FINAL REPORT

WATER ALTERNATIVES STUDY AND WATER CONSERVATION PLAN

Florida Power & Light Company

Port Everglades Next Generation Clean Energy Center

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Rev. 1, April 2012 **113-87618**

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EXECUTIVE SUMMARY

The Florida Power & Light Company (FPL) Port Everglades Plant is located at 8100 Eisenhower Road, Fort Lauderdale, Broward County, Florida. FPL plans to demolish the existing Units 1 through 4 and construct a next generation clean energy center at the same site. The new Port Everglades Next Generation Clean Energy Center (PEEC) will use high-efficiency combined cycle natural gas technology to produce electricity. An important component of constructing a modernized plant is to determine the most appropriate water supply to meet the water requirements of the plant.

This Water Alternatives Study has been conducted to evaluate the environmental, technical, and economic feasibility of utilizing various potential water sources, as required by Sections 3.2 and 3.2.3 of the SFWMD Basis of Review for Water Use Applications (2010). PEEC will have four primary water requirements: cooling water to condense steam in the steam generator and for auxiliary cooling of other equipment; process water for steam system makeup and for air pollution control; potable water for employees; and landscape irrigation. Potential water sources assessed for each of the PEEC primary water requirements included surface water, groundwater, potable, and reclaimed supplies.

A combination of water supplies was selected as the preferred sources to satisfy the cooling, process, potable, and irrigation demands of PEEC due to their environmental, economical, and technical feasibility. The preferred alternative for cooling supply is to continue to use marine surface water for once-through cooling at PEEC. The preferred alternative for process, potable and irrigation supply for PEEC continues to be potable water from the City of Fort Lauderdale.

Currently the four wastewater treatment facilities within a 12 mile radius of PEEC do not supply reclaimed water to the PEEC Site. While reclaimed water is potentially feasible from an environmental, economic and technical perspective for use to meet PEEC process and irrigation demands, it is not economically feasible for cooling. The capital investment, operation and maintenance expenses, and total net loss of power generation efficiency for the life of the Project make the use of reclaimed water for cooling at PEEC economically prohibitive. If in the future reclaimed water could be delivered to the PEEC Site at a reasonable price, in acceptable quantity and quality for use as process or irrigation supply, FPL would reevaluate potential use of reclaimed water for those purposes.

1.0 INTRODUCTION

The Florida Power & Light Company (FPL) Port Everglades Plant is located at 8100 Eisenhower Road, Fort Lauderdale, Broward County, Florida. The Port Everglades Plant began operating in the 1960s and consists of four generating units (Units 1 through 4). Units 1 and 2 began commercial operation in 1960 and 1961, respectively. Units 3 and 4 began commercial operation in 1964 and 1965, respectively. The existing plant historically has utilized 60 percent oil and 40 percent natural gas to generate approximately 1,200 megawatts (MW) of electricity.

FPL plans to dismantle the existing Units 1 through 4 and construct a next generation clean energy center at the site. Construction of the new Port Everglades Next Generation Clean Energy Center (PEEC) will begin in 2013 and construction is expected to be complete by 2016. PEEC will use high-efficiency combined cycle natural gas technology to produce approximately 1,250 MW of electricity, which will provide power to about 260,000 customers. The combined cycle power unit will consist of three advanced combustion turbines, three heat recovery steam generators and one steam turbine generator. The combined cycle technology uses waste heat from the combustion turbines to produce steam for the steam turbine generator. The new high-efficiency combined cycle natural gas facility will use approximately 35 percent less fuel per megawatt-hour (MWh) than the existing power plant.

An important component of constructing a modernized plant is to determine the most appropriate water supply to meet the cooling, process and potable water requirements for the plant. Therefore, a water supply alternatives study has been conducted to evaluate the technical, financial, and environmental aspects of utilizing various potential water sources, as required by the SFWMD Basis of Review for Water Use Permit Applications (SFWMD BOR, 2010). The results of the study are provided herein.

Section 2 discusses the power plant water demands for two potential cooling technologies and the effect of source water quality on the cooling water demands. Section 3 discusses potential water supply sources. Section 4 discusses the potentially feasible options for once-through cooling and for cooling towers using reclaimed water. Section 5 discusses water conservation methods and procedures that will be used to minimize water use. Section 6 summarizes the conclusions reached through this Water Alternatives Analysis.

2.0 PROJECT WATER DEMANDS

PEEC will have four primary water requirements, summarized below.

- Cooling water is used to condense steam in the steam generator and for auxiliary cooling of other equipment. The cooling water demand depends upon the cooling technology used (once-through cooling or cooling towers) and the selected water source, which could be either fresh water, brackish water, or salt water.
- Process water is used primarily to make demineralized water for steam system makeup and for air pollution control when the unit is fired with oil.
- Potable water for use by employees.
- Landscape irrigation.

The cooling water requirements for once-through and cooling tower technologies are discussed further below. The process, potable and landscape irrigation demands are shown in Table 1.

2.1 Once-Through Cooling

The most thermodynamically efficient cooling technology is once-through cooling. This type of cooling system, however, has a high water demand requirement. A once-through cooling system would withdraw water from Port Everglades (Intracoastal Waterway) via an existing intake canal, as it is today. The once-through cooling system for the existing power plant has a maximum daily average demand of approximately 1,295 million gallons per day (MGD). The maximum daily average demand for the modernized plant using once-through cooling would be approximately 635 MGD, which is about 51 percent less than the existing plant requirement. Table 1 below summarizes the water demand requirements for the modernized PEEC power plant using once-through cooling.

Table 1: Estimated PEEC Water Demand with Once-Through Cooling System

	Daily Average Demand (MGD)	Maximum Daily Demand (MGD)
Cooling Water	635.4	635.4
Process Water	0.24	1.1
Potable Water	0.0014	0.014
Irrigation Water	0.014	0.115
Total	635.65	636.63

Data Source: FPL Figure 4.5.0-1 (Water Balance for PEEC)

2.2 Cooling Towers

If a wet cooling tower system were used, the cooling water makeup requirements would depend on the source water quality and the cycles-of-concentration that could be maintained in the cooling towers. Demand requirements for process water, potable water, and irrigation water are independent of the type of cooling system used (cooling towers or once-through cooling). Potential water sources for cooling tower makeup include reclaimed water (fresh), or brackish, marine water and groundwater. Because the cooling tower demand depends on the total dissolved solids (TDS) concentration of the source water, the cooling water demand has been calculated for four source water categories based on TDS concentrations. Table 2 below summarizes the TDS concentrations for various water source categories and the corresponding cooling tower water demands for a 1,200 MW combined cycle unit. These demands were estimated using data from FPL's West County Energy Center (WCEC), which uses similar sized combined cycle units with cooling towers. These values are reasonable for planning purposes; however, the final demand would depend on several other water quality constituents in the source water.

Table 2: Cooling Water Demand for 1,200 MW Combined Cycle Unit with Cooling Towers

Cooling Water Demand for a 1,200 MW Combined Cycle Unit With Cooling Towers			
Source Water	**Source Water TDS Concentration (mg/L)**	**Daily Average Demand (MGD)**	**Daily Maximum Demand (MGD)**
Fresh	<1,000	9	10
Brackish	1,000 – 10,000	10	11
Saline	10,000 – 30,000	14	16
Salt	>30,000	20	23

Note: Flows estimated from design data for FPL WCEC SCA

When fresh water is available for makeup to the cooling towers, the cycles of concentration can be maintained in the range of 4 to 7 and the cooling water makeup demand is estimated to be 9 to 10 MGD. When saltwater is used in the cooling towers, the cycles of concentration must be reduced to approximately 1.5 and the cooling water demand increases to between 20 and 23 MGD.

3.0 POTENTIAL WATER SUPPLY SOURCES

The potential water sources available in the vicinity of PEEC include the following:

- Marine water from Port Everglades (Intracoastal Waterway), various tidal canals or the Atlantic Ocean,
- Fresh water from regional drainage canals or from onsite stormwater reuse,
- Groundwater from the Biscayne Aquifer (i.e., the surficial aquifer),
- Groundwater from the Floridan Aquifer System, including the Boulder Zone,
- Potable water from the City of Fort Lauderdale, and
- Reclaimed water from Hollywood Regional Wastewater Treatment Plant or other nearby wastewater treatment facilities.

3.1 Marine Water

Marine water sources could include an offshore intake in the Atlantic Ocean, a withdrawal from one of the nearby tidal canals or the existing intake canal from the Intracoastal Waterway. An offshore intake from the Atlantic Ocean is not economically, technically or environmentally feasible. The costs of constructing a large intake pipeline from PEEC to the Atlantic Ocean, which is 1.5 miles east of the Site, would be prohibitive. In addition, significant problems likely would be encountered in obtaining access (i.e., constructing miles of intake pipeline through active Port property, wetlands, sovereign submerged lands and/or high density commercial/residential property). Furthermore, there is no significant environmental advantage to this option over simply withdrawing water from the existing intake canal. In fact, the once-through cooling water system at the Port Everglades Plant induces a small net circulation through the Port Everglades Turning Basin. Maintaining withdrawals from the existing intake canal will continue to generate water circulation providing a beneficial water quality impact on some areas of the Port. Similarly, there is no significant environmental advantage to withdrawing water from other nearby tidal canals (i.e., canals other than the existing intake canal). Therefore, the best marine water source is the existing intake canal that withdraws water from the Port Everglades Turning Basin and the Intracoastal Waterway. For the foregoing reasons, the Atlantic Ocean and other nearby tidal canals are not considered further as potential water sources for PEEC.

3.2 Fresh Water

3.2.1 Regional Drainage Canals

The only fresh surface water sources in the vicinity of PEEC with flows that could potentially supply the required water are the regional drainage canals. Regional fresh water canals in the vicinity of the Site include the C-12 basin (a.k.a., Old North New River Canal), North New River Canal and the South New River Canal. These canals are part of the flood control water conveyance system that is managed by the South Florida Water Management District (SFWMD). The C-12 basin, which is located about 5.5 miles northwest of PEEC, has a small drainage basin of only 19 square miles. Consequently, available flows from the C-12 canal at structure S-33 are too small to supply the required cooling water. The North New River Canal is fresh water upstream of SFWMD control structure G-54, which is located approximately 6.5 miles west-northwest of PEEC. The South New River Canal is fresh water upstream of SFWMD control structure S-13, which is located approximately 5 miles southwest of PEEC. Downstream of these structures, the canals are tidally influenced and likely would be brackish or saline during low flow periods. These freshwater access points are located on the west side of the City of Fort Lauderdale, while PEEC is located on the east side of the City of Fort Lauderdale. Furthermore, to access structures G-54 or S-13 from PEEC a pipeline would have to be constructed to cross at least four major highways (US1, I-95, US441, the Florida Turnpike (G-54) or I-595 (S-13)). From an engineering standpoint, it would be very difficult to construct a pipeline through the City of Fort Lauderdale without substantial impact to existing infrastructure. Furthermore, flows from these sources would be episodic, and large storage facilities would be required to utilize these sources. Consequently, the costs would be prohibitive. While adequate water supplies may be available from these sources (not confirmed), the freshwater access points are too far from the PEEC site and access is not feasible. Therefore, the regional fresh water canals are not considered further as a potential water source for PEEC.

3.2.2 Stormwater Reuse

Stormwater runoff from the site could potentially be used as a source of fresh water to supply irrigation or process water. This source, however, could only supply at most 10 to 30 percent of the process and irrigation water demand of PEEC. Stormwater is usually only available in significant quantities for a relatively short period of time following a significant runoff event. By regulation, the stormwater management system must recover the required treatment volume within 72 hours. Consequently, if storm water were reused a significant onsite storage capacity would be required (at least 0.5 million gallons for irrigation supply only and 10 million gallons or more for process and irrigation supplies). The reuse storage volume would have to be separate from the water storage volume required for stormwater management. Furthermore, if stormwater were reused for process water, this supply would require an additional treatment system. The limited benefit of utilizing a stormwater reuse system at PEEC does not justify the significant additional cost. Therefore, stormwater reuse is not considered further as a potential water source.

3.3 Ground Water

3.3.1 Biscayne Aquifer (Surficial Aquifer)

The Biscayne Aquifer (surficial aquifer) is an unconfined aquifer that underlies approximately 4,000 square miles within Palm Beach, Broward, Miami-Dade, and Monroe Counties. In Broward County, the surficial aquifer is comprised primarily of sands, shell beds, and sandy limestone. The Biscayne Aquifer is a source of drinking water for Broward County and is designated as a Sole Source Aquifer under the Safe Drinking Water Act. Due to the close proximity of PEEC to the coast, the surficial aquifer at the Site is only marginally fresh (TDS concentrations <1,000 mg/L) in a relatively thin layer near the surface. The water table at the Site is approximately 1 ft above local mean sea level. Therefore, based on the Ghyben-Herzberg principle, the fresh water layer should be approximately 40 ft thick. While the surficial aquifer could supply a limited amount of process water, increased pumping could cause salinity upwelling from below or local salinity intrusion from the tidal boundaries near the Site (i.e., intake and discharge canals and Port). Therefore, the surficial aquifer is not considered further as a potential water source for PEEC.

3.3.2 Floridan Aquifer

The Floridan Aquifer System (FAS) is divided into the Upper Floridan Aquifer, the Middle Confining Unit and Lower Floridan Aquifer. Near the coast in Broward County, the top of the Upper Floridan Aquifer exists at a depth ranging from approximately -950 ft-msl to -1,000 ft-msl. Water at this depth is brackish with TDS concentrations ranging from about 2,500 to 7,500 mg/L. Water from the Upper FAS could be used for process water supply, with significant treatment, and for cooling tower makeup. However, a large well field would be required and significant costs would be incurred to obtain the required 11 MGD of water and to operate PEEC with cooling towers.

The Avon Park Permeable Zone (APPZ) is located within the middle confining unit between -1400 ft-msl and -1700 ft-msl (Reese & Richardson, 2008). At the Site, the APPZ is located at approximately the same depth as the salinity transition zone in the FAS (Reese, 1994). Consequently, water from this aquifer could have TDS concentrations between 5,000 mg/L and 35,000 mg/l (Reese, 1994). Water from the APPZ could be used for process water supply, with significant treatment, and for cooling tower makeup. However, a large well field would be required and significant costs would be incurred to obtain the required 11 to 23 MGD of water (depending on the source water salinity) and to operate PEEC with cooling towers. Furthermore, in this aquifer the potential for highly variable source water salinity would pose significant engineering design and operational challenges.

The Lower FAS is more mineralized than the Upper FAS, with TDS concentrations typically approaching or exceeding 35,000 mg/L. Water from the Lower FAS could be used for process water supply, with significant treatment, and for cooling tower makeup. However, a large well field would be required and significant costs would be incurred to obtain the required 23 MGD of water and to operate PEEC with cooling towers.

The Boulder Zone is located within the Lower FAS. In coastal Broward County, the top of the Boulder Zone exists at a depth ranging from 2,900 ft-msl to 3,100 ft-msl. The TDS concentration in this aquifer is about equal to seawater (greater than 30,000 mg/L). The Boulder Zone has a high transmissivity and would be capable of supplying the 23 MGD of water needed for saltwater cooling towers. However, the Boulder Zone is being utilized at nearby locations for wastewater injection. Because it is being utilized for disposal of wastewater from the City of Fort Lauderdale George T. Lohmeyer Regional Wastewater

Treatment Plant and could be used as a backup disposal option for PEEC, the Boulder Zone cannot be used for process or cooling water supply at PEEC.

Therefore, the FAS is not considered further as a primary long-term water source for PEEC. The Upper Floridan Aquifer could possibly be used as an emergency backup supply if reclaimed water were used as the primary water source for cooling towers.

3.4 Potable Water

The existing Port Everglades Plant has used potable water from the City of Fort Lauderdale for process, potable, and irrigation water for many years. The maximum combined process, potable, and irrigation water demand for PEEC will be approximately 1.1 MGD, which is less than the existing facility demand. Therefore, this option remains feasible for process, potable and irrigation water supply at PEEC. It would not be feasible or appropriate to use potable water from the City of Fort Lauderdale for cooling tower makeup.

3.5 Reclaimed Water

Reclaimed water is water that has received at least secondary treatment and is reused after flowing out of a wastewater treatment facility. FPL has evaluated the environmental, economic, and technical feasibility of using reclaimed source for PEEC. FPL has determined that use of reclaimed water is not economically feasible for cooling.

3.5.1 Potential Sources of Reclaimed Wastewater

The George T. Lohmeyer Regional Wastewater Treatment Plant (GTLWTP) is located approximately 1 mile north of PEEC. According to the Ocean Outfall Study, conducted by the University of Florida for FDEP (April 2006), GTLWTP has a treatment capacity of 55.7 MGD and disposes treated effluent into the Boulder Zone via five 24-inch diameter deep injection wells, each 3,500 feet deep. GTLWTP currently does not supply reclaimed water. Furthermore, this facility has no ocean outfall and all the wastewater is currently discharged through deep injection wells. Consequently, at this time there are no official plans to upgrade the facility to supply reclaimed wastewater. However, personal communications with engineering staff at the plant indicate that they are in the early stages of evaluating reclaimed water alternatives. Therefore, GTLWTP may be a potential supplier of reclaimed water to PEEC in the future.

The Broward/North Wastewater Treatment Plant (BNWTP) is located approximately 12 miles north of PEEC. According to the Ocean Outfall Study, BNWTP has a treatment capacity of 84 MGD and expansion plans are in place to expand the treatment capacity to 100 MGD. Currently, 36.5 MGD of treated wastewater is discharged to the Atlantic Ocean via a 54-inch diameter pipeline at a distance of approximately 7,300 feet offshore. The remaining treated wastewater is disposed of in the Boulder Zone through six Class I injection wells or reclaimed (4.5 MGD) for water reuse. From an engineering standpoint, it would be difficult and costly to construct a pipeline 12 miles through a heavy residential/commercial area without substantial impacts to existing infrastructure. Therefore, BNWTP is not considered further as a potential reclaimed water source for PEEC.

The Miami-Dade/North Wastewater Treatment Plant (MDNWTP) is located approximately 12 miles south of PEEC. According to the Ocean Outfall Study, MDNWTP has a treatment capacity of 82.9 MGD. Currently, 80.6 MGD of treated wastewater is discharged to the Atlantic Ocean via a 90-inch diameter pipeline at a distance of approximately 11,700 feet offshore. The remaining treated wastewater (2.3 MGD) is reclaimed for water reuse at Florida Atlantic University. From an engineering standpoint, it would be difficult and costly to construct a pipeline 12 miles through a heavy residential/commercial area without substantial impacts to existing infrastructure. Therefore, MDNWTP is not considered further as a potential reclaimed water source.

The Hollywood Wastewater Treatment Plant (HWTP) is located approximately 5 miles south of PEEC. According to the Ocean Outfall Study, HWTP has a treatment capacity of 42.1 MGD, and the City of Hollywood is currently implementing a program to increase the facility’s treatment capacity to 50 MGD. Currently, most of wastewater from HWTP is treated and discharged to the Atlantic Ocean (39.5 MGD) via a 60-inch diameter pipeline at a distance of approximately 10,000 feet offshore. The remaining 2.6 MGD is utilized as reclaimed water for irrigation of six golf courses. The current reuse system has a permitted capacity of 4 MGD. The high-level treatment system includes an 8 MGD continuous backwash tertiary filter system, high level disinfection and contact tanks, 0.5 MG of onsite reuse storage, pumping facilities and a reuse transmission and distribution system. As part of the 50 MGD improvement program, two 24-inch Class I injection wells have been constructed to dispose of wastewater.

The HWTP has 39.5 MGD of uncommitted treated wastewater effluent that is currently being discharged into the Atlantic Ocean. The GTLWTP has 55.7 MGD of uncommitted wastewater effluent that is currently being discharged to deep injection wells. Furthermore, there are pipeline routes that appear feasible for transmitting reclaimed water to PEEC. The process and irrigation water demands for PEEC total about 0.25 MGD (average daily) and 1.2 MGD (maximum daily). If reclaimed water were to be used for cooling at PEEC, cooling towers would be required because once-through cooling systems require more water than is available or reasonable to use, as discussed in section 4.1. If cooling towers were used, the combined cooling, process and irrigation water demand would average between 9 and 10 MGD. Therefore, if HWTP or GTLWTP could upgrade their system to meet the water quality and quantity requirements of FPL, and construct the necessary pipeline to deliver the water to PEEC, it would be technically feasible for the HWTP or the GTLWTP to supply reclaimed water to PEEC. The environmental, technical and economic feasibility of using reclaimed water in cooling towers is discussed in greater detail below.

3.5.2 Feasibility (Environmental, Technical, Economic)

3.5.2.1 Environmental Feasibility

According to the Ocean Outfall Study, HWTP discharges 39.5 MGD of treated wastewater into the Atlantic Ocean. This discharge volume would be more than adequate to provide process, irrigation and cooling water to PEEC, if cooling towers were used. Considering impending water shortages in Southeast Florida and the nutrient loads that are being discharged into the Atlantic Ocean, continued use of ocean outfalls for effluent disposal is not sustainable. Water reuse would offer substantial advantages to Southeast Florida in terms of water conservation, augmentation of available water resources, and reducing nutrient discharges into the ocean environment. Therefore, the use of reclaimed water from HWTP or GTLWTP is considered environmentally feasible assuming that deep well injection is feasible for wastewater disposal. The use of reclaimed water from HWTP would provide an environmental benefit because this option should reduce the quantity of wastewater currently discharged to the ocean.

3.5.2.2 Technical Feasibility

As discussed above, there may be an adequate supply of treated wastewater available for reuse at PEEC. However, HWTP currently does not have the facilities or capacity to provide the required quantity and quality of reclaimed water to PEEC. The current reuse system has a permitted capacity of 4 MGD, and 2.6 MGD is allocated to golf course for irrigation. Therefore, HWTP could potentially provide process and irrigation water to PEEC. However, HWTP would need to significantly upgrade their facility to provide an additional 9 MGD to meet the cooling water demands of PEEC with cooling towers. In addition to facility upgrades, a transmission system would need to be constructed to route reclaimed water from HWTP to PEEC. The transmission system with a 10 MGD capacity would include approximately five miles of 24-inch diameter underground pipeline and necessary pumping stations to transport reclaimed water to PEEC. A potentially feasible pipeline route is discussed below in Section 3.5.3. Therefore, the use of reclaimed water is considered technically feasible if HWTP can upgrade their facility to meet the quantity and quality requirements of FPL and if a transmission system can be constructed to deliver reclaimed water to PEEC.

The GTLWTP would need to upgrade their wastewater treatment facilities to produce any reclaimed water, and would need to install approximately 1 mile of transmission pipeline to deliver the reclaimed water to PEEC. This potential upgrade and pipeline route have not been evaluated in detail, but no technical reason has been identified that would preclude the option. Therefore, for the purpose of this study it is considered technically feasible.

3.5.2.3 Economic Feasibility

According to the 2010 Reuse Inventory Study, conducted by the Florida Department of Environmental Protection (FDEP), HWTP charged non-residential customers $0.10/1000 gallons for use of reclaimed water. However, this rate would be expected to increase substantially if HWTP provides reclaimed water to PEEC for the following reasons.

- HWTP would have to expand the reclaimed water treatment system to meet the added demand and construct the pipeline, pumps, transmission system, etc. to deliver reclaimed water to PEEC and other customers. These capital and operational costs would be annualized and passed on to future customers.
- The cost for reclaimed water depends on market conditions of supply and demand. Future market conditions and regulatory treatment of reclaimed water pose a risk to price and availability.
- Based on FPL's historical experience at West County Energy Center, the cost of reclaimed water delivered to the Site could be $1.25/1000 gallons.

If reclaimed water can be supplied to PEEC at $1.25/1000 gallon or less, the cost of reclaimed water is likely economically feasible for process and irrigation. However, with respect to the potential use of reclaimed water for cooling at PEEC, the total cost to FPL's customers must be considered carefully. The costs of using reclaimed water for cooling are discussed further in Section 4.2.

3.5.3 Reclaimed Water Supply Pipeline Route

A potentially feasible reclaimed water supply pipeline route from HWTP to PEEC is depicted in Figure 1. As stated above, this route would have a total approximate length of 5 miles and would follow the course as described below.

- From HWTP, travel approximately 150 feet northwest across Eco Golf Club property to the intersection of Hardin Street and N 14th Avenue.
- From the intersection of Hardin Street and N 14th Avenue, travel approximately 8,800 feet north to the intersection of N 14th Avenue and E Dania Beach Boulevard. This leg will involve fourteen minor roadway crossings, and one major roadway crossing.
- From the intersection of N 14th Avenue and E Dania Beach Boulevard, travel approximately 3,200 feet east to the intersection of E Dania Boulevard and W Shore Drive. This leg will involve one minor roadway crossing and one major roadway crossing.
- From the intersection of E Dania Boulevard and W Shore Drive, travel approximately 3,000 feet north to the Dania Cutoff Canal. This leg will follow the FPL power transmission line route from PEEC.
- At this point, the pipeline would have to cross the Dania Cutoff Canal. The pipe likely would be placed under the canal using directional drilling technology.
- From the Dania Cutoff Canal, travel a total of approximately 9,300 feet in a northerly direction bordering the western boundary of Port Everglades Terminal to Florida 862. This leg will involve a canal crossing (Dania Cutoff Canal) and will follow the FPL power line transmission route from PEEC.
- From Florida 862, travel approximately 190 feet west to the intersection of Florida 862 and SE 14th Avenue.
- From the intersection of Florida 862 and SE 14th Avenue, travel approximately 1,100 feet north to PEEC.

3.5.4 Reclaimed Water for Cooling-- Additional PEEC Infrastructure Requirements

If reclaimed water is used as the primary water source for cooling, additional infrastructure would be required at PEEC. The requirement to install cooling towers when using reclaimed water has already been noted. Additionally, use of reclaimed water would necessitate a backup or secondary water supply source in the event that the reclaimed water supply is interrupted for any reason. Also, facilities for disposal of the wastewater would be required. These additional requirements are discussed below.

Backup or Secondary Water Supplies: Potential backup or secondary sources for short-term water supply include potable water from the City of Fort Lauderdale, marine water from the existing intake canal, and brackish/saline water from a groundwater source. The City of Fort Lauderdale likely could supply process water on short notice as a backup supply. The City of Fort Lauderdale, however, likely would not be able to supply enough potable water on short notice as a backup to meet the 10 MGD combined demand for process and cooling water supply. As discussed in Section 3.3.2, brackish/saline water from the Upper Floridan Aquifer could also be used on a short-term basis as a secondary source for cooling water supply. But this alternative does not provide a significant cost advantage over using water from the intake canal. Both sources of water would require high capacity deep injection wells for disposal of cooling tower blowdown from salt water cooling towers. Therefore, the most feasible and cost effective secondary water supply for cooling tower makeup is to utilize water from the existing intake canal.

Wastewater Disposal: The use of reclaimed water for cooling at PEEC would require a means of wastewater disposal. One wastewater disposal option that was considered is to construct a return line to HWTP. A return line could be constructed in conjunction with the reclaimed water supply line for approximately $2 million. Then cooling tower blowdown and process wastewater could be disposed through HWTP's Class I injection wells. This wastewater disposal option, however, would still require PEEC to have a high volume injection well system for instances when HTWP is not in operation and is not able to accept wastewater; and the cooling towers are operated on saline or salt water. Consequently, a return line is not cost effective and is not considered further as a primary or secondary disposal option.

If cooling towers were used at PEEC with reclaimed water as the primary source, the best option for wastewater disposal would be deep injection wells. The required capacity for the deep injection well system would depend on the water quality of the secondary or backup cooling water source. As discussed above, the most cost effective and feasible secondary source for the cooling water supply is the existing intake canal. With marine water (intake canal) for makeup to the cooling towers, the cycles of concentration in the cooling tower must be reduced to approximately 1.5 and the cooling tower blowdown would be approximately 15 MGD. As such, the only technically and environmentally feasible option for disposal of cooling tower blowdown would be deep injection wells with a system capacity of 15 MGD. The estimated cost to construct a deep injection well system with a capacity of 15 MGD is $33 million.

4.0 POTENTIALLY FEASIBLE OPTIONS

4.1 Once-Through Cooling System Option

The Port Everglades Plant currently uses a once-through cooling water system and has for over 40 years. This cooling system is the most thermodynamically efficient cooling process for the steam cycle (i.e., the greatest amount electricity generated for the least amount of fuel consumed). A once-through cooling water system can also have positive environmental benefits. The warm water that is discharged provides a cold weather refuge for manatees. Additionally, the once-through cooling system circulates water through the Port Everglades Turning Basin, which very likely improves water quality in the area.

However, the water demand for once-through cooling is much higher than the water demand for cooling towers. The cooling water demand for PEEC using a once-through cooling system is estimated to be 636 MGD. The only available source that can supply this quantity of water is the existing intake canal that is connected to the Intracoastal Waterway. Process water, potable water, and irrigation water would be supplied by the City of Fort Lauderdale. Since the intake canal already exists and this cooling technology is proven and efficient, a once-through cooling water system is clearly both technically and economically feasible.

The Port Everglades once-through cooling system intake minimizes environmental impacts because the intake withdraws water from the back of Port Slip No. 3, which opens into the Port Everglades Turning Basin.

Because once-through cooling systems withdraw and heat large quantities of water, these cooling systems may impact the local environment if they are not located, designed and constructed to minimize impacts.

This area is very deep with vertical walls at the shoreline. There is no submerged aquatic vegetation or emergent fringe wetland vegetation in the vicinity. Consequently, this area is not a biologically productive (i.e., it is not a nursery, spawning, feeding or cover area for fish or shellfish). The heated water is released to a man-made canal that flows into the Intracoastal Waterway south of the port. The Intracoastal Waterway in this area is dredged to about 38 ft and much of the shoreline is bulk headed or stabilized. Consequently, passage ways are available below the thermal plume to allow fish to avoid the thermally influenced zone; and benthic impacts are minimal. Biological studies conducted by Applied Biology, Inc (May 1987) concluded that operational impacts on resident biological communities (fish, shellfish, plankton and benthic communities) associated with the discharge of once-through cooling water were minimal outside the immediate discharge canal. When PEEC is operational, the flow rate and the maximum heat load to the aquatic environment will be reduced by approximately 50 percent. In addition, state-of-the-art traveling screens with an aquatic organism return system will be installed on the intakes to minimize impingement mortality. Consequently, while impacts from the existing once-through system are minimal, they will be even less in the future.

A once-through cooling system has been operating at this location for over 40 years with no significant documented environmental impact. PEEC will be equipped with state-of-the-art traveling screens and an organism return system to minimize impingement mortality. PEEC will reduce both the water withdrawal rate and the heat load to the environment by approximately 50 percent. Therefore, a once-through cooling water system is also environmentally feasible.

4.2 Cooling Tower Option

Accessible and available water sources that have the capacity to meet the demand requirements of a cooling tower system include reclaimed water (fresh), marine water from the Intracoastal Waterway or brackish/saline water from the Upper Floridan Aquifer. When high TDS water is used as makeup to the cooling tower, the water circulating within the cooling tower will contain significant amounts of salt (typically between 1.5 and 5 times the source water concentration). Cooling tower drift, while mitigated to a high degree by current cooling tower designs, can contain high concentrations of dissolved minerals as TDS when using brackish, saline or sea water as makeup water for the cooling cycle. Over time, deposition of high TDS drift particles can influence corrosion rates and adversely impact vegetation.

Natural atmospheric deposition occurs as a result of gases and small particles continually emitted by man-made and natural sources and subsequently deposited as either wet or dry deposition. All areas of Florida have natural background deposition with higher levels near coastal environments. Natural deposition would vary depending upon the location relative to coast. Natural deposition rates for coastal areas on the east coast of Florida near beach communities have been measured to be about 7.4 kilogram per hectare per month (kg/ha/month) (FCG, 1988).

Air modeling studies suggest that the use of high TDS water in mechanical draft cooling towers can increase the average salt deposition by about 3 times the natural background within 1 kilometer of the cooling tower. In a highly urbanized area this deposition could lead to increased corrosion of materials. In addition, non-salt resistant landscaping foliage could be damaged depending on the sensitivity of the species to salt drift.

On a relatively small site in a highly developed area such as PEEC, salt drift could, over time, potentially damage offsite property and equipment. It could also affect the reliability of plant operations given the close proximity of the cooling towers to the switchyard and other electrical equipment. Therefore, primary use of brackish, saline or salt water sources for cooling tower makeup is not considered feasible. Short-term use as an emergency backup may be feasible.

If HWTP can supply reclaimed water to PEEC that meets the quantity and quality requirements for process and/or cooling water, then reclaimed water is a technically and environmentally feasible option. If reclaimed water were available as the primary source for cooling water, a reliable secondary (backup) cooling water supply would be needed for the power plant. The City of Fort Lauderdale likely would not be able to supply enough potable water as a backup source to meet a sudden 10 MGD demand. Therefore, the only other option for the backup cooling water supply would be either marine water from the Intracoastal Waterway or brackish/saline water from a groundwater source. In order to minimize the effect of salt drift, a brackish/saline secondary water supply for the cooling towers should only be utilized for a short period of time. Furthermore, if saline or salt water is used as the backup supply the injection wells would need to have a capacity of approximately 15 MGD to dispose of the increased cooling tower blowdown.

Constructing cooling towers at PEEC to use reclaimed water would require a significant capital investment. Capital costs (base year 2016) including costs for cooling towers, injection wells, injection pumps, and an onsite 10 million gallon storage tank would be approximately $122.5 million. Total net annual costs would be approximately $21.8 million. Table 3 below summarizes total capital and total net annual costs. The annual costs do not include the direct cost for purchasing reclaimed water.

Table 3: Total Capital Costs and Total Net Annual Costs for PEEC Cooling Towers Using Reclaimed Water

Total Capital Costs (2016; Escalation 3% per year)	
Item	**Cost**
Cooling Towers[1]	$83.6 million
Injection Wells and Pumps (15 MGD)	$32.7 million
10 Million Gallon Onsite Storage Tank	$6.1 million
Total	**$122.5 million**
Annual Costs (20 Year Life, Discount Rate 7%)	
Annualized Capital	$11.6 million
Cooling Tower Maintenance[2]	$0.7 million
Injection O&M[3]	$0.4 million
Operating Penalty	$9.1 million
Total Annual Cost	**$21.8 million**

[1] EPA TDD (2011) Exhibit 8-16 w/ Plume Abatement
[2] EPA TDD (2011) Exhibit 8-16 w/out Power Costs
[3] Operations and Maintenance (O&M)

Cooling towers also require significant amounts of power to run the fans that move air and to run the pumps that lift the water, detracting from the produced power that can be delivered to customers. This lost power is called a “parasitic load”. The total net loss of efficiency, including the parasitic load penalty for operating cooling towers instead of a once-through cooling system at PEEC, is estimated to be approximately 15.6 MW. This results in an annual operating penalty of approximately $9.1 million as summarized in Table 3. It also increases the green house gas (GHG) emissions per unit of electric power supplied to the customer.

In summary, the cost for FPL to use reclaimed water in cooling towers at PEEC (not including any direct costs for the reclaimed water) would be approximately $6/1000 gallons. This would result in an estimated electric rate cost increase of 6.2 percent to FPL customers. Therefore, using reclaimed water in cooling towers at PEEC is not economically feasible option when compared to once-through cooling.

5.0 WATER CONSERVATION PLAN

Combined cycle technology will be used at PEEC. With this technology, steam electric generation is only about 35 to 40 percent of the total generating capacity. The remaining 60 to 65 percent is produced by combustion turbines, which do not use water for condenser cooling. Consequently, this technology significantly reduces the requirement for cooling water. Because the combined cycle technology reduces the steam electric portion of the generating facility, it also reduces the amount of water required to make steam; thus, reducing the requirements for process water. Combined cycle technology with once-through cooling provides the highest generation efficiency, with respect to conversion of fuel energy to electricity. This high efficiency minimizes fuel, consumptive water use and air emissions. In addition, since PEEC will be among the most efficient in the FPL system, operation of PEEC will offset water use at other plants in Florida.

PEEC will use demineralized water for makeup to replace blowdown from the Heat Recovery Steam Generators (HRSGs), which is necessary to maintain low dissolved solids in the HRSGs. The required makeup water to the HRSGs will be minimized by using good engineering design and best operating practices that reduce the required blowdown and by the recovery and reprocessing of water for reuse.

All new systems that involve the use of water will be designed and operated to minimize water loss. This will include an in-service leak test, inspection, or hydro-test to ensure the system is leak tight. After commissioning, procedures will be in place to ensure that the systems are inspected on a regular basis and that a repair program is in place to repair any leaks quickly. Other features in the design of the new PEEC facilities will include the following:

- Hot water lines will be insulated to save energy;
- Automatic shutoff valves will be used on all hoses used for cleaning purposes;
- Flow restrictors will be installed where appropriate;
- Low-volume sanitary facilities meeting EPA WaterSense specifications will be used in all restrooms, including high efficiency toilets (1.28 gallons per flush), high efficiency urinals (0.5 gallons per flush or less), high efficiency shower heads (2.0 gpm or less), and lavatory faucets (0.5 gpm or less); and
- Florida Friendly drought-resistant design principles will be used for all new landscaping.

FPL will implement an awareness program for both construction and operational employees on water conservation for the project. The awareness program will educate employees on water conservation methods, techniques, and requirements on in-place construction and operation procedures. Procedures for conservation during plant operation will be developed prior to commissioning PEEC. Procedures will be reviewed on a periodic basis and updated as necessary.

6.0 CONCLUSIONS

The conclusions reached by this analysis are as follows:

1. The preferred water alternative for cooling is to continue to use the existing intake canal for once-through cooling at PEEC.

2. At this time, the preferred alternative for process, potable and irrigation water supplies continues to be the City of Fort Lauderdale.

3. Currently, no reclaimed water supplies are available at the PEEC site.

4. Two wastewater treatment plants are located near PEEC that could provide reclaimed water in the future. The Hollywood Wastewater Treatment Plant (HWTP) is located approximately 5 miles south of PEEC and the George T. Lohmeyer Regional Wastewater Treatment Plant (GTLWTP) is located approximately 1 mile north of PEEC. Both facilities have uncommitted wastewater flows that potentially could be used to produce reclaimed water. Only the HWTP is currently producing reclaimed water.

5. HWTP has adequate wastewater flow to supply the reclaimed water that PEEC could use for process and irrigation supply. However, HWTP would need to construct a pipeline from HWTP to PEEC, and may need to upgrade or expand some of their treatment processes. The use of reclaimed water from HWTP by PEEC for process and irrigation supply and construction of the pipeline appear to be technically, environmentally and economically feasible.

6. Even if an adequate quantity and quality of reclaimed water could be delivered to the PEEC Site, it would not be economically feasible to use reclaimed water for cooling due to the availability of once-through cooling, which is environmentally, economically and technically feasible. To use reclaimed water for cooling at PEEC, a 10 MG storage tank, cooling towers and a 15 MGD injection well system for disposal of wastewater would be required. The capital investments, the operations and maintenance costs and the net loss of efficiency imposed by cooling towers make the cost to use reclaimed water for cooling at PEEC prohibitive, regardless of the price charged by the supplier.

7. If reclaimed water can be supplied to the Site at a reasonable price, in acceptable quantity and quality for use as process or irrigation supply, FPL will consider using the reclaimed water for those purposes.

7.0 REFERENCES

FDEP, May 2011. 2010 Reuse Inventory, Water Reuse Program, Florida Department of Environmental Protection, Tallahassee, FL.

University of Florida, April 2006. Ocean Outfall Study Final Report, Department of Engineering Sciences, University of Florida, Gainesville, FL.

FIGURES