Hazen Memorandum

October 29, 2019

To: Paul Berg/City of Fort Lauderdale (City)

From: Janeen Wietgrefe, PE/Hazen

cc: Talal Abi-Karam, PE / City; Omar Castellon, PE / City; Aneisha Daniel / City; Todd Hiteshew / City; George Brown, PE / Hazen; Patricia Carney, PE / Hazen; Robert Taylor, Jr, PE / Hazen; Patrick A. Davis, PE / Hazen

Re: The Decision to Purchase C-51 Reservoir Allocation

Background

Water demand within the City of Fort Lauderdale's (City) service area is currently satisfied exclusively by the Biscayne Aquifer (BA) supply source. The amount of water which can be withdrawn from this source is currently capped via the Regional Water Availability Rule (RWAR). Significant water demand growth coupled with potential treatment technology modifications related to the City's largest water supply source (Prospect Wellfield) result in a projected water supply deficit for the City in future years. One option to satisfy this deficit is utilization of a different aquifer (the Floridan Aquifer - FA). Several South Florida utilities have adopted this option. Expansion of water extraction from the BA is also possible, but only if an equivalent amount of water is introduced into the regional system, thereby ensuring compliance with the RWAR.

A regional project known as the C-51 Reservoir provides the potential to capture (and re-introduce to the regional system) stormwater currently lost to tide. Utilization of the C-51 Reservoir affords participating utilities the ability to increase BA withdrawals. Several South Florida utilities have purchased capacity from the C-51 Reservoir, and others are considering doing so. The City of Fort Lauderdale is considering the purchase of a 6 mgd allocation from this reservoir. Hence, the City of Fort Lauderdale has choices to make when considering methods to satisfy its future water supply deficit. This memorandum is intended to provide general cost guidance and a discussion of other factors associated with the City's specific decision of whether to finalize the C-51 Reservoir purchase agreement.

In order to focus the discussion, it is useful to define both a planning horizon (to allow comparative analysis of net present worth of options) and water supply options, which would be applicable to the specific demand-not-met calculated for the City. The planning period selected is the year 2045. This assumes/allows five years to implement Fiveash improvements (rehabilitation and/or replacement on-site or elsewhere) and 20 years of operation, which is long enough to allow a fair comparison of options, accounting for different amounts and timing of capital and operational expenditures. The two options under consideration are summarized as follows:

- Option 1 assumes that the City completes the purchase of the 6-mgd C-51 allocation, thereby enabling additional BA withdrawal from the Prospect Wellfield.

Job no

- Option 2 assumes that the City does not purchase the C-51 allocation, and instead makes up the deficit from the permitted Floridan Aquifer at Dixie Wellfield.

It is noted that the amount of raw water necessary in the future is dependent upon 1) finished water demand and 2) the treatment technology used to treat raw water. The latter is important, as different technologies (lime softening, nanofiltration, reverse osmosis, etc.) each have different characteristics relative to efficiency of water use.

It is recognized that the City of Fort Lauderdale is currently studying potential technology changes at the Fiveash Water Treatment Plant. As the report associated with that study is not yet available, this memorandum will make certain assumptions relative to raw water use efficiency as described in the applicable section below. These assumptions are intended to bracket the worst case (highest) raw water demand and best case (least) raw water demand. Moreover, the exercise will necessarily make rough assumptions on the capital and operation and maintenance expenditures to be realized at Fiveash and Peele-Dixie over the planning horizon.

C-51 Current Status

The C-51 Reservoir is being developed in Phases. Phase 1 is already excavated. Final construction activities would commence when a certain percentage of capacity is reached. Final construction is expected to take approximately 2 years.

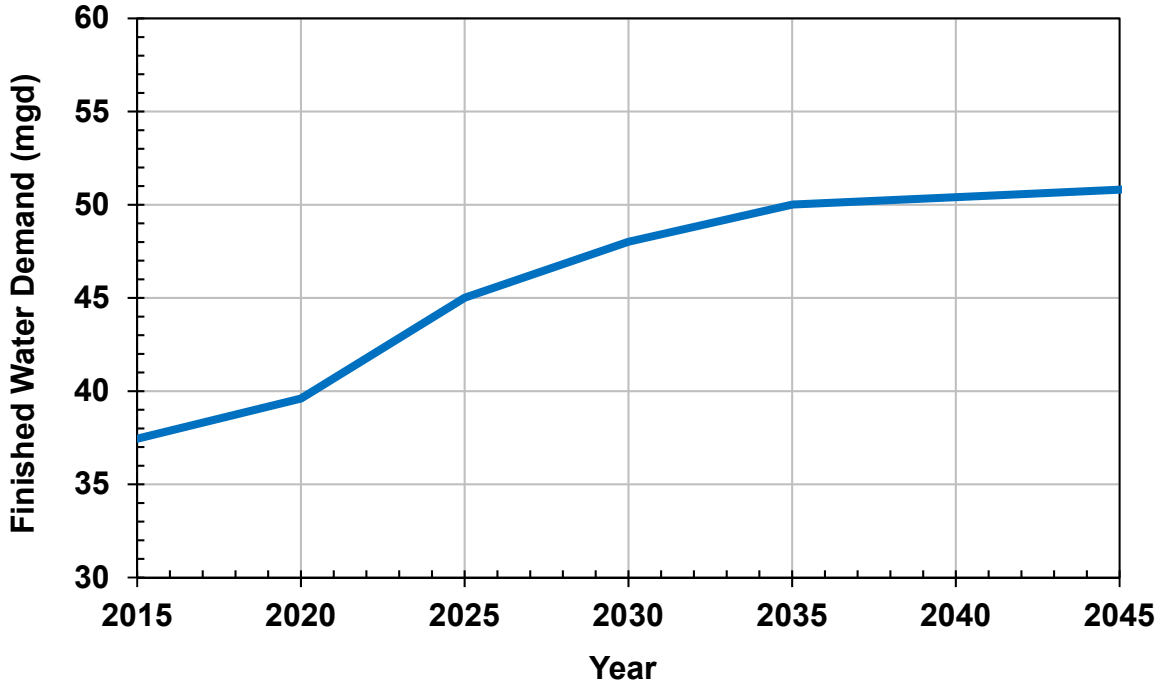
Palm Beach Aggregates (PBA) has reserved capacity in Phase 1 for certain public utilities. Presently, four utilities have signed an agreement reserving 13 mgd of the Phase 1 allotment (Broward County, Sunrise, Dania Beach and Hallandale Beach). This week, the City of Margate issued a letter of intent for 2 mgd and the City of Fort Lauderdale issued a letter of intent for 6 mgd. Finally, Pompano Beach reportedly requested 2 mgd. Altogether, this represents 23 mgd. The total Phase 1 capacity is 35 mgd, leaving 12 mgd available. PBA and Miami-Dade Water and Sewer Department are reportedly in discussions relative to reservation of this remaining capacity. Miami-Dade's potential demand reportedly exceeds remaining capacity.

Phase 2 is under consideration but is not a certainty. Moreover, current discussions with applicable regulatory agencies suggest that Phase 2 may be reserved for environmental purposes, and not for public water supply. Given the lack of certainty of Phase 2 availability, and possible competition for remaining Phase 1 water, the City has submitted a letter of intent regarding the purchase of 6 mgd from PBA under Phase 1.

Projections of Raw Water Required

Raw water requirements are predicated upon finished water demand for the City's water service area. Figure 1 illustrates the finished water demand through the Year 2045 and is reflective of the City's most recent population projections, performed by the Corradino Group for the water service areas.

Figure 1 – Projected Finished Water Demand for the City of Fort Lauderdale

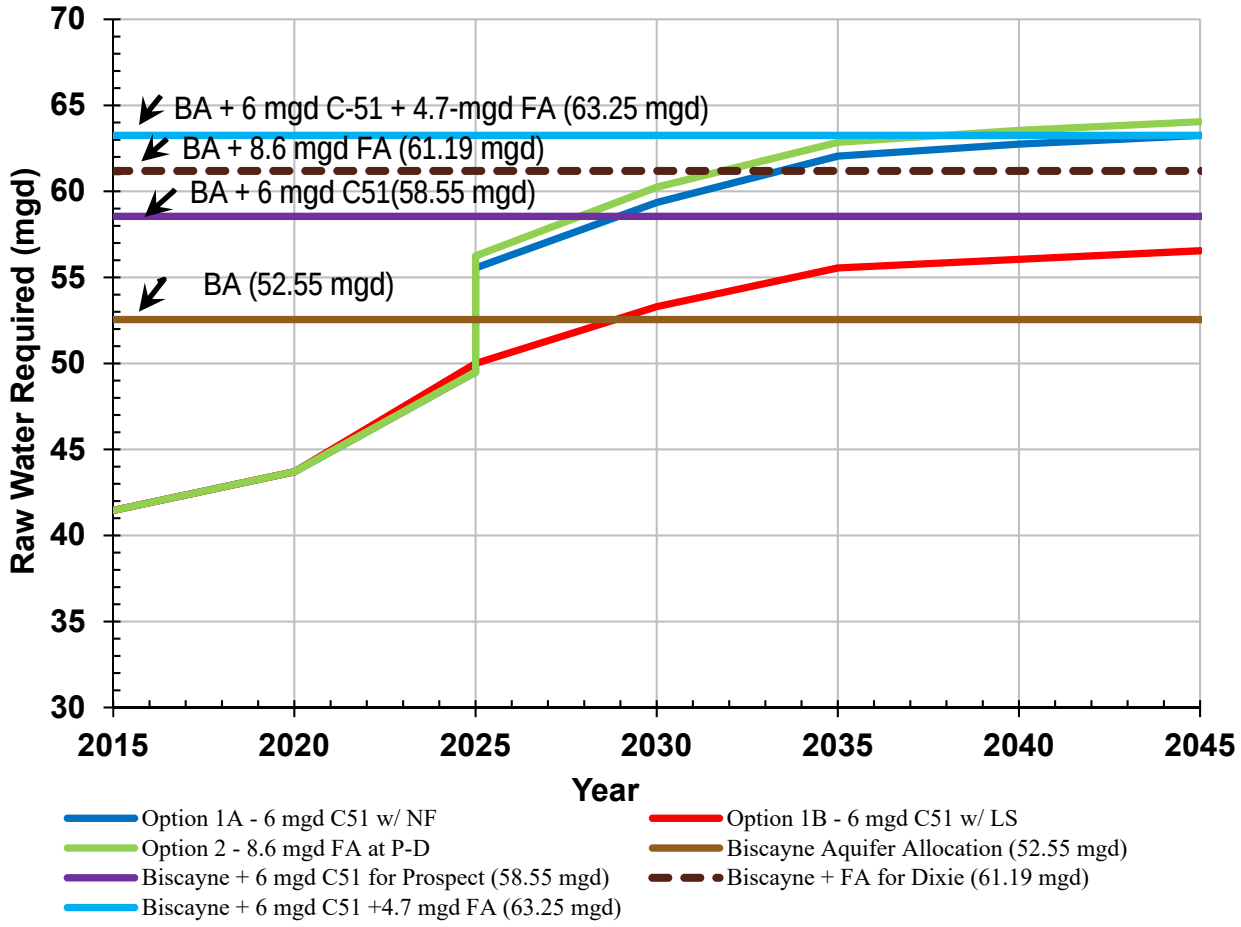


Graph Notes:

1. *The population estimates developed by the Corradino Group were utilized for this analysis.*
2. *The FW annual average demand calculation assumes the current overall net consumption rate of 164 gallons per person per day (gpcd) continues through the planning period.*

Figure 2 was developed to depict the necessary raw water requirements for the options (red, green and blue curves) under consideration to produce FW as shown in Figure 1. Additionally, the horizontal lines in Figure 2 show various raw water availabilities which would result from different investments. The solid light brown line shows the existing BA allocation of 52.55 mgd. The purple line adds more BA water made available through purchase of a 6-mgd C-51 allocation. The dashed brown line illustrates raw water available from the existing BA allocation plus 8.6-mgd FA water from the Dixie wellfield. The dotted line at the top of the graph represents the total raw water available if 6 mgd BA and 4.7 mgd FA were utilized as Alternative Water Supply (AWS). It is noted that FA water could also be withdrawn from the Prospect wellfield, however the Peele-Dixie plant was designed with room for FA treatment units (reverse osmosis), hence, this represents the lowest cost FA option initially.

Figure 2 – Raw Water Demand Based on Finished Water Projections



Graph Notes:

1. *Raw water required varies by treatment option due to recovery efficiencies. Current treatment recovery rates are 85% for nanofiltration at Peele-Dixie and 95-97% for lime softening at Fiveash WTP.*
2. *For Option 2, reverse osmosis is assumed to have a treatment recovery rate of 75% of the raw water.*

The blue curve (Option 1A) in Figure 2 shows that the first option (purchase 6 mgd of C-51 capacity) may allow the City to satisfy water demand through the Year 2028 assuming the worst-case water treatment efficiency (100% nanofiltration at Fiveash). In the Year 2028, another AWS source must be in place such that adequate water supplies are available to meet finished water demand through 2045. Hence, Option 1A necessarily includes an investment in the FA at Peele-Dixie (again—the lowest cost FA possibility). The timing and amount of these investments are illustrated in the net present value calculations below.

A second Option 1 curve (Option 1B) in red suggests that the C-51 allocation purchase enables demand to be satisfied through the Year 2045 should the efficiency at Fiveash be 95% to 97% (assumes similar recoveries to lime softening). If lime softening (or another option with similar treatment recovery) is implemented at Fiveash WTP, the investment in the FA would not be required within the planning horizon. The net present value calculation presented in the next section will reflect the size and timing of these investments.

Option 2 assumes that the alternative water supply requirement is met initially with the FA at the Dixie Wellfield. This curve is shown in green. (Note: this option also assumes Fiveash is converted to nanofiltration). In Year 2035, an additional AWS source must be in place to satisfy water demand through the planning period. At that point, if the City had not already purchased C-51 allocation, the City would then need to invest in the Floridan Aquifer at Prospect Wellfield (if another AWS was not available).

Net Present Value of the Options

Capital expenditures (Capex) required in Option 1A are estimated as follows:

- $4.6 million per mgd ($27,600,000) for purchase of C-51 allocation from PBA
- Construction costs at $9 per gallons per day (gpd) ($54 million for infrastructure to treat the 6-mgd C-51 allocation via nanofiltration at Fiveash WTP)
- Construction costs at $8 per gpd to construct wellheads, conveyance pipeline, RO skids, degasifiers, post-treatment stabilization, plus ancillary chemical, electrical, and instrumentation systems at Peele-Dixie in years 2026 and 2027

Operational and maintenance costs (Opex) for Option 1A are:

- $219,309 per year for O&M of reservoir and conveyance system
- $1.00 per 1,000 gpd for treatment costs related to nanofiltration facilities at Fiveash WTP

Capex required in Option 1B are estimated as follows:

- $4.6 million per mgd ($27,600,000) for purchase of C-51 allocation from PBA
- Construction costs at $5 per gpd ($30 million for infrastructure to treat the 6-mgd C-51 allocation via lime softening at Fiveash WTP) in years 2033 and 2034

Opex costs for Option 1B are:

- $218,400 per year for O&M of reservoir and conveyance system
- $0.60 per 1,000 gpd for treatment costs related to lime softening facilities at Fiveash WTP

Capex required for Option 2 are:

- Construction costs at $8 per gpd to construct wellheads, conveyance pipeline, RO skids, degasifiers, post-treatment stabilization, plus ancillary chemical, electrical, and instrumentation systems at Peele-Dixie in years 2026 and 2027
- Construction costs at $11 per gallons per day (gpd) ($66 million for infrastructure to construct facilities to produce up to 6 mgd from three 2 mgd RO skids at Fiveash WTP) in years 2031 and 2032. Note that three 2-mgd skids are required for redundancy purposes.

Opex costs for Option 2 are:

- $1.25 per 1,000 gpd for O&M costs related to reverse osmosis at Peele-Dixie WTP

The timing of investments and resultant cash flow diagrams for the two options are shown in Figures 3, 4, and 5 below and on the next page.

Figure 3 – Cash Flow for Option 1A – 6 mgd from C-51 with Nanofiltration at Fiveash WTP

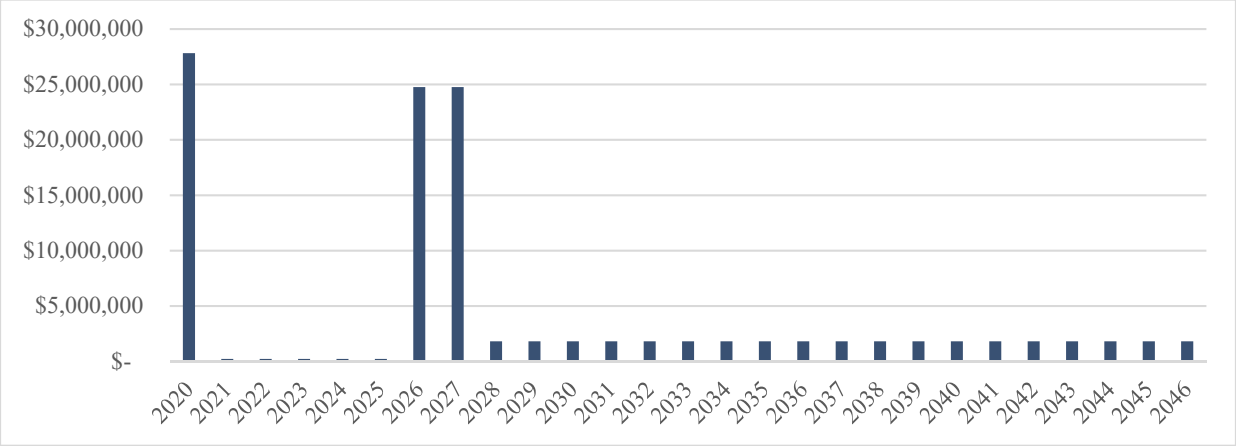


Figure 4 – Cash Flow for Option 1B - 6 mgd from C-51 with Lime Softening at Fiveash WTP

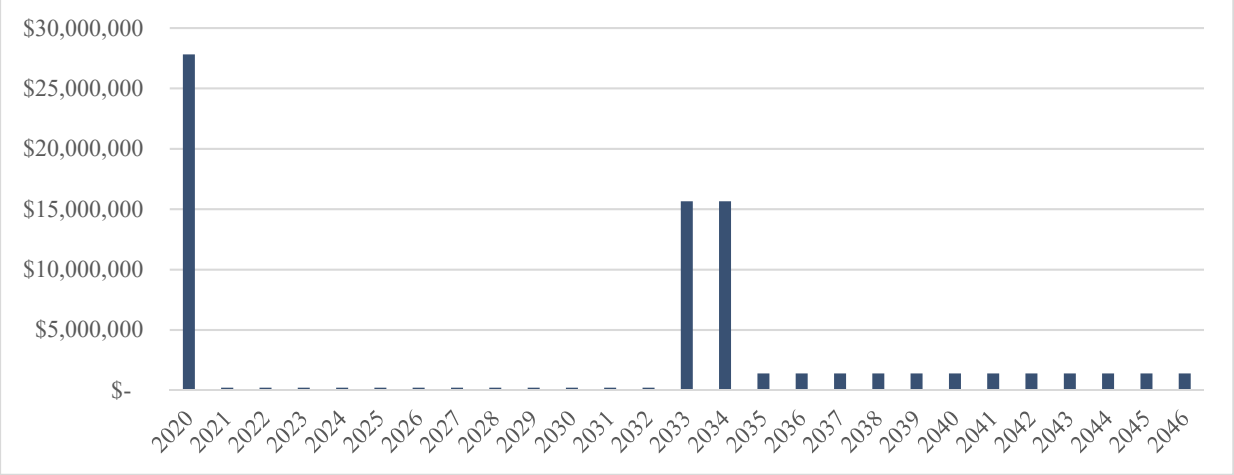
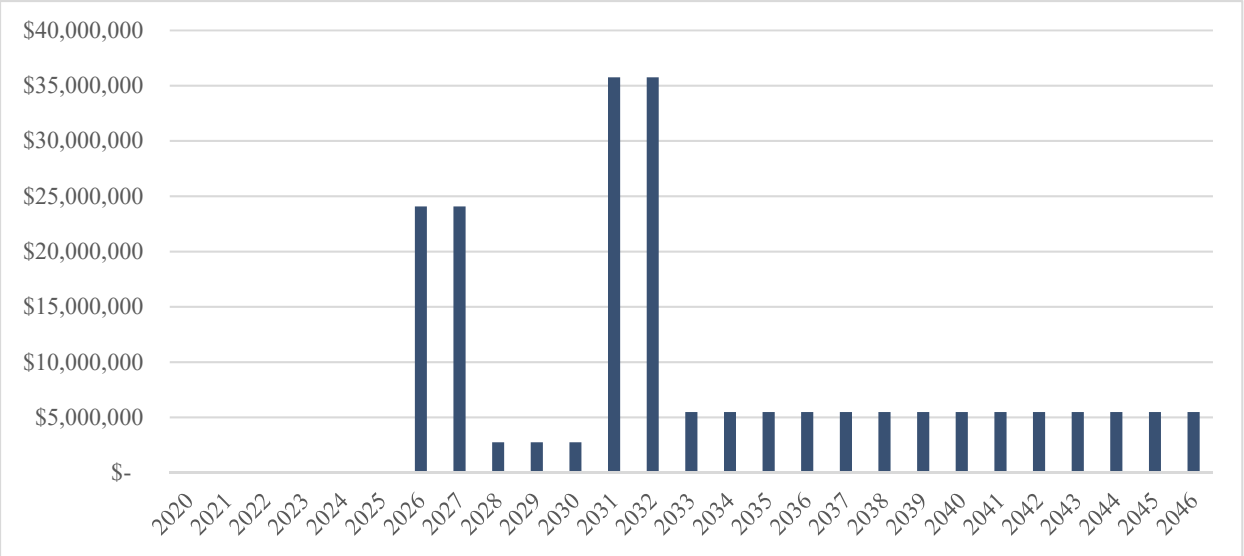


Figure 5 – Cash Flow for Option 2 – 8.6 mgd from FA for Reverse Osmosis at Peele-Dixie WTP



The net present value (NPV) of the options are shown in Table 1 below.

Table 1 – NPV of Raw Water Supply Options

	NPV for the Additional Finished Water Produced (r= 3.5%)
Option #1A = 100% NF of Prospect Wellfield from Purchase of 6 mgd of C-51 Allocation	$120,900,000
Option #1B = 100% LS of Prospect Wellfield from Purchase of 6 mgd of C-51 Allocation	$64,800,000
Option #2 = RO of 8.6-mgd FA at P-D	$127,900,000

Based upon this calculation, it appears that purchase of C-51 water (Option 1) may be economically advantageous compared to utilization of FA water at Peele-Dixie, dependent upon the treatment efficiency of the technology selected for Fiveash water treatment plant improvements. Even if the efficiency of a modified/replaced Fiveash is low, the options result in similar net present values. It is further noted, however, that Option 1 (purchase C-51 capacity) requires capital to be spent earlier than Option 2 due to the nature of the agreement with PBA. The reader is again reminded that the economic analyses presented herein are conceptual in nature and are not based upon detailed planning or cost estimates. They are believed, however, to accurately represent the relative economic comparison of the options considered.

Other Considerations and Discussion

Beyond monetary considerations, the City can consider general, non-quantitative items such as lower carbon footprint and the benefit of participating in a regional project as they relate to prioritizing development of the FA versus the BA water sources. A brief summary of such qualitative considerations is provided in Table 2.

Table 2 - Qualitative Comparison of Treating C-51 Allocation vs Installing RO at Peele-Dixie

Consideration	Option 1 - Purchase of C-51 Allocation for Treatment at the Fiveash WTP	Option 2 - Install RO at Peele-Dixie to Treat Permitted FA from Dixie Wellfield
Regional Solution	YES	NO
Lower carbon footprint	YES	NO
Higher utilization of raw water resource (Higher recovery of raw water)	YES, 85-95%	NO, 70-75%
Maximizes diversification of water sources (BA, BA from C-51, and/or FA)	YES	NO

It should be recognized that there are two notable elements of risk associated with these options. With regard to use of the Floridan Aquifer, the potential exists for water quality changes over time. If the degradation (of water quality) was great enough, increased Capex and Opex could be incurred, affecting the net present value of the alternative. This risk may be exacerbated should the complete volume of FA water identified in the Lower East Coast Water Supply Plan be exploited. It is not currently known if this will occur, nor can this risk be readily quantified. It is noted, however, that SFWMD modeling suggests such water quality changes can occur and in fact have occurred at certain South Florida utilities.

A second notable risk involves use of the C-51 allocation. Although the SFWMD will permit such use for an approximately 47-year term (presently), some risk exists relative to the availability of water in the reservoir. This stems from the fact that water availability from the C-51 canal was calculated based upon a historical record. It is possible, but not necessarily probable, that climate change could negatively influence water availability, thereby necessitating policy changes in the future. Neither of these risks can be completely defined given currently available data and science.

A final thought on risk, however, is that selection of Option 2 (FA at Peele-Dixie) could eliminate the future use of C-51 water as other utilities would presumably use the capacity of Phase 1, and Phase 2 is not guaranteed to be built. If instead the City completes the purchase of C-51 allocation, the FA remains viable at a future time. Hence, selection of Option 1 would be considered a more diversified and therefore more resilient investment.