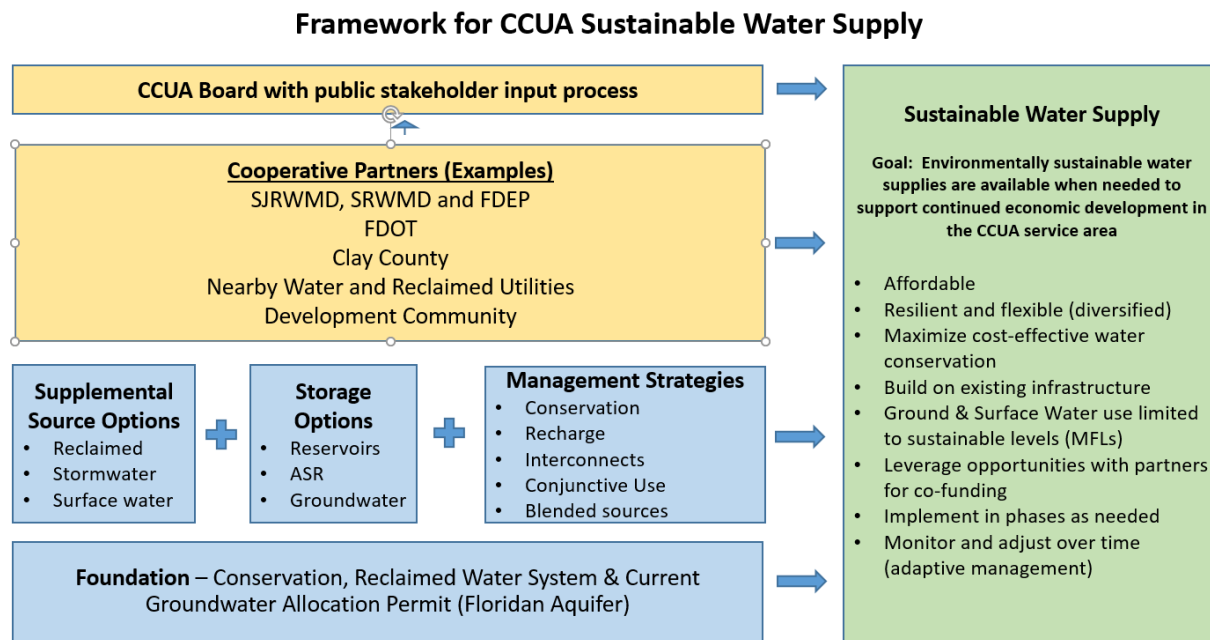


Figure 1. Framework for Sustainable Water Supplies/AWS Development

This framework recognizes the solid foundation that CCUA has already developed with groundwater and the use of reclaimed water resources. These sources will continue to be the foundation for the future. Various AWS options will be explored, recognizing that most of these options require aspects of short-term or seasonal storage, along with management strategies such as water conservation, interconnections, and conjunctive use of multiple sources. It should be acknowledged that AWS options are expensive and CCUA will likely have to partner with other entities to successfully fund projects. Co-funding is a viable option when project benefits are shared by multiple parties. The St. Johns River Water Management District (SJRWMD) and Florida Department of Environmental Protection (FDEP) encourage AWS development through various cost-sharing programs. The CCUA

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Board of Supervisors, considering input from customers in their ongoing public process (bi-monthly public meetings), establishes the overall goal of the program, along with objectives and expenditures for development of specific water supply projects.

A program goal for consideration by the CCUA Board of Supervisors is....

“...environmentally sustainable supplies are available when needed to support continued economic development in the CCUA’s service areas...”

Captured in this goal are attributes such as affordable water supply, resilient and flexible (diversified) supplies, maximum cost-effective water conservation, building on existing infrastructure, water use limited to sustainable levels defined by minimum flows and levels (MFLs), leveraging opportunities for collaboration and cooperative funding, timely implementation of AWS projects in phases only when needed, and adaptive management to make adjustments in plans and operations.

Planning for sustainable supplies requires careful consideration of the need for water in CCUA’s existing and proposed service areas. Key utility water data is provided in Table 1 below, reported as average annual daily flow (AADF).

Table 1. Water and Reclaimed Water Supply and Demand Projections (AADF in MGD)

CATEGORY	2015	2025	2040
AVERAGE ANNUAL DAILY FLOW	MGD	MGD	MGD
POTABLE WATER USE DEMAND	11.355	14.128	17.78
CONSUMPTIVE USE PERMIT (CUP) ALLOCATION	23.911	34.073 (Last year of current permit)	No allocation - Permit expires 2025
RECLAIMED WATER DEMAND	3.885	6.538	10.032
RECLAIMED WATER FLOW	6.995	8.672	10.912

Source: (Ken Fraser, Personal Communication, December 18, 2015)

1.1 Potable Water Supply

CCUA is planning for a significant increase in potable water use demand by 2040, approximately a 32% increase in the projected 2015 potable water use. This is due in large part to completion of the First Coast Expressway through Clay County within the next 10 years, with the resulting large scale development of lands in proximity to the expressway in numerous approved developments of regional impact (DRIs). The expressway is a driver for anticipated growth, but also provides opportunity for new water supply (stormwater harvesting).

CCUA has a consumptive use permit (CUP) from SJRWMD that expires in 2025. The current allocation for groundwater use is more than adequate through the remainder of the permit duration (2025). However, there is considerable uncertainty about future CUP allocations. The ongoing North Florida Water Initiative is likely to include MFL prevention and recovery strategies for the Keystone Heights lakes and Santa Fe River. In addition, SJRWMD indicates it will revise MFLs on lakes Brooklyn and Geneva in 2017. **The primary constraint to groundwater use in the North Florida**

Water Initiative region is likely to be MFLs on the lakes in the Keystone Heights area and on the Santa Fe River.

Thus, it is prudent to plan for sufficient AWS options to cover the most conservative scenario with respect to yet to be permitted groundwater allocations through the 2040 timeframe, with an expectation that significant AWS implementation may be needed sometime in the 2025 to 2040 timeframe. A reasonable conservative scenario is to assume that future allocations may not exceed current levels of groundwater pumping. Based on Table 1, that scenario would result in the use of 7 MGD of AWS to meet potable water supply needs by 2040. Of course, actual AWS development by 2040 will ultimately depend on yet to be revised MFLs and water supply plans (SJRWMD and Suwannee River Water Management District regional water supply plans and Clay County's water supply facilities work plan). **Therefore, this assessment attempts to identify AWS options more than sufficient to provide 10 MGD by 2040.**

1.2 Reclaimed Water

CCUA has a long history, dating back to 1995, of implementing AWS through its reclaimed water system which currently serves approximately 11,000 active customers (residences, businesses, and golf courses) with reclaimed water for landscape irrigation.

There are two goals for CCUA's reuse program. The first is to maximize the use of lower quality reclaimed water for irrigation to preserve higher quality groundwater for potable water supply. To date, the reclaimed water system along with water conservation, have resulted in a remarkable decline in groundwater use on a per capita basis, from nearly 160 GPCD (gallons per person per day) in 2002, to around 100 GPCD in 2014.

The second goal is to fully eliminate the discharge of treated wastewater to the St. Johns River and its tributaries. This goal is a priority to ensure that CCUA can avoid having to meet the FDEP chronic testing requirement for wastewater influent discharges to the marine portions of the St. Johns River.

Meeting both of these goals is challenging, given the very seasonal nature of reclaimed water, which can be seen in Figure 2 for 2014. Average daily demand is significantly less than reclaimed flows most of the year, but during the late spring and summer, demands meet or exceed supply in many cases. In order to balance supply and demand, a combination of storage and supplemental supply is necessary. CCUA has already taken steps to increase seasonal storage with the interconnection of its reclaimed water facilities to the new Mid-Clay Land Application and Recovery Facility. In order to fully use all of the reclaimed water produced throughout the year, continued expansion of the customer base will be needed, along with a combination of storage and feasible supplemental sources to address the peak seasonal demand periods. **As a result, a goal is to development AWS sources to supplement the reclaimed water sources as well. CCUA has estimated the deficit in meeting the peak reclaimed water demand to be 3 MGD by 2040 (CCUA, 2014).**

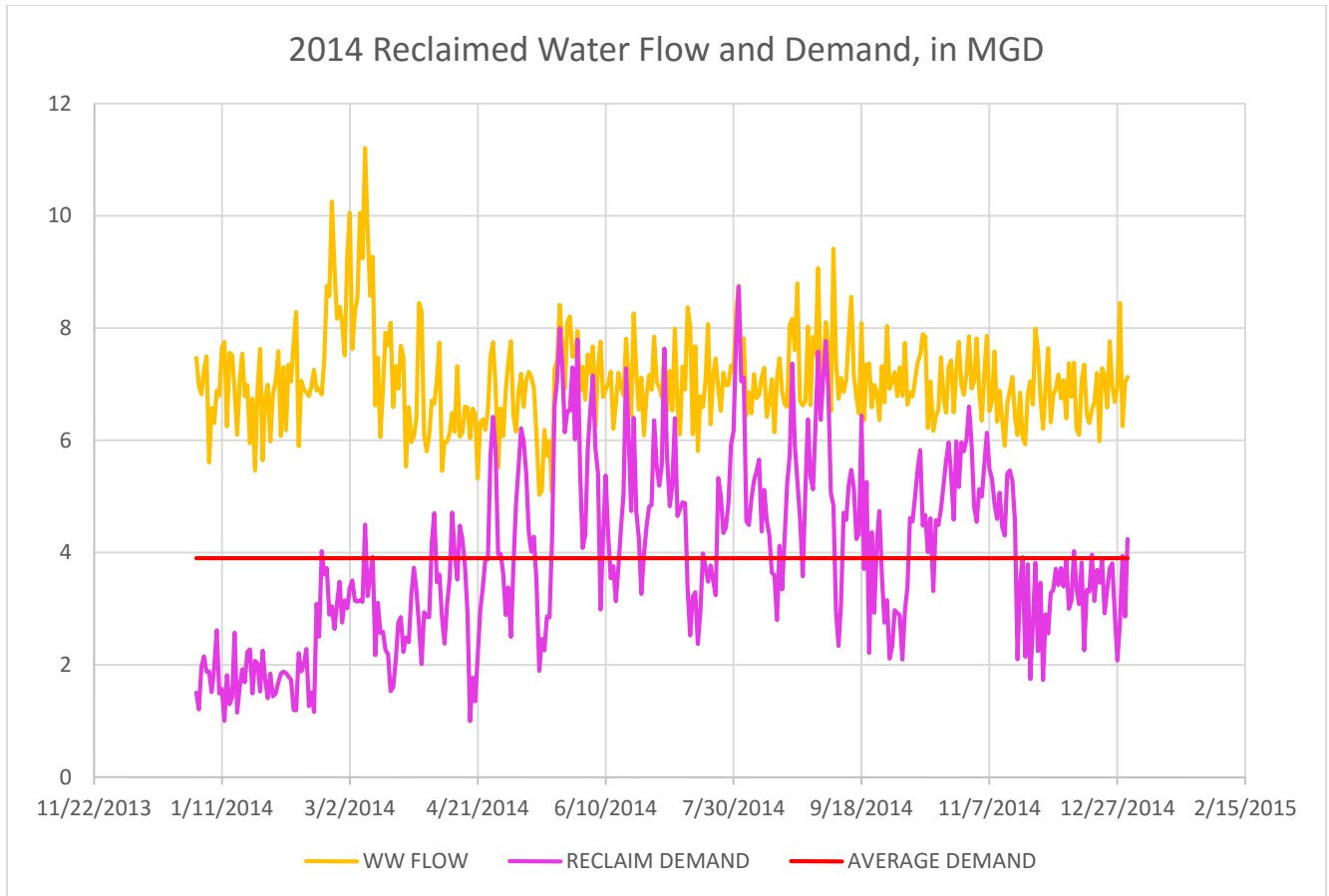


Figure 2. CCUA 2014 Reclaimed Water Flows Compared to Reclaimed Water Demand

2.0 Water Supply Source Options

In addition to CCUA’s current Floridan aquifer wells and reclaimed water production, potential additional AWS sources include stormwater harvesting, fresh surface water from Black Creek, additional reclaimed water transferred from other utility reclaimed water facilities, and brackish surface water from the St. Johns River. Options for using each of these sources is discussed below.

Seasonable storage is needed for many of these options to be successfully implemented. Storage options include reservoirs, aquifer storage and recovery wells, and aquifer replenishment through rapid infiltration basins or aquifer injections wells.

As a frame of reference, typical costs for common traditional and AWS water supply sources are shown in Table 2. These costs do not include transmission cost from source to use area. However, general implications can be drawn from the data in Table 2:

- Fresh groundwater is clearly the least expensive, and is preferable when available and sustainable
- Brackish and surface sources are generally more expensive than fresh water sources, primarily due to higher treatment costs
- Seawater is the most expensive by a significant amount, owing to higher capital and operating costs for membrane treatment and byproduct disposal.

Table 2. Comparison of Typical Costs for AWS in 10 and 20 MGD Increments (FDEP, 2015)

Water Supply Source	Avg. Daily Flow (MGD)	Unit Cost (\$/1000 gal)	Type of Source
Upper Floridan Aquifer	10	\$0.27	Traditional
Upper Floridan Aquifer	20	\$0.25	Traditional
Seawater	10	\$8.51	Alternative
Seawater	20	\$7.21	Alternative
Brackish Ground Water	10	\$2.55	Alternative
Brackish Ground Water	20	\$2.05	Alternative
Surface Water	10	\$2.43	Alternative
Surface Water	20	\$1.74	Alternative

Source: (SJRWMD, 2014)

For this assessment, planning level cost estimates are provided for potential CCUA-specific options. Taylor Engineering developed these estimates upon consideration of estimates in existing recent reports, and also using SJRWMD’s publication, “Engineering Assistance on Updating Information on Water Supply and Reuse System Component Costs” published in 2008 (Black & Veatch, 2008), and supplemented with additional commentary in 2010 (Wycoff, 2010). As part of the publication, SJRWMD has an estimating tool in a spreadsheet format. This estimating tool was successfully used by SJRWMD, South Florida Water Management District (SFWMD), Southwest Florida Water Management District (SWFWMD), and stakeholders as part of the Central Florida Water Initiative (CFWI). Further, SJRWMD’s 2008 publication provides conceptual level costs for common water supply components and is assumed to be a reasonable reference for unit costs to apply to AWS options being considered in this assessment. It is intended to provide a Class 4 cost estimate as defined by the Association for the Advancement of Cost Engineering. Class 4 estimates are based on a 1 to 5 percent complete level of design and an expected accuracy range of -15 to -30 percent on the low side and +20 to +50 percent on the high side (Black & Veatch, 2008). Key metrics in the cost estimating tool are:

- Capital cost is the sum of construction cost, land cost, and non-construction costs (planning, engineering design, permitting, land, and construction management).
- Annual operating and maintenance cost is the estimated annual cost of operating and maintaining the facility when operated at average day capacity.
- Equivalent annual cost is the total annual life cycle cost of the project based on service life and time value of money.
- Unit production cost is the equivalent annual cost divided by total annual water production, and expressed as dollars per 1,000 gallons produced.

As part of this assessment, the spreadsheet cost estimate tabulations are provided to CCUA in electronic format, so that further refinements such as estimating costs on various modifications to these

AWS options can easily be made by CCUA as part of the ongoing planning for new alternative water supplies.

2.1. Option 1– Stormwater Harvesting

The stormwater harvesting option has been fully described in a previous CCUA document (CCUA, 2014). It is an ambitious proposal to harvest stormwater runoff from the First Coast Expressway and new land development projects that are planned along the expressway over the next 20 years. The first project phase is to install a series of horizontal wells adjacent to the Florida Department of Transportation (FDOT) storm ponds along the expressway, harvest stormwater that is naturally filtered through the natural soil matrix, and then disinfected prior to being pumped to supplemental reclaimed water facilities in proximity, including Oakleaf, Old Jennings, Mid-Clay and two future reclaimed water plants that would serve Governors Creek, Saratoga Springs, and Reinhold DRIs. Horizontal wells would ideally be co-located as part of FDOT Phase III (Blanding Blvd to S.R. 17) construction, and remaining pump, disinfection, and transmission piping could be deferred until the stormwater supply is needed to augment the reclaimed water system for new customers as new residential developments are completed. Wells would also be installed at selected locations along Phase I of the expressway, after construction is complete.

A second phase is proposed to include similar types of collection facilities adjacent to stormwater management systems that serve land developments. This phase will require coordination with developers and is expected to offer benefits in terms of increasing stormwater treatment efficiencies from traditional stormwater management systems, thus reducing the land areas otherwise needed for stormwater management, particularly when discharging to impaired water bodies with more stringent nutrient reduction requirements.

CCUA is proposing a pilot project at an existing stormwater pond in Phase I, but FDOT has only permitted the project to begin after their contractor completes construction in the immediate area. Unfortunately, current FDOT estimates are that the completion date will be delayed significantly—until mid-2017. This pilot project will provide useful operating and performance data, serving to verify if the proposed system meets FDEP’s rules standards for filtration and disinfection of stormwater prior to addition to public access reclaimed water system. Alternative pilot project sites are being investigated by CCUA.

For the entire project concept, the total capital cost estimate is \$26.8 million, annual operation and maintenance costs of about \$920,000, yielding a unit production cost of about \$0.82/1,000 gallons (see Table 6 for a summary of estimated costs of all AWS options). The pilot project will cost about \$1 million, and a cost-share application for 50% of funding from SJRWMD is under review with a decision expected in February 2016.

Stormwater harvesting is an option that is being encouraged throughout the state by SJRWMD and FDEP. As such, there should be opportunities to obtain cost-share funding. Recently, the City of Altamonte Springs’ new stormwater harvesting project became operational, where stormwater from the improved Interstate 4 within the city is treated and combined with unused reclaimed water flows during wet periods, and pumped to the City of Apopka for reuse and recharge. Altamonte Springs obtained cost-share funding from FDEP, FDOT, and SJRWMD.

The project offers many excellent opportunities, including the following:

- Very cost-effective to supplement reclaimed water supplies in CCUA's higher growth areas
- Flexibility to implement incrementally as needed
- Could help developers meet stormwater permitting requirements more cost-effectively, and also potentially result in nutrient credits for use in Clay County's MS-4 stormwater permit
- Since this source when fully implemented is likely to far exceed supplemental needs for the reclaimed water system, this water could also be a source for an aquifer replenishment project

Challenges faced in this option:

- Delays in moving forward due to FDOT construction delays on Phase I and an uncertain timeframe on Phase III
- Horizontal wells may be subject to clogging and operational performance will need to be carefully evaluated in the pilot project for long-term performance. Other options for collection and treatment may be needed, such as a more conventional water diversion at the stormwater pond outlet with transmission to an engineered stormwater filtration and disinfection module at each reclaimed water plant.
- Water yield may be less than estimated due to system performance and the degree to which the plan is ultimately fully implemented at all locations.
- Ensuring that these systems are implemented in a manner also beneficial to FDOT and land developers, thus requiring careful ongoing collaboration
- Challenge of utilizing the source during dry periods, when demand may be high, and availability of stormwater is low. The use of horizontal wells is expected to extend the period of water availability longer following storm events; however, this benefit will need to be verified during the pilot project.

2.2 Option 2 – Surface Water from Black Creek (Options 2a, 2b, and 2c)

Black Creek is a significant natural fresh surface water resource, in addition to fresh groundwater, available in the CCUA area. Since it is anticipated that fresh groundwater will be limited at some point, and the cost of developing brackish surface water is significantly more expensive, it is prudent to consider options for developing the fresh surface water supply in Black Creek. SJRWMD, CCUA, and other stakeholders have been discussing, as part of ongoing MFL prevention and recovery strategies, the potential environmental benefits from using water from Black Creek for new potable supplies, aquifer recharge, or direct lake augmentation in the Keystone Heights area.

Although no specific project proposals have moved forward, SJRWMD recently completed the "Black Creek Yield Assessment and Conceptual Design Project Technical Memorandum" (Liquid Solutions, 2014). The memorandum provides useful information directly applicable to this broader AWS assessment. Relevant information from that memorandum is used as the basis for describing this AWS option.

In the memorandum, SJRWMD considered three potential intake locations (Figure 3) and simulated a synthetic flow data set, based on the recorded flow data available, for each location for the period of 1940 to 2013. The resulting streamflow hydrographs are shown in Figure 4. Key flow statistics are provided in Table 3, expressed in units of MGD for easy comparison to potential water supply yields.

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Black Creek streamflow is highly variable, with a significant portion of flow coming in high pulses in response to rapid runoff from the watershed, with extended periods of low flow conditions. These characteristics present challenges in developing a water supply.

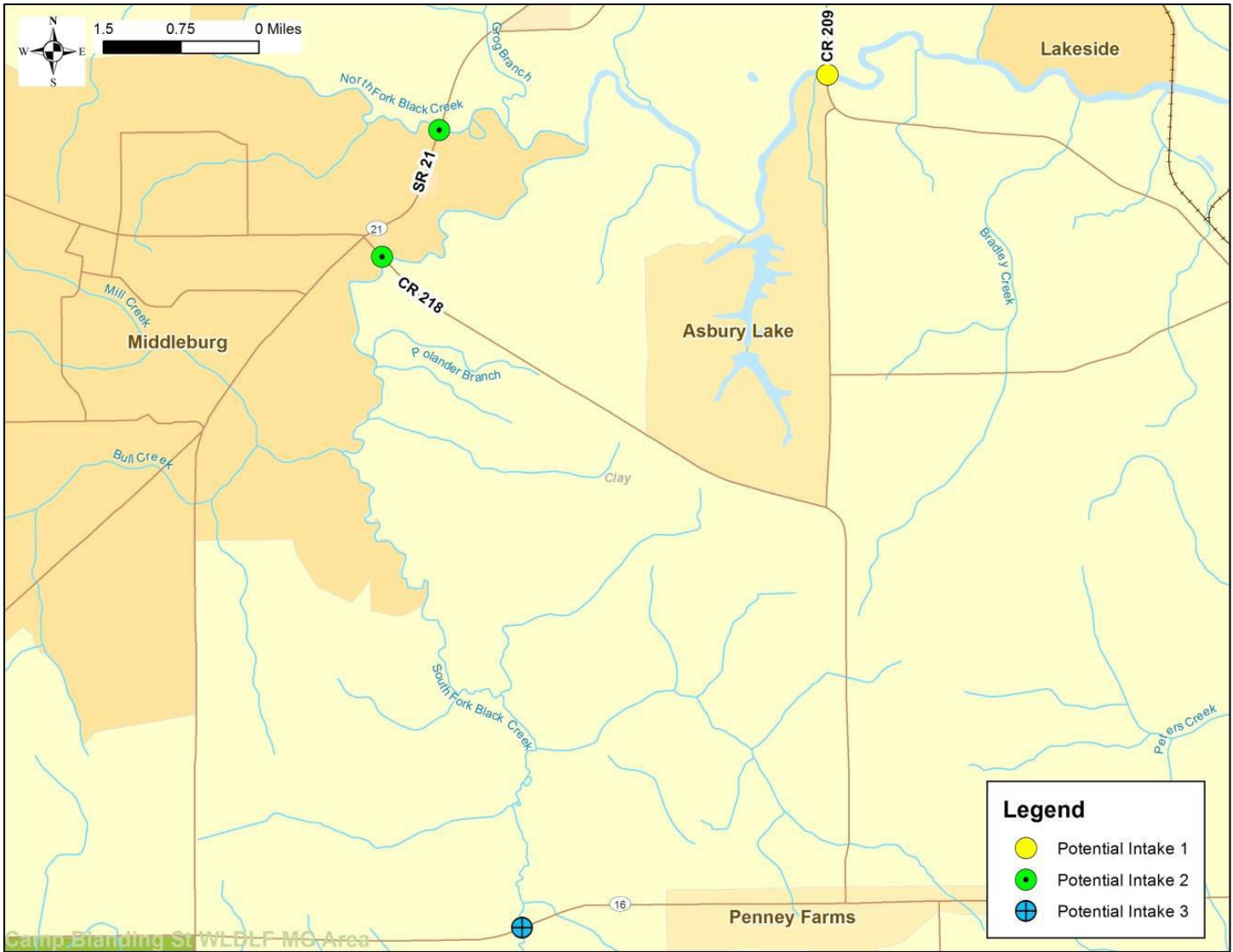


Figure 3. Potential Intake Locations on Black Creek (Liquid Solutions, 2014)

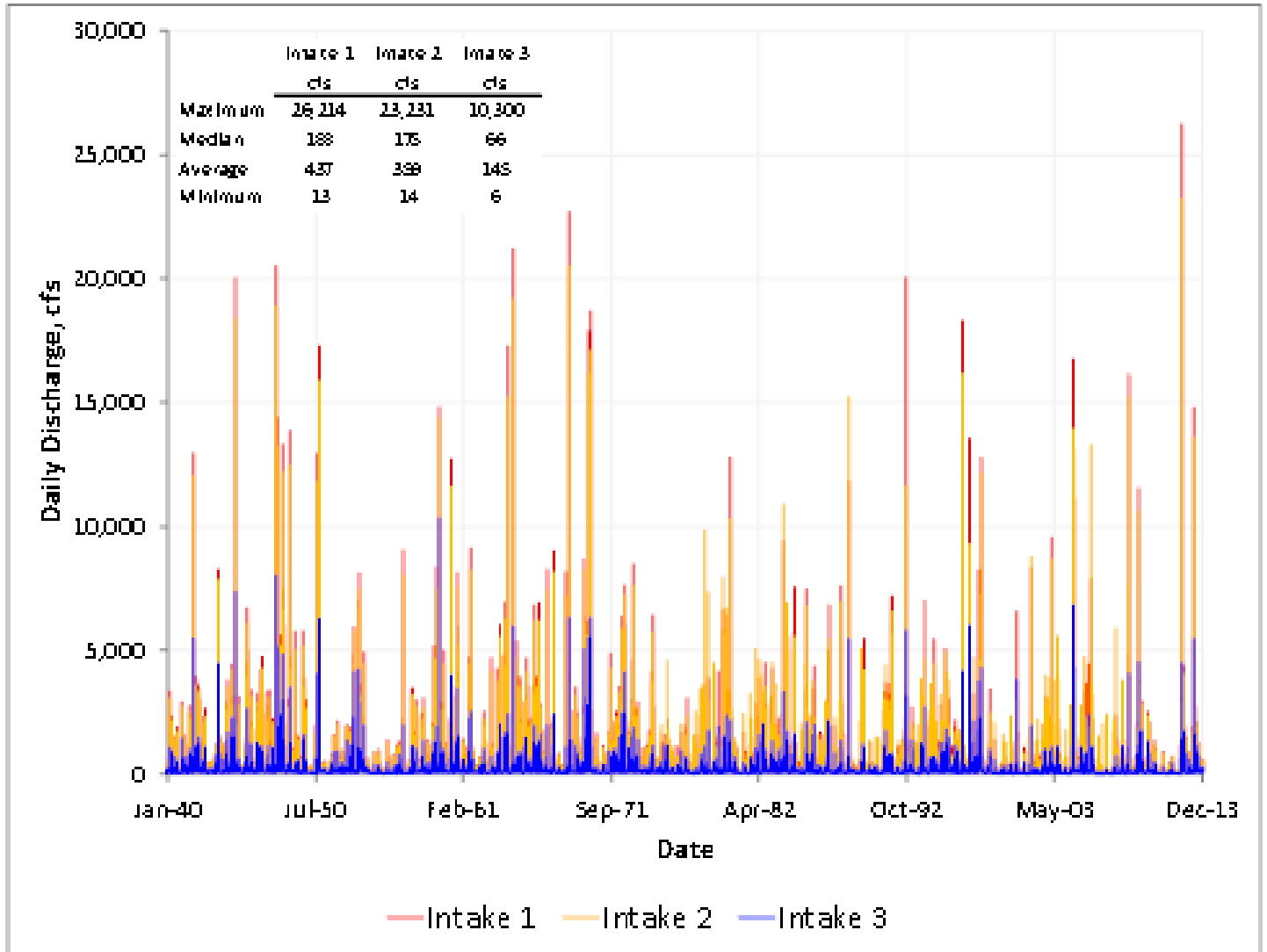


Figure 4. Black Creek Simulated Discharge at Three Potential Intake Locations (Liquid Solutions, 2014)

Table 3. Flow Characteristics at Potential Intake Locations on Black Creek (Liquid Solutions, 2014)

FLOW STATISTIC	INTAKE 1	INTAKE 2	INTAKE 3
	MGD	MGD	MGD
MAXIMUM	16,942	15,014	6,656
MEDIAN	121	113	43
AVERAGE	282	258	94
MINIMUM	8	9	4

For the purposes of this assessment, Taylor Engineering selected the intake at S.R. 209 (Intake 1) as the potential AWS project. We chose this location due to its proximity to CCUA Mid-Clay facilities, ease of access, and providing the largest potential yield. Other intake locations, particularly Intake 3, may be preferable for an aquifer recharge or lake augmentation project; however, the focus here is a potential AWS source for CCUA.

The memorandum points out that based on water quality data available from SJRWMD for the period-of-record from 1984 through 2013, observed Cl and TDS concentrations in Black Creek at the C.R. 209 bridge are above state drinking water standards (250 milligrams per liter [mg/L] and 500 mg/L, respectively) approximately 29% of the time, with peak concentrations in excess of 2,500 mg/L and 4,000 mg/L, respectively. Water quality appears to continue to degrade downstream of the C.R. 209 bridge, but also appears to notably improve upstream of the bridge. Thus, it is likely that withdrawals could not occur during these low flow periods in order to avoid more expensive treatment. However, it is also likely that environmental constraints would also limit withdrawals during these low flow periods.

It is important to note that SJRWMD has not established MFLs for Black Creek. There are numerous important water-dependent environmental resources on Black Creek that must be protected, and would be considered if an MFL is established. In the interim, the memorandum uses a “Minimum Flow Threshold (MFT)” concept as a surrogate for MFLs. The MFT is a user-specified flow rate below which withdrawals are not allowed, ensuring that withdrawals do not occur below certain flowrates that could be related to environmental considerations and/or poor water quality. For the Black Creek yield model, MFTs were evaluated at the 85th, 90th, and 95th percentiles on the flow duration curve of the creek at each location. This range of percentages represents a potential environmental limitation associated with MFLs and is an approximation based on previous SJRWMD work on hydrologic systems that do not have adopted MFLs. This previous SJRWMD work indicates the Frequent Low MFL tends to occur between the 85th and 95th percentiles on the flow duration curve for a surface water system. For the purposes of this assessment, the most conservative MFT (85%) was selected and used in evaluating the yield and reliability of various project options.

Option 2a: 10-MGD water intake structure, with transmission to a 10 MGD conventional surface water treatment plant at or near the Mid-Clay facility site. This option envisions a conventional surface water treatment plant (coagulation, flocculation and sedimentation) that is capable of feasibly treating water from Black Creek during moderate to higher flow periods. This is typical water treatment process employed by water utilities using surface water for potable water supply in Florida, but is a more complex process than CCUA currently uses for its fresh groundwater supply.

Planning level opinion of cost for this option is provided in Table 6; estimated yield and reliability are provided in Table 4. Reliability is expressed as the percent of time, over the simulated period-of-record (1940 to 2014) that the system would provide water. The reliability (approximately 80%) is less than suitable for a potable water supply source. For that reason, two additional options with seasonal storage are also considered.

Table 4. Estimated Yield and Reliability of Black Creek Options with 10 MGD Withdrawal (Liquid Solutions, 2014)

BLACK CREEK WITHDRAWAL SCENARIO WHEN FLOW IS ABOVE MFT	MAX WITHDRAWAL RATE, MGD	AVERAGE YIELD, MGD	RELIABILITY (%)
NO STORAGE (OPTION 2A)	10	7.7	79.4%
200 MG RESERVOIR (OPTION 2B)	15	8.6	89.4%
3000 MG ASR WELL SYSTEM (OPTION 2C)	15	9.7	97.9%

Option 2b: 15 MGD water intake structure, with transmission to a 200 MG reservoir and a 10 MGD conventional surface water treatment plant at the Mid-Clay facility site. Because of the inherent unreliability of Black Creek flow conditions, a reservoir option can be considered to provide seasonable storage for period when flow conditions are too low to allow for water withdrawal. The concept for reservoir storage would consist of a diked area where water is pumped for storage above-ground. The SJRWMD memorandum concluded that an upper limit for a reservoir, considering the potential availability of land in the area, is probably about 200 million gallons (MG).

The potential feasibility of a reservoir is highly dependent on a number of factors, including: the availability of sufficient land acreage; location of available land; surrounding property ownership and land use considerations; potential impacts on environmental, cultural, archeological and historic resources; geotechnical investigations to ensure suitable site conditions for a safe and water-tight structure; topographic, surface water and groundwater evaluations to assess site suitability and to minimize impacts to surrounding areas; evaporative losses; sufficient land area for construction, maintenance and, expansion; access for power, personnel, equipment and chemical deliveries; and compliance with pertinent regulatory requirements.

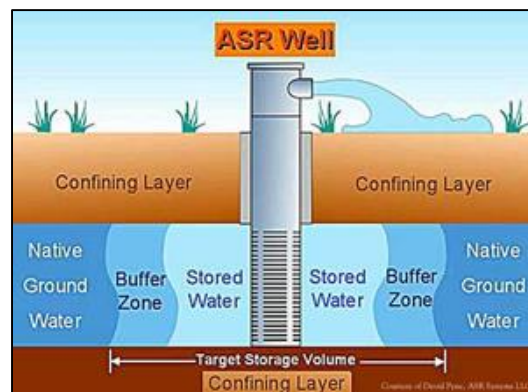
The costs to construct surface reservoirs vary considerably with the required capacity, associated land costs, and the other considerations. Based on recent examples of large seasonal reservoirs, unit construction costs were found to range from less than \$10,000 to greater than \$80,000 per million gallons of capacity, with an average of about \$27,000 per million gallons of storage capacity. The substantial range in unit costs for reservoir construction reinforces the need to closely evaluate specific project conditions before attempting to establish a reservoir project budget.

Planning level opinion of cost for this option is provided in Table 6 based on generalized assumptions; estimated yield and reliability are provided in Table 4. This option improves both yield and reliability, but reliability is still less than typically required for a potable supply system.

Option 2c: 15 MGD water intake structure, with transmission to a 300 MG Aquifer Storage and Recovery (ASR) system and a 10 MGD conventional surface water treatment plant at the Mid-Clay facility site. This option is similar to option 2b, except using ASR. ASR systems offer great potential for cost-effective storage by injecting treated water into the aquifer to create a “water storage bubble” (area of higher aquifer level or pressure) for later recovery when needed (Figure 5). However, considerable time and expense goes into initial hydrogeologic testing, followed by sometimes lengthy cycle testing needed to arrive at a suitable water quality pre-treatment regime to address potential leaching of arsenic from the limestone formation, and confirm aquifer confinement and recovery volumes (which is typically less than injection volumes). Based on recent case studies in central Florida, in which SJRWMD and several utilities conducted a cooperative ASR construction and testing program, the period of time for initial desktop evaluation through the final construction and cycle testing programs needed for operational permits can be expected to take five to 10 years. However, as part of the directive to promote greater use of alternative water supplies (Senate Bill 536), FDEP proposes regulatory changes that would likely help to reduce this implementation period (FDEP, 2015).

A planning level opinion of cost for this option is provided in Table 6; estimated yield and reliability are provided in Table 4. Yield and reliability are further improved, and represent a reliability appropriate for a potable water supply system.

Figure 5. Schematic of an ASR Well (from Cocoawaterworks.com)



Comparison of Black Creek Project Options. Even with significant costs for reservoir storage, the reliability does not appear sufficient for a public water supply. With ASR storage, a suitable reliability can be achieved. Capital costs are lower for ASR than a reservoir, but annual operating and maintenance are higher for ASR. Overall, the use of ASR appears to be more cost-effective, but a more detailed investigation would be needed to verify costs and benefits.

An additional option worth consideration is a “conjunctive use” of groundwater from CCUA’s existing permitted wells along with surface water when available from Black Creek. Conjunctive use projects, where excess surface waters are utilized seasonally and traditional groundwater supplies are used during drier periods, represent an important strategy for the development of surface water supplies. WMDs should encourage the development of conjunctive use systems through their regional water supply plans and cooperative funding programs (FDEP, 2015).

Conjunctive use appears to be one way to implement option 2a in a manner that would meet reliability standards. Under this kind of operation, CCUA would obtain an allocation for a maximum groundwater use rate for periods when Black Creek is not available, and then reduce pumping during periods when water is available from Black Creek. The concept of conjunctive use has been discussed among water utilities and SJRWMD, but more definition is needed regarding the permitting process. Also, there are technical issues that need further investigation concerning the intermittent operation of a treatment plant and the mixing of groundwater and surface water to produce a final potable water product.

Another possible implementation for Option 2a (no storage) would be to use Black Creek supplies, when available, as part of an aquifer recharge project (see discussion at section 2.4).

Opportunities for the Black Creek options include:

- Availability of a freshwater source in close proximity to areas of CCUA service area with projected growth
- Potential partnership with SJRWMD in developing this as a potential source for both CCUA water supply and as water resource development project with regional environmental benefits

Challenges with these options:

- Establishing environmental constraints, including MFLs and suitable water quality
- Dealing with the highly variable flow conditions and extensive storage needed for a reliable supply if this source is used as a reliable component of the potable water supply
- Solving technical and permitting issues with conjunctive use of this source and groundwater well production
- Blending treated water sources (surface and groundwater) for finished potable water supply
- Likely opposition from environmental advocacy groups of any proposed use of water from any surface water source, including Black Creek

2.3 Option 3 – Brackish Surface Water from the St. Johns River

Surface water from the St. Johns River is also a potential option for future potable water supply. A potential location for a water intake facility would be along the St. Johns River between Black Creek and the Shands Bridge, or on the lower portion of Black Creek near the St. Johns River. This general location would be closest to the portion of the CCUA service area subject to highest projected growth in demand. We did not specify a location in this assessment.

This AWS option includes the following major components: 10 MGD water intake structure (to produce approximately 8 MGD finished supply), booster pump, and approximately five miles of transmission line to a 10 MGD AADF membrane treatment plant located at or near the Mid-Clay facility.

A relevant case study is the Seminole County Yankee Lake Regional Wastewater Treatment Facility. Seminole County proposed a 50 MGD AADF public water supply to serve multiple utilities in the central Florida area. The 50 MGD AADF water intake and raw water transmission line have already been constructed, but only 5 MGD is currently permitted for use. The project also includes 90 miles of large diameter transmission line to several utilities, and a Lower Floridan well for reverse osmosis (RO) concentrate disposal. The estimated cost, as reported in the Central Florida Water Initiative

Water Supply Plan is \$565.8 million total capital cost, \$18.5 million for annual operation and maintenance, and a unit production cost of \$4.01/1,000 gallons.

Estimated planning level costs for this option, provided in Table 6, assume that RO concentrate could be managed by sending it to CCUA's reclaimed water plant. However, that assumption will need further review and if not feasible, additional costs would be required for concentrate disposal. The unit cost estimate is comparable with the Seminole County project.

The opportunity for this option:

- Potential future source of water when no additional freshwater sources are available to meet additional water demands

Challenges with this option:

- Operation of a RO membrane plant and disposal of RO concentrate
- Likely opposition from environmental advocacy groups to any proposed use of water from the St. Johns River
- Need for a St. Johns River MFL to be set to verify availability of water
- Blending treated water sources (surface and groundwater) for finished potable water supply

2.4 Option 4 – Aquifer Replenishment (Options 4a and 4b)

Aquifer replenishment is a potential AWS project option that can be used to increase CCUA's Floridan aquifer (groundwater) water supply yield by raising aquifer pressure (or water level in unconfined portions) of the Floridan aquifer. Replenishment can be accomplished with rapid infiltration basins (RIBs) in the surficial aquifer that indirectly leak into the Floridan aquifer, or more directly by recharging the Floridan aquifer through injection wells. These types of aquifer replenishment strategies are considered to be indirect potable reuse, with purified water introduced into the aquifer system by recharge, and later withdrawn at water production wells in the same aquifer zone (in this case in the upper and lower zones of the Floridan aquifer). Direct potable reuse, on the other hand, would directly use the purified water product as part of the potable water supply system.

CCUA's Mid-Clay Land Application and Recovery System (LARS) represents an important first step in providing indirect aquifer recharge, in addition to recapturing stored reclaimed water through a horizontal well when needed to meet peak reuse demand periods. However, confining layers between the surficial aquifer and the Upper Floridan aquifer are prevalent throughout most of Clay County which limit the potential to recharge significant quantities for water supply benefits.

Examples of successful aquifer recharge projects include those operated by the Orange County (California) Water District; Central Arizona Groundwater Replenishment District; the Peace River-Manasota Regional Water Supply Authority (Florida); United Water Resources (Idaho); Rio Rancho, New Mexico; and Dayton, Ohio. There are hundreds of such projects in place across the nation (NGWI, 2015).

The City of Clearwater (similar size as CCUA with 11 MGD water delivery and 7 MGD reclaimed water delivery) is in the final phases of planning and design to move forward with an indirect potable reuse project using groundwater replenishment technology. The project will include an advanced purification plant (filtration and membranes), an aquifer injection system, and all of the monitoring infrastructure necessary to recharge the Floridan aquifer with 2.4 MGD of purified effluent from the

city's Northeast Water Reclamation Facility. Beneath the city, the fresh water from the Upper Floridan aquifer used for drinking water sits on top of a layer of brackish, or somewhat salty, water. The Floridan aquifer can be protected by balancing the recharge from this project and the withdrawals from the potable water supply wells. Design, permitting, and construction of the indirect potable reuse project is estimated to cost \$28.5 million. The co-funded project is under construction in central Pinellas County in the Northern Tampa Bay Water Use Caution Area of SWFWMD (FDEP, 2015).

Aquifer recharge options for the north Florida area were investigated by SJRWMD and SRWMD as part of the North Florida Water Initiative (Atkins, 2013). This study concluded that aquifer recharge is generally feasible and beneficial, and investigated direct and indirect project options, including 30 MGD aquifer recharge at JEA's Southwest and Buckman Wastewater Treatment Plants (WWTPs).

A project concept for a 10 MGD aquifer recharge facility was recently investigated by SJRWMD and JEA for JEA's Southwest Wastewater Treatment Plant (SWTP) (CDM, 2015). The study provided a desktop analysis of treatment technologies appropriate for treating reclaimed water from a typical domestic wastewater treatment plant that could then be injected into a potable aquifer. Taylor Engineering used this information to estimate the range of potential treatment costs, which are the primary costs associated with this option.

The study found that while the effluent from the SWTP would likely meet all primary and secondary drinking water criteria, additional total organic carbon (TOC) removal would be required for injection into a potable aquifer. In addition, the study considered the additional public interest that JEA (and CCUA in this case) would have in understanding how to control currently unregulated compounds such as pharmaceuticals, personal care products, and endocrine disrupting compounds. Protection of the Floridan aquifer water quality is of paramount importance.

Two different treatment processes were investigated. The first was full advanced treatment (FAT), which is the most widely used treatment process for potable aquifer recharge in the U.S. This process includes micro-filtration, reverse osmosis, and UV-advanced oxidation processes, often abbreviated as MF/RO/UV-AOP. The FAT process, while clearly technical feasible, has high capital and operating costs. An alternative advanced treatment process competitive with FAT was also considered, involving a combination of filtration, ozonation, and biologically activate carbon (BAC). This process, denoted as "ozone-BAC," has significantly lower capital and operating costs, and does not produce a concentrate waste stream to be handled. The initial assessment was promising, and the study recommends that pilot testing be commenced to verify the ozone-BAC process is technically feasible.

Taylor Engineering applied cost data from the CDM study to prepare planning level cost estimates for the CCUA 10 MGD aquifer recharge option discussed below, with options for both treatment processes (Options 4a and 4b), summarized in Table 6. As a frame of reference, generalized cost data recently developed by FDEP and SJRWMD are provided in Table 5 for various potable reuse options. The data in Table 4 reflects different efficiencies for the various recharge options, considering the resulting benefit in terms of water supply yield. The actual benefit of the recharge options for water supply can only be determined after more detailed analysis using regional groundwater modeling analysis. It should be noted that estimated cost for the two treatment options varied significantly - \$10.97/1000 gal. for FAT (Option 4a) versus \$2.97/1000 gal. for the ozone-BAC process (Option 4b). The generalized cost data for direct potable recharge (from Table 4) lies in between the estimates for

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Options 4a and 4b. Economic feasibility of the recharge option will largely depend on whether the ozone-BAC process is determined to be feasible.

Table 5. Comparative Costs of Potable Reuse within SJRWMD (SJRWMD, 2014)

Potable Reuse Water Supply Source	Avg. Daily Flow MGD	Unit Cost \$/1000 gal	Unit Cost to Treat for GW Injection \$/1000 gal	Unit Cost to Recover and Treat Injected GW \$/1000	% cost Adjustment for Losses and Net Water Supply Benefit	Adjusted Yield MGD	Total Unit Cost \$/1000 gal
Rapid Infiltration Basin	10	\$0.60	NA	\$0.27	20%	8	\$1.04
Rapid Infiltration Basin	20	\$0.59	NA	\$0.27	20%	16	\$1.01
Direct Potable Aquifer Recharge	10	\$0.17	\$2.94	\$0.27	15%	8.5	\$3.69
Direct Potable Aquifer Recharge	20	\$0.16	\$2.45	\$0.25	15%	17	\$3.11
Aquifer Storage and Recovery	10	\$0.29	\$2.94	\$0.27	5%	9.5	\$3.68
Aquifer Storage and Recovery	20	\$0.29	\$2.45	\$0.25	5%	19	\$3.14
Direct Reuse	10	\$3.91	NA	NA	NA	10	\$3.91
Direct Reuse	20	\$3.85	NA	NA	NA	20	\$3.85

(Source: SJRWMD, 2014)

Options 4a and 4b include the following major components:

- Collection of water supplies, including reclaimed water and stormwater at a central location for treatment. CUA already has infrastructure in place to collect unused reclaimed water at the Mid-Clay LARS site. Stormwater harvesting would add stormwater flows into the reclaimed system.
- 10 MGD treatment plant to provide supplemental treatment of reclaimed water flows, to meet all primary and secondary drinking water standards.

- A Floridan aquifer recharge well in the vicinity of Mid-Clay LARS site. If other locations provide significant improvement in benefits, an additional transmission component would be needed.
- Comprehensive monitoring well system to meet regulatory requirements and ensure that the Floridan aquifer is protected.

Aquifer replenishment provides the following opportunities:

- Potential to use the natural aquifer system for storage of purified water derived from multiple CCUA water sources, including unused reclaimed water, stormwater harvesting, and fresh surface water when available from Black Creek
- By raising aquifer levels in proximity to CCUA's Floridan aquifer production wells, potential to offset increases in well production in existing facilities that would not otherwise be permissible.
- Potential to also provide environmental benefits by improving aquifer levels as part of an MFL prevention or recovery strategy for lakes in the Keystone Heights area
- By providing a use for reclaimed water supplies not needed during non-peak demand periods, this option will meet CCUA's goals to eliminate all surface discharge.

Challenges for aquifer replenishment include:

- Verifying that a cost-effective treatment process such as ozone-BAC is technically feasible to produce purified water, ensuring protection of the Floridan aquifer as CCUA's primary water supply, and meeting all state and federal regulatory requirements
- Balancing multiple raw water sources (stormwater, reclaimed water, and surface water), and determining optimal location of treatment plant(s), Floridan aquifer injection wells, and Floridan aquifer injection zones
- Blending treated water sources (surface and groundwater) for finished potable water supply

3.0 Comparison of Options and Potential Scenarios for Further Investigation

A comparison of AWS project options is provided in Table 6. In addition, a proposed screening tool is provided in Table 7 which provides a visual representation of how various options compare to potential criteria of importance. One note with regard to the permitting criteria is that the green designation for an option does not necessarily mean the process of obtaining the permit is simple and quick. For instance, permitting an aquifer replenishment project will be complex and take a significant amount of time; however, it should be fundamentally achievable. This screening tool could be further developed to consider other CCUA priorities.

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Table 6. Comparison of Planning-level Opinion of Cost Estimates for AWS Options

Option	Name	Conceptual Planning Level Cost Estimate			Sources of cost estimates
		Capital Cost in \$M	Annual O & M, \$M	Unit Production \$/1000 gallons	
1	Stormwater Harvesting, 8 MGD AADF	\$27	\$0.90	\$0.81	CCUA Report, 2014 and Pilot Project Design Information
2a	Black Creek with 15 MGD withdrawal, with no storage (7.7 AADF)	\$67	\$2.28	\$1.70	For intake, pumps, transmission - Liquid Solutions 2014, and 10 MGD WTP - Planning level cost estimating tool (Black and Veatch, 2008 and Wycoff, 2010)
2b	Black Creek 15 MGD withdrawal, with 200 MG reservoir (8.6 mgd AADF)	\$145	\$2.80	\$3.36	For intake, pumps, transmission, reservoir - Liquid Solutions 2014, and 10 MGD WTP - Planning level cost estimating tool (Black and Veatch, 2008 and Wycoff, 2010)
2c	Black Creek 15 MGD withdrawal, with ASR (9.8 AADF)	\$99	\$3.80	\$2.53	For intake, pumps, transmission, ASR - Liquid Solutions 2014, and 10 MGD WTP - Planning level cost estimating tool (Black and Veatch, 2008 and Wycoff, 2010)
3	St Johns River Brackish Water, 10 mgd withdrawal, 8 MGD AADF	\$153	\$5.80	\$4.56	Planning level cost estimating tool (Black and Veatch, 2008 and Wycoff, 2010)
4a	Aquifer Replenishment with Purified Water (indirect Potable Reuse) using Full Advanced Treatment (FAT) - 10 MGD AADF	\$149	\$30.00	\$10.97	CDM,2015 and Planning level cost estimating tool (Black and Veatch, 2008 and Wycoff, 2010)
4b	Aquifer Replenishment with Purified Water (indirect Potable Reuse) MGD using ozone-BAC treatment, 10 MGD AADF	\$32	\$6.00	\$2.37	CDM,2015 and Planning level cost estimating tool (Black and Veatch, 2008 and Wycoff, 2010)

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Table 7. Screening Tool for Comparison of AWS Options

Option No.	Option	Screening Criteria				
		Technical feasibility	Regulatory Feasibility	Public acceptance	Reliability	Economic feasibility
1	Stormwater harvesting from First Coast Expressway	Pilot project being implemented to validate technical feasibility of horizontal well capture	Feasible	Feasible	Feasible	Feasible
2a	Surface water from Black creek (fresh) with no storage	Feasibility of capturing large flows from the creek over short periods, MFLs need to be set to define availability	Feasible	Possible public concern about environmental impacts	Source is inherently unreliable and would require either significant storage or conjunctive use	As an intermittent source, could be used in conjunction with groundwater without seasonal storage
2b	Black Creek with 200 MG reservoir	Feasibility of capturing large flows from the creek over short periods, MFLs need to be set to define availability	Feasible	Possible public concern about environmental impacts	Source is inherently unreliable and would require either significant storage or conjunctive use	Highly intermittent, will require significant reservoir storage to create reliable source
2c	Black Creek with 3000 MG ASR storage	Significant hydrogeologic testing to design ASR, followed by pilot testing before permitting	Feasible	Possible public concern about environmental impacts	Source is inherently unreliable and would require either significant storage or conjunctive use	Highly intermittent, will require significant storage
3	Surface water from the St. Johns River (brackish)	Treatment process would need to be investigated further to address daily fluctuations in Chlorides and disposal of RO concentrate	Feasible	Based on Central Florida proposals, likely to be public concerns about possible negative impacts to the river	Feasible	Found to be feasible in Central Florida, more expensive treatment likely here
4	Florida Aquifer Replenishment with purified water	Proposed hydrogeologic testing would provide data needed for technically feasible design, also pilot testing of treatment needed	Feasible	Public education process required to address concern about recharging the Floridan Aquifer. Implemented in California and other locations, now in Clearwater	Feasible	Will depend on treatment costs - further feasibility testing on whether ozone BAC alternative can be used instead of more expensive Full advanced treatment (FAT)
	Key to rating criteria					
	Sufficient information exists to conclude option likely scores high on this criteria	Insufficient data to make determination - additional investigations needed	Sufficient information to conclude option likely scores low on this criteria			

In summary, CCUA has several AWS options to meet 2040 potable and peak reclaimed water demands if groundwater allocations are constrained at or below currently permitted levels. Each option is worthy of continued consideration; however, it needs to be kept in mind that each option has opportunities as well as challenges to be overcome through continued data collection, planning, and pilot testing. In consideration of the above planning level cost estimates and screening tool, the options that appear most promising are:

- **Option 1 - Stormwater Harvesting** – First for use to supplement reclaimed water supplies and then as a potential source to create purified water for aquifer replenishment or potable water supply
- **Options 4a and 4b** – Aquifer replenishment with purified sources developed from reclaimed water and stormwater available from CCUA and reclaimed flows potentially from the JEA Southwest Plant WWTP (assuming that a more cost-effective treatment process other than full advanced treatment is ultimately demonstrated to be feasible)
- **Options 2a and 2c** – Potential use of Black Creek for supplemental water supply, either with ASR seasonal storage (option 2c), or used without seasonal storage (option 2a) conjunctively with CCUA wellfield production or as a source in for a future aquifer replenishment project

4.0 Recommendations for Next Steps

4.1 Stormwater Harvesting (Option 1)

- Complete pilot project to confirm the feasibility of horizontal well capture of stormwater
- Coordinate closely with FDOT and SJRWMD on the permitting of Phase III of the expressway to best incorporate CCUA's system for stormwater harvesting
- Propose this project in the “project identification” phase of the North Florida Water Initiative

4.2 Aquifer Replenishment (Options 4a and 4b)

- Conduct pilot testing of ozone-BAC treatment compared to FAT
- Investigate interconnection with JEA and potential transfer of reclaimed water from the SWTP to supplement
- Engage SJRWMD and other utilities to partner with CCUA, as part of the North Florida Water Initiative, in collecting needed Floridan aquifer hydrogeologic and geochemical data to fully evaluate and design aquifer recharge project(s)
- Conduct modeling scenarios of the aquifer replenishment using the North Florida/South Georgia Regional Groundwater Flow Model when available from SJRWMD
- Propose this project in the “project identification” phase of the North Florida Water Initiative
- Implement a public education process using resources available from the Water Reuse association

4.3 Black Creek as Supplemental Water Source (Options 2a, 2b, and 2c)

- Continue discussions with SJRWMD about the potential for a water resource development project involving the use of flow from Black Creek, when available, for aquifer recharge and supplemental water supply
- Consider proposing this project in the “project identification” process of the North Florida Water Initiative

References

- Atkins, 2013. *Upper Floridan Aquifer Regional Recharge Concepts and Feasibility Study*, prepared for SJRWMD and SRWMD.
- Avery, Ray O., 2014. *Reclaimed Water Deficit & Augmentation of Reclaimed Water System Projection Study on Long Term Water Supply*, Report prepared for Clay County Utility Authority.
- Barnes, Ferland and Associates, 2012. *Expanded Executive Summary, Orange County Utilities, Aquifer Storage Recovery (ASR) System*, SPECIAL PUBLICATION SJ2012-SP.
- Black and Veatch, Inc., 2008. *Engineering Assistance in Update Information on Water Supply and Reuse System Component Costs* prepared for St. Johns River Water Management District, Palatka, FL. Special Publication SJ 2008-SP10.
- CDM Smith, 2015. *Aquifer Recharge Using Reclaimed water - Reuse Treatment Standards and Recommendations for a Potential Pilot Project*, Technical Memorandum prepared for SJRWMD, March, 2015.
- Coates, Mike, September 2012. *Comparison of Costs and Operational Requirements for an Off-Stream Raw Water Storage Reservoir and an Aquifer Storage and Recovery System at the Peace River Water Treatment Facility*. Florida Water Resources Journal.
- Florida Department of Environmental Protection, Office of Water Policy, *Report on Expansion of Beneficial Use of Reclaimed Water, Stormwater and Excess Surface Water (Senate Bill 536)*, December 2015.
- Jones Edmunds & Associates, Inc., 2013. *Preliminary Site Assessment. Hydrologic Investigation of RIB Sites in Southwest Clay County*, report prepared. for St. Johns River Water Management District, Palatka, FL, September 2013.
- Jones Edmunds & Associates, Inc., 2014. *Black Creek Literature and Data Review* Prepared for St. Johns River Water Management District, Palatka, FL, September 2014.
- Liquid Solutions Group, 2014. *Black Creek Yield Assessment and Conceptual Design*, Project Technical Memorandum Prepared for SJRWMD.
- National Groundwater Association, *Managed aquifer recharge growing as important infrastructure tool to cope with water shortages*, Press Release, December 31, 2015.
- Ron E Wycoff, P.E., 2010. *Cost Estimating and Economic Criteria for 2010 DWSP*, Prepared for St. Johns River Water Management District, Palatka, FL. Special Publication SJ2010-SP4
- SJRWMD. (2014). Potable Reuse Investigation of the St. Johns River Water Management District: The Costs for Potable Reuse Alternatives. St. Johns River Water Management District.
- Water Supply Solutions, Inc. 2008. *Water Supply Facilities Cost Equations for Application to Alternative Water Supply Projects Investigations and Regional Water Supply Planning* Prepared for St. Johns River Water Management District, Palatka, FL. Special Publication SJ2008-SP13

Wiley, David A, Robert Fahey, and Nan Bennet, 2013. *City of Clearwater's Groundwater Replenishment Program of Direct Recharge to the Aquifer Using Purified Reclaimed Water*. Florida Water Resources Journal, August 2013.