WATER SUPPLY ALTERNATIVES ANALYSIS

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WATER SUPPLY ALTERNATIVES ANALYSIS

Florida Power & Light Company
Turkey Point

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March 29, 2016

Mr. Scott Burns
Florida Power & Light Company
700 Universe Boulevard
Juno Beach, FL 33408

RE: TURKEY POINT
WATER SUPPLY ALTERNATIVE ANALYSIS

Dear Mr. Burns:

Enclosed is Golder Associates Inc.'s Water Supply Alternatives Report for the Turkey Point Cooling Canal System. This analysis was undertaken to fulfill the requirements of paragraph 17.a.ii of the Consent Agreement between Florida Power & Light Company and the Miami-Dade County Division of Environmental Resources Management.

If we can be of any further assistance, please don't hesitate to contact me at any time.

Sincerely,

GOLDER ASSOCIATES INC.

Gregory M. Powell, PhD, PE
Senior Consultant and Principal

EXECUTIVE SUMMARY

Florida Power & Light Company (FPL) retained Golder Associates, Inc. (Golder) to evaluate alternative water sources for the Turkey Point Cooling Canal System (CCS) to satisfy a requirement of the Consent Agreement between FPL and Miami-Dade County Division of Environmental Resources Management (MDC DERM) that was executed by FPL on October 6, 2015. The specific paragraph of the Consent Agreement is shown below.

> 17.a.ii: FPL shall evaluate alternative water sources to offset the CCS water deficit and reduce chloride concentration in the CCS, and as a means of abating the westward movement of CCS groundwater. FPL will consider the practicality and appropriateness of using reclaimed wastewater from the Miami-Dade County South District Waste Water Treatment Plant as an alternative water source. FPL will provide DERM a summary of its Alternative Water Supply plan within 180 days of executing the Consent Agreement. FPL recognizes the importance and potential for reuse water, and FPL will make good faith efforts to implement the use of reuse water where practicable.

Based on the language of the Consent Agreement and discussions with FPL, Golder developed a statement of the project objective, goals and constraints, which is discussed in Section 1.1. Preliminary evaluations and results from previous studies that constrain some of the alternatives are discussed in Section 1.2.

Eight potential water source alternatives that could potentially meet the project objective and goals were identified and defined. The alternatives included two options for using reclaimed water with high-level disinfection (HLD) from the Miami-Dade County South District Waste Water Treatment Plant (SDWWTP). The eight alternatives listed below are discussed in detail in Section 2.

Alternative No. 1	Excess Surface Water from the L-31E Regional Canal.
Alternative No. 2	Inland Biscayne Aquifer Wellfield.
Alternative No. 3	Reclaimed Water from SDWWTP with Nutrient Removal.
Alternative No. 4	Reclaimed Water from SDWWTP with Nutrient Removal and Advanced Treatment for Other Constituents of Concern (COC).
Alternative No. 5	UFA (Upper Floridan Aquifer) Artesian Wells Flowing into CCS.
Alternative No. 6	Direct Treatment of CCS Water to Remove Salinity.
Alternative No. 7	Marine Groundwater from Wells on the Turkey Point Peninsula with additional Fresh Water from another Source.
Alternative No. 8	Marine Surface Water from Biscayne Bay or Card Sound with Additional Fresh Water from another Source.

Eighteen evaluation criteria were developed and grouped into four themes or categories (technical, environmental, economic and social). Four themes and 18 criteria are listed below.

Technical Criteria

1. Salinity
2. Quantity
3. Availability

4. Reliability
5. Nutrients
6. Quality (other COCs)
7. Operations
8. Risk, Safety and Security

Environmental Criteria

9. Hydrologic
10. Water Quality
11. Wetlands
12. Ecology

Economic Criteria

13. Total Cost
14. Schedule

Social Criteria

15. Regulatory Approvals
16. Impacts to Others
17. Societal Resources
18. Compatibility

A five-level rating scale was developed for each of the 18 criteria. Weighting factors were applied to the four themes and to each of the 18 evaluation criteria. The screening criteria and weighting factors are discussed in Section 3.

Subject matter experts then rated each alternative against the evaluation criteria rating scale. The water alternative evaluation results and rating scores are discussed in Section 4. The individual scores for each alternative and criteria, and the weighted average score for each alternative are shown in Table 4.1.

The overall scores for each of the four themes, as a percent of the maximum possible score, are shown in Figure 4.1 for each water source alternative. This figure also shows spider diagrams for each alternative water source. The spider diagrams visually display how well balanced each alternative is relative to the four themes (technical, environmental, economic and social).

Alternative No. 5, *(Upper Floridan Aquifer Artesian Wells Flowing into the CCS)*, had the highest (i.e., best) score, with a weighted average of 4.71, out of a maximum of 5.0. This alternative is significantly better than the next highest alternative (Alternative No. 1). Alternative No. 5 is the most balanced alternative relative to the four themes. In addition, it has a relatively short implementation schedule and it is the best source of relatively fresh water to be combined with a marine water source. This water supply alternative is the best choice to meet the project goals and objective. It should be the first priority.

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1.0 INTRODUCTION

In early November 2015, FPL asked Golder to provide a draft scope of work to conduct a Water Alternatives Analysis to satisfy a requirement of the Consent Agreement between FPL and MDC DERM that was executed by FPL on October 6, 2015. The specific paragraph of the Consent Agreement is shown below.

> 17.a.ii. FPL shall evaluate alternative water sources to offset the CCS water deficit and reduce chloride concentration in the CCS, and as a means of abating the westward movement of CCS groundwater. FPL will consider the practicality and appropriateness of using reclaimed wastewater from the Miami-Dade County South District Waste Water Treatment Plant as an alternative water source. FPL will provide DERM a summary of its Alternative Water Supply plan within 180 days of executing the Consent Agreement. FPL recognizes the importance and potential for reuse water, and FPL will make good faith efforts to implement the use of reuse water where practicable.

Golder provided the draft scope/proposal to Mr. Steven Scroggs, Senior Director, Project Development via email on November 24, 2015. FPL retained Golder on December 15, 2015 to provide the necessary services to evaluate alternative water sources for the Turkey Point CCS. The Consent Agreement requires FPL provide MDC DERM with a summary of the Alternative Water Supply plan by April 1, 2016.

1.1 Objective, Goals and Constraints

Based on the language of the Consent Agreement and discussions with FPL, Golder developed the following summary of the project objective, goals and constraints. The project objective is to evaluate all potential water sources that could be used to offset CCS water deficits, including reclaimed wastewater from the MDC SDWWTP in order to meet the following goals:

1. Reduce annual average salinity in the CCS to 34 PSU, as a means of abating the westward movement of CCS groundwater, and
2. Maintain or improve hydrologic and water quality conditions in the CCS.

To accomplish the project objective and goals, without causing significant adverse impacts to the CCS or the environment, the water source alternatives must also meet the following constraints:

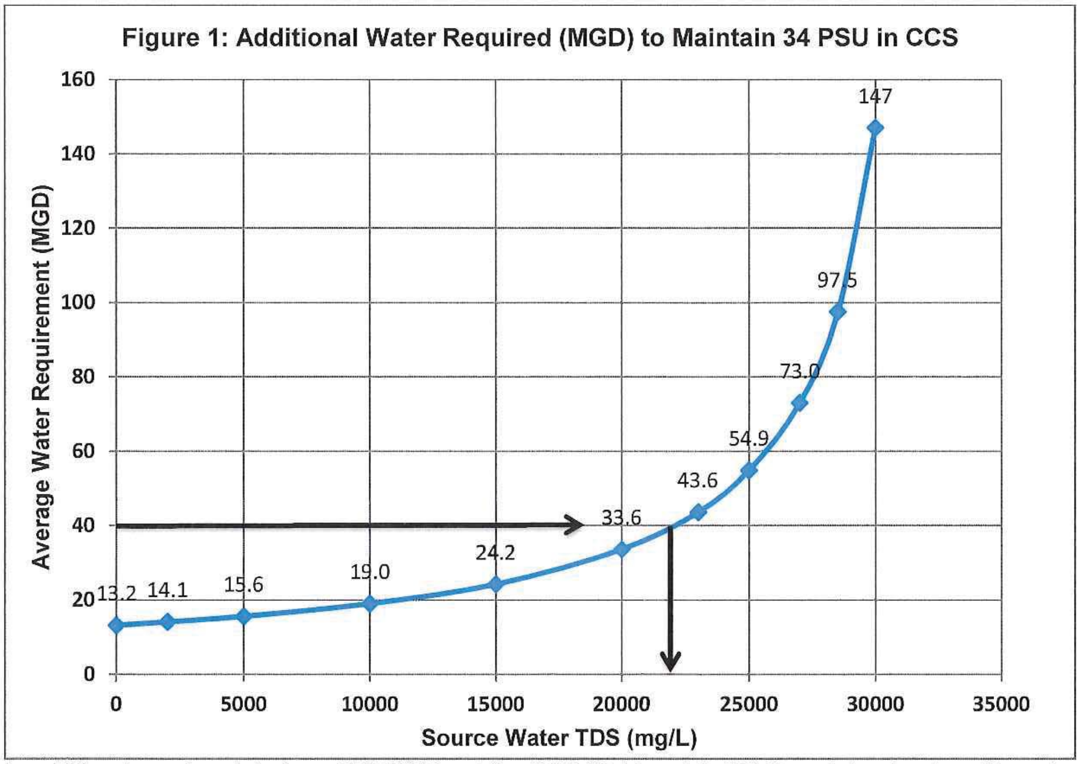
1. The source water quality must not cause nutrient enrichment of the CCS, or the water source must be treated to avoid nutrient enrichment;
2. The source water quality must not cause a contravention of groundwater quality standards at the point of compliance, or it must be treated to avoid the contravention of standards; and
3. The quantity of water added to the CCS, on an annual average basis, must not cause a significant hydrologic imbalance in the CCS.

1.2 Preliminary Evaluations

Based on recent water budget studies conducted over several years (Tetra Tech Memorandums: November 13, 2014, May 9, 2014, and March 13, 2015), the average daily absolute (+/-) change in CCS water volumes has been approximately 40 million gallons per day (MGD). This variation is due primarily to daily, seasonal and interannual differences between rainfall and evaporation. Therefore, to minimize the potential for hydrologic imbalances (Goal No. 2 and Constraint No. 3) the amount of water added to the CCS from any alternative water source should not exceed approximately 40 MGD, on an annual average basis.

The amount of water that must be added to the CCS to maintain the annual average salinity of the CCS at 34 practical salinity units (PSU) depends on the salinity, or total dissolved solids (TDS) concentration, of the source water. Figure 1, below shows the relationship between the source water quality and the required quantity. The curve is based on a steady-state mass balance model calibrated using the most recent CCS water and salt balance data (Tetra Tech Memorandum, March 13, 2015). The figure shows that if the average source water TDS is approximately 2,000 milligrams per liter (mg/L) the salinity can be maintained at 34 PSU with about 14 MGD of additional water. However, if the source water TDS concentration is greater than approximately 22,000 mg/L (salinity > 22 PSU), the project goals cannot be met, because Constraint No. 3, discussed above, will be exceeded.

Consequently, marine water sources (22,000 mg/L ≤ TDS ≤ 35,000 mg/L), used alone, are not feasible options for meeting the project goals and objective. Marine water sources may be part of a feasible solution designed to limit the buildup of non-TDS constituents in the CCS, if the marine water is used together with other low-salinity water sources, such that the combined average salinity of the additional water is less than 22 PSU.



In addition, based on data from SDWWTP and the CCS (Golder, July 2015), reclaimed water will require HLD and significant treatment for nutrient removal to avoid nutrient enrichment of the CCS. Reclaimed water also may require additional treatment for micro-constituents or other constituents of concern (COC).

1.3 Project Approach

The Water Supply Alternative Analysis requires an objective, systematic and transparent evaluation of several alternatives, with multiple incommensurable bottom lines (technical, environmental, economic and social), using various complex evaluation criteria. As a practical way to accomplish this task, Golder used the Options Analysis component of our decision support software called GoldSET (Golder's Sustainability Evaluation Tool). This software is a flexible tool that has been used around the world on a wide range of engineering projects. The project approach followed the sequence of activities discussed below.

First, Golder developed and defined eight potential water supply alternatives that could meet the project objective and goals, within the constraints discussed above. For completeness, the alternatives included a wide range of water sources, including two alternatives for using reclaimed water from the SDWWTP. The eight alternatives are discussed in Section 2 of this report. To help ensure that no water supply alternatives were omitted, the alternatives list was provided to FPL for review.

Golder also developed a list of 18 evaluation criteria, grouped into four incommensurable themes or categories (technical, environmental, economic and social). For each of the 18 criteria, Golder developed a five-level rating scale (one is the lowest rating and five is the highest rating). Weighting factors were applied to the four themes and each of the evaluation criteria. The screening criteria and weighting factors are discussed in Section 3.

Golder's subject matter experts then rated each alternative against the evaluation criteria and rating scales. The GoldSET options analysis tool was used to evaluate the alternatives. The water alternative evaluation results and rankings are discussed in Section 4. The final recommendation is discussed in Section 5.

1.4 Salinity Definitions

Descriptive terms for various salinity levels, or TDS concentrations, are not always consistently defined between the scientific and regulatory literature. Therefore, for the purpose of this study, the following definitions from the USGS Water Science Glossary of Terms are used:

- Freshwater – TDS less than 1,000 mg/L.
- Slightly Saline – 1,000 mg/L to 3,000 mg/L.
- Moderately Saline - 3,000 mg/L to 10,000 mg/L.
- Highly Saline – 10,000 mg/L to 35,000 mg/L.
- Seawater or Saltwater – 35,000 mg/L.
- Hypersaline Water – salinity greater than seawater.

Based on the source water TDS limit discussed in Section 1.2, the term "marine waters" is defined, for the purpose of this report, as water with a TDS concentration between 22,000 mg/L and 35,000 mg/L.

The definitions from the USGS are generally consistent, but not exactly the same, as the regulatory definitions used in Florida. For example, the South Florida Water Management District (SFWMD) defines seawater as water with a chloride concentration of 19,000 mg/L and the Consent Agreement (page 3, paragraph 9) defines "hypersaline water" as water that exceeds 19,000 mg/L chlorides. These definitions equate to a TDS concentration of approximately 34,400 mg/L, while standard seawater is 35,000 mg/L. Also, the SFWMD defines freshwater as water with a chloride concentration of 250 mg/L. This chloride concentration equates to a TDS concentration of approximately 450 mg/L. The USGS defines freshwater as water with a TDS concentration less than 1,000 mg/L.

2.0 WATER SUPPLY ALTERNATIVES

2.1 Alternative No. 1 – Excess Surface Water from the L-31E Regional Canal

This alternative has been used in the past on a temporary emergency basis. For the purpose of this study, it is only considered a secondary short-term resource to be used to lower or maintain salinities when other sources are not available or appropriate.

This alterative involves pumping excess surface water during the rainy season (typically six months between June 1 and November 30 each year) from the L-31E Canal to the Turkey Point CCS. The withdrawal would be allowed only as authorized by a water use permit from the SFWMD, and only after the Biscayne Bay daily allocation volume has been satisfied. Consequently, this alternative requires daily coordination between FPL and the SFWMD.

Design drawings (Taylor Engineering, Jan 20, 2015), included in the previous Consumptive Use Permit, and historical water use data from 2014 and 2015 are the basis for evaluation of this alternative. The withdrawal point is the L-31E Canal, north of Palm Drive (SW 344th Street). Water is pumped to the L-31E (south) Canal through three, 30-inch high-density polyethylene (HDPE) pipes under Palm Drive. The L-31E canal (south of Palm Drive) conveys the water to a pump station located near the northern end of the Turkey Point CCS. From that point, an equal amount of water is pumped through two, 36-inch pipelines to the CCS. The design drawings show a total of 0.45 acres of temporary impacts to wetlands at the pump stations and along the pipeline route.

The pumping capacity is approximately 100 MGD. However, based on flow data from 2014 and 2015, the average pumping rate during the rainy season was only 14 to 15 MGD. Based on water quality data collected during this same time, the water pumped to the CCS is fresh (TDS < 1,000 mg/L) and no water treatment was required to use the water in the CCS.

Based on cost/expense data provided by FPL, the capital cost for this alternative is approximately $7.4 million. Most of the capital costs have already been incurred. Based on the FPL data and estimates of power requirements, the annual operating and maintenance costs are estimated to be approximately $0.3 million. The net present value (NPV), including the capital costs plus annual operation and maintenance (O&M) costs for 10 years at 3 percent discount, is approximately $10 million.

Since the infrastructure for this alternative water source has been previously designed, permitted and constructed, the implementation schedule is estimated to be approximately six months, primarily for updating permits and for component assembly. This water supply alternative has no significant impact on plant operations. Because some of the infrastructure is located outside the security boundary and exposed to the public, there is some concern for security, but the risk is low.

2.2 Alternative No. 2 – Inland Biscayne Aquifer Wellfield

This water alternative would require siting, design, permitting and construction of a 15 MGD wellfield at an inland location where the Biscayne Aquifer water quality is slightly to moderately saline (1,000 mg/L ≤ TDS ≤ 5,000 mg/L). While the exact location is to be determined, the wellfield likely would have to be located approximately 6 to 8 miles inland (west) from the Turkey Point facility in order to achieve the water quality objective.

The wellfield would require approximately six to eight wells. Each well would be 16- to 18-inches in diameter and 70 to 100 feet deep. To supply 15 MGD, each well would be equipped with 1,500 gallons per minute (gpm) to 2,000 gpm pumps. Based on the hydrogeologic properties of the Biscayne Aquifer, the wells would be spaced between 500 to 1,000 feet apart. The zone of significant wetland impacts (i.e., drawdown greater than 0.5 feet) could extend out 3.5 to 4 miles from the center of the wellfield. The total radius of influence (defined by drawdown of 0.1 feet) could extend out approximately 12 miles. Consequently, wetland impacts, salt water intrusion impacts, impacts to existing legal users and consistency with Comprehensive Everglades Restoration Project (CERP) and minimum flow and levels (MFLs) would be significant issues.

Water would be transported to the Turkey Point facility via a 32- to 36-inch HDPE pipeline. The pipeline route would be approximately 8 to 12 miles in length and would follow existing road right-of-way, where practical. Based on the previous reclaimed water pipeline routing study (Golder, July 2015), a 10-mile pipeline in the area near the Turkey Point facility is likely to impact approximately 20 and 25 acres of wetland and 20 to 25 other property owners.

Based on a recent feasibility study (Golder, July 2015), capital costs for the wells, pumps and pipeline (not including the cost of land for the wellfield) are estimated to be approximately $26 million. The annual O&M cost, including power, is estimated to be approximately $0.61 million. The NPV of the capital costs plus 10 years of operating costs at 3 percent discount would be approximately $31 million. The environmental and social impacts associated with this alternative, would make regulatory approval very difficult. Consequently, the implementation schedule for siting, permitting design and construction would be several years.

2.3 Alternative No. 3 – Reclaimed Water from SDWWTP with Nutrient Removal

Water Supply Alternative No. 3 uses 15 MGD of reclaimed water (effluent) from the Miami-Dade County, SDWWTP to supplement and freshen the CCS. Treatment is required to avoid degrading the water quality of the CCS water with nutrients (nitrogen and phosphorus), which could cause eutrophication and excess algae growth in the CCS. Treatment of the reclaimed water would entail advanced biological treatment, including membrane filtration, for nitrogen removal; physical-chemical treatment, including continuous media filtration, for phosphorus removal; and ultraviolet light disinfection to kill coliform and pathogenic organisms. Approximately 98 percent removal of nitrogen and phosphorus will be needed, as well as 2-log removal of microorganisms (Golder, July 2015).

The Reclaimed Treatment Plant (RTP) would be located close to the SDWWTP to minimize conveyance costs for return of residual streams (sludge, backwash water) to the SDWWTP for processing and disposal. About 7 to 10 acres of land will be required for installation of the RTP. Costs for reclaimed water, residual stream disposal and for land purchases are not included in the cost estimates for this alternative.

Pumps at the RTP, would convey the treated (low nutrient) water to Turkey Point CCS through a 10-mile long, 32-inch diameter pipeline. The reclaimed water is "fresh", having a TDS concentration of about 600 mg/L, and would thus effectively reduce the salinity of the CCS water. Since the reclaimed water is currently disposed by deep well injection, its reuse in the CCS would cause no adverse impact on availability of surface water resources for higher value uses, nor would adverse changes to surface water hydrology occur.

Operational risk for the relatively complex RTP would translate to less than 100 percent availability of the reuse water supply to the CCS, but would be manageable. Since the RTP would not be inside the Turkey Point security boundary and the 10-mile pipeline could be exposed to the public in places, security is a concern, but it is manageable. Construction of the RTP and 10-mile pipeline would affect over 20 acres of wetlands, but most of the wetlands would be lower quality. Impacts to higher quality wetlands would be minimized by using horizontal directional drilling.

Based on the recent feasibility study (Golder, July 2015), the capital costs of supplying low nutrient, disinfected reuse water to the CCS would be approximately $153 million, or approximately 15 times higher than the lowest cost alternative. The annual operating costs are estimated to be approximately $7.5 million. The NPV of the capital costs plus 10 years of operating costs at 3 percent discount would be approximately 217 million; over 20 times higher than the lowest cost alternative. The implementation schedule for this alternative would be much longer as well, about 40 months.

No significant social impacts are expected for this water supply alternative, although 21 landowners would be potentially, but only temporarily impacted during pipeline construction. The complexity of this alternative will make regulatory approvals more difficult.

2.4 Alternative No. 4 – Reclaimed Water from SDWWTP with Nutrient Removal and Advanced Treatment for Other Constituents of Concern

Similar to Water Supply Alternative No. 3, Alternative No. 4 uses reclaimed water (effluent) from the Miami-Dade County, SDWWTP to supplement and freshen the CCS. Treatment is more extensive for Alternative No. 4 because other potential COCs, such as endocrine disrupting compounds and personal care products, will be removed by a combination of reverse osmosis (RO) and advanced oxidation using ultra-violet catalyzed chemical oxidation. The inclusion of RO treatment will allow for removal of the physical-chemical phosphorus treatment that is used in Alternative No. 3. However, due to a large reject stream from the RO process that will have to be returned to the SDWWTP for deep well disposal, a higher reclaimed water flow rate (21 MGD for Alternative No. 4 vs. 16 MGD for Alternative No. 3) will have to be treated to produce 15 MGD of treated water. Thus expanding the size of the treatment facilities. The result will be an even higher quality reuse flow to the CCS.

The Alternative No. 4 process train will be similar to the Alternative No. 3, but the RO treatment system may slightly increase operational risk and decrease reliability. Again, the risk is manageable and reuse water should be available for freshening of the CCS water. The reclaimed water is considered "fresh", having a TDS concentration of about 600 mg/L, and would thus effectively reduce the salinity of the CCS water.

Since the reclaimed water is currently disposed by deep well injection, its reuse in the CCS would cause no adverse impact on availability of surface water resources for higher value uses, nor would adverse changes to surface water hydrology occur. Since the maximum treatment will be used that is considered state-of-the-art for producing reuse water of exceptionally high quality, Alternative No. 4 will have negligible potential to impact ground water quality in the zones close to the CCS.

The capital costs of supplying low nutrient, low COCs water to the CCS is estimated to be approximately $240 million; the highest of all alternatives considered and over 25 times higher than lowest cost alternative. The annual operating cost for this alternative is estimated to be approximately $13 million. Therefore, the NPV for capital costs and 10 years of operating costs at 3 percent discount would be approximately $351 million; over 35 times higher than the lowest cost alternative. As with Alternative No. 3, costs for reclaimed water, residual stream disposal and for land purchases are not included in the cost estimates for this alternative. The implementation schedule for this alternative is estimated to be approximately 49 months, due to additional pilot testing and project complexity.

With respect to criteria other than water quality, operational reliability, cost, schedule and regulatory approval, Alternative No. 4 is similar to Alternative No. 3.

2.5 Alternative No. 5 – UFA Artesian Wells Flowing into CCS

Water supply Alternative No. 5 uses water from the UFA to supplement and freshen the CCS. This alternative requires installation of up to six production wells in the UFA. One well, previously constructed to meet NRC requirements, can be utilized as one of the water supply wells for this alternative. Therefore, up to five additional production wells will be required. The wells will be constructed within the CCS along the northern most canal and along the west side of the CCS east of the interceptor ditch. The total depth of the wells will be approximately 1,250 feet.

Pressure in the UFA is significantly greater than sea level, consequently the UFA wells will be artesian and the wells will flow into the CCS, without using pumps. The total flow will be between 14 MGD and 15 MGD. The UFA water quality is slightly saline, with a TDS concentration between 2,000 mg/L and 4,000 mg/L. No water treatment is required for nutrient removal or for removal of other COC.

Modeling conducted as part of the state Site Certification process shows that the design, construction and operation of the wells will not cause harm to water resources or existing legal users of the UFA (Tetra Tech, November 13, 2014).

All construction activities are within previously developed areas of the existing Turkey Point property, stormwater runoff will be contained within the CCS and pumping of the wells will not cause drawdown in the surficial aquifer. Therefore, no adverse impact to wetland systems, surface waters, critical habitat, protected species or other important biological resources is anticipated.

This water supply alternative is compatible with existing land uses and is consistent with CERP.

Based on construction costs for other Turkey Point UFA wells, the capital cost for construction of each well is estimated to be approximately $2 million. Based on installing up to five additional wells, the total capital costs are estimated to be $10 million. Since pumps will not be required, power costs are much lower than for other alternatives. Consequently, O&M costs are estimated to be 0.1 million per year. The NPV for capital and 10 years of O&M at 3 percent is approximately $11 million. The implementation schedule for this alternative is estimated to be approximately 18 months.

2.6 Alternative No. 6 – Direct Treatment of CCS Water to Remove Salinity

Alternative No. 6 uses RO treatment of the CCS water to maintain annual average salinity in the CCS at 34 PSU. Other sources of fresh water (e.g., Alternative No. 1) may be required initially to more rapidly lower salinity in the CCS to 34 PSU. However, this is not required for this Alternative. Figure 2.1 shows a water-balance block-diagram for this alternative.

Seawater RO treatment systems can operate at approximately 50 percent efficiency (i.e., treated water production rate is approximately 50 percent of the influent rate). The treatment system would pump approximately 28 MGD of water from the CCS to a RO treatment unit located on the Turkey Point property. The exact location has not been determined at this time. The treatment unit would return approximately 14 MGD of fresh or slightly saline water to the CCS and discharge approximately 14 MGD of hypersaline reject water to the Boulder zone of the Lower Floridan Aquifer through two deep injection wells.

Based on a steady-state water and salt budget model of the CCS, an additional 8.63 MGD of marine water, primarily from the aquifer under Biscayne Bay, will flow into the CCS and groundwater outflow from the CCS will be reduced by 5.37 MGD. These changes make up the difference between the 28 MGD removed from the CCS and the 14 MGD returned to the CCS. This alternative is equivalent to removing 22.63 MGD of water from the CCS at 34 PSU and returning the same amount at a salinity of 14.8 PSU.

All construction activities would be within the Turkey Point property. There will be no net increase in the water added to the CCS and groundwater recharge from the CCS will be reduced. The RO concentrate will be discharged to the Boulder zone, which is used routinely in south Florida for discharge of wastewater. Therefore, no significant adverse impacts to groundwater, wetland systems, surface waters, critical habitat, protected species or other important biological resources is anticipated.

This water supply alternative is compatible with existing land uses and is consistent with the CERP.

Based on cost data from the Florida Department of Environmental Protection (FDEP, 2010), the production cost (2016 dollars) for seawater RO treatment is approximately \$5.5 per 1,000 gallons produced. This is equal to \$30.1 million per year for a system that produces 15 MGD. The capital costs for a 15 MGD seawater facility, including costs for two injection wells and one dual zone monitoring well, is estimated to be approximately \$224 million and annual O&M costs are estimated to be approximately \$16.3 million. The NPV of capital costs plus 10 years of O&M costs at 3 percent discount rate is approximately \$363 million.

2.7 Alternative No. 7 – Marine Groundwater from Wells on the Turkey Point Peninsula with Additional Fresh Water from another Source

Existing marine wells (SW-1, SW-2 and PW-1) have been used in the past and will be maintained as short-term backup water option to be used when appropriate and as needed during extreme conditions.

This water source, however, can only achieve the project objective of 34 PSU in the CCS if fresh water from another source is also added to the CCS. The average TDS of the combined flow must be less than 22,000 mg/L and the total annual average addition must be less than 40 MGD (see Section 1). For example, 25 MGD of marine groundwater (TDS ≈ 34,000 mg/L) and 15 MGD of slightly saline UFA water (TDS ≈ 2,000 mg/L) could be added to the CCS and meet the project objectives. The difference between this alternative and other alternatives that simply add 15 MGD of reclaimed water or slightly saline UFA water (e.g., Alternatives No. 3 or 5), is that this approach increases flow through the CCS, which can reduce concentrations of other constituents in the CCS (e.g., ammonia or nutrients).

The quantity of water available from the marine wells is more than adequate; the water is available continuously and is highly reliable. Water from the marine wells does not require treatment to remove nutrients or other COC. The marine well supply has no significant impact on plant operations. However, because the wells and some of the pipeline are located outside the security boundary and exposed to the public, there is some concern for security, but the risk is low.

The marine wells withdraw from a seawater surficial aquifer. The aquifer is recharged from Biscayne Bay over a very large area. Consequently, this alternative will cause no significant adverse impact to aquatic organisms from entrainment or impingement; to the hydrology or quality of surface water resources; to wetlands, protected species, critical habitat or biological resources; or to other property owners. While modeling shows there will be positive impacts on groundwater resources from freshening the CCS, the regulatory agencies and some existing legal users are very concerned about the potential for increased saline water intrusion caused by adding water to the CCS.

The capital cost estimate for the three 15 MGD wells on the Turkey Point peninsula and the pipeline required to convey the water to the CCS is approximately $3.0 million. The O&M cost estimate, including power to operate the pumps, is approximately $0.4 million per year. The NPV for the capital costs plus 10 years of O&M costs at 3 percent discount is approximately $6.5 million for the marine wells. The total NPV for this alternative includes the NPV for the marine wells plus the NPV for the additional fresh water source. Alternative No. 5 has one of the lowest NPVs and the best overall ratings. Therefore, using Alternative No. 5 as the source of additional fresh water, the total NPV for this alternative is approximately $17.5 million.

2.8 Alternative No. 8 – Marine Surface Water from Biscayne Bay or Card Sound with Additional Fresh Water from another Source

This alternative is the same as Alternative No. 7, except that the marine water source is surface water from Biscayne Bay or Card Sound. As with Alternative No. 7, this water source can only achieve the project objective of 34 PSU in the CCS if fresh water from another source is also added to the CCS. The average TDS of the combined flow must be less than 22,000 mg/L total annual average addition must be less than 40 MGD (see Section 1).

The quantity of marine water available from Biscayne Bay and Card Sound is more than adequate; the water is available continuously and is highly reliable. Surface water from this source does not require treatment to remove nutrients or other COC. However, this alternative requires a new intake structure with a design intake flow of approximately 45 MGD. A surface intake near Biscayne Bay National Park would cause significant concern relating to impingement and entrainment of aquatic organisms. The new intake structure would be located near the barge canal at the north end of the CCS, or near the canal that flows into Card Sound at the south end of the CCS. The new intake structure would use cylindrical wedge-wire screens or traveling screens. To minimize impingement, the structure would be sized to maintain the through-screen velocity at less than 0.5 fps.

Environmental concerns for Biscayne Bay National Park, nearby aquatic preserves, wetlands and aquatic ecology will make regulatory approvals for this alternative very difficult. If it can be permitted, the implementation schedule for this alternative would be at least 24 months.

This alternative will have no significant impact on plant operations. However, because the intake structure and some of the pipeline are located outside the security boundary and exposed to the public, there is some concern for security, but the risk is low.

The capital cost estimate for the 45 MGD intake structure and the pipeline required to convey the water to the CCS is approximately $5.5 million. The O&M cost estimate, including power to operate the pumps, is approximately $0.4 million per year. The NPV for the capital costs plus 10 years of O&M costs at 3 percent discount is approximately $9.0 million for this alternative. The total NPV for this alternative must include the NPV for the intake plus the NPV for the additional fresh water source. Alternative No. 5 has one of the lowest NPVs and the best overall ratings. Therefore, using Alternative No. 5 as the source of additional fresh water, the total NPV for this alternative is approximately $20.0 million.

3.0 SCREENING CRITERIA AND WEIGHTING FACTORS

With input and review by FPL, 18 screening criteria were developed to evaluate the eight water supply alternatives. The criteria were selected and defined based on their ability to capture the project objective, goals and constraints, including important and relevant project concerns, success factors and risk factors. For each criterion, a five-level rating scale was developed, with five being the best or the highest priority, and one being the worst or the lowest priority.

The screening criteria were grouped into four incommensurable themes: technical, environmental, economic and social. The four themes were each assigned an equal weighting (25 percent). The number of criteria developed for each theme was not the same. The technical theme had eight criteria; environmental had four; economic had two; and social had four. To ensure that the number of criteria used in each theme did not influence the overall weight assigned to that theme, the evaluation criteria within each group were assigned individual weighting factors totaling 100 percent.

Recognizing that not all issues considered have the same importance, the weighting factor assigned to each criteria was adjusted up or down from an average value based on the professional judgement of Golder's subject matter experts. The evaluation criteria and the rating scales are discussed below by group.

3.1 Technical Criteria

The technical theme evaluates the engineering feasibility of meeting the project objective, goals and constraints, while not compromising plant operations. The individual criteria included in the technical theme and the weight assigned to each, are discussed below:

1. **Salinity (20%)** – The salinity, or TDS concentration, of the water source must be suitable to meet the project objective, goals and constraints (e.g., achieve 34 PSU in CCS). The rating scale used for this criteria is as follows:

Scale	Criteria
5	TDS ≤ 5,000 mg/L
4	5,000 mg/L < TDS ≤ 10,000 mg/L
3	10,000 mg/L < TDS ≤ 15,000 mg/L
2	15,000 mg/L < TDS ≤ 22,000 mg/L
1	TDS > 22,000 mg/L

2. **Quantity (10%)** -- The quantity of water available, Q(available), must be adequate to meet the project requirements, Q(required), considering the source water TDS concentration?

Scale	Criteria
5	Q(available) ≥ 110% Q(required)
4	Q(available) ≥ 105% Q(required)
3	Q(available) ≥ 100% Q(required)
2	Q(available) ≥ 95% Q(required)
1	Q(available) < 95% Q(required)

3. **Availability (10%)** -- The fraction of each year that the water source normally available?

Scale	Criteria
5	Available continuously, all year.
4	Available at least 9 months each year.
3	Available at least 6 months each year.
2	Available at least 4 months each year.
1	Available at least 2 months each year.

4. **Reliability (10%)** -- Is the water source reliable at the time that it is normally expected (i.e., what is the probability that the expected water quantity or quality will not be available)?

Scale	Criteria
5	Source highly reliable (probability of failure ≤ 1 in 50; ≤ 2%).
4	Source very reliable (probability of failure ≤ 1 in 20; ≤ 5%).
3	Source reliable (probability of failure ≤ 1 in 10; ≤ 10%).
2	Source not very reliable (probability of failure ≤ 1 in 5; ≤ 20%).
1	Source unreliable (probability of failure ≥ 1 in 5; > 20%).

5. **Nutrients (15%)** -- Can the water source be used without causing eutrophication of the CCS? What level of treatment is required?

Scale	Criteria
5	Water can be used without treatment.
4	Limited water treatment required (< 30% removal).
3	Standard treatment methods required (30% to 60% removal).
2	Advanced treatment methods required (60% to 90% removal).
1	State-of-the art treatment methods (> 90% removal).

6. **Quality (Other COCs) (5%)** -- After treatment that may be required for nutrient removal, can the water source be used without causing contravention of groundwater quality standards at the point of compliance; and without introducing other (COC)? What level of additional treatment?

Scale	Criteria
5	Water can be used without additional treatment.
4	Only minor additional treatment using standard methods.
3	Significant additional treatment using standard methods.
2	Significant additional treatment using advanced methods, with potential pilot testing.
1	Significant additional treatment using state-of-the-art methods and pilot testing.

7. **Operations (15%)** -- Will the water supply alternative pose adverse impacts to power plant operations?

Scale	Criteria
5	No significant adverse impact to plant operations.
4	Some minor or temporary impacts are expected.
3	Alternative will require changes to SOPs.
2	Alternative will require significant changes to SOPs.
1	Alternative will require changes that are not acceptable.

8. **Risk, Safety and Security (15%)** -- Will the water supply alternative pose concern for facility risk, safety or security.

Scale	Criteria
5	No concern identified.
4	Some concern, but risk is very low.
3	Some concern, but risks are acceptable and can be managed.
2	Significant concern, but risk acceptable if carefully managed.
1	Significant concern, that is not likely to be acceptable.

3.2 Environmental Criteria

The four environmental criteria evaluate offsite (non-CCS) impacts to hydrology, water quality, wetlands and ecology.

1. **Hydrologic (25%)** -- Will the water supply alternative adversely affect the resource being utilized, or cause adverse hydrologic impacts to the offsite environment?

Scale	Criteria
5	No significant adverse impact identified.
4	Impacts minor, temporary and/or easily mitigated.
3	Impacts typical and reasonable, alternative acceptable.
2	Impacts significant, mitigation difficult, acceptance marginal.
1	Impacts extreme, mitigation difficult, alternative unacceptable.

2. **Water Quality (25%)** -- Will the water supply alternative adversely affect the resource being utilized, or cause an adverse water quality impact to the offsite environment?

Scale	Criteria
5	No significant adverse impact identified.
4	Impacts minor, temporary and/or easily mitigated.
3	Impacts typical and reasonable, alternative acceptable.
2	Impacts significant, mitigation difficult, acceptance marginal.
1	Impacts extreme, mitigation difficult, alternative unacceptable.

3. **Wetlands (25%)** -- Will the water supply alternative cause adverse impacts to wetlands? Consider both the type/quality of the wetlands and the acres adversely impacted. Add the scores and divide by 2.

Scale	Criteria
Wetland Type /Quality (weight 50%)	
5	Exotic wetland hardwoods (Brazilian pepper/melaleuca)
3	Freshwater marsh/mixed wetland hardwoods (MDC Class IV)
1	Mangrove swamp/tidal (MDC Class 1 wetlands)
Acreage (weight 50%)	
5	Less than 5 acres.
4	5 acres ≤ Impacts < 10 acres
3	10 acres≤ Impacts < 15 acres
2	15 acres ≤ Impacts ≤ 20 acres
1	Greater than 20 acres.

4. **Ecology (25%)** -- Will the water supply alternative have an adverse impact on rare threatened or endangered (RTE) species, critical habitat, or other important and sensitive biological resources?

Scale	Criteria
5	No significant adverse impact expected.
4	No significant adverse impact to RTE species, or their critical habitat, but minor impacts to RTE or other sensitive biological resources.
3	No direct adverse impact to RTE species, but potential impacts to critical habitat that can be mitigated.
2	No direct adverse impact to RTE species, but potential impacts to critical habitat that cannot be mitigated.
1	Direct adverse impact to RTE species and their critical habitat that cannot be mitigated.

3.3 Economic Criteria

The economic criteria evaluate total costs (capital and O&M), as measured by the Net Present Value (NPV) of the alternative, and the implementation schedule. Future O&M costs for ten years of operation, at an annual discount rate is 3 percent, is included in the NPV.

1. **Total Costs (60%)** -- NPV of capital plus 10 years of O&M costs (at 3% discount) relative to other water supply options. Linear scale from one (max NPV alternative) to five (min NPV alternative). Round the computed score to an integer value.
2. **Schedule (40%)** -- Length of time required to permit, design and construct the water supply facilities relative to the other alternatives. Linear scale from one (max duration alternative) to five (min duration alternative). Round computed score to integer value.

3.4 Social Criteria

1. **Regulatory Approvals (20%)** -- What level of effort is required to obtain regulatory approvals?

Scale	Criteria
5	Very easy, requires only one or two agency approvals.
4	Less difficult than most projects, limited agency approvals.
3	Typical or normal level of effort.
2	More difficult than most projects.
1	Significant effort required and approval not certain.

2. **Impacts to Others (25%)** -- Will the water supply alternative adversely impact existing legal users of the resource, or other property owners?

Scale	Criteria
5	No significant adverse impact identified.
4	Impacts minor, temporary and/or easily mitigated.
3	Impacts typical and reasonable, alternative acceptable.
2	Impacts significant, mitigation difficult, acceptance marginal.
1	Impacts extreme, mitigation difficult, alternative unacceptable.

3. **Societal Resources (25%)** -- Will the water supply alternative adversely affect Biscayne Bay National Park, Everglades National Park or outstanding Florida waters?

Scale	Criteria
5	No significant adverse impact identified.
4	Impacts minor, temporary and/or easily mitigated.
3	Impacts typical and reasonable, alternative acceptable.
2	Impacts significant, mitigation difficult, acceptance marginal.
1	Impacts extreme, mitigation difficult, alternative unacceptable.

4. **Compatibility (30%)** -- Is the water supply alternative compatible with approved MFLs, CERP projects and MDC Comprehensive Development Master Plan?

Scale	Criteria
5	No compatibility issues identified.
4	Issues minor, temporary and/or easily mitigated.
3	Issues typical and reasonable, alternative acceptable.
2	Issues significant, mitigation difficult, acceptance marginal.
1	Issues extreme, mitigation difficult, alternative unacceptable.

4.0 ALTERNATIVES EVALUATION AND RANKING

Three subject matter experts evaluated the eight water supply alternatives using the 18 review criteria. After the initial evaluations, the reviewers discussed their differences and adjusted 10 of the 144 individual scores up or down by one unit to achieve a final consensus. The consensus values for the individual scores and the weighted average score for each alternative are shown in Table 4.1.

Based on the number of individual scores adjusted to reach consensus and the weighting factors for each criteria, a Monte Carlo simulation technique was used to estimate a statistically significant (alpha =0.05) difference between weighted average scores. The analysis shows that an absolute difference of 0.15 between any two weighted average scores is significant.

Alternative No. 5, *UFA artesian wells flowing directly into the CCS*, had the highest score, with a weighted average of 4.71, out of a maximum of 5.0. This alternative is significantly (4.71 > 4.26+0.15) better than the next highest alternative (Alternative No. 1) with a weighted average score of 4.26.

Alternative No. 1 *(Excess Surface Water from L-31E Regional Canal)* and Alternative No. 7 *(Marine groundwater from wells on Turkey Point peninsula with additional fresh water from another source)* have weighted average scores of 4.26 and 4.19, respectively. While these scores are significantly less than the score for Alternative No. 5, they are not significantly different from one another.

Alternative No. 6 *(Direct RO treatment of CCS water to remove TDS, with reject water discharged to deep injection well)*, Alternative No. 3 *(Reclaimed water from SDWWTP with nutrient removal),* and Alternative No. 4 *(Reclaimed water from SDWWTP with nutrient removal and advanced treatment for other COCs)* had weighted average scores of 3.70, 3.64, and 3.53, respectively. While these alternatives are not significantly different from one another, they are all significantly lower than Alternative No. 7, which has a weighted average score of 4.19.

Alternative No. 8 *(Marine Surface Water from Biscayne Bay or Card Sound)* has a weighted average score of 3.40. This is the second lowest weighted average score.

Alternative No. 2 *(Groundwater from an Inland Biscayne Aquifer Well Field)* has the lowest weighted average score, equal to 2.65. This score is significantly lower than any other alternative.

The overall scores for each of the four themes, as a percent of the maximum possible score, are shown in Figure 4.1. This figure also shows the spider diagrams for each of the eight alternative water sources. The spider diagrams visually display how well balanced each alternative is relative to the four themes or dimensions.

Again, Alternative No. 5 is the best choice. It is well balanced and it scores very high in all four themes.

Alternative No. 2 is the least desirable. It is poorly balanced and very weak in the environmental and social dimensions because it would adversely affect many acres of wetlands, would be competing for freshwater resources and could induce saltwater intrusion in the Biscayne Aquifer.

Alternative No. 1 scores very high on the environmental and economic themes, but poor on the social theme primarily because of long-term compatibility with the CERP Biscayne Bay Coastal Wetlands Restoration project; and on the technical theme because of water availability, reliability and security.

Alternatives No. 3, 4 and 6 are very high cost and have very long implementation schedules because these three alternatives require significant water treatment systems. Consequently, these alternatives score very low on the economic theme.

Alternative No. 7 scores high in the economic dimension and is acceptable in the technical, environmental and social dimensions. However, because it must be matched with another source of fresh water (e.g., Alternative No. 5), this alternative is most useful as a backup water source and not as a primary source.

Alternative No. 8 is weaker than Alternative No. 7 in the environmental, social and economic themes primarily because of regulatory issues around impingement of aquatic organisms associated with a surface water intake near Biscayne National Park and other Outstanding Florida Waters.

5.0 RECOMMENDATIONS

Alternative No. 5 has the best overall weighted average score and it is the most balanced alternative relative to the four themes (technical, environmental, economic and social). Furthermore, it has a relatively short implementation schedule and it is the best source of relatively fresh water to be combined with a marine water source. This water supply alternative should be the first priority.

Alternative No. 1 and Alternative No. 7 should be maintained as short-term backup water options to be used when appropriate and as needed during extreme conditions. Alternative No. 1 also may be useful during initial implementation of Alternative No. 5 to lower salinities in the CCS more quickly. While these options have been used in the past without significant adverse effects and the infrastructure is already available, so they can be implemented relatively quickly, they are not long-term individual solutions.

Alternative No. 3 has a high cost and a very long implementation schedule relative to Alternative No. 5; however, because it makes beneficial use of reclaimed water, it should be evaluated further, as a long-term potential solution to a regional problem.

Alternatives No. 2, 4, 6 and 8 provide no significant advantage relative to the other alternatives. These alternative water sources should not be evaluated further unless conditions change.

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3/29/2016
Date

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GMP/ams

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TABLE

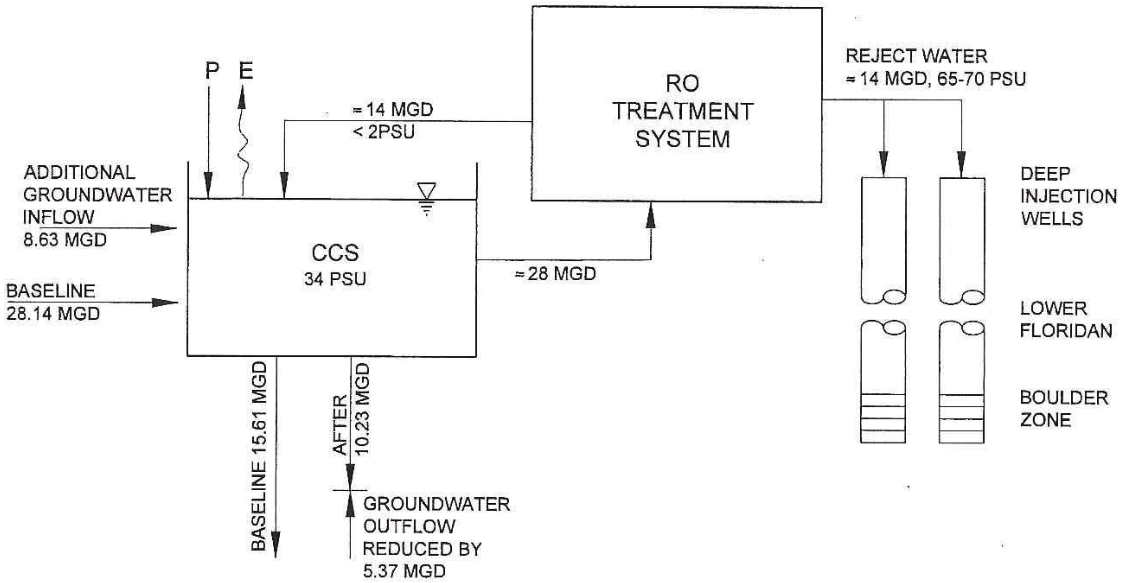
TABLE 4.1
WATER ALTERNATIVES ANALYSIS

Water Supply Alternatives Analysis
Florida Power & Light
Turkey Point

		Technical Theme (25%)								Environmental Theme (25%)				Economic Theme (25%)		Social Theme (25%)				
	Criteria Weighting Factor	20%	10%	10%	10%	15%	5%	15%	15%	25%	25%	25%	25%	60%	40%	20%	25%	25%	30%	
	Criteria Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
	Criteria Title	Quality Salinity	Quantity	Availability	Reliability	Quality Nutrients	Quality Other COC	Operations	Risk, Safety, Security	Hydrologic	Water Quality	Wetlands	Ecology	Total Costs	Schedule	Regulatory Approvals	Impacts to Others	Societal Resource Impacts	Compatibility	
Alt. No.	Alternative Names																			Total Score
1	Excess Surface Water from L-31E Regional Canal.	5	3	3	2	5	5	4	3	5	5	5	5	5	5	3	5	3	2	4.26
2	Groundwater from an Inland Biscayne Aquifer Well Field.	5	3	5	3	5	5	5	4	2	1	1	2	5	1	1	1	2	1	2.65
3	Reclaimed water(HLD) from SDWWTP with nutrient removal.	5	5	5	4	1	5	5	3	5	4	4	4	3	1	3	4	4	5	3.64
4	Reclaimed water (HLD) from SDWWTP with nutrient removal and advanced treatment for other COC.	5	5	5	4	1	1	5	3	5	5	4	5	1	1	4	4	5	5	3.53
5	UFA artesian wells flowing into CCS.	5	4	5	4	5	5	5	5	4	5	5	5	5	4	5	5	5	4	4.71
6	Direct RO treatment of CCS water to remove TDS, with reject water discharged to deep injection well.	3	4	5	5	5	5	5	5	5	4	5	5	2	1	1	5	4	5	3.70
7	Marine groundwater from wells on TP peninsula with additional fresh water from another source.	1	5	5	5	5	5	5	4	3	3	5	4	5	5	4	5	4	3	4.19
8	Marine Surface Water from Biscayne Bay or Card Sound with additional fresh water from another source.	1	5	5	5	5	5	5	4	3	3	3	2	5	3	1	5	1	3	3.40

ECRC-17-015052

FIGURES



LEGEND

1. RO - REVERSE OSMOSIS (SEA WATER EFFICIENCY ≈ 50%)
2. CCS - COOLING CANAL SYSTEM
3. P - PRECIPITATION (UNCHANGED)
4. E - EVAPORATION (UNCHANGED)

CLIENT FPL		PROJECT FPL TURKEY POINT WATER ALTERNATIVES STUDY	
CONSULTANT Golder Associates	YYYY-MM-DD: 2016-03-21 DESIGNED: GMP PREPARED: BCL REVIEWED: KFK APPROVED: GMP	TITLE **ALTERNATIVE 6: WATER BALANCE BLOCK FLOW DIAGRAM**	
		PROJECT NO 15-45273	Control No. 1545273-A001 · REV · FIGURE 2.1

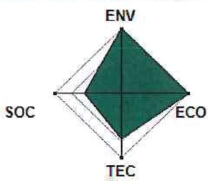
Path: ... | File Name: 1545273-A001.dwg

1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

FIGURE 4.1
WATER SUPPLY ALTERNATIVE SPIDER DIAGRAMS

Alternative 1

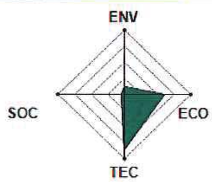
Environmental	100%
Social	55%
Economic	100%
Technical	71%



Alternative 1 - Excess Surface Water from L-31E Regional Canal

Alternative 2

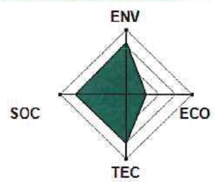
Environmental	13%
Social	6%
Economic	60%
Technical	86%



Alternative 2 – Groundwater from an Inland Biscayne Aquifer Well Field

Alternative 3

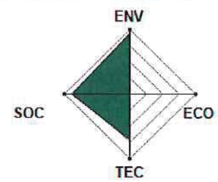
Environmental	81%
Social	78%
Economic	30%
Technical	75%



Alternative 3 – Reclaimed Water (HLD) from SDWWTP with Nutrient Removal

Alternative 4

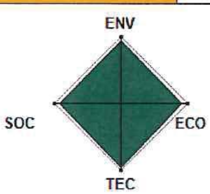
Environmental	94%
Social	89%
Economic	0%
Technical	70%



Alternative 4 – Reclaimed Water (HLD) from SDWWTP with Nutrient Removal and Advanced Treatment for other COC

Alternative 5

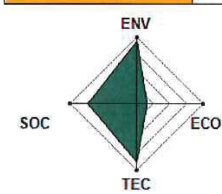
Environmental	94%
Social	93%
Economic	90%
Technical	95%



Alternative 5 – UFA Artesian Wells Flowing into CCS

Alternative 6

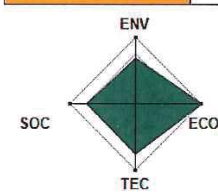
Environmental	94%
Social	74%
Economic	15%
Technical	88%



Alternative 6 – Direct RO Treatment of CCS Water to Remove TDS, with Reject Water Discharged to Deep Injection Well

Alternative 7

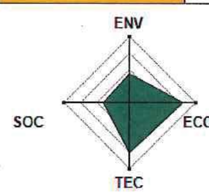
Environmental	69%
Social	74%
Economic	100%
Technical	76%



Alternative 7 – Marine Groundwater from Wells on TP Peninsula with Additional Fresh Water from another Source

Alternative 8

Environmental	44%
Social	40%
Economic	80%
Technical	76%



Alternative 8 – Marine Surface Water from Biscayne Bay or Card Sound with Additional Fresh Water from another Source