United States Nuclear Regulatory Commission Official Hearing Exhibit

In the Matter of: FLORIDA POWER & LIGHT COMPANY
(Turkey Point Nuclear Generating, Units 3 and 4)

ASLBP #: 15-935-02-LA-BD01
Docket #: 05000250 & 05000251
Exhibit #: INT-001-00-BD01
Identified: 1/4/2016
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Rejected:
Stricken:
Other:

INT-001

THE SCIENCE OF THE TURKEY POINT WETLANDS

NOTE: The terms PSU/Practical Salinity Units and PPT/parts per thousand are, for our purposes, functionally equivalent.

WHAT IS SALTWATER INTRUSION? INT-041

Saltwater Intrusion of Coastal Aquifers in the U.S. James Spatafo

Johnson State College Senior Seminar May 6, 2008

http://kanat.jsc.vsc.edu/student/spatafora/setup.htm

“What is saltwater intrusion?

Salt water intrusion occurs in coastal freshwater aquifers when the different densities of both the saltwater and freshwater allow the ocean water to intrude into the freshwater aquifer. These areas are usually supporting large populations where the demanding groundwater withdrawals from these aquifers is exceeding the recharge rate…. This can cause lateral and vertical intrusion of the surrounding saltwater, and evidence of saltwater intrusion has been found Some coastal regions of the United States have and continue to be densely populated. Currently, over half of the population resides on land areas classified as coastal regions (NOAA, 2007). Due to over extraction from an increasing demand for freshwater resources, the coastal aquifers located in these regions are experiencing a hydrologic problem known as saltwater intrusion. throughout the eastern seaboard of the U.S. (USGS, 2007).

The encroaching seawater will encounter an area known as the zone of dispersion, where the freshwater and saltwater mix and form an interface… This interface moves back and forth (a.k.a, pulse) naturally because of fluctuations the recharge rate of freshwater back into these coastal aquifers (Ranjan, 2007). Aquifers are naturally replenished by precipitation and surface waters through the soil and geologic material to the water table.

When groundwater levels in aquifers are depleted faster than they can recharge. This is directly related to the position of the interface and determines the amount of saltwater that can intrude into the freshwater aquifer system. Since saltwater intrusion is directly related to the recharge rate of the groundwater, this allows for other factors that may contribute to the encroachment of seawater into the freshwater aquifers. Climatic variables, such as precipitation, surface runoff, and temperature can play a big role in affecting saltwater intrusion. With lower precipitation amounts and warmer temperatures, the recharge rate will be much less due to lack of groundwater present and increased evaporation (Ranjan, 2007). Along with this, other factors may influence the groundwater recharge rate indirectly. An example of this would be the rising carbon dioxide emissions in the atmosphere. Increasing carbon dioxide levels can lead directly to an increase in average surface temperatures, indirectly increasing the evaporation rate and affecting the recharge of freshwater into the coastal aquifers. … major pumping of well water (can) lead to a cone of depression in the water table. …major pumping of the well water (can) lead to a cone of depression in the water table. When this occurs, it will move the saltwater freshwater interface inland, resulting in a higher saline concentration in the aquifers' water, rendering it useless for human consumption, unless it is treated.

Another factor that directly affects coastal aquifer depletion is land use planning and management. Different activities such as irrigating crops and industrial processing can require a substantial amount of freshwater resources to be withdrawn.… If certain wells are relying on these coastal aquifers to provide enough freshwater to support agricultural, industrial, municipal, and residential demands, then the recharge rate of the aquifer must be able to keep up. The over-pumping of these coastal aquifers has decreased the underground water table level and decreased the abundance, pressure, and storage capacity the freshwater aquifer. This will cause the zone of dispersion to move inland and drastically reduce the freshwater that is available from the well and it may result in contamination of the freshwater aquifer and eliminate it as a potential freshwater source.
Probably the most detrimental effect that ground water depletion causes is the lowering of the water table. The water table is the area underneath the ground that is completely saturated with freshwater and can be drilled into and extracted as a freshwater resource. As the water level declines, extraction of water may prove to be more difficult. If the water level drops below the well, then it must be re-drilled and set at a lower depth. This can be quite an expensive

procedure, especially for a residential consumer with an independent well system. As the water table declines, extraction of the freshwater becomes more difficult and expensive, and the rate of water that can usually be pumped out of the well will decline (USGS, 2005). Keeping this in mind, if water tables continue to decrease, extraction of groundwater for all different activities will become increasingly more expensive as time progresses. Currently in Vermont, the price of well drilling is going up. On average, a 250 foot well will cost somewhere around $4,000 (Helmich, 2000). However, the more complicated the project gets due to location, underground geological rock formation, and lower water tables, the higher the cost of drilling a well becomes. If this is true for a non coastal, lightly populated area such as Vermont, you can extrapolate the costs of well drilling in a densely populated, coastal area such as coastal South Carolina and Georgia, where the water table is extremely low.

Changing the Interface

Another problem that takes place when saltwater intrusion occurs in coastal freshwater aquifers is the changing of the saltwater- freshwater interface. Also known as the zone of dispersion or transition zone, this is the area where the body of saltwater and freshwater meet and form a hydrologic barrier. The natural hydrologic movement of the underground freshwater towards the ocean usually prevents the seawater from intruding into the coastal aquifer system (Ranjan, 2007). Over-pumping of these coastal aquifers will cause a fluctuation in the amount of freshwater moving towards the coastal discharge areas and will allow for the oceanic water to move inland, into the aquifer system. This will result in higher chlorinated concentrations of water and less available storage space for the freshwater in the aquifer. Figure 6 accurately shows how the saltwater freshwater interface can intrude into the confined coastal aquifer. When the interface moves inland, the deeper wells will begin to withdraw saline contaminated freshwater. This means that the water must be treated before human consumption. The other option is to stop using this well until the natural recharge rate of the aquifer can force the saltwater freshwater interface back to its normal position. This process can take a long time and it reduces the freshwater availability of this region.

What areas are currently experiencing saltwater intrusion?

Currently in the U.S., many coastal aquifers are experiencing different degrees of saltwater intrusion. The most commonly studied coastal area experiencing saltwater intrusion on the eastern seaboard of the U.S. is the surficial aquifer system of the southeastern U.S. This aquifer system covers most of Florida and the coastal areas of South Carolina and Georgia …The average thickness of the surficial aquifer is around 50 feet, however, in some places such as St. Lucie County in Florida, it can reach a depth of over 400 feet (Miller, 2002). The Biscayne aquifer is a surficial aquifer located in southeastern Florida. This is the most heavily used water source for Florida, and it spans over 3,000 square miles. In many areas, the Biscayne aquifer has been contaminated by industrial discharge, landfills, and saltwater intrusion (University of Florida, 2003). In 1985, the Biscayne aquifer was providing 786 million gallons of water a day, where public water supply withdrawals were around 569 million gallons a day (Miller, 2002). A combination of large groundwater withdrawals and a new drainage canal system has allowed the freshwater level to promoting the landward movement of the saltwater into the freshwater aquifer and canal systems (Miller, 2002).” (emphasis added)

An Attack from Below

In addition to surface flooding, there is trouble brewing below the surface too. That trouble is called saltwater intrusion, and it is already taking place along coastal communities in south Florida. Saltwater intrusion occurs when saltwater from the ocean or bay advances further into the porous limestone aquifer. That aquifer also happens to supply about 90% of south Florida’s drinking water. Municipal wells pump fresh water up from the aquifer for residential and agricultural use, but some cities have already had to shut down some wells because the water being pumped up was brackish (for example, Hallandale Beach has already closed 6 of its 8 wells due to saltwater contamination).

Schematic drawing of saltwater intrusion. Sea level rise, water use, and rainfall all control the severity of the intrusion. (floridaswater.com)

The wedge of salt water advances and retreats naturally during the dry and rainy seasons, but the combination of fresh water extraction and sea level rise is drawing that wedge closer to land laterally and vertically.

In other words, the water table rises as sea level rises, so with higher sea level, the saltwater exerts more pressure on the fresh water in the aquifer, shoving the fresh water further

away from the coast and upward toward the surface.
Map of the Miami area, where colors indicate the depth to the water table. A lot of area is covered by 0-4 feet, including all of Miami Beach. (Dr. Keren Bolter)
Map of the Miami area, where colors indicate the depth to the water table. A lot of area is covered by 0-4 feet, including all of Miami Beach. (Keren Bolter, FAU)

INT-013

http://www.rsmas.miami.edu/blog/2014/10/03/sea-levelrise-in-miami/ (Water, Water Everywhere)

INT-042

Emergency Order No. 2015-034-DAO-WU [PDF] - South ...www.sfwmd.gov/.../sfwmd.../f
Final Order Re: Withdrawal from L-31E Canal August 14, 2015

INT-043

Tara Dolan study:
"A Case Study of Turkey Point Nuclear Generating Station ...
scholarlyrepository.miami.edu › ETDS › OA_THESES › 354

> *The goal of this study was to assess the perception of risk to Biscayne Bay from the operation of current and proposed cooling systems by a targeted group of individual stakeholders and managers*.

PERMEABILITY Discussed in INT-044 and INT-046
To fully understand the nature of the CCS one must know that they are unlined.

INT-044

2010 USGS Borehole geophysical logging for the Florida Power & Light Turkey Point Plant groundwater, surface water, and ecological monitoring plan:

Study Area: Miami-Dade County, Florida
Period of Project: February 2010 through September 2010
Principal Investigators: Kevin J. Cunningham, Robert A. Renken, Dorothy Payne
Co-Investigators: Michael A. Wacker, Jeffrey F. Robinson
Cooperator: Florida Power & Light Company

Background:

The **effect of salinity and temperature** (emphasis added) differences and aquifer heterogeneity on density-driven convection, and the combined impact on surface water, groundwater, and ecologic conditions is being evaluated at the Florida Power & Light Company (FPL) Turkey Point Nuclear Plant in southeastern Florida. The power plant contains a large cooling canal system with warm water;which has salinities elevated above typical, natural surface water in southeastern Florida, circulating within the canals in the uppermost part the highly permeable karst carbonate Biscayne aquifer. The salinity of the cooling water is greater than natural groundwater salinities in the area, and thus, the presence of unstable density-driven convection is possible.

The potential for unstable density-driven convection is somewhat diminished, however, by cooling water temperatures that are greater than local groundwater temperatures. Recirculating cooling systems at thermoelectric power plants are of considerable interest to USGS Water Resource Programs because engineered cooling systems are common in populated areas, are source-water sinks due to high evaporation rates. This Technical Assistance Agreement is part of a collaborative effort between the USGS and FPL.

INT-045

Origins and Delineation of Saltwater Intrusion in the Biscayne Aquifer and Changes in the Distribution of Saltwater in Miami-Dade County, Florida

By Scott T. Prinos, Michael A. Wacker, Kevin J. Cunningham, and David V. Fitterman   Prepared in cooperation with Miami-Dade County
Scientific Investigations Report 2014–5025
U.S.

The report Abstract states, in part,

Intrusion of saltwater into parts of the shallow karst Biscayne aquifer is a major concern for the 2.5 million residents of Miami-Dade County that rely on this aquifer as their primary drinking water supply. Saltwater intrusion of this aquifer began when the Everglades were drained to provide dry land for urban development and agriculture. The reduction in water levels caused by this drainage, combined with periodic droughts, allowed saltwater to flow inland along the base of the aquifer and to seep directly into the aquifer from the canals. The approximate inland extent of saltwater was last mapped in 1995.
An examination of the inland extent of saltwater and the sources of saltwater in the aquifer was completed during 2008–2011 by using (1) all available salinity information, (2) time-series

electromagnetic induction log datasets from 35 wells, (3) time domain electromagnetic soundings collected at 79 locations, (4) a helicopter electromagnetic survey done during 2001 that was processed, calibrated, and published during the study, (5) cores and geophysical logs collected from 8 sites for stratigraphic analysis, (6) 8 new water-quality monitoring wells, and (7) analyses of 69 geochemical samples.

The results of the study indicate that as of 2011 approximately 1,200 square kilometers (km2) of the mainland part of the Biscayne aquifer were intruded by saltwater. The saltwater front was mapped farther inland than it was in 1995 in eight areas totaling about 24.1 km2. In many of these areas, analyses indicated that saltwater had encroached along the base of the aquifer. The saltwater front was mapped closer to the coast than it was in 1995 in four areas totaling approximately 6.2 km2. The changes in the mapped extent of saltwater resulted from improved spatial information, actual movement of the saltwater front, or a combination of both.

Turkey Point Nuclear Power Plant Cooling Canal System

The cooling canal system (CCS) of the Turkey Point Nuclear Power Plant east of Florida City (fig. 8) was constructed during the early 1970s and contains hypersaline water (Janzen and Krupa, 2011). This hypersaline water may be contributing to saltwater encroachment in this area (Hughes and others, 2010). Water in the cooling canals is reported to have tritium “concentrations at least two orders of magnitude above surrounding surface and groundwater and [tritium] therefore [is] considered a potential tracer of waters from the CCS” (Janzen and Krupa, 2011, section 2, p. 8). The tritium concentration of samples collected from sites located within 8.5 km of the CCS ranged from 4.1 to 53.3 TU and averaged 12.4 TU, whereas the tritium concentration of samples collected farther away from the CCS averaged 1.3 TU (appendix 2, table 2–3) (see the Tritium and Uranium Concentration section of this report). Saltwater intrusion is a recent occurrence at most of the groundwater monitoring wells (figs. 18, 19, 21–26) within 8.5 km of the CCS, except at wells FKS4 and FKS8 near the Card Sound Road Canal (see the Card Sound Road Canal section of this report). No samples were collected from the CCS or wells within it as part of the current study to detect any possible influxes of CCS water into the aquifer; however, monitoring wells were installed in 2010 adjacent to the CCS for other studies and these wells are being monitored using electromagnetic induction logging.

The Summary and Conclusions state:

The highest tritium concentrations (3.2 to 53.3 TU) measured during the study were measured in water from wells FKS4, FKS7, G–1264, G–3698, G–3699, G–3855, and G–3856. These seven wells are within 10 km of the Turkey Point Nuclear Power Plant, and hypersaline water with high tritium concentrations from the cooling canals may be contributing to saltwater encroachment near the wells. Geochemical analyses and long-term monitoring data from wells G–1264, G–3698, G–3699, G–3855, and G–3856 confirmed the recent arrival of saltwater intrusion.

In Miami-Dade County, the principal source of drinking water is the Biscayne aquifer. Prior to development, the estimated level of freshwater (3 to 4.3 m) in the Everglades near Miami was likely sufficient to prevent saltwater encroachment in the Biscayne aquifer in this area. The head differential between the

Everglades and the coast was evidenced by numerous freshwater springs that flowed near the coast line and boiled up in Biscayne Bay. Beginning in 1845, drainage canals effectively drained the Everglades and resulted in an estimated 2.9-m permanent reduction in Biscayne aquifer water levels in east-central Miami-Dade County, which allowed saltwater to encroach landward along the base of the Biscayne aquifer. Landward encroachment was exacerbated during drought periods when water levels in the aquifer fell to or below sea level. Saltwater also flowed inland up the canals and into the Biscayne aquifer. Water control structures on most of the major drainage canals in Miami-Dade County reduced, but did not completely eliminate, the ability of saltwater to flow inland through these canals during drought periods. The various pathways of seawater into the highly permeable Biscayne aquifer have combined to intrude approximately 1,200 km2 of this aquifer with saltwater.

To map the inland extent of saltwater in the Biscayne aquifer, the following data were compiled and analyzed: (1) all available salinity information, (2) TSEMIL datasets from 35 wells that were processed using a newly developed method, (3) TEM soundings collected at 79 locations in 2008 and 2009 and used to evaluate the depth to saltwater (if present) and the depth to the base of the Biscayne aquifer, (4) a HEM survey collected in 2001 that was processed and interpreted during this study, (5) cores and geophysical logs collected from 8 sites for stratigraphic analysis, (6) analyses of samples from 8 new single or multi-depth monitoring wells installed in these core holes, and (7) analyses of 69 geochemical samples. These data were evaluated, and GIS software was used to map the inland extent of saltwater in the Biscayne aquifer in 2008 and in 2011.

The saltwater front was mapped farther inland than it was in

1995 in eight approximated areas totaling 24.1 km2, most notably near the Florida City Canal where the front had advanced by as much as 1.9 km between 1995 and 2011. The saltwater interface was mapped closer to the coast than it was in 1995 in four approximated areas totaling 6.2 km2. The saltwater interface was mapped closer to the coast near the Snapper Creek Canal than it had been in 1995. Some revisions to the saltwater interface were the result of the improved spatial coverage provided by additional wells, TEM soundings, and the HEM survey. One area with extensive revisions resulting primarily from improved spatial coverage was near the Card Sound Road Canal and U.S. Highway 1.

The sources and changes in the distribution of saltwater in the Biscayne aquifer were evaluated by using (1) geochemical sampling, (2) salinity measurements collected in canals, and (3) TSEMIL datasets. A total of 69 geochemical water samples were collected from 44 sites. Analyses included (1) major ion chemistry and trace ion chemistry, (2) strontium isotope ratios, (3) oxygen and hydrogen isotope ratios, (4) tritium concentration, (5) tritium/helium-3 (3H/3He) age dating, (6) sulfur hexafluoride (SF6) age dating, and (7) dissolved gas composition.

The results of geochemical analyses indicate that saltwater intrusion has recently arrived at wells G–1264, G–3615, G–3698, G–3699, G–3704, G–3705, and G–3855. Long-term records of chloride concentration confirm that the saltwater interface (1,000 mg/L) first became evident at most of these locations during or after 1994. Geochemical analyses at wells FKS4, FKS8, G–939, G–3600, G–3601, G–3602, G–3604, and G–3605 generally indicate preexisting saltwater intrusion as reported by previous researchers.

Droughts and intruded saltwater are closely connected. The piston-flow ages determined from 3H/3He age samples of saltwater with a chloride concentration of about 1,000 mg/L or greater generally correspond to a period of frequent droughts. Recharge temperatures of water samples determined by using dissolved-gas analyses are consistent with air temperatures that occur in April or early May, when water levels are typically at their lowest. Conversely, most of the samples of water with chloride concentrations less than about 1,000 mg/L indicate recharge temperatures corresponding to air temperatures in mid to late May when water levels in the aquifer begin to increase, and the piston-flow age determinations correspond to wet years. The piston-flow ages of freshwater samples were generally younger than ages determined for saltwater.

The silica concentrations in samples from well G–3701 indicate that this well is screened in the Pinecrest Sand Member of the Tamiami Formation below the base of the Biscayne aquifer. Samples from the wells G–3600 and G–3601, which are screened in a part of the Biscayne aquifer that includes the Tamiami Formation, also indicated silica concentrations that were elevated relative to samples from most other wells.

The strontium (87Sr/86Sr) isotope ratio in samples was used to evaluate the origin of saltwater in the Biscayne aquifer, but the method did not prove useful because the standard error was too large relative to the range of the 87Sr/86Sr isotope ratios in the study area. Most of the 87Sr/86Sr isotope ratios determined from samples corresponded with the Pleistocene age of most sediments in the Biscayne aquifer. Two of the lowest ratios were observed for samples from wells G–3701 and G–3601. These wells likely are open to materials that are of Pliocene age. Oxygen and hydrogen isotopes indicated that water from well G–3608 was similar in isotopic composition to water from the adjacent Snapper Creek Canal. The relatively shallow increase in bulk conductivity evident in the TSEMIL dataset from G–3608, the interpreted piston-flow age of water from this well, and the local hydraulic gradient indicated that the saltwater at this location likely emanated from seawater that had flowed up the Snapper Creek Canal and leaked into the aquifer.

Geochemical analyses had indicated preexisting saltwater intrusion at wells G–3600, G–3601, G–3602, G–3604, and G–3605. The highest tritium concentrations (3.2 to 53.3 TU) measured during the study were measured in water from wells FKS4, FKS7, G–1264, G–3698, G–3699, G–3855, and G–3856. These seven wells are within 10 km of the Turkey Point Nuclear Power Plant, and hypersaline water with high tritium concentrations from the cooling canals may be contributing to saltwater encroachment near the wells. Geochemical analyses and long-term monitoring data from wells G–1264, G–3698, G–3699, G–3855, and G–3856 confirmed the recent arrival of saltwater intrusion.

3H/3He age dating indicated that the water sampled from wells G–3601 and G–3701 contained too little tritium to be evaluated using this method. The sample from well G–3600 showed the characteristics of gas fractionation and could not be dated using 3H/3He age dating. Water samples from wells G–3600, G–3601, G–3602, G–3604, and G–3701 also indicated silica concentrations that were greater than the theoretical mixing of freshwater and saltwater in the area would produce. These elevated silica concentrations could be caused by relatively longer residence times within a quartz-sand-rich formation.

SF6 age dating could not be used effectively in the study area principally because there was excess SF6 in most samples that may have been caused by leakage of SF6 from electrical switching facilities. Moreover, SF6-interpreted piston-flow ages are generally younger than 3H/3He ages. The lowest SF6 concentrations determined were for water sampled from wells G–3601 and G–3701. These samples also contained no tritium. Evaluations of long-term chloride monitoring and the geochemistry of water samples indicated that the saltwater sampled in the Biscayne aquifer is likely not relict seawater of Pleistocene or Pliocene ages. Some saltwater likely leaked from canals prior to the installation of water control structures. Near the Miami Canal northwest of the water control structure S–26, this saltwater is gradually mixing with the groundwater, and salinity is gradually decreasing. Modern leakage of saltwater likely is occurring along the Card Sound Road Canal and upstream of salinity control structures in the Biscayne, Black Creek, and Snapper Creek Canals. Saltwater also may have leaked from the Princeton Canal and the canal adjacent to well G–3698, although this leakage could not be confirmed or refuted with available information.

Additional information, such as TEM soundings or resistivity surveys collected from the canals and monitoring wells adjacent to these canals, could be used to evaluate the effect that saltwater leakage around or through existing structures has on the inland extent of saltwater in the Biscayne aquifer. Influxes of saltwater in canals may be undetected because the interval between samples is too long. Continuous salinity monitoring in canals could be useful in the detection of any future influxes of saltwater upstream of existing water control structures.

MIGRATION OUT OF THE CCS INT-046
Permeability

McNeill, Donald F., 2000. A Review of Upward Migration of Effluent Related to Subsurface Injection at Miami-Dade Water and Sewer South District Plant. Prepared for Sierra Club - Miami Group. 30 p.

Dr. Donald McNeill (Univ. Miami) wrote a report in 2000 looking at the same question for the south M-D treatment plant. There, the presumed very thick low permeability zone was in fact only about 14 feet in thickness and lay just above the Boulder zone at a depth of 2,456'-1,443' depth. Ten of the 17 deep injection well for the effluent came out above the low permeability zone. As you can see from the depth difference between Turkey Point and Black Point, his low permeability surface rises up to the northwest. Effluent injected at Turkey Point will flow up the surface's gradient to the NW and then probably N. IT will have lots of opportunities to encounter breaks in the permeability barrier in this lateral travel.

INT-047

GROUND WATER ATLAS of the UNITED STATES
Alabama, Florida, Georgia, South Carolina
HA 730-G http://pubs.usgs.gov/ha/ha730/ch_g/G-text4.html

Biological Assessment on the American Crocodile (Crocodylus acutus) Turkey Point Nuclear Generating Unit Nos. 3 and 4 Proposed License Amendment to Increase the Ultimate Heat Sink Temperature Limit July 2014 Docket Numbers 50-250 and 50-251 ML14206A806 prepared by NRC Staff:

At 13,

Algae In 2011, FPL began to notice increased blue green algae concentrations in the CCS. The concentrations have steadily increased since that time. FPL has performed engineering and environmental analyses and believes that the presence of higher than normal CCS algae concentrations may be diminishing the CCS's heat transfer capabilities. FPL developed a plan to gradually reduce algae concentrations through controlled chemical treatment of the CCS over the course of several weeks. On June 18, 2014, FPL (2014h) submitted a request to the Florida Department of Environmental Protection (FDEP) to approve the use of copper sulfate, hydrogen peroxide, and a bio-stimulant to treat the algae. On June 27, 2014, the FDEP (2014) approved FPL's treatment plan for a 90-day trial period. The FDEP requested that during the 90-day treatment period, FPL monitor for total recoverable copper and dissolved oxygen and submit its results to the FDEP. The FDEP also recommended that FPL coordinate with the Florida Fish and Wildlife Conservation Commission (FWC) due to the presence of crocodiles in the cooling system. The FWC (2014) provided its comments on FPL's treatment plan in a letter dated July 1, 2014. Appendix A contains the letters referenced in this paragraph, which provide additional information on the algal treatment plan, timeline, and anticipated effects. FPL also developed a Water Quality Monitoring Plan for the chemical treatments, and this plan is also enclosed in

Appendix A

Aquifer Withdrawals The CCS is situated above two aquifers: the shallower saltwater Biscayne Aquifer and the deeper brackish Floridan Aquifer. A confining layer separates the two aquifers from one another. Turkey Point, Unit 5, uses the Floridan Aquifer for cooling water. The South Florida Water Management District (SFWMD) granted FPL approval to withdraw a portion (approximately 5 million gallons per day [MGD]) of the Unit 5 withdrawal allowance for use in the CCS. FPL began pumping Floridan Aquifer water into the CCS in early July. FPL has also received temporary approval to withdraw 30 MGD from the Biscayne Aquifer, though FPL has not yet used this allowance. (FPL 2014f, 2014g) FPL (2014f) also anticipates the FDEP to issue an Administrative Order requiring FPL to install up to six new wells that will pump approximately 14 MGD of water from the Floridan Aquifer into the CCS. Modeling performed by FPL consultants and the SFWMD indicates that in approximately two years, the withdrawals would reduce the salinity of the CCS to the equivalent of Biscayne Bay (about 34 parts per thousand [ppt]). Such withdrawals could also help moderate water temperatures.

Turkey Point Nuclear Power Plant Cooling Canal System

The cooling canal system (CCS) of the Turkey Point Nuclear Power Plant east of Florida City (fig. 8) was constructed during the early 1970s and contains hypersaline water (Janzen and Krupa, 2011). This hypersaline water may be contributing to saltwater encroachment in this area(Hughes and others, 2010). Water in the cooling canals is reported to have tritium “concentrations at least two orders of magnitude above surrounding surface and groundwater and [tritium] therefore [is] considered a potential tracer of waters fromthe CCS” (Janzen and Krupa, 2011, section 2, p. 8). The tritium concentration of samples collected from sites located within 8.5km of the CCS ranged from 4.1 to 53.3 TU and averaged 12.4 TU, whereas the tritium concentration of samples collected farther away from the CCS averaged1.3 TU (appendix 2, table 2–3) (see the Tritium and UraniumConcentration section of this report). Saltwater intrusion is arecent occurrence at most of the groundwater monitoring wells (figs. 18, 19, 21–26) within 8.5 km of the CCS, except at wells FKS4 and FKS8 near the Card Sound Road Canal (see the Card Sound Road Canal section of this report). No samples were collected from the CCS or wells within it as part of the current study to detect any possible influxes of CCS water into the aquifer; however, monitoring wells were installed in 2010 adjacent to the CCS for other studies and these wells are being monitored using electromagnetic induction logging.

Recent Leakage from Canals

Although salinity control structures have been installed in most ofthe tidal canals, the leakage of saltwater through the porous rockof the Biscayne aquifer and around existing salinity control structures is documented (emphasis added) (Parker and others, 1955; Kohout and Leach, 1964; Leach and Grantham,1966). Kohout and Leach (1964) reported that any saltwater upstream of the salinity control structures could be driven into the aquifer when freshwater heads in the canals upstream of these structures increased. Monthly measurements of salinity collected by the Miami-Dade County Permitting, Environmental, and Regulatory Affairs (M-D PERA) during 1988 to 2010 (appendix 11)show influxes of saltwater in many of the canals upstream of thesalinity control structures. These measurements at stations BL03,BS04, CD02, GL03, LR06, PR03, MI03, MW04, and SP04,located in the Black Creek, Biscayne, Cutler Drain, Goulds Canal,Little River, Princeton, Military, Mowry, and Snapper CreekCanals, respectively (fig. 8), have detected influxes of saltwater upstream of the water control structures in these canals. The occurrences have ranged from rare influxes of water with salinity between 0.5 and 1.4 PSU at station SP04 in the Snapper Creek Canal, to frequent influxes of water with a salinity of between 15 and 32 PSU at station BS04 in the Biscayne Canal (appendix 11). This saltwater may be leaking into the aquifer in some areas.

INT-049

Sources of Saltwater in the Biscayne Aquifer
Hughes, J.D., Langevin, C.D., and Brakefield-Goswami, Linzy, 2010, Effect of hypersaline cooling canals on aquifer salinization: Hydrogeology Journal, v. 18, p. 25–38.

INT-050

Turkey Point Unit 1 Eco System BY RUSS FINLEY ON MAR 3, 2015 WITH 14 RESPONSES
Blogger statement:

You forgot to mention that it was a lawsuit by the EPA for violations of the Clean Water Act which was the driving force in changing how the discharge of the water was handled. The design of the cooling canals was created by the power company itself and the choice to save money and not line them was theirs.
http://www.energytrendsinsider.com/2015/03/03/turkey-point-power-stationand-its-ecosystem/

Since this is a uniquely designed system and there were concerns about the long term effects of it, a monitoring program was set up. At the time, it was the choice that was agreed to by both the power company and the regulators. I am not saying, in retrospect, that it was the best choice but no one had the perspective we have today, back then. About the crocodiles, a little follow up and research might be helpful. The hatchlings are being relocated because of contamination in the cooling canals. While the cooling canals served as a "habitat", they are now so contaminated that the crocodile population is crashing going from around 20 nests last year to 5-6 this year. The older crocodiles are dying for lack of

food. You see, all the fish are dying or dead from a problem that started in 2012 which required massive amounts of chemicals to try to get under control. I think that now is an excellent opportunity to do a little more research and write a follow-up article that presents the issues on a more level playing field.

INT-051

The National Park Service website states:

Biscayne Bay is a shallow ***estuary*** (emphasis added), a place where freshwater from the land mixes with salt water from the sea and life abounds. It serves as a nursery where infant and juvenile marine life reside. Lush seagrass beds provide hiding places and food for a vast array of sea life. In fact approximately 70 percent of the area's recreationally and commercially important fishes, crustaceans, and shellfish spend a portion of their young lives in the bay's protective environment.
Protected from the ocean to the east by a chain of islands or keys and by the mainland to the west, the bay is one of the most productive ecosystems in the park. Fresh water flow brings nutrients from inland areas. Plants use these nutrients, along with energy from the sun, carbon dioxide, and water to produce food through photosynthesis.
http://www.nps.gov/bisc/learn/nature/biscaynebay.htm

INT-052

~~Knowledge of Groundwater Responses— A Critical Factor in Saving Florida's Threatened and Endangered Species Part I: Marine Ecological Disturbances~~

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~~Abstract~~

~~Florida's marine species, including threatened and endangered species, are subjected to adverse environmental conditions due to groundwater alterations because agencies charged with implement- ing and enforcing the Clean Water Act and Endangered Species Act fail to consider those impacts. Examples of anthropogenic groundwater perturbations that can result in direct, indirect, secondary and cumulative impacts to marine species include: (1) aquifer injection of effluent and other ecologi- cally hazardous wastes; (2) aquifer 'storage' and 'recovery'; (3) groundwater mining; and (4) struc- tural mining of the aquifer system (e.g., limerock, sand, phosphate). Groundwater flow in Florida's regional karst aquifer system varies greatly both spatially and temporally, in response to those anthropogenic alterations. Those perturbations can result in significant physical, chemical and biological changes in the marine ecosystem. Related adverse impacts can include: (1) predisposing organisms to disease (e.g., decreasing host resistance, increasing pathogen vigor), including catalyzation by carbon-loading; (2) introducing new pathogens; (3) promoting rapid, antagonistic evolution of~~

~~microbes; and (4) introducing hazardous chemicals, including endocrine disrupters. The adverse effects of those alterations may be a significant factor in the major ecological disturbances of Florida's marine environment described in volume 18(1) of Endangered Species UPDATE. The magnitude of adverse impacts to marine species from those groundwater perturbations is unknown. Currently, the agencies have not fulfilled their fiducal responsibilities by failing to require the neces- sary studies, proceeding with permitting actions in the absence of that required information, and failing to take enforcement action against existing violations.~~

~~Conclusions~~

~~The regional karst aquifer system un- derlying south Florida is not a static system, but changes spatially and tem- porally, particularly in response to an- thropogenic perturbations. The historic submarine groundwater discharge in south Florida occurred from the mar- gin of the submerged carbonate plat- form, outcrops in terraces, and areas of discontinuities (e.g., karst dissolution/ subsidence features, paleo channels). Data suggest that the historic discharge of pristine, low-salinity, low-nutrient ground water of constant temperature into Florida's coastal areas was signifi- cant in maintaining the associated eco- systems. The quantity and quality of that historic SGD has been and will be altered by: (1) aquifer injection of ef- fluent and other ecologically hazard- ous wastes, (2) aquifer 'storage' and 're- covery,' (3) groundwater mining, and (4) structural mining of the aquifer sys- tem (e.g., limerock, sand, phosphate).~~

~~The same subsurface flow paths that supplied historic pristine ground water to coastal areas now may be points of preferential induced discharge for fluid wastes injected into~~

~~wells along south Florida's coast. The 110 million gallons a day of minimally- treated sewage permitted for injection at the Miami/Dade facility, and smaller volumes injected in approximately 1,000 shallow wells throughout the Florida Keys, in addition to the 1.7 bil- lion gallons of surface water proposed for ASR injection in south Florida are examples. Minimal dilution, disper- sion, and adsorption should be expected for injected contaminants due, in part, to rapid travel times in the aquifer, prior to induced discharge into nearshore surface waters.~~

~~Current literature suggests that induced discharges containing aqui- fer-injected contaminants are occur- ring in the Gulf of Mexico, Straits of Florida, Gulf Stream, and Atlantic Ocean, and may be a factor in harm- ful algal blooms and hypoxia. Government agencies charged with implementing and enforcing the Clean Water Act and the Endangered Species Act have failed to consider the direct, indirect, secondary, and cumulative impacts of those ground- water alterations to Florida's marine species, including threatened and endangered species. By proceed- ing with permitting actions, in the absence of the required informa- tion, the agencies are negligent and therefore liable.~~

INT-053

Slide 10 in the exhibit INT-002, based on FPL data and compiled by MDC DERM illustrates further the USGS description of the **movement of water into and out of the CCS** showing s a computer generated arial view of tritium leaving the CCS based on well monitoring. The tritium, while not at a level to be of concern, does act as a tracer showing the effluent from the CCS which is hypersaline and carries all of the chemicals in the CCS many of which are toxic. Because, as noted above, the CCS is unlined, there is nothing to prevent this flow of water from the CCS or, conversely, nothing to prevent the flow of water into the CCS including saltwater pulsing in from Biscayne Bay.

INT-054

Illustration 3, (INT-045) Initial Statement, at 12, illustrates how salinity descends from unprotected canals into the aquifer. From each furrow in the CCS water descends to the bottom of the Biscayne Aquifer and then spreads out. According to Dr. Philip Stoddard, FIU biologist, the **heavy metals and other chemicals are absorbed into the soil** and will stay there until disturbed by a vessel or a storm. **The many salts in the water slowly dissipate but, in the mean time, they impact the flora and fauna in the surrounding area.**