RE: Docket ID NRC-2018-0101

Florida Power and Light Application for Renewal Facility Operating

License No. DPR-31 and DPR-41

Ocean Reef Community Association

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August 10, 2019

Mr. Marc Harris, P.E.
Department of Environmental Protection
Bob Martinez Center
Industrial Wastewater Program
2600 Blair Stone Road Mail 3545
Tallahassee, FL 32399

I am writing to you on behalf of the members and residents of the Ocean Reef Community Association located in Ocean Reef Club in northern Key Largo, Florida. This letter is an update to my May 21st, 2019 comment letter to FDEP regarding the State of Florida's intent to issue the new Industrial Wastewater Facility permit FL001562-012-IW1N for the ongoing operation of the facility at the Florida Power and Light Turkey Point Nuclear Power Plant.

Because of the expected impact to our community we remain opposed to the proposed permit unless modifications are made to the permit to require:

1) the construction and operation of nuclear power industry standard cooling towers for Reactors 3 and 4 within five years from the effective date of the permit, and the decommissioning of the canal system thereafter,
2) the addition of sea grass monitoring and testing in the Card Sound and Biscayne Bay National Park surface waters off Turkey Point,
3) the continuing operation of the Recovery Well system for the next five years to attempt to arrest and capture/remove the hyper saline plume and stop its migration through the Biscayne Aquifer and into the bay as well as the removal of accumulated salt in the CCS,
4) the abatement of the uncontrolled seepage from the CCS into the Biscayne Aquifer, and the surrounding environment and surface waters of Biscayne Bay Park and Card Sound, and
5) that FPL pay for the relocation of FKAA Florida City potable water supply well field and for the expansion of the J. Dean WTP RO Water Treatment System should it become necessary due to the continuing migration of the hyper saline plume in the direction of said supply well field

In support of this opposition we reference the following updated information and documents:

I. Florida Keys Aqueduct Authority Presentation July 27th, 2019 (Attached as Exhibit A)

   a. Kirk Martin; FKAA Hydro Geologist, reports that the underground hyper saline plume (HSP) caused by the Turkey Point Cooling Canals is threatening drinking water supplies. From May 2018 through 2019 the hyper saline plume has continued to move through the Biscayne Aquifer towards the potable water

supply for Monroe County. It is now located 3¼ miles from the eastern boundary of the FKAA well field where the presence of tritium, a chemical signature in the saline water sampled from the FKAA monitoring wells located at this boundary, confirms that the source is the FPL property.

b. In May 2019, FPL reported to FKAA and FDEP that the average saline concentration in the CCS for the year was 64,000 ppm, which is almost double the 34,000 ppm saline concentration of seawater in Biscayne Bay.

c. FKAA data indicates that the salt water interface continues to move westward at the same 500 feet per year rate after one year of the operation of the FPL Remediation Plan under the Consent Order.

The following expert reports supplement and update those expert reports we filed with our prior comments letter to FDEP dated May 21st, 2019. These reports were filed with the NRC In Re the Matter: FPL (Turkey Point Nuclear Generating Station, Unit Nos. 3and 4) Docket No. 50-250-SLR and Docket No. 50-251-SLR June 24, 2019 but are also applicable to FDEP's decision as to whether to issue the FPL NPDES permit.

II. Updated Expert Report of James Fourqurean, Ph.D. June 24th, 2019 (Attached as Exhibit B)

a. A leading international expert on sea grass studies, Dr. Fourqurean has been monitoring the full extent of the migration of CCS water beneath and into the surface waters of Biscayne Bay for several years and its impact on fish and wildlife by monitoring sea grass.

b. He concludes that several years of data show alarming impacts to the environment surrounding the CCS and information on degradation to the bay to the east of the CCS. He points out that governmental agencies had discontinued pore water sampling in Biscayne Bay after May 2013 as part of monitoring reductions and he opposed the renewal of the FPL NRC license because of this failure without further testing.

c. The SFWMD recent pore water preliminary sampling indicates that tritium, a tracer of water with CCS origin is elevated in groundwater and pore water of the sea grass supporting regions of Biscayne Bay, an essential fish habitat, adjacent to the CCS.

Based upon his research and the current available data, Dr. Fourqurean further concludes that:

1) The operation of the CCS creates hyper-saline water which infiltrates the ground water that is transported and discharged under the sea grass.

2) The operation of the CCS has carried polluted ground water to near shore surface waters through the highly porous bedrock, dissolving carbonate in that bedrock and releasing additional phosphorous that had been incorporated into that bedrock. As this Phosphorous reaches the

sea grass meadows offshore, it will continue to degrade the ecosystem and cause an imbalance, change the nature of the surrounding marine environment. This imbalance will harm fish and wildlife that use these habitats and thus adversely affect fishing, recreational and other activities based on that habitat change and eventual loss in violation of F,A.C. 62-302 (48) (a).

III. Updated Expert Report of EJ Wexler Filed June 24th, 2019 (Attached as Exhibit C)

a. Mr. Wexler is the Director of Earthfx and qualified as an expert. He has been engaged in determining the adequacy of the FPL Tetra Tech Model used by FPL to develop its current remediation plan. His conclusions are based upon three different sources:

   1) Data available to him as of May 2019 regarding the hydrogeology, hydrology, and water quality of both surface water and groundwater in the South Dade area
   2) His prior numerical modeling studies in the vicinity of the CCS
   3) Reviews of modeling work prepared by Tetra Tech on behalf of FPL.

b. New water quality information produced for the period between November 2016 and May 2017 shows that FPL was unable to achieve freshening (i.e. reduce the average salinity) within the CCS despite the addition of an average of 12.8 million gallons per day (MGD) of brackish water from the Upper Floridan Aquifer into the CCS. Salinities in the CCS did not go down to the required 35,000 ppm (FPL 2017a); rather, average salinity concentrations in the CCS were 64,900 ppm in May 2017 (FPL 2017b).

c. Wexler's analysis using the FPL Tetra Tech model shows that the recovery system will not be able to meet the target of retracting the hyper saline water unless the salinity is reduced, and this has not occurred.

d. In his updated report he presents results from a new, independently developed model that examines processes within the CCS. This model indicates freshening the CCS to 34,000 ppm and sustaining that through the life of a new extended NPDES permit would be difficult to achieve with only the volumes of water now being added and the locations selected for adding the water into the CCS.

e. He states that conditions in the adjacent aquifer and surrounding bay waters are expected to worsen if nutrient-laden reuse water is added to the CCS from a planned waste water treatment plant agreement with Miami Dade County.

IV. Updated Expert Report of William Nuttle Ph.D. Filed June 24th, 2019 (Attached as Exhibit D)

a. Dr. William Nuttle, a hydrologist with 25 years of experience working in South Florida. From 2009 to 2015 The SFWMD tasked him with reviewing and monitoring the conditions in and around the FPL Turkey Point cooling canals.

b. Dr. Nuttle concludes that the current administrative challenge by Miami Dade County against FDEP based upon the impact of a 2018 permit modification

granted to FPL, exacerbates adverse impacts of the CCS operations on groundwater, surface water and ecological resources in the 21,000 acres of Model Lands Basin which bound the CCS to the west. This challenge is based on two factors:

1) Freshwater withdrawn by FPL Interceptor Ditch operations lowers the water table in the freshwater wetlands west of the CCS and reduces the seaward gradient that provides a barrier against the inflow of salt water into the Biscayne Aquifer.

2) The decreased water level in the freshwater wetlands opens a pathway for vertical movement of the CCS water which is already present deep in the aquifer up into the L31E canal and then throughout the basin of network drainage through the network of drainage canals that connect with the L31E.

c. Although freshening activities have been used by FPL from 2014 – 2019, only in one year out of six was there a reduction in salinity that matched the results of the FPL's model of the freshening process. This was in 2015 and the amount of additional water required to achieve this result was more than double the amount of water prescribed in the FPL model. This reduction in salinity came at the cost of increased discharge of high nutrient, high salinity CCS water into the Biscayne Aquifer (Kirk Martin Report). The salinity in all other years from 2014-2018 remain outside and well above the predicted and required 34,000 ppm target concentration. The FPL report from May 2019 shows that salinity at 64,000 ppm which is double the required saline concentration level.

d. Dr. Nuttle also cites a recent study in 2019 that predicts a general shift toward increased drought conditions for South Florida in future years which will which will increase the need for alternative water sources for the CCS. This new information on mechanisms of drought in South Florida provides evidence that "more favorable climatic conditions" that FPL is relying on to meet salinity targets may not occur. Anteneh Z. A., A. M. Melesse, and W. Abtew, 2019. Teleconnection of Regional Drought to ENSO, PDO, and AMO: Southern Florida and the Everglades. Atmosphere 10(6) DOI: 10.3390/atmos10060295

The operation of the CCS by FPL during the last 35 years demonstrates that the CCS is a failed antiquated water-cooling system as designed and constructed and that FPL has been out of compliance with its current and prior permits for years. The G111 water migrating from the cooling canal system continues to degrade the freshwater G11 portion of the aquifer. FPL cannot now provide "reasonable assurances" that their ongoing remediation system under the Consent Order will succeed in reducing the salinity in the canals and stop the radial movement of the hyper saline and industrial effluent water plume from the CCS. To the contrary, the current and prior scientific data shows that FPL's continued attempts since 2014 to "freshen" the canal water and dilute the saline level to the required level are not producing the required results based upon the current FPL model. Moreover, the "freshening" effort may actually be increasing the migration of the hyper saline polluted plume into the surrounding environment, significantly contributing to the long-term degradation of Biscayne Bay, Biscayne National Park and Card Sound.

Continued operation of the CCS threatens our freshwater supplies and risks both the known and as yet to be seen impact to our aquifer and surrounding surface water environments. Prior experience and the opinions of experts demonstrate that proper operation of the CCS to cool reactor water would demand an ever-growing volume of fresh water from South Florida's limited water resources. Add to this the reality of sea level rise at an accelerated rate and the resulting faster rate of seawater intrusion into the Biscayne Aquifer, the risk to our vital source of potable water becomes intolerable.

A new NPDES permit which allows the CCS to continue to threaten our fresh water supplies and surrounding environment without a specific mandate to replace that failed system with proven technology consistent with industry standards which would eliminate the ongoing contamination of the Biscayne Aquifer, Biscayne Bay National Park and Card Sound by the Turkey Point Plant canal system is unacceptable.

Sincerely,

Gary List, Chairman
Ocean Reef Community Association

Cc: Ron DeSantis, Florida Governor
Shane Strum, Gov. DeSantis Chief of Staff
Thomas Frazer, Chief of Science
Noah Valenstein, FDEP Secretary
John Truitt, FDEP Deputy Secretary
Benjamin Melnick, Esq., FDEP
Cindy Mulkey, FDEP Program Administrator
Terrie Bates, SFWMD Executive Director
James McAdams, US Army Corp of Engineers
Jim Valade, FWS
Kerrie-Jo Shell, EPA
Molly Davis, EPA
Permitting, EPA
Marco Rubio, US Senate
William Burton, NRC
Rick Scott, US Senate
Debbie Mucarsel-Powell, US Representative
Laura Rodriguez, Debbie Mucarsel-Powell Chief of Staff
Anitere Flores, FL Senate
Demi Bussatta, Senator Flores Staff
Lisette Vasquez, Senator Flores Staff
Tiffany Lorente, Senator Flores Staff
Holly Raschein, FL House of Representatives
Julio Rodriguez, Rep. Raschein Staff
Sylvia Murphy, Monroe County Mayor
Danny Kolhage, Monroe County Mayor Pro Tem

Michelle Coldiron, Monroe County Commissioner
Heather Carruthers, Monroe County Commissioner
David Rice, Monroe County Commissioner
Ramon Gastesi, Monroe County Manager
Lisa Tennyson Legislative Affairs
Robert Dean, FKAA Chairman
Robert Toppino, FKAA Vice-Chairman
David Ritz, FKAA Board of Directors
Antoinette Appell, FKAA Board of Directors
Cara Higgins, FKAA Board of Directors
Kirk Zuelch, FKAA Executive Director
Kent Nelson, P.E., FKAA Deputy Executive Director
Lee Hefty, DERM
Mayor, Miami Dade County
Barbara Jordan, Miami Dade County Commissioner
Jean Monestime, Miami Dade County Commissioner
Audrey Edmonson, Chairwoman
Sally Heyman, Miami Dade County Commissioner
Eileen Higgins, Miami Dade County Commissioner
Rebeca Sosa, Vice-Chairwoman
Xavier Suarez, Miami Dade County Commissioner
Daniella Levine Cava, Miami Dade County Commissioner
Javier D. Souto, Miami Dade County Commissioner
Jose Martinez, Miami Dade County Commissioner
Jose "Pepe" Diaz, Miami Dade County Commissioner
Esteban Bovo, Jr., Miami Dade County Commissioner
Dennis Moss, Miami Dade Commissioner
Carolyn McLaughlin, Associate Director NPCA
National Park Conservation Association
Harold Brewer, Bonefish and Tarpon Trust
Margaret Goodro, Biscayne National Park Superintendent
Pedro Ramos, Everglades and Dry Tortugas Superintendent
Rachel Silverstein, Miami Water Keeper
Laura Reynolds, Keys Fishing Guides Association

Exhibit A

FKAA Freshwater Monitoring Status Update

FKAA Board Meeting
July 24, 2019

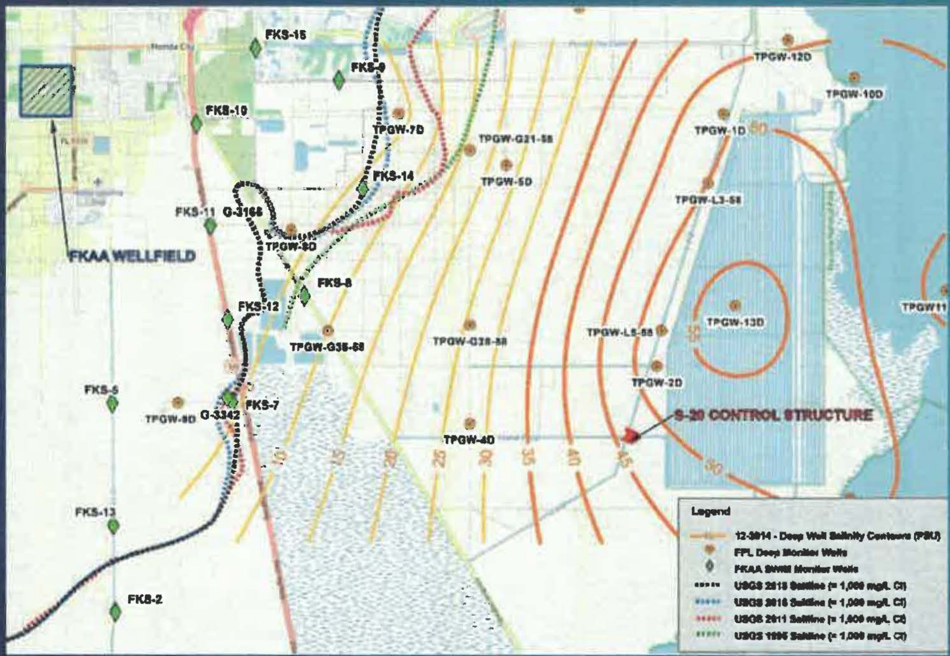
Kirk Martin

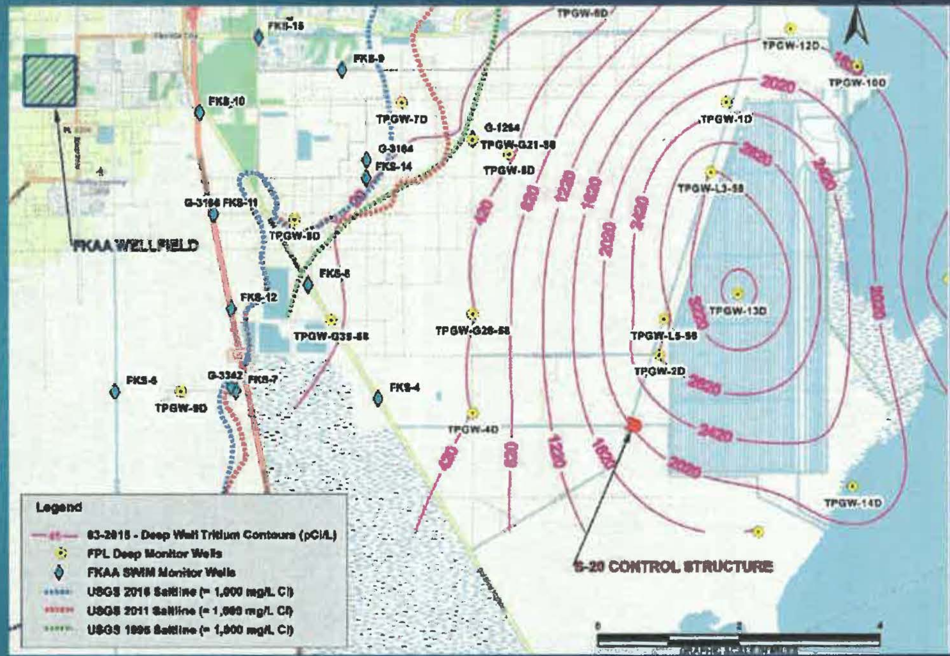
Discussion Topics

- SWIM Plan Update
- Saline Water Interface Update
- FPL Remediation Update
- Groundwater Modeling Update
- Wellfield Reliability Discussion

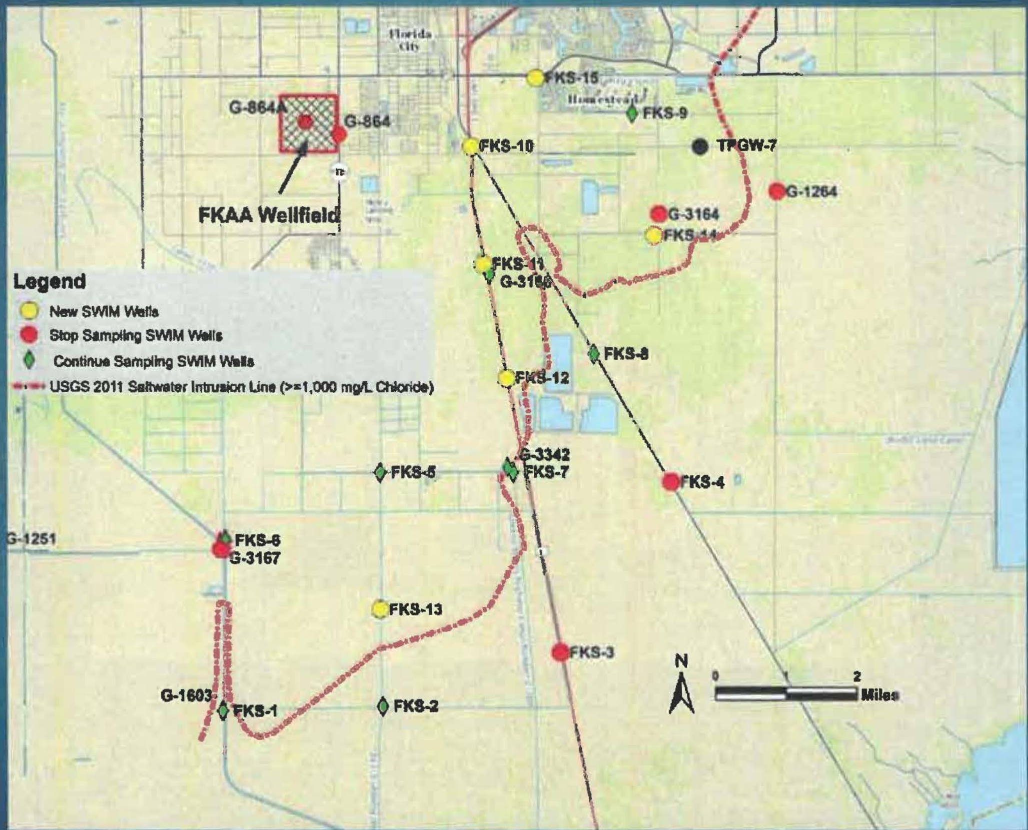
Swim Plan Update

Hypersaline Plume and Saline Water Interface

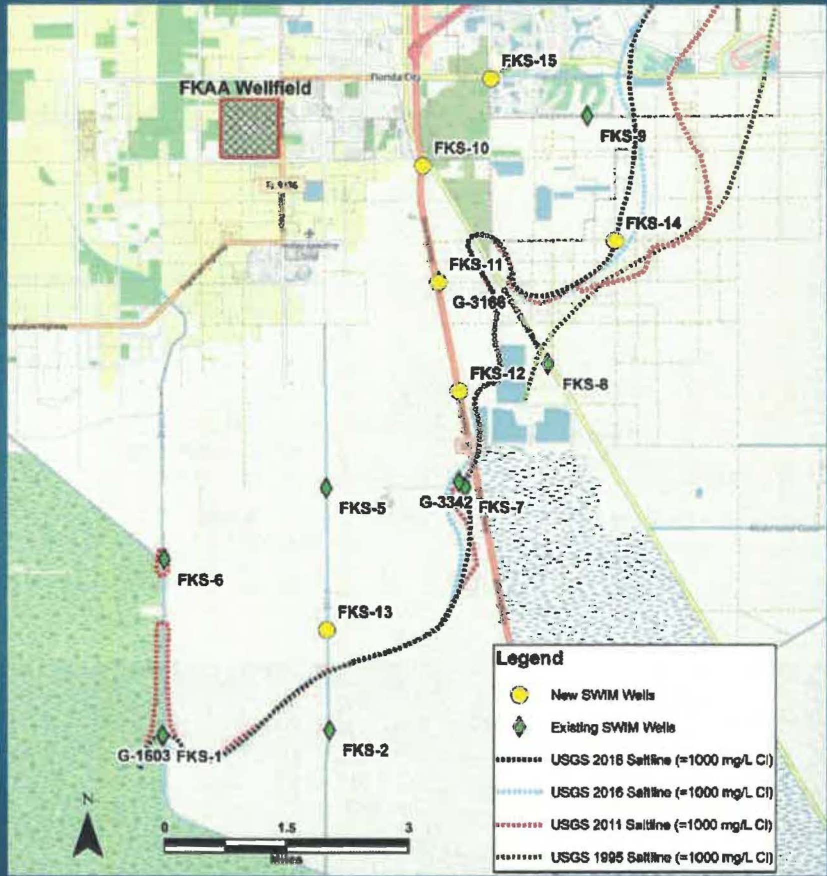




SWIM Plan Modifications

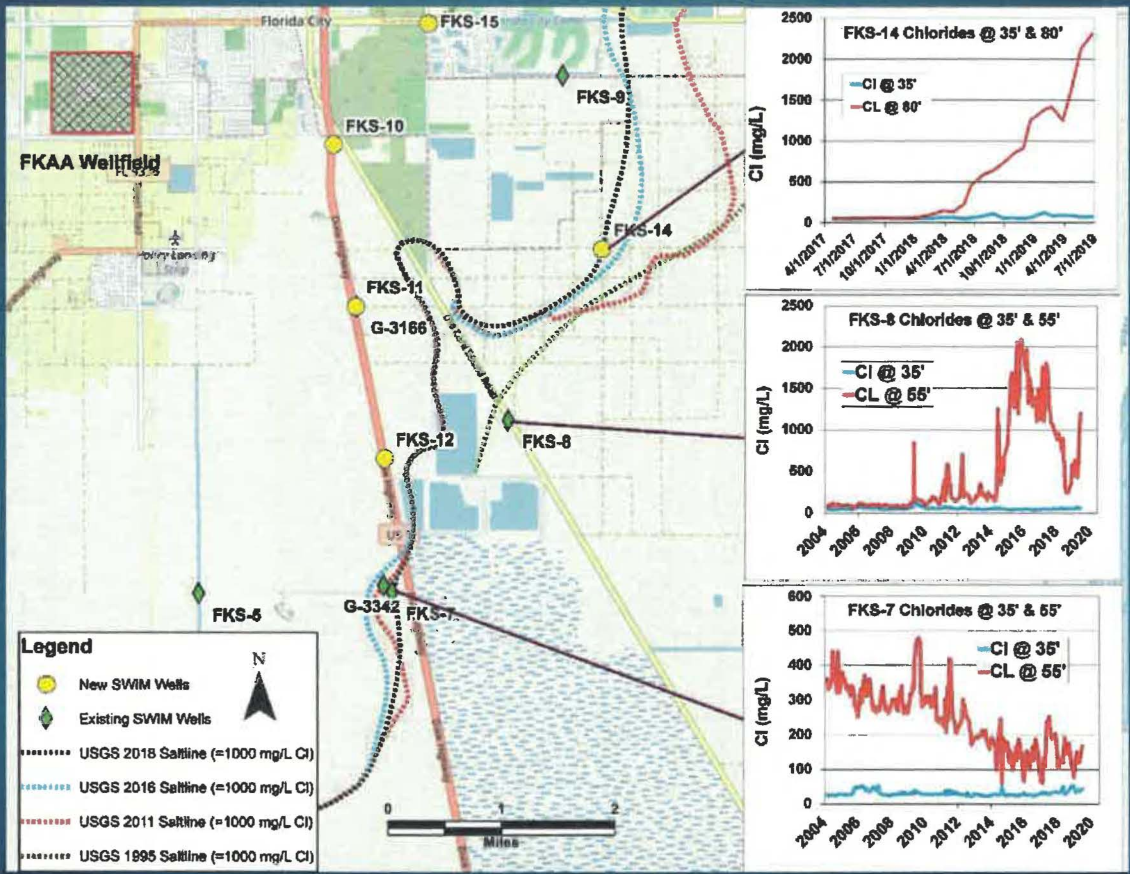


Current SWIM Plan Sites

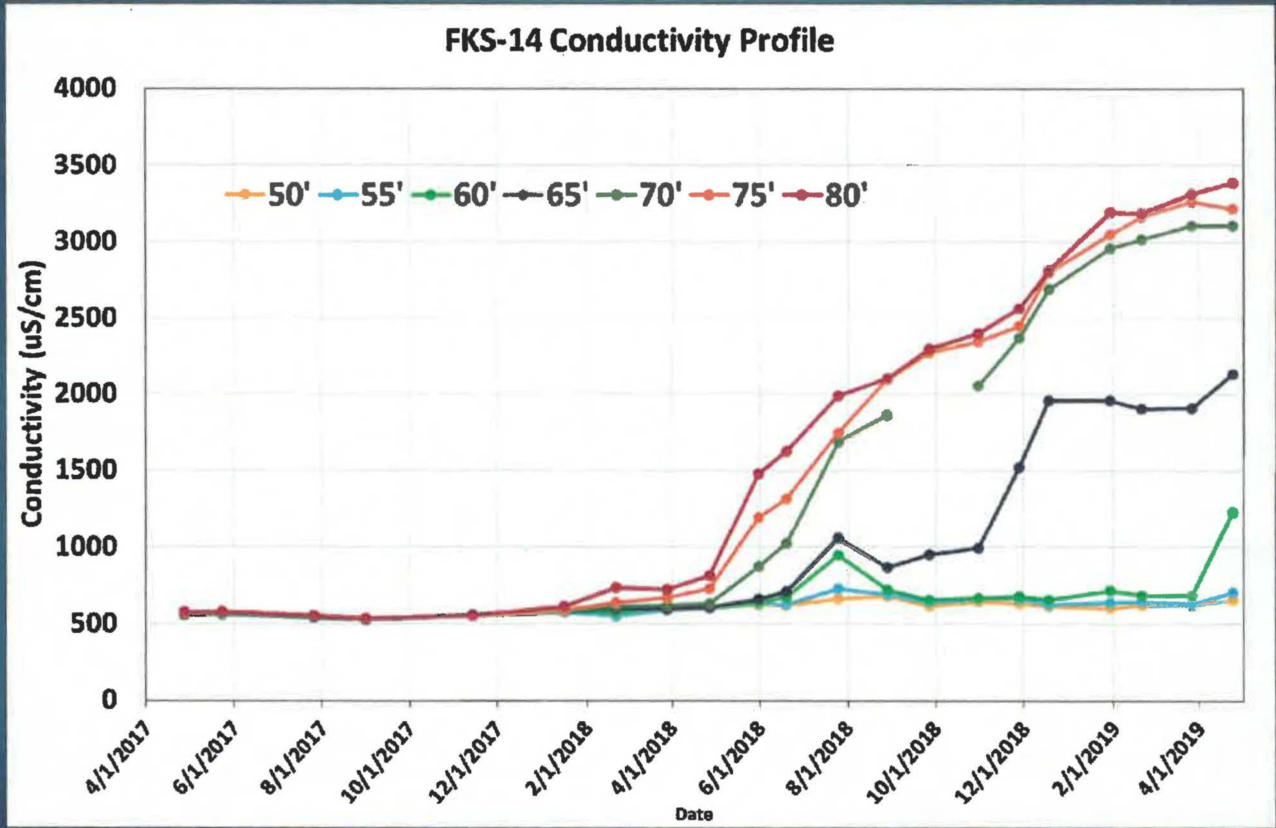


Saline Water Interface Update

Saline Water Interface

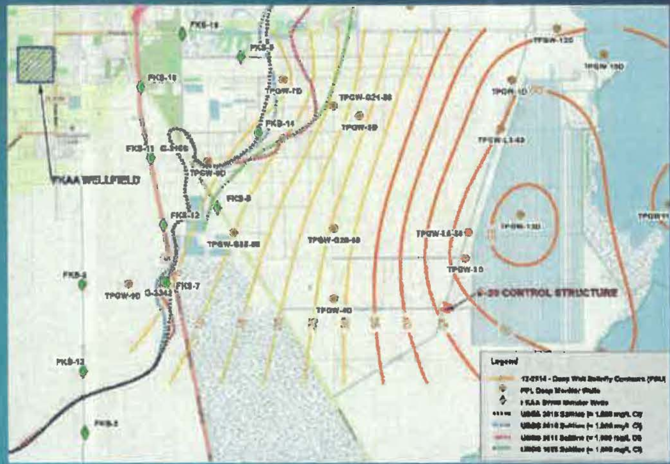


FKS-14 Conductivity Profile



FPL Remediation Update

FPL Biscayne Aquifer Recovery Wells



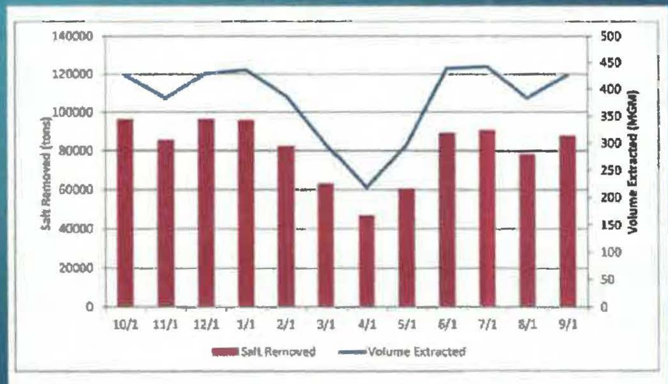


Figure 2.2-2 Monthly Total Salt and Volume of Hypersaline Groundwater Removed from Biscayne Aquifer

One Year Monitoring Report

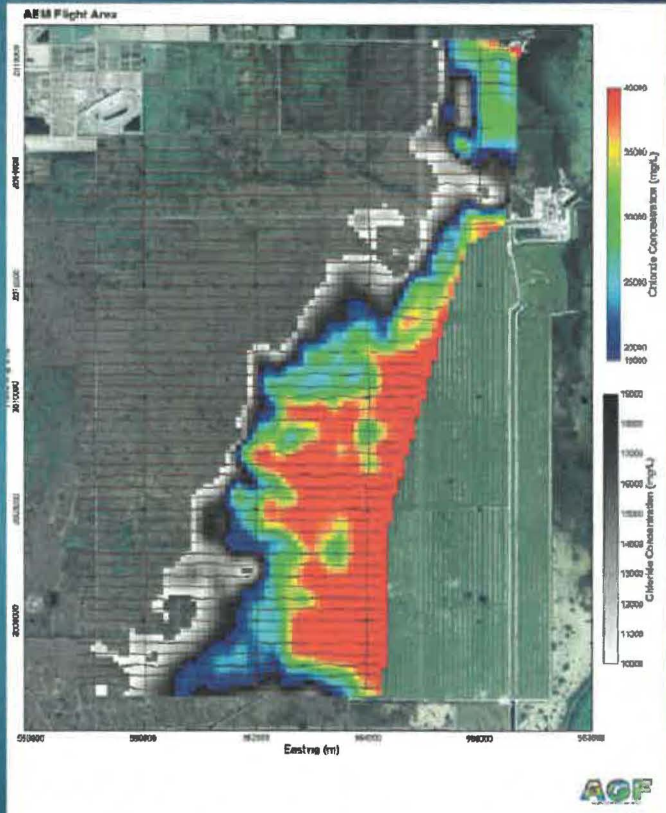
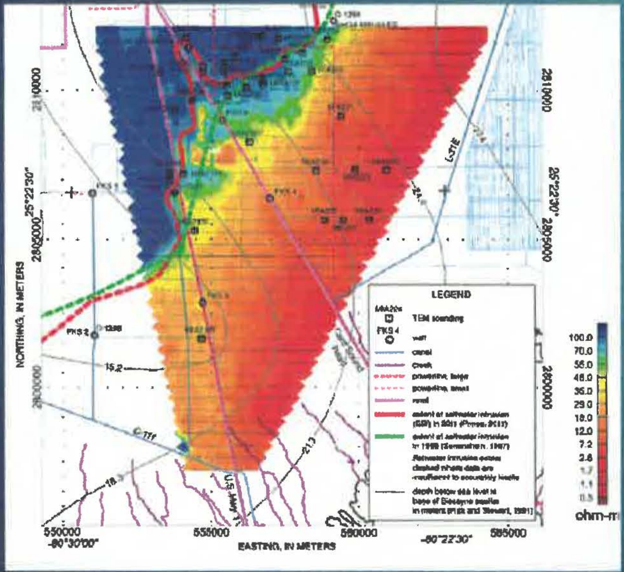


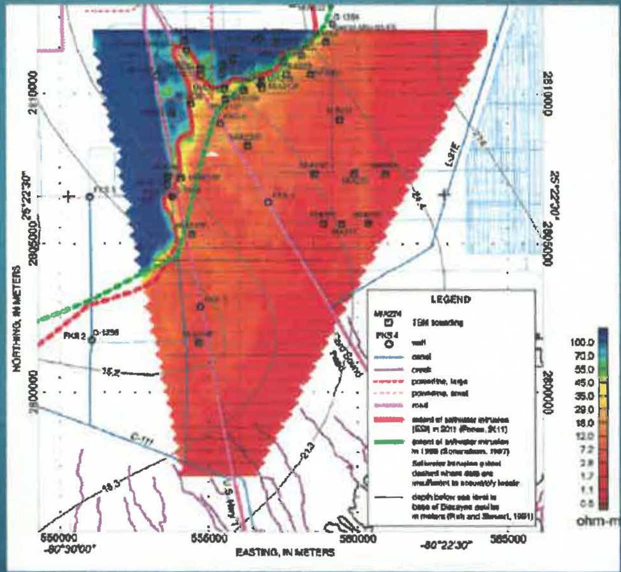
Figure 3-1. Plan View of hypersaline groundwater within Layer 7, between 26 and 32 feet below ground surface (bgs)

Aerial Electromagnetic Surveys

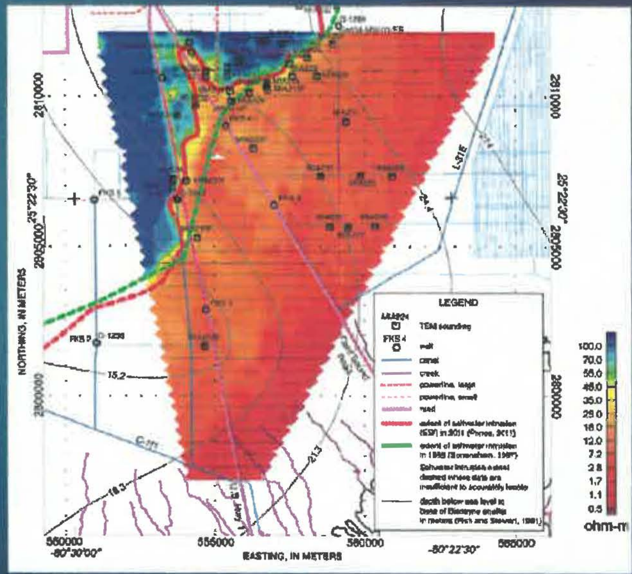
10 Meter Depth



20 Meter Depth



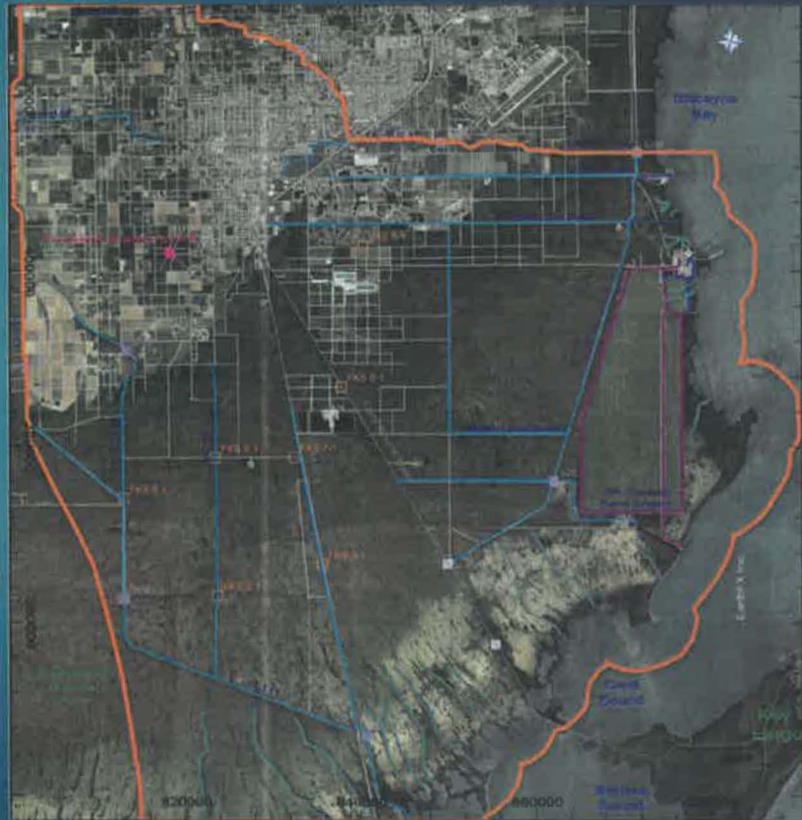
30 Meter Depth



Groundwater Modeling Update

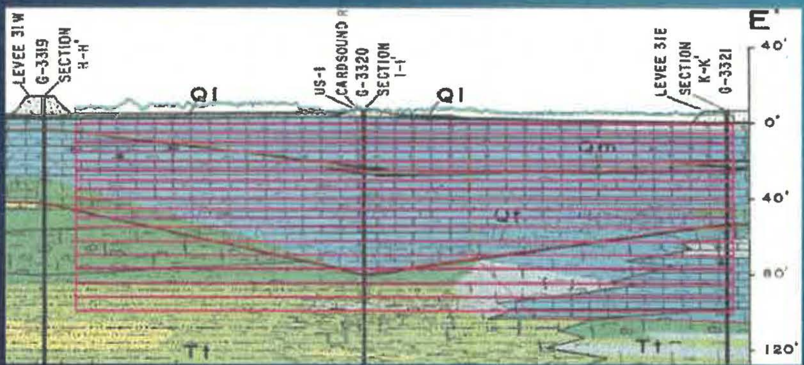
Groundwater Model Improvements

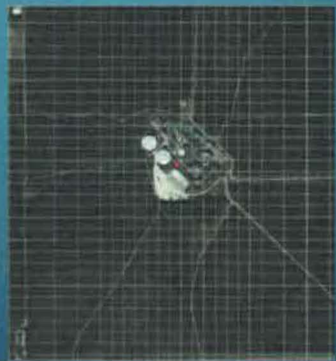
- Density Dependent Hydraulic / Solute Transport
  - Originally developed for ACI Quarry vs. FPL
- Model Updated to Most Current Conditions
  - CERP Improvements
  - Salinity Movement Data
  - FPL Remediation System



Groundwater Model Improvements

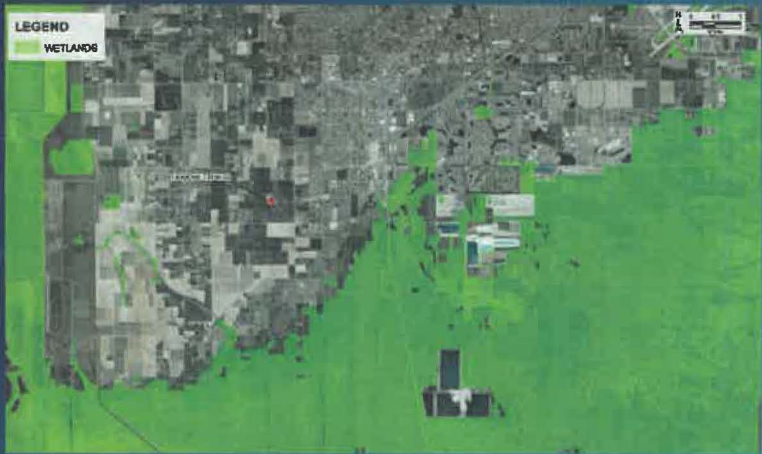
- Refocused Model on FPL CCS and FKAA Wellfield
- Refined Model Grid for Higher Resolution
  - More Accurate Saline Water Tracking
- Model Layers Refined for Detailed Hydrogeology
  - 20 Layers to Define the Biscayne Aquifer



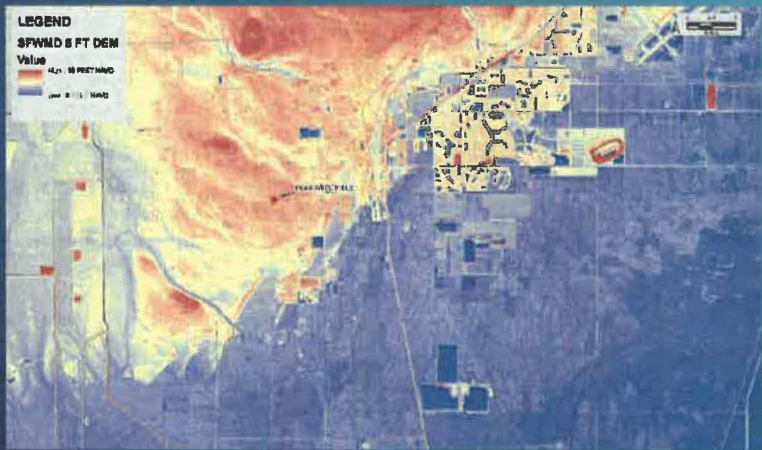


Wellfield Reliability

Wetlands



Canals



Topography

Water Users

FKAA Freshwater Monitoring Status Update

Discussion

FLORIDA KEYS AQUEDUCT AUTHORITY

Water Science Associates

Exhibit B

EXPERT REPORT OF JAMES FOURQUREAN, Ph.D.

I have been retained to offer my expert opinions on behalf of the intervenors in this matter. I have attached a C.V. with my qualifications and publications as Attachment 1 to the report. A list of all other cases in which, during the previous 4 years, I have testified as an expert at trial or by deposition is attached as Attachment 2.

My opinions are based on the data on seagrass distribution, nutrient availability and water quality of both surface water and groundwater available to me as of June 23, 2019. I will continue to search for new data to inform my opinions as set forth below.

My earlier report on this matter that was filed during the scoping process has been updated with information first compiled for the Greater Everglades Ecosystem Restoration Conference (GEER) on April 23, 2019 (submitted as an electronic supplement with this report). That poster and the abstract from this conference is attached as supplemental electronic material, and it was the first time the information was presented.

In addition, I have provided the pore water sampling data from the SFWMD monitoring plan requirements which is relevant to the reasons we are going to expand this effort and continue to sample and analyse all available data and information on degradation to the East of the CCS and work toward publishing a paper once a full 3 years of data are collected and is corelated with all existing data. Porewater sampling at the C, D, and E transects in each monitoring area in Biscayne Bay was discontinued after May 2013 as part of the monitoring reductions approved by the Agencies in July 2013. Because this Data does not overlap with the years we have sampled the N:P ratio within the pore water a resampling effort needs to be undertaken before any license extension should be considered. (These data are submitted as an electronic supplement to this report)

SUMMARY OF OPINIONS

Seagrasses are the foundation species for the essential fish habitat in the shallow underwater environments to the east of the Turkey Point Cooling Canal System (CCS). Seagrasses only proliferate and survive in places with low nutrient availability. In Biscayne Bay, the availability of the nutrient phosphorus (P) controls the abundance, productivity and species composition of seagrasses. Additions of P to this kind of system first fertilizes the seagrass and create denser seagrass meadows, but P accumulation is cumulative and permanent, so continued P loading leads to replacement of the seagrasses by macroalgae and finally macroalgae as enough P gets capture by the system. Since seagrass are the foundation species in the essential fish habitat in Biscayne Bay, P pollution disrupts this essential fish habitat. Currently, seagrasses show signs of abnormally high P concentrations in areas that hydrological models and field data show receive P-laden discharge from the CCS. Further, preliminary analysis of time series of aerial Google

Earth images collected since the 1990's show that some patches of seagrass offshore of the CCS first became much denser than the historical seagrass communities, then died back leaving bare mud. CCS water itself has very high P concentrations compared to Biscayne Bay, but it is likely that P concentrations of CCS water increase as they discharge subterraneanly because of interactions between changing salinity of groundwater and the properties of the aquifer through which it passes. The spatial pattern of the increased P availability (and recent dieoff of dense patches coincides with discharge of CCS water. It is likely that operations of the CCS are leading to the increased P availability and therefore the balance of flora and fauna in Biscayne Bay and Biscayne National Park.

OPINIONS

Specific opinions and evidence to support them:

1. The seagrass beds of Biscayne Bay and the rest of south Florida require very low nutrient loading to survive. In essence, seagrasses are killed and replaced by fast-growing, noxious seaweed or planktonic algae if nutrient delivery is increased. Nutrient delivery can be increased either by increasing the concentration of nutrients in discharges, OR by increasing the volume of water containing nutrients, even at very low nutrient concentrations that would pass drinking water quality standards.

All plants, including seagrasses, require light, water, and mineral nutrients, such as phosphorus and nitrogen, to grow. The required supply of nutrients for any plant population to grow is a function of the plant's relative growth rate. Plants that grow quickly require high rates of nutrient supply, while plants that grow more slowly require a lower rate of supply. As a consequence, rapidly growing plants are found where nutrient supplies are high, and slow-growing plants where nutrient supplies are low. High nutrient supplies are not necessarily bad for slow-growing plants, but at high nutrient supply rates fast growing plants can overgrow and shade out the slow growers.

In general, the size of a plant is a good indicator of its relative growth rate, with smaller plants having higher growth rates. In seagrass beds in Biscayne Bay, the fastest growing plants are the single-celled algae that live either in the water, in the sediments, or attached to surfaces, such as seagrass leaves. Filamentous algae that grow on surfaces grow slightly slower, followed by more complex macroalgaes, like the fleshy and calcareous seaweeds. Seagrasses grow even slower. Different species of seagrass have different growth rates and nutrient requirements. The narrow-bladed species widgeon grass (*Ruppia maritima*) and shoal weed (*Halodule wrightii*) grow faster than the spaghetti-like manatee grass (*Syringodium filiforme*) which in turn has a faster growth rate, and therefore higher nutrient requirements, than turtle grass (*Thalassia testudinum*). It quite common in south Florida, that nutrient supplies can be so low as to constrain the growth of even the slowest growing species (Fourqurean and Rutten 2003).

Evidence to support the relationship between growth rate and nutrient requirement come from both the distribution of seagrasses around natural nutrient "hot spots" in south Florida (Powell et al 1991) and from fertilization experiments (Armitage et al 2011, Ferdie and Fourqurean 2004). For example, the natural state of eastern Florida Bay is very low nutrient availability. However, on some of the mangrove islands in Florida Bay, there are large colonies of wading birds that hunt for food around the bay (Figure 1).

Those birds roost and nest on the islands, and bring food home to feed their young. Both adults and young defecate on the islands, causing natural point sources of nutrient supplies around these small islands. In response to this point source, nutrient availability is very high within a few meters of the islands and decreases with distance away from the mangrove shoreline. In response to this gradient, there are concentric halos of different plants growing on the bottom. Closest to the island where nutrient pollution is greatest, there is only a coating of microalgae covering the sediments. Further away from the island there is a macroalgae zone, followed by a halo of dense widgeon grass, a halo of dense shoal weed, then a zone of mixed shoal grass and dense turtle grass. Farther away still, outside the zone of influence of nutrients from the bird colony, turtle grass declines in density to very sparse coverage.

Fertilization experiments have confirmed that a change in nutrient supply first leads to a change in the density, and then the species composition, of seagrass beds in south Florida (Fourqurean et al 1995). In Florida Bay, fertilizing sparse turtle grass beds with phosphorus first results in an increase in the density of turtle grass; however, once shoal grass becomes established in the fertilized patches, it rapidly displaces the turtle grass (Figure 2). Less controlled experiments illustrate how the seagrass beds of the Florida Keys changed as the Keys became developed. Early developments relied on cesspools or septic tanks for wastewater "treatment." Neither provide nutrient removal in the rocky limestone substrate of the Keys. Thus, wastewater and stormwater nutrients emanating from the shoreline development resulted in the growth of lush seagrass beds immediately off shore of Key Largo (Figure 3). This observation could be interpreted as a "good" thing because seagrass growth and coverage expanded. However, data from other observations and experiments temper this optimism.

A model has been developed to illustrate how normally low-nutrient seagrass beds of south Florida will change as nutrient availability changes (Fourqurean and Rutten 2003, Figure 4). The model shows that seagrass beds composed of abundant turtle grass, the slowest-growing species, become lush with increased nutrient conditions. But, as nutrient supply continues to increase, the species composition gradually changes as faster-growing species replace the slower-growing ones. At the highest nutrient levels, seagrasses are replaced by seaweeds and microalgae, Loss of the seagrass community will result in a dramatic change in community structure and function. Animal species dependent on seagrass for food and shelter (e.g., speckled trout, redfish, bonefish and tarpon) are replaced by less desirable species (e.g., jellyfish). The model predicts that the

relative abundance of benthic plants at a site is an indicator of the current rate of nutrient supply. Changes in the relative abundance from slow-growing to fast-growing species at any site indicates an increase in nutrient supply.

2. The seagrasses along the coastline of the Cooling Canal System (CCS) existed for thousands of years in a nutrient-limited state, which means any addition of new nutrients changes the balance of these ecosystems. Increased nutrients harm the ecosystem by increasing the rates of primary production by marine plants. Increase in growth rates means that faster-growing, noxious marine plants, like macroalgae (seaweeds) and microscopic algae and photosynthetic bacteria, overgrow and outcompete seagrasses and corals for light, leading to the losses of corals and seagrasses.

The density and species composition of the seagrasses of southern Biscayne Bay are controlled by the availability of phosphorus. The water column in southern Biscayne Bay has very low concentrations of dissolved phosphorus, and the grand mean TN:TP ratios (ie, the ration of moles of nitrogen to the moles of phosphorus) of the water in southern Biscayne Bay average 177.9 (Caccia and Boyer 2005). When TN:TP of oceanic water is above 16 it indicates that the availability of phosphorus limits the growth of plankton (Redfield 1958). Seagrasses are more complex than phytoplankton, so that the critical ratio determining whether N or P limits plant growth for seagrasses is 30 (Fourqurean and Rutten 20013). The N:P of Turtle Grass (*Thalassia testudinum*) collected in the vicinity of Turkey Point was 88.6 in 2013, a clear indication of phosphorus limitation (Dewsbury, 2014). Fertilization experiments (Armitage et al 2011, Ferdie and Fourqurean 2004) clearly show that phosphorus fertilization of turtle grass with N:P > 80 first leads to an increase in density of turtle grass, then a replacement of turtle grass by faster-growing seagrasses, followed by a loss of seagrasses as P loading continues.

3. Around the world, there are many nutrients that can limit noxious plant growth, but most often, the nutrients that limit this growth are either nitrogen or phosphorus. In south Biscayne Bay, phosphorus is limiting to phytoplankton and macroalgae. This means that addition of phosphorus will upset the ecological balance of seagrass beds as has been exhibited in Northern Biscayne By and Florida Bay. Upsetting the balance of populations of aquatic flora and fauna by nutrient addition is a violation of Florida surface water quality standards.

As set forth in F.A.C. 62-302.520(48)(b), Nutrients, "In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna." Although there are numeric nutrient criteria for Biscayne Bay, F.A.C. 62-302.532(h), the narrative criterion still applies. F.A.C. 62-302(48)(a) states, "Man-induced nutrient enrichment (total nitrogen or total phosphorus) shall be considered degradation in relation to the provisions of Rules 62-302.300, 62-302.700, and 62-4.242, F.A.C." Because Biscayne Bay is Outstanding

Florida Waters under 62-302.700, man-induced nutrient enrichment from the FPL CCS is considered degradation, which is prohibited.

4. Current seagrass species composition and abundance data collected by ongoing seagrass monitoring programs show that there are places where Turtle Grass biomass offshore from the CCS is unusually dense compared to other areas in southern Biscayne Bay, likely as a consequence of increased P availability in the region and concentrated by the operations of the adjacent CCS The P sources are likely to be the result of Turkey Point operations that includes chemical components added for cleaning, biomass death that occurred within the CCS in 2014, and any nutrient pulled into the system from the surrounding environment that has been concentrated overtime as the freshwater evaporates away over the life of the plant.

Seagrass density data collected around Turkey Point in the late 1960's-early 1970's describe a system with very sparse turtle grass interspersed with a few slightly denser patches more than a few hundred meters offshore (Zieman 1972). In addition, long-time fisherman report that the dense Turtle Grass flats they fished further offshore near the Arsenicker Keys in the early 1970's are now devoid of seagrasses, likely because of continued P addition. In my opinion, there is an imbalance in the seagrass meadows of southern Biscayne Bay in the vicinity of the CCS, likely caused by increased P discharged from the CCS. Anecdotal statements from keen observers about the results of ongoing seagrass monitoring programs in the vicinity suggest seagrasses are denser than elsewhere along the southern coastline of Biscayne Bay.

I have begun following up these anecdotal report with scientific investigation. In 2018 we established transects within the nearshore area of Turkey Point to identify potential areas of elevated nutrient inputs as a result of the operations of Turkey Point, we added this filed season together with existing data from 2014 to establish a map that shows the influence of nutrients in surface waters of Biscayne Bay. Biscayne Bay is a phosphorus-limited ecosystem, consequently the ratios of N to P in seagrass leaves is generally greater than 85. Immediately offshore from the CCS, seagrass N:P suggests that P availability is much higher than normal Biscayne Bay background levels. And time series aerials from Google Earth show that high P in this area is related to very dense seagrasses that collapsed over the period 2010-2014. Under P pollution, normally P-limited turtlegrass (*Thalassia testudinum*) first increase in density (see dark patch in 2010, aerial figure 5), then gets displaced by progressively faster-growing species until no benthic vegetation is left at the highest P pollution levels as indicated by the bare patch in 2017, Figure 5. This has occurred in several hot spots found near the Arseniker Keys and we plan to sample the area again to better define these areas in late July of 2019.

5. The nearshore seagrass beds are incredibly efficient at removing P from the water column and storing P at vanishingly small concentrations. In fact, even 30 feet from large point-sources of P in Florida Bay, it is not possible to measure increases in P concentrations in the water column because it has all been captured by the algal and seagrass communities. This P capture causes increased plant growth and ecosystem imbalances. This imbalance first leads to an actual increase in the abundance of seagrass, but rapidly it causes a change in species composition, first to faster-growing seagrasses, then to seaweeds, then to microscopic algae.

6. Groundwater discharges along the coast of southern Biscayne Bay contain elevated concentrations of phosphorus and tritium, so that any process that causes groundwater discharge to the local seagrasses will supply the limiting nutrient (P) that upsets the balance of the ecosystem. Groundwater under the seagrass meadows of this part of Biscayne Bay contain tritium at concentrations that can only be explained by this water coming from the CCS.

P concentrations in the deeper canals offshore of the CCS and in caves offshore of Turkey Point are 10-20 times higher than the median concentrations (0.03 µM) of inorganic phosphorus in Biscayne Bay waters (Caccia and Boyer 2005). The discharge of water from the cooling canal system (CCS) into Biscayne Bay occurs intermittently through multiple hydrological connections provided by the Biscayne aquifer and its transmissive bedrock. Changed operations of the CCS since 2012 have accelerated the seepage to Biscayne Bay. (Nuttle, 2018) High concentrations of nutrients and tritium have been detected over a three year period in Biscayne Bay immediately adjacent to the CCS in deep canals and cave sites. (Martin, 2018) The highest nutrient levels occur during periods of sustained high-water levels in the CCS when the volume of water is at or near its maximum and Biscayne Bay tides are at a minimum, this occurs approximately 30% of the time (Nuttle, 2018). Preliminary sampling indicate that tritium, a tracer of water with CCS origin, are elevated in the groundwater and porewater of the seagrass supporting regions of Biscayne Bay adjacent to the CCS (see SFWMD-FPL porewater sampling report, appended to these opinions, as well as Brand 2018). Due to current changes and planned future changes in operations to try to decrease the salinity and temperature of the CCS, these conditions are expected to worsen if nutrient-laden reuse water is added to the CCS from a planned waste water treatment plant agreement with Miami Dade County as shown in Figure 6. (see Miami-Dade county Joint Participation Agreement with FPL, dated 4-10-18). Recent modeling completed by EJ Wexler indicates freshening the CCS to 34 PSU and sustaining that through the life of a new extended permit (if granted) would require additional water inputs beyond what is identified in the SEIS from the Floridan Aquifer.

7. The geology underlying the CCS and the adjacent seagrass meadows is based on limestone, which is made of calcium carbonate minerals. Calcium carbonate minerals strongly absorb orthophosphate onto their surfaces. But, respiration by plants, animals and bacteria dissolve calcium carbonate minerals, releasing the orthophosphate absorbed to the surfaces. During normal conditions, south Florida ecosystems are incredibly efficient at holding on to captured phosphorus– so much so that the impacts caused by adding P to seagrass beds in south Florida for even short periods can still be measured 30 years after the P additions. On the other hand, bacteria cause added N captured by south Florida ecosystems to be rapidly removed from those ecosystems. These facts result in P additions causing permanent and cumulative imbalances in nearshore marine waters of the Keys while N additions cause imbalances that can be corrected by the cessation of N addition.

Inorganic phosphorus strongly sorbs onto limestone minerals, retarding the transport of phosphorus through the limestone aquifer. However, the binding of phosphate to those minerals is a function of both the salinity of the groundwater (Price et al 2010) as well as the oxidation state of that groundwater (Flower et al 2017a). Both large increases and decreases in the salinity can desorb the phosphate, and make it mobile in the groundwater The seawater of Biscayne Bay and the fresh groundwater of the Biscayne Aquafer are both supersaturated with respect to limestone minerals, and therefore they will not liberate phosphate immobilized on limestone in the groundwater, but calcite will dissolve, and phosphorus will be released, where these two waters mix (Wigley and Plummer 1976). Hence, mixing of saltwater and freshwater in the aquifer can liberate phosphorus and transport it to the surface. This phenomenon explains the plant biomass and productivity increases along the coast of south Florida where brackish groundwater discharges (Price et al 2006). Further, injection of salty groundwater into freshwater aquifers through saltwater intrusion drives phosphorus release from that bedrock (Flower et al 2017b).

When saline and fresh groundwater mix in south Florida sources mix, they create a brackish water solution that dissolves calcium carbonate minerals, releasing orthophosphate stored on the surfaces of the limestone particles.

When this P-laden water reaches the surface, it will be captured by the ecosystem and cause an imbalance because it will be used by the ecosystem resulting in the growth of noxious plants (algae) which outcompete the seagrasses.

The operations of the CCS create saline water that infiltrates the groundwater and is transported and discharged under the seagrass It is my opinion that operation of the CCS has 1) carried phosphorus-polluted groundwater to near-shore surface waters through the highly porous bedrock and 2) has dissolved carbonates in that bedrock, releasing additional phosphorus that had been incorporated into that rock. As this phosphorus reaches the seagrass meadows offshore

in Biscayne Bay, it will continue to degrade the ecosystem and cause an imbalance and change the nature of the surrounding marine environment.

8. An imbalance of the seagrasses that form the near-shore habitat near the CCS in Biscayne Bay and provide the food at the base of the food chain harms the fish and wildlife that use these habitats and therefore effects fishing, recreational activities such as bird watching and other activities based on that habitat change and eventual loss.

Salinity and the abundance and species composition of Biscayne Bay's seagrass beds interact to control the types and numbers of animals that live in the area (Santos et al 2018, Zink et al. 2017). For example, Biscayne Bay's fish populations reflect the salinity regime along the shoreline, with lower salinity sites having fewer fish like bluestriped grunt, schoolmaster snapper and sailors choice, and higher densities of fishes like killifishes, than higher-salinity sites (Serafy et al 2003). Salinity variability can be as important as mean salinity along this coastline in influencing fish communities (Machemer et al 2014).

OPINIONS on the Draft Supplemental Environmental Impact Statement

Specific Concerns Regarding Estimation of Risk to Aquatic Resources

On Page 3-95, Line 9-19, the authors state their assumption that Biscayne Bay is a lagoon and that the salinity is 24-44PSU. In fact, the nearshore area of Biscayne Bay offshore of Turkey Point is currently completely blocked by the CCS from receiving fresh surface and groundwater that would naturally flow into Biscayne Bay along the entire shoreline. Historically, fresh water from inland sources would travel through the same limestone passages which now bring polluted CCS discharges into the surface waters of Biscayne Bay when conditions are right.

The historical estuarine nature of Biscayne Bay is reflected in the restoration goals of the Everglades Restoration Project Biscayne Bay Coastal Wetlands project, known as RECOVER. RECOVER calls for mesohaline conditions (10-18ppt) and clearly estuarine indicator species in the very nearshore coastal regions of Biscayne Bay. According to Biscayne National Park, at no time should salinities exceed 30 ppt in this part of the Bay. As can be seen from the environmental report card for the Everglades just published by the RECOVER group, Biscayne Bay and the southern estuaries are failing due a lack of freshwater inflow and resulting high salinities, and these operations are indirect conflict with the goals outlined in CERP.

On Page 3-96 through page 3-112, the authors describe aquatic resources at Turkey Point from the review and perspective of FPL. To my knowledge no third party or regulator has done a complete analysis of the impact of the CCS operations on aquatic resources of Biscayne Bay. Monitoring and Analysis in the bay has not been sufficient enough and needs to be expanded to

delineate the full extent of the migration of CCS water beneath and into the surface waters of Biscayne Bay and its impact on fish and wildlife completely understood. I have begun to do this by monitoring the seagrass and several years of data show alarming results. It is not advisable to issue a new license extension until this is fully understood.

Another assumption contained in this report is the idea that FPL will be capable of solving the problem of regular algal blooms within the CCS at any point in the medium –term future. The concern is that the authors may be overly optimistic about FPL's capacity to relieve the CCS of its recurring algal blooms. Page 3-99 discusses FPL's nutrient management plan and experimentation in the use of flocculants, skimming, etc. for algae control. There is little to no evidence that this nutrient management or algae control plan will be effective. Numerous previous efforts by FPL to control algal blooms using methods such as the application of copper sulfate herbicide have failed. And, such herbicides may kill the target algal species but they do nothing to reduce the phosphorus contamination that lead to the algal blooms in the first place and have the potential to cause more harm when they are exported from the CCS through groundwater.

The achievement of a seagrass target of 50% of the CCS water acreage is totally hypothetical at this time and should not be counted upon as a given. On page 3-99 the authors noted that the seagrass colonies in the CCS began to die off as a result of increased temperature and salinity levels. Seagrass bed creation is a very difficult and expensive process, and such smallscale restoration efforts with the species common to south Florida generally fail. Without addressing the drivers of seagrass loss, seagrass restoration efforts almost always fail (Van Katwijk et al 2016). Considering that subsequent to the finalization of Turkey Point's uprate in 2014 the salt concentration and temperature conditions within the CCS have risen markedly, it is possible the conditions for maintaining a healthy seagrass community no longer exists within the canals.

Furthermore, even should FPL achieve their target for seagrass coverage, there is absolutely no reason to believe that another seagrass die-off in the CCS would not occur. The phosphorus fueling these blooms will not be addressed. Considering that FPL has not shown itself capable of controlling these periodic algae blooms in the near-decade since the problem first arose, it is wholly premature to presume the emergence of a long-term solution at any point in the near future. Projections for the future impacts of the CCS system should instead assume the perpetuation of an algal-based system, with all the accompanying potential for nutrient pollution such a scenario entail.

Specific Concerns Regarding Estimation of Risk to Special Status Species and Habitats

As stated in the preceding paragraph there is a concern that the report did not delve into the possibility of seagrass habitat degradation as a potential result of continued operation of the CCS. I am concerned that the Generic Environmental Impact Statement does not properly recognize the importance of the seagrasses of the region to the east of the CCS, even though

these plants form the basis of the essential fish habitat near Turkey Point, described on pages 3-112 and 3-113. Further, while the potential for impacts of cooling canal operations on emergent salt tolerant vegetation is recognized and assessed beginning on page 4-24, this general assessment only applies to saltmarsh vegetation. Herbaceous saltmarsh vegetation, however, is rare surrounding the Turkey Point CCS, while emergent woody vegetation (mangroves) and submerged herbaceous plants (seagrasses) are quite common. These special plant communities deserve a proper consideration because such consideration could change the conclusions of the GEIS. I believe we are recognizing environmental degradation of the seagrasses offshore of the CCS, as detailed above. Recent data (Miami Dade DERM) and modeling runs (done by E. J. Wexler) suggest that the input of heated water at the north end of the CCS is so great that water not only flows south into the CCS as designed, but also flows north, through the mangrove forest and into Biscayne Bay to the northeast of the CCS. There is evidence that this water is causing harm to the mangrove forests visible on Google Earth aerial images, and I believe that we can also see the footprint of this water in the enhanced P content of seagrasses along the shore (Figure 5).

Nutrient-loaded CCS water can have pronounced negative impacts on the ecological resources of Biscayne Bay. Phosphorus pollution specifically is a major concern arising from these discharges. The average concentration of phosphorous measured in the CCS canals is 0.035 mg/l, which is five times the numerical criteria for phosphorous in the south-central inshore region of Biscayne Bay, 0.007 mg/l. Concentrations in the deeper canals offshore of the CCS and in caves offshore of Turkey Point are 10-20 times higher than the median concentrations (0.006 mg/L) of inorganic phosphorus in Biscayne Bay waters. However, a major issue may also exist in the form of legacy phosphorus sorbed onto limestone over the course of many decades of CCS operations. Phosphorus strongly sorbs onto limestone minerals, retarding the transport of phosphorus through the limestone aquifer. However, the binding of phosphate to those minerals is a function of both the salinity of the groundwater as well as the oxidation state of that groundwater. Both large increases and decreases in the salinity can desorb the phosphate, and make it mobile in the groundwater. 'Freshening' activities which will serve to flush additional CCS water into the surrounding channels could provide the catalyst for desorption and transport into Biscayne Bay Surface Waters .

The seagrass beds of Biscayne Bay require very low nutrient loading in order to remain stable and healthy. Phosphorus concentration is the principal limiting factor in the seagrass beds and benthic communities of Southern Biscayne Bay as the Surface waters of Biscayne Bay are naturally low in concentrations of dissolved phosphorus. Experiments have confirmed that a change in nutrient supply first leads to a change in the density, and then the species composition, of seagrass beds in south Florida. Seagrass beds first experience increased density, then displacement. At the highest nutrient levels, seagrasses are replaced by seaweeds and microalgae.

Unfortunately, it can be exceedingly difficult to accurately assess phosphorus contamination using traditional sampling methods. Seagrass beds are incredibly efficient at removing phosphorus from the water column and storing it at vanishingly small concentrations. In fact, even 30 feet from large point-sources of phosphorus in Florida Bay, it is not possible to measure increases in phosphorus concentrations in the water column because it has all been captured by the seagrass communities. Although these phosphorus discharges are difficult to detect, they are nonetheless incredibly impactful, causing increased plant growth and ecosystem imbalances first resulting in increased abundance, then displacement and potential collapse.

I submitted this updated report on June 24, 2019.

Signed:

James W. Fourqurean, Ph. D.

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QUALIFICATIONS

My resume is attached hereto and contains my qualifications and a list of all publications that I have authored.

PRIOR TESTIMONY

During the past 4 years, I have participated in the following cases:
(1 deposition and 1 administrative hearing)

STATE OF FLORIDA
DIVISION OF ADMINISTRATIVE HEARINGS — Case No. 15-1233
MIKE LAUDICINA; DON DEMARIA; CUDJOE GARDENS PROPERETY OWNERS ASSOC. INC.; AND SUGARLOAF SHORES PROPERTY OWNERS ASSOC., INC.,
PetitionerS,
vs.
FLORIDA KEYS AQUADUCT AUTHORITY AND DEPARTMENT OF ENVIRONMENTAL PROTECTION,
Respondents.

I gave deposition in this case on October 14, 2015 at Veritext Legal Solutions, 2 South Biscayne Blvd., Suite 2250, Miami, FL 33131

STATE OF FLORIDA — Case No. 14-5302
DIVISION OF ADMINISTRATIVE HEARINGS
LAST STAND (PROTECT KEY WEST AND THE FLORIDA

KEYS,b/d/a LAST STAND, AND
GEORGE HALLORAN,
Petitioners,
vs.
KET WEST RESORT UTILITIES
CORPORATION, AND STATE OF
FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION,
Respondents
_____________________________/

The final hearing in this matter was held on April 21-May1, 2015 at the Freeman Justice Center, Conerence Room A, 302 Fleming Street, Key West, Florida, before Cathy M. Sellers, an Administrative Law Judge of the Division of Administrative Hearings ("DOAH").

FIGURES

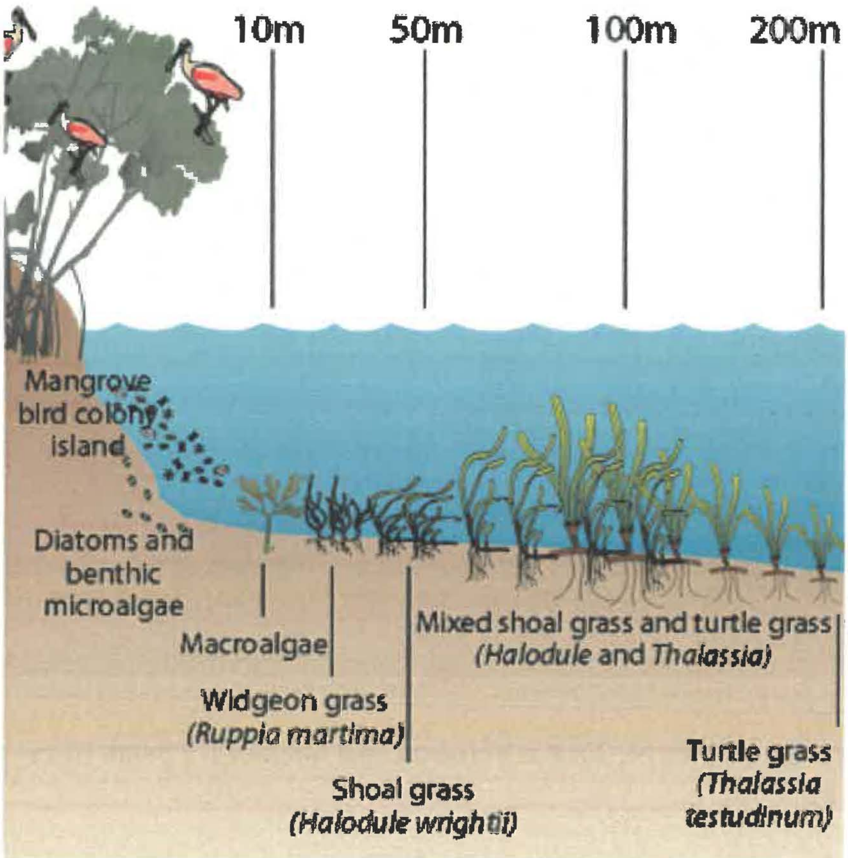


Figure 1. Islands with large bird colonies in Florida Bay are natural nutrient sources that cause zonation of the benthic habitat, with fast-growing microalgae dominant near the nutrient source and slow-growing turtle grass dominant far from the nutrient supply. See Powell et al 1991. Figure reproduced from Kryczynski and Fletcher 2012, page 276.

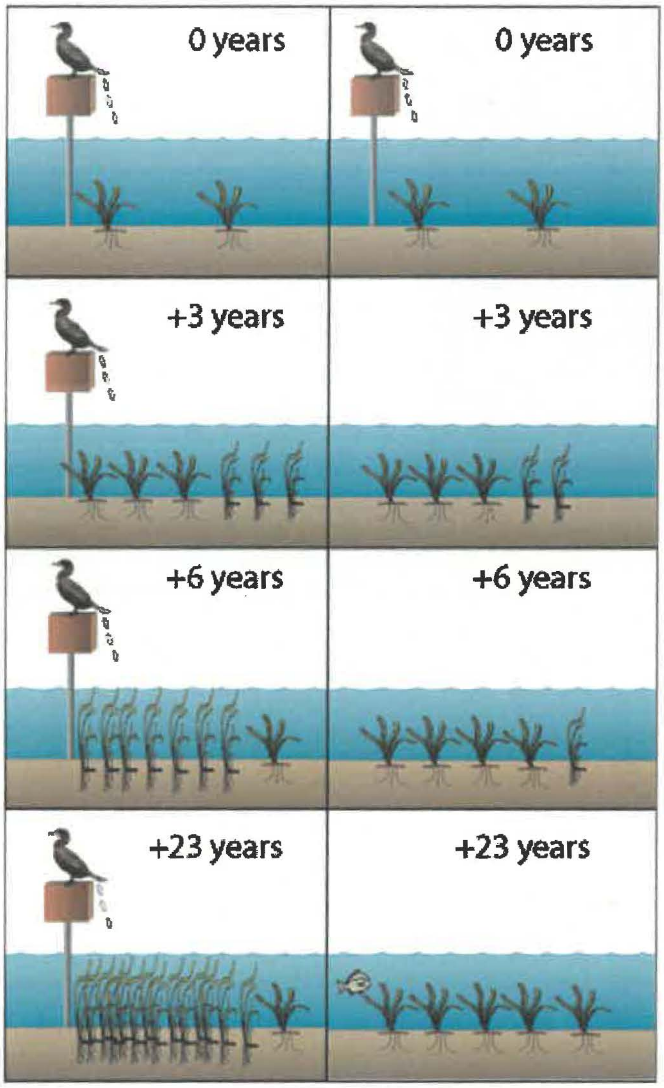


Figure 2. Artificial bird perches have been used to study the effects of nutrient additions to nutrient-limited seagrass beds in south Florida (Fourqurean et al 1995). Fertilization initially leads to more turtle grass, but that turtle grass is replaced by faster-growing shoal weed (left column). Short term fertilization has impacts that last for decades (right column). Figure reproduced from Kryczynski and Fletcher 2012, page 276.

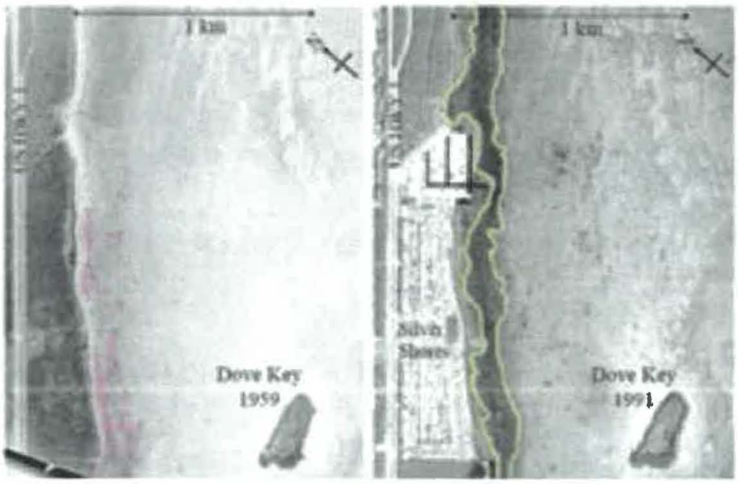


Figure 3. Seagrass distribution along the shoreline of Key Largo near Dove Key in 1959 (left) and 1991 (right). Prior to development, seagrass coverage was sparse along the shoreline. However, by 1991 seagrass coverage and density increased substantially along the shoreline in response to nutrients emanating from development. Figure reproduced from Kryczynski and Fletcher 2012, page 277.

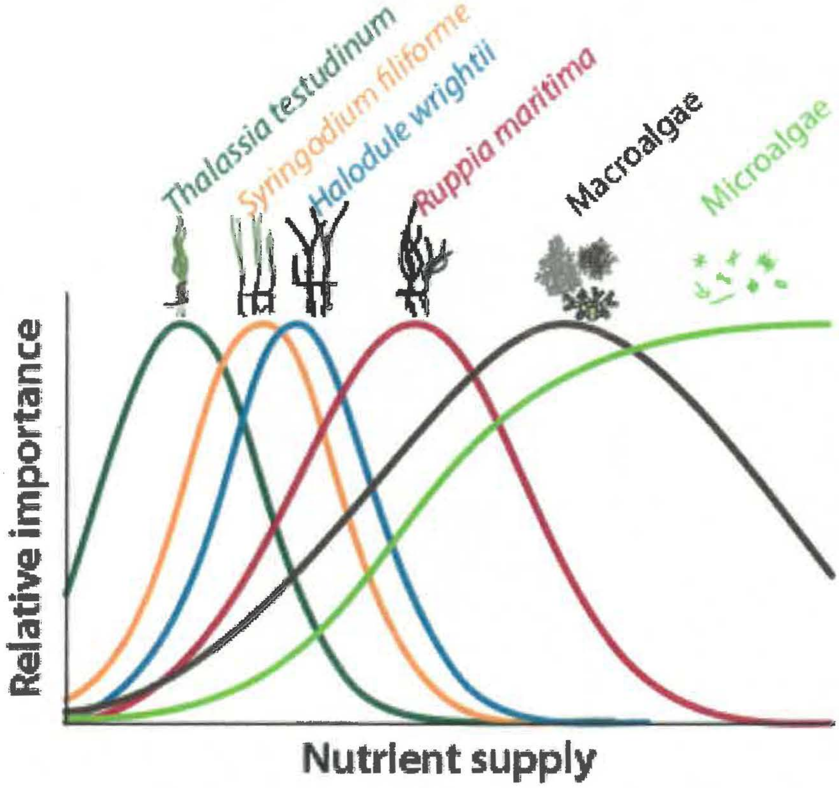


Figure 4. This model describes how the dominant organisms from shallow Biscayne Bay change with addition of nutrients. Nutrient supply can increase either with an increase in concentration OR and increase in volume of nutrient sources. This figure is based on Fourqurean and Rutten (2003) and is reproduced from Kryczynski and Fletcher 2012, page 276.

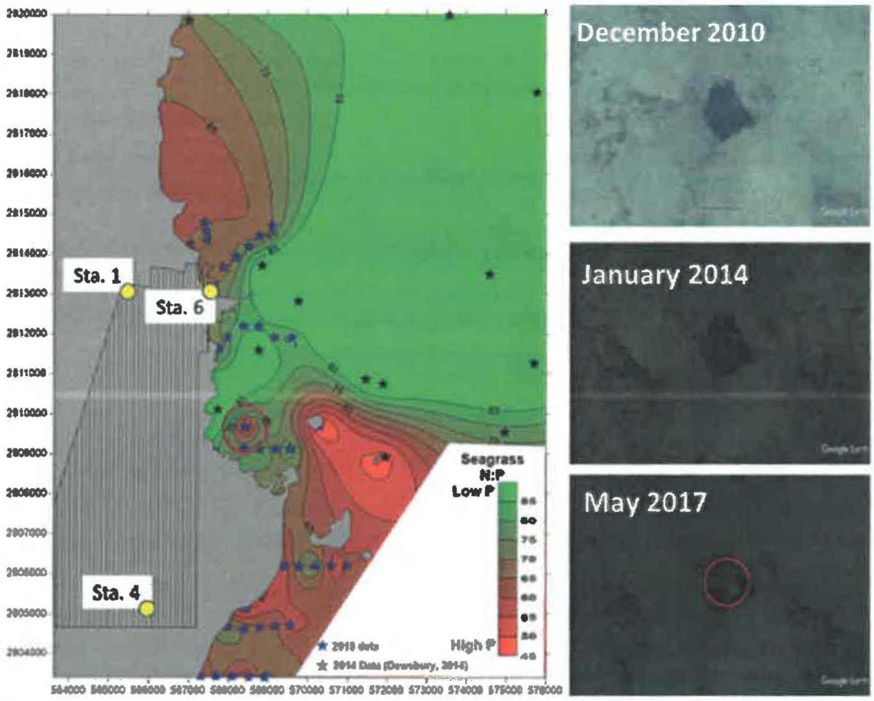
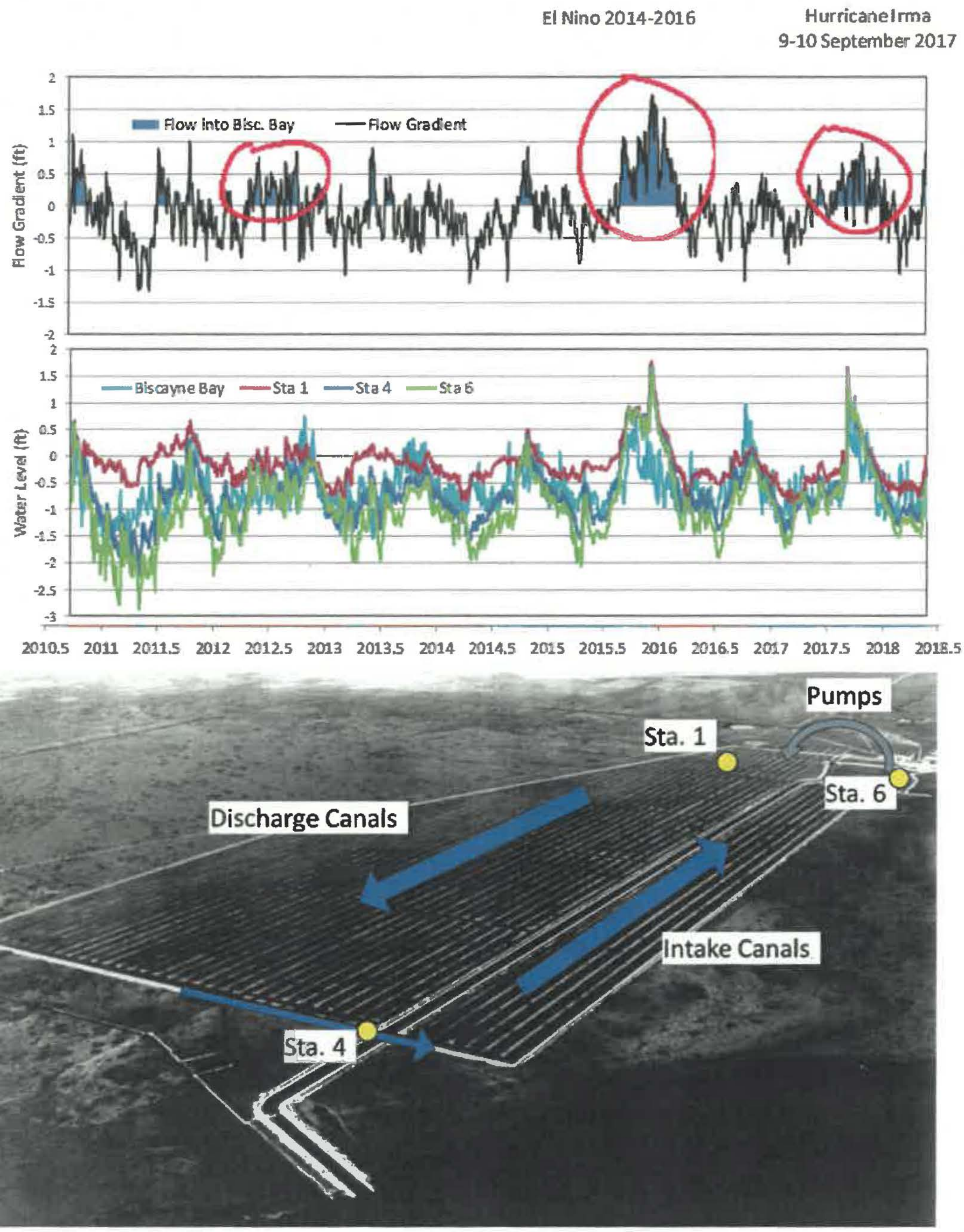


Figure 5. Biscayne Bay is a phosphorus-limited ecosystem, consequently the ratios of N to P in seagrass leaves is generally greater then 85. Immediately offshore from the CCS, seagrass N:P suggests that P availability is much higher than normal Biscayne Bay background levels. And time series aerials show that high P in this area is related to very dense seagrasses that collapsed over the period 2010-2014. Under P pollution, normally P-limited turtlegrass (Thalassia testudinum) first increase in density (see dark patch in 2010 aerial), then gets displaced by progressively faster-growing species until no benthic vegetation is left at the highest P pollution levels. Note the opening up of bare areas in the dense patch by 2017. (Froquean, et al 2019)



Cooling canals showing general circulation and locations of water level data.
[Image source: https://commons.wikimedia.org/wiki/File:HD.6B.314_(11842469035).jpg]

Figure 6. Detailed information on the water quality and salt budgets, the result of 10 years of in-depth monitoring by multiple agencies, reveals how the cooling canals interact with the Biscayne aquifer and Biscayne Bay. Miami Dade DERM's multi-year water quality monitoring data revel that discharge from the CCS into the surface waters of Biscayne Bay is occurring and those high levels of nutrient are violating Numeric Nutrient Standards as well as narrative water quality

standards meant to protect Biscayne Bay, a historically nutrient poor system. On average, there is a net inflow of groundwater into the canals to help balance water loss due to high rates of evaporation. However, significant outflows of water from the cooling canals also occurs in response to the variation in water levels in space and over time. Under normal operations, pumps circulate water through the power plants. This draws down water level in the intake canals (Sta. 6) and raises water level where the pumps discharge into the canals (Sta. 1). The difference in water level between Sta. 1 and Sta. 6 drives flow down the discharge canals and up the intake canals back to the plants. Elevated water level at Sta. 1 drives the outflow of hypersaline water down into the aquifer. (Nuttle et al, 2019)

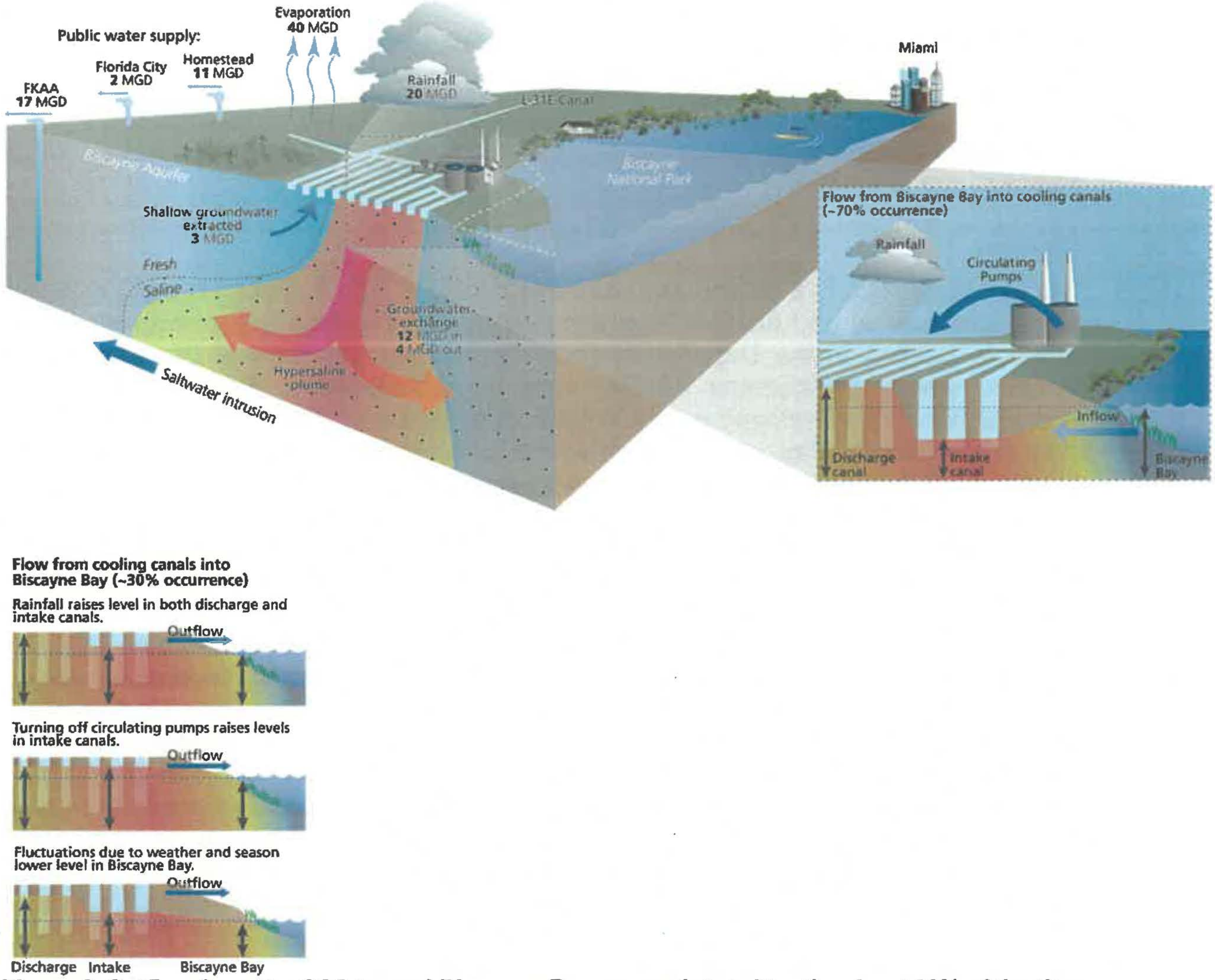


Figure 6. Outflow from the CCS toward Biscayne Bay occurs intermittently, about 30% of the time, in response to heavy rainfall, plant operations including additional water inputs from remediation, and fluctuations in Biscayne Bay water levels, which occur in response to weather and seasonal changes in sea level. This open system is completely dependent upon weather patterns and is vulnerable in the future because it is at sea-level, dependent on rainfall and regional water availability and carved into porous limestone that communicates with surface waters of the US that are protected. (Nuttle, 2018)

Curriculum Vitae
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Profile
James Fourqurean is a marine and estuarine ecologist with a special interest in benthic plant communities and nutrient biogeochemistry. He received his undergraduate and graduate training in the Department of Environmental Sciences at the University of Virginia, where he became familiar with the Chesapeake Bay and its benthic communities. He developed a love of tropical ecosystems while doing his dissertation research in Florida Bay. After a post doc at San Francisco State studying planktonic processes in Tomales Bay, California, he was recruited to return to south Florida to join a new research group at the newest research university in the country, Florida International University. He has at FIU since 1993, where he is now Professor of Biological Sciences and the Director of the Center for Coastal Oceans Research in the Institute for Water and Environment. For the past three decades, his main research areas have been in the seagrass environments of south Florida, but he has also worked in coastal environments around the Gulf of Mexico, in Australia, Indonesia, Mexico, Panama, Bahamas, Bermuda, the United Arab Emirate and the western Mediterranean. He is the lead scientist and overall manager of FIU's Aquarius Reef Base, the world's only saturation diving habitat and laboratory for research, education and outreach. He has served as the Principal Investigator of over $25M in grants and contracts at FIU, and published 127 papers in the refereed scientific literature and 13 book chapters. Seven graduate students have received PhD degrees working under his direction, along with 15 MS students. His global leadership in coastal oceans research was recently recognized when he was elected President of the Coastal and Estuarine Research Federation, the world's leading body of scientists who study coastal issues.

Education
Ph.D.	1992	University of Virginia, Department of Environmental Sciences
M.S.	1987	University of Virginia, Department of Environmental Sciences
B.A.	1983	University of Virginia, Depts of Biology and Environmental Sciences

Career Summary
2006-	Professor, Department of Biological Sciences, Florida International University
2017 -	President-elect, Coastal and Estuarine Research Federation
2014 -	Adjunct Professor, School of Plant Biology, University of Western Australia
2014	Visiting Research Fellow, Oceans Institute, University of Western Australia
2012-	Director, Center for Coastal Oceans Research, Institute of Water and Environment, Florida International University

2012- Director, Center for Coastal Oceans Research, Institute of Water and Environment, Florida International University
2012- Visiting Research Fellow, Oceans Institute, University of Western Australia
2002 - 2006 Chair, Department of Biological Sciences, Florida International University
2001 - 2002 Visiting Professor, Institut Mediterrani d'Estudis Avançats, CSIC-Universitat des Illes Balears, Esporles, Mallorca, Spain
1998 - 2006 Associate Professor
1993 - 1998 Assistant Professor, Department of Biological Sciences and Southeast Environmental Research Center, Florida International University
1992 Postdoctoral research associate, San Francisco State University
1983 - 1992 Graduate research assistant, University of Virginia. J.C. Zieman, advisor.
1983 - 1987 Research biologist, National Audubon Society

Scientific Publications

Scientific Journals

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Exhibit C

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY & LICENSING BOARD

	)	
In the Matter of	)	Docket Nos. 50-250 & 50-251
	)	
FLORIDA POWER & LIGHT COMPANY	)	ASLBP No. 18-957-01-SLR-DB01
	)	
(Turkey Point Nuclear Generating Station,	)	June 24, 2019
Unit Nos. 3 and 4)	)	
	)	
(Subsequent License Renewal Application)	)	

DECLARATION OF E.J. WEXLER IN SUPPORT OF THE FRIENDS OF THE EARTH, NATURAL RESOURCES DEFENSE COUNCIL & MIAMI WATERKEEPER

I, E.J. Wexler, P.Eng. (Ontario), being competent to provide this Declaration, declare as follows:

1. I am a hydrogeologist with over expertise in groundwater modeling. I hold a Masters' Degree in Civil Engineering, a M.S. in Earth Sciences, and a B.E. in Civil Engineering. Since 2002, I have been Director of Modeling Services for Earthfx, Inc., where I lead a team of surface water and groundwater modelers. A copy of my curriculum vitae is attached as Attachment B.
2. I have been retained by Friends of The Earth, Natural Resources Defense Council & Miami Waterkeeper to offer a declaration in this proceeding. A copy of my report is offered as Attachment A.
3. Previously, I was retained by Southern Alliance for Clean Energy, Tropic Audubon Society, and Friends of the Everglades as an expert witness in Southern Alliance for Clean Energy, et al. v. Florida Power & Light Company, No. 1:16-cv-23017-DPG in the United States District Court for the Southern District of Florida, Miami Division ("CWA Lawsuit"). In that lawsuit, the plaintiffs allege that Florida Power & Light Co. ("FPL") has violated and is violating the federal Clean Water Act by discharging pollutants from the Turkey Point Units 3 and 4 nuclear reactors, including nutrients, hypersaline water and other chemical and radioactive contaminants, into waters of the United States in the Biscayne Bay and into the Biscayne Aquifer in violation of FPL's CWA permit. On May 14, 2018, I submitted an Expert Report in the CWA Lawsuit regarding the adequacy of FPL's groundwater models to predict the behavior of the body of hypersaline water introduced into the Biscayne Aquifer by the Turkey Point cooling canal system ("CCS").
4. The facts in my Expert Report (Attachment B) are true and correct to the best of my knowledge, and the opinions expressed in my Expert Report are based on my best professional judgment.

I declare under penalty of perjury under the laws of the United States that the foregoing is true to the best of my knowledge.

Eliezer J. Wexler

7/25/2018

Executive Summary

Evaporation from the Florida Power and Light (FPL) Cooling Canal System (CCS) has increased the salinity of the CCS water to values as high as 90 practical salinity units (PSU) or almost three times that of seawater. This hypersaline water has seeped out through the unlined canals, entered the underlying Biscayne Aquifer, and due to its higher density, the hypersaline water has moved to depth in the aquifer and formed a large body of hypersaline groundwater. Field studies have confirmed that high salinity groundwater has migrated westward of the CCS. Results of recent groundwater modeling analyses by Tetra Tech (2018) have also confirmed that migration of saline water from the CCS over a 45 year period was the prime contributor to the presence of a large body of hypersaline groundwater and observed changes in the location of the freshwater/saltwater (FW/SW) interface.

Under a 2016 consent order between FPL and the Florida Department of Environmental Protection (FDEP), FPL is required to maintain the average annual salinity of the CCS at or below 34 PSU, halt the westward migration of hypersaline water from the CCS, and reduce the westward extent of the hypersaline plume to the L-31E Canal within 10 years. A recovery well system consisting of 10 deep groundwater extraction wells has been installed along the western edge of the CCS with the intent of retracting the hypersaline water. The draft supplemental environmental impact statement (SEIS) has accepted analyses by Tetra Tech (2016a) that the recovery system will achieve this objective.

It was noted that the Tetra Tech analyses assumed that the CCS would be maintained at 34 PSU for the duration of the recovery period. New water quality information shows that FPL was unable to achieve freshening (i.e., reducing average salinity) within the CCS despite the addition of an average of 12.8 million gallons per day (MGD) of brackish water from the Upper Floridan Aquifer to the CCS from November 2016 to May 2017, salinities in the CCS did not go down to 35 PSU (FPL 2017a); rather, average salinity concentrations in the CCS were 64.9 PSU in May 2017 (FPL 2017b). My analysis using the Tetra Tech model shows that without freshening the CCS, the recovery system will not be able to meet the target of retracting the hypersaline water. My analysis also points out other limitations in the Tetra Tech analyses and the reliability of the model predictions. We also present results from a new, independently developed model that examines processes within the CCS and indicates that freshening of the CCS will be difficult to achieve with the volumes of water currently being used and the locations selected for adding the water.

My opinions are based on data regarding the hydrogeology, hydrology, and water quality of both surface water and groundwater in the South Dade area available to me as of May 2019, and on my prior numerical modeling studies conducted by myself in the vicinity of the CCS and on reviews of modeling work prepared by Tetra Tech on behalf of FPL.

Background:

Cooling Canal System and Hypersaline Plume

The Florida Power and Light (FPL) Cooling Canal System (CCS) is a "closed loop" system that originally contained seawater from Biscayne Bay. The canals are not lined and the system interacts with the underlying groundwater. Inputs into the canals include treated process water, rainfall, stormwater runoff, and groundwater infiltration. Losses include evaporation and seepage from the canals. Over time, evaporation has increased the salinity of the CCS water to values as high as 90 practical salinity units (PSU) or almost three times

that of seawater. During the same period, this water entered the underlying Biscayne Aquifer. Due to its higher density, the hypersaline water has moved to depth in the aquifer and formed a body of water with elevated concentrations that has migrated westward of the CCS. The extent of the hypersaline water in the Biscayne Aquifer has been confirmed by water quality samples from monitoring wells and electromagnetic mapping (EM) surveys (e.g., FPL, 2018, Appendix G).

A consent order (Florida Department of Environmental Protection, 2016) between FPL and the FDEP requires FPL to add water from alternative sources to maintain the average annual salinity of the CCS at or below 34 PSU, halt the westward migration of hypersaline water from the CCS, and reduce the westward extent of the hypersaline plume to the L-31E Canal within 10 years. FPL constructed five wells to extract up to 15 MGD of brackish water (2.5 PSU) from the Floridan Aquifer with the bulk of the water used to freshen the CCS (i.e. reduce average CCS salinity). A groundwater recovery well system consisting of 10 deep extraction wells, located along the western edge of the CCS, was constructed and went into operation in May 2018. The wells extract water near the base of the Biscayne Aquifer at a permitted rate of 14 MGD. The water is disposed of through a deep injection well.

Modeling the Extent of the Hypersaline Plume

A key aspect of the draft supplemental environmental impact statement (SEIS), from a groundwater perspective, is the discussion of the results of groundwater modeling studies conducted related to (1) assessing the historic impacts of the CCS on the water quality in the Biscayne Aquifer and (2) the likely effectiveness of proposed recovery wells in retracting the zone of hypersaline water back to the CCS and retracting the freshwater/saltwater (FW/SW) interface back from its current position.

With respect to historic impacts, the draft SEIS cites Hughes et al. (2010), who evaluated the combined effects of salinity and temperature and other variables associated with operation of the CCS and demonstrated that hypersaline water would move downward beneath the CCS to the bottom of the of the Biscayne Aquifer in a period ranging from days to several years. The modeling also indicated that the inland migration of the FW/SW interface, to the west of the CCS, was closely related to high total dissolved solids (TDS) levels. The Hughes et al. (2010) model was mainly intended to demonstrate the likely fate of hypersaline discharge from the CCS and did not attempt to relate the movement to any other factors affecting the FW/SW interface in the area. Tetra-Tech adopted the Hughes et al. (2010) model and used it in early analyses (prior to 2016) of hypersaline water from the CCS.

I independently developed and calibrated a three-dimensional density-dependent groundwater flow/solute transport model for the area surrounding a rock quarry close to the FPL site (Earthfx 2012, 2014). A significant effort was directed to recreating the hydrologic history of the South Dade area starting in 1945 to the present and on representing the migration of the FW/SW interface over time. There was also an effort made to incorporate measured values of aquifer properties based on U.S. Geological Survey (USGS) studies (e.g. Fish and Stewart, 1991 and Merritt, 1997). While the primary focus of the modeling effort was to examine the impact of the quarry development on the position of the FW/SW interface, simulations showed that since its inception, the CCS was the key influence on the migration of the freshwater/saltwater in the Model Lands area. As salinities in the CCS have increased over time, there was a corresponding westward migration of the FW/SW toward the quarry. This more detailed work confirmed the results of the Hughes et al. (2010) simulations and was later shown to be in good agreement with field data from wells and EM surveys.

The Tetra Tech (2016a) model closely followed the implementation of the Earthfx work but differed in critical areas that limit its effectiveness as a predictive tool especially in the western part of their model. Earthfx conducted a critical review of the Tetra Tech (2016a) model (Earthfx 2017). In particular, the Tetra Tech (2016a) model did not honor observed regional values but applied local values from on-site testing uniformly across the South Dade area. Changes were made to improve the model calibration as documented in subsequent reports (Tetra Tech, 2016b, 2017c) but these are not cited in the draft SEIS and still did not did not honor observed regional values. Updates to the recovery well analysis made using the revised models were not conducted or have not been presented. We have focussed our analysis on the adequacy of the model and the reliability of the model in light of new information on water quality in the study area.

Finally, Tetra-Tech updated the model for a 2018 "attribution analysis". Additional changes were made with significant modifications to the hydraulic conductivity values used in the model. Model results demonstrated that the CCS was the prime contributor to changes in the location of the FW/SW interface, confirming earlier results by Earthfx. Updated analyses of the effectiveness of the recovery wells based on the Tetra Tech (2018) model were not conducted or have not been presented.

Analysis of Recovery Wells in Light of New Evidence.

A common point in the modeling analyses discussed above, especially the new 2018 attribution analysis, is that the extent of the hypersaline plume is the result of about 45 years of seepage from a very large contributing body (the CCS). For remediation efforts to be successful, they should be based on a similar spatial scale and time frame. Retracting the hypersaline plume in a highly permeable aquifer with a limited number of wells in a 10 year period will be a considerable challenge. The draft SEIS, however, simply accepts the FPL statement that "that operation of its recovery well system will achieve retraction of the plume back to the FPL site (i.e., Turkey Point site) boundary within 10 years, as required by the 2016 consent order with FDEP". This conclusion was based on the Tetra Tech (2016a) modeling of a recovery system with 10 deep wells spaced about 4000 ft apart along L-31 west of the site. The modeling results for the recovery well system predicted retraction of the westward plume to the edge of the CCS by about 5 years and complete retraction within 10 years, with minor aquifer drawdown impacts.

The Tetra Tech (2016a) modeling has some serious flaws that are especially critical in light of new water quality information showing that FPL was unable to achieve freshening of the CCS even with the addition 10 to 15 MGD of brackish water from the Floridan aquifer. [Specifically, new water quality information shows that FPL was unable to achieve freshening of the CCS even with the addition of an average of 12.8 MGD of Upper Floridan aquifer brackish water to the CCS from November 2016 to May 2017, salinities in the CCS did not go down to 35 PSU (FPL 2017a), at the end of May 2017, average salinity concentrations in the 25 CCS were 64.9 PSU (FPL 2017b)]. Most significantly, the Tetra Tech (2016a) simulations of the recovery wells included the assumption that TDS in the CCS would be brought down to 35 PSU at the outset of recovery well operations.

To test the effect of not being able to achieve the 35 PSU target, I first conducted separate simulations with and without the remedial pumping using the Tetra Tech (2017) model (the most recent model files for Alternative 3D provided by FPL for review). The results indicated that much of the change in the area west of the CCS was due to freshening of the CCS rather than the pumping.

Additional simulations with the FPL model and no freshening of the CCS (i.e. the CCS remains at 60 PSU) resulted in hypersaline water continuing to move west of the CCS. Results showing the simulated relative chloride levels

in Layer 8 (the "Lower High Flow zone" in the Tetra Tech (2016a) model) for the baseline conditions (pumping and freshening) are shown in Figure 1. The 1.0 relative salinity contour represents seawater salinity and is mostly near the CCS boundary. Results without freshening are shown in Figure 2 and show the 1.0 contour as much as 12,000 ft west of the CCS. These results indicate that, without being able to achieve freshening at the current time or in the future, the retraction of the hypersaline water is not likely to occur without the addition of more wells and increased pumped volumes. More analysis would be required to determine whether the additional withdrawals would have harmful effects and the additional water may, therefore, be unavailable. Thus despite the considerable lead time cited in the draft SEIS, groundwater remediation and improvement may not be possible prior to the subsequent period of extended operations without significant changes to the CCS operations and recovery well system.

It should be also be noted that the FPL models (Tetra Tech, 2016a, 2016b, and 2017) showed that pumping would not pull the hypersaline plume back in the deeper layers (e.g., model Layer 10 near the aquifer base) within the 10 year period despite that pump screens being located in the deep layers. Figure 3 shows the simulated concentrations in the Layer 10 after 10 years of pumping and freshening. The concentrations within and west of the CCS remain above sea water concentrations. These results indicate again that meeting the 2016 consent order with FDEP is not achievable with the number of wells and pumping volumes proposed.

As was noted above, the Tetra Tech (2017) model was changed significantly for the 2018 attribution assessment but the recovery wells analysis was not updated or reported. If this model represents an improved understanding of the area, there is a need to verify that the proposed recovery system can meet its design objectives.

In particular, the horizontal hydraulic conductivity values have been changed from the previous (2017 update) model, with the newer values being generally higher. The spatial distribution of the high and low hydraulic conductivity values within Layer 8 (the most permeable layer) has been altered significantly. The zone of high hydraulic conductivity in the southwest part of the CCS (centered between TPGW-2 and TPGW-17) (shown in Figure 4) has been removed and relatively low values are assigned below the CCS and to the west in the 2018 model (Figure 5). This results in reduced westward migration of hypersaline water in the 2018 analyses. Layer 8 contributes the most to the transmissivity of the Fort Thompson Formation (the high permeability unit forming the principal part of the Biscayne Aquifer) and significant changes in transmissivity of this unit can be seen. Figure 6 shows the transmissivity of the Fort Thompson Formation (model Layers 3 to 11) in the Tetra Tech (2017) model (Figure 7), in thousands of ft^2/d with a zone of high transmissivity within the southwestern part of the CCS. Figure 8 shows the transmissivity of the Fort Thompson Formation with the high transmissivity zone absent. Transmissivities west of Card Sound Road are generally higher in the 2018 model but still well below the observed values (e.g., Fish and Stewart, 1991 or Hughes and White, 2014).

The spatial distributions of hydraulic conductivity in the 2017 and 2018 Tetra Tech models are based on the use of the pilot point technique for automated parameter estimation, a technically advanced and accepted method. It should be recognized that the method can easily accommodate known values in the interpolation of hydraulic conductivities, such as data from Fish and Stewart and other sources, but this was not done by Tetra Tech. As well, the number of pilot points used (16) is extremely small for a study area of this size and with the known high degree of spatial heterogeneity. This partly explains the large shifts in property values between model versions. These deficiencies need to be examined further as they can compromise the effectiveness of the model to be used in the analysis of recovery wells.

The earlier model (Tetra Tech, 2016a) did not simulate ET processes directly. Instead, a net recharge was calculated as the recharge rate minus ET. However, recharge rates were set to zero when ET exceeded recharge (Tetra Tech, 2016a). This negated the effect of groundwater ET processes that, at times, reversed the natural eastward flow in the Model Lands area and facilitated the westward movement of hypersaline water from the CCS. The 2018 model now simulates groundwater ET when ET exceeds recharge. The analysis of recovery well performance should be updated to see if the retraction of the plume can still be achieved in light of the increased ET rates.

Recharge and evaporation rates were set to zero over the CCS in the Tetra Tech (2016a) model and these processes are not simulated. Instead, the water levels and concentrations in the CCS were specified as boundary conditions based on external water budget model calculations, a process that can lead to inconsistencies. As well, because of the large size of the CCS, the linear geometry of the berms and canals, and the placement of flow restriction measures, mixing of water in the CCS may not be uniform, as is assumed in the Tetra Tech model.

As part of this review, Earthfx developed a more refined model of the study area that attempted to better represent flow in the CCS and the effect of evaporation and adding water to the CCS. Key features of the model are described in a draft report (Earthfx, 2019). Simulations of future conditions were conducted with flow in the CCS, evaporation, and the introduction of 10 MGD of Floridan water and 14 MGD from the recovery wells. The recirculation of water option was used in SEAWAT to estimate the concentrations of the recovery well water and to represent the recirculation of water through the plant. Concentrations vary over time from the starting conditions (about 1.71 relative salinity (60 PSU)) and reach a relative equilibrium by 2028. Simulated concentrations are shown in Figure 8 and indicate that placement of the Floridan and recovery water along the west side of the CCS has helped in preventing movement of the hypersaline water over most of the western boundary of the CCS but the bulk of the CCS is still hypersaline and a breakout zone occurs in the northeast corner due to the higher water levels in that area.

While the Earthfx model differs from the Tetra Tech (2016a) model, the results indicate that more analysis is required to understand the dynamics of CCS and the effects of where freshening water is applied. The current spreadsheet water balance model used is in the FPL environmental report is not adequate for this analysis.

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Figures

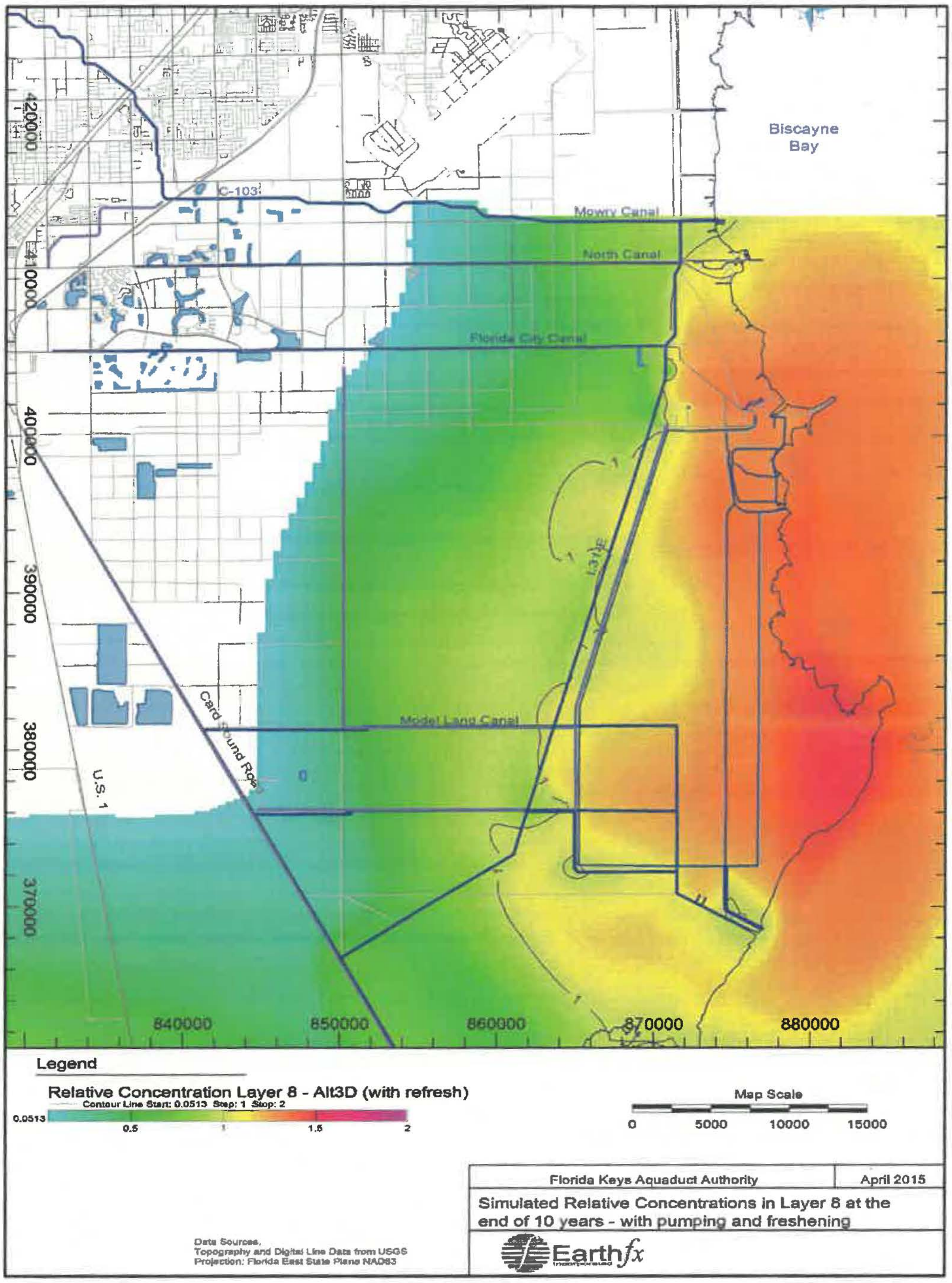

Figure 1: Simulated relative salinity values (with 1.0 equivalent to seawater) in Tetra Tech (2017) model Layer 8 (the "Lower High Flow zone") after 10 years of pumping the recovery wells and with freshening of the CCS to 35 PSU (relative salinity of 1). Note that the 1.0 contour has generally drawn close to the CCS boundary, that the relative salinity beneath the CCS is still above 1.0, and that there is a zone of higher salinity outside the northwest corner of the CCS.

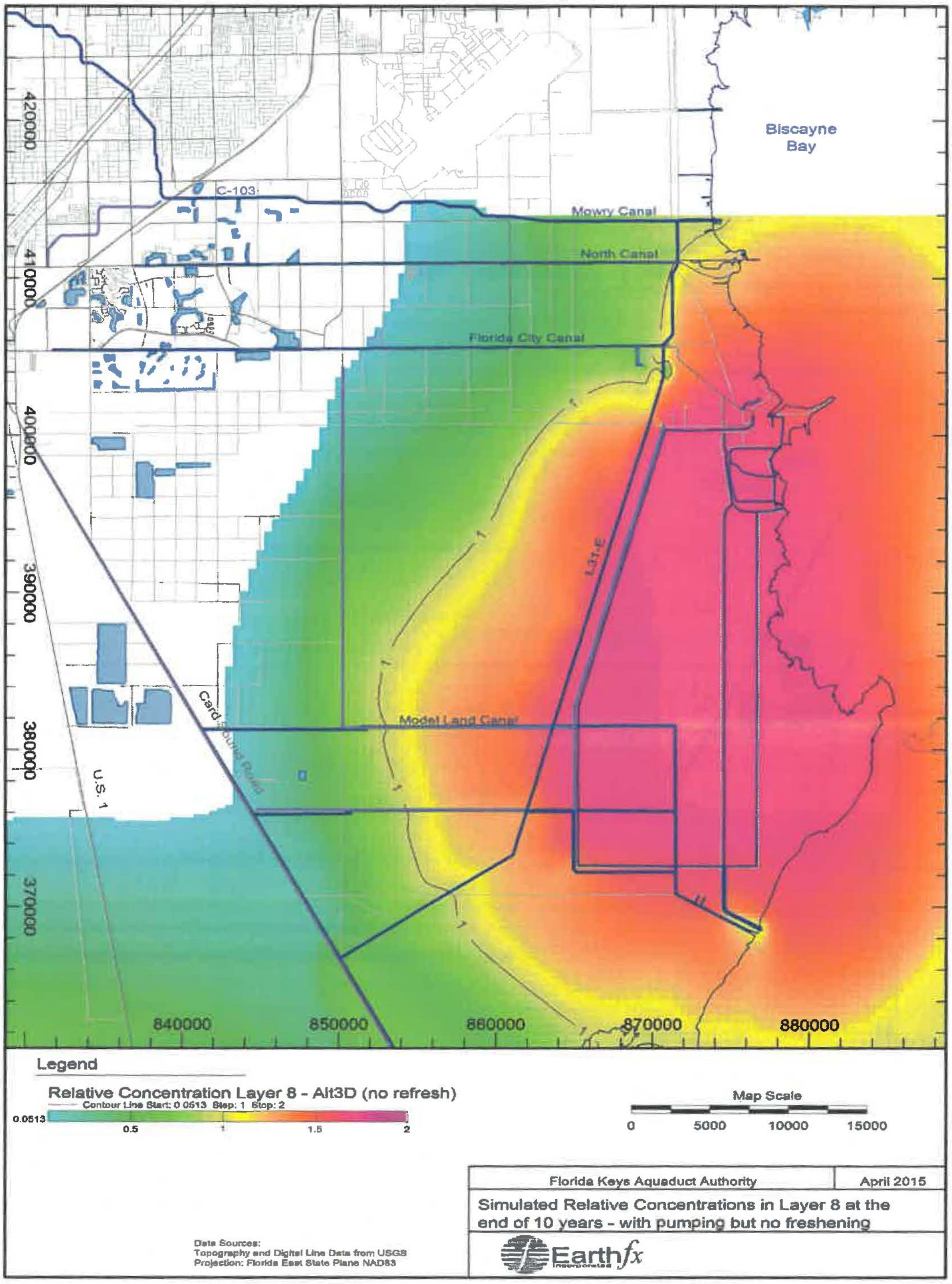

Figure 2: Simulated relative salinity values (with 1.0 equivalent to seawater) in Tetra Tech (2017) model Layer 8 (the "Lower High Flow zone") after 10 years of pumping the recovery wells and with the CCS at 60 PSU (relative salinity of 1.71). Note that the 1.0 contour is up to 12,000 ft west of the CCS boundary.

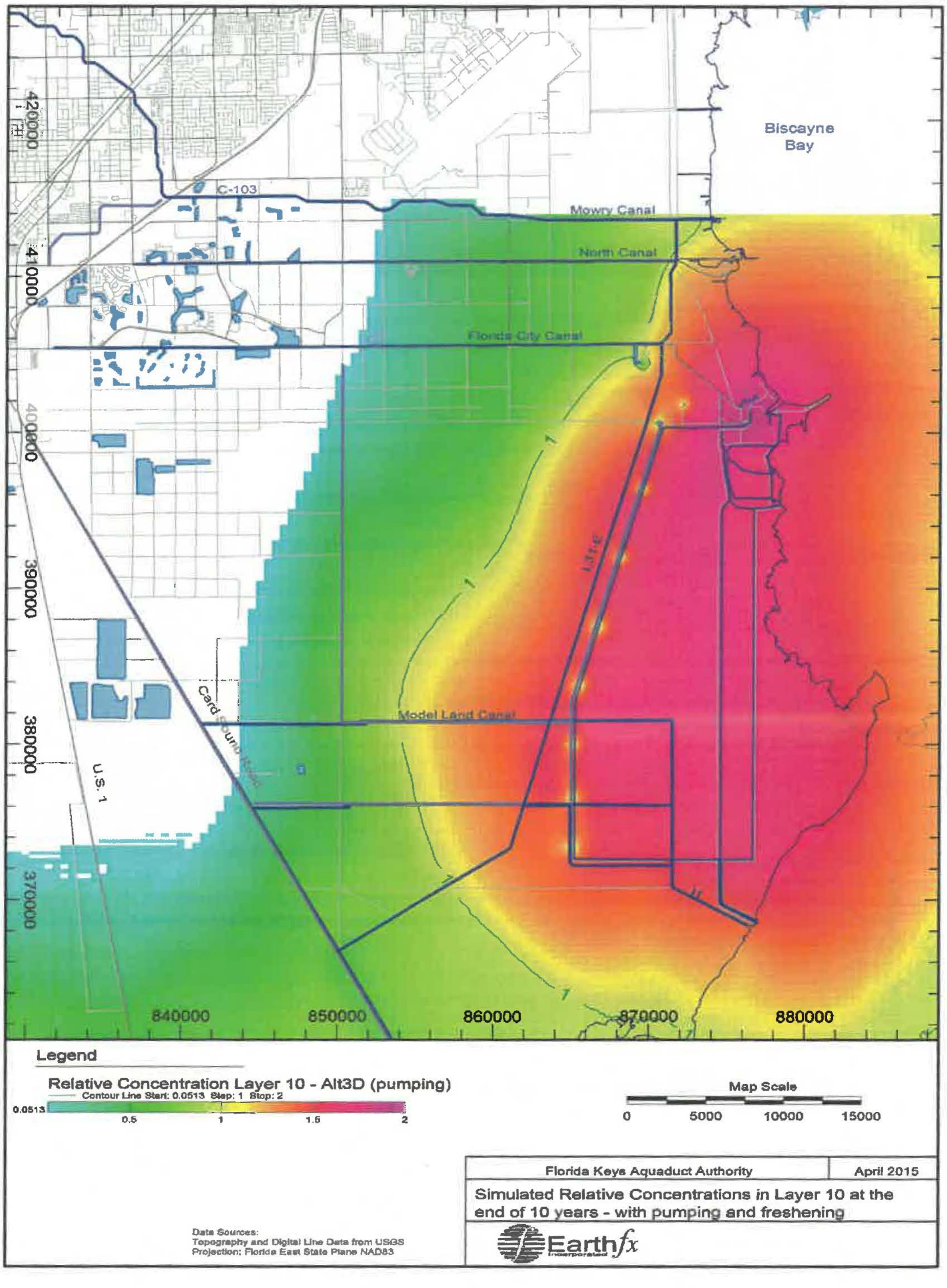

Figure 3: Simulated relative salinity values (with 1.0 equivalent to seawater) in Tetra Tech (2017) model Layer 10 (near the base of the Biscayne Aquifer) after 10 years of pumping the recovery wells and with the CCS at 35 PSU (relative salinity of 1.0). Note that the 1.0 contour is located over 10,500 ft west of the CCS boundary and that the relative salinity beneath the CCS is still above 60 PSU (relative salinity of 1.7).

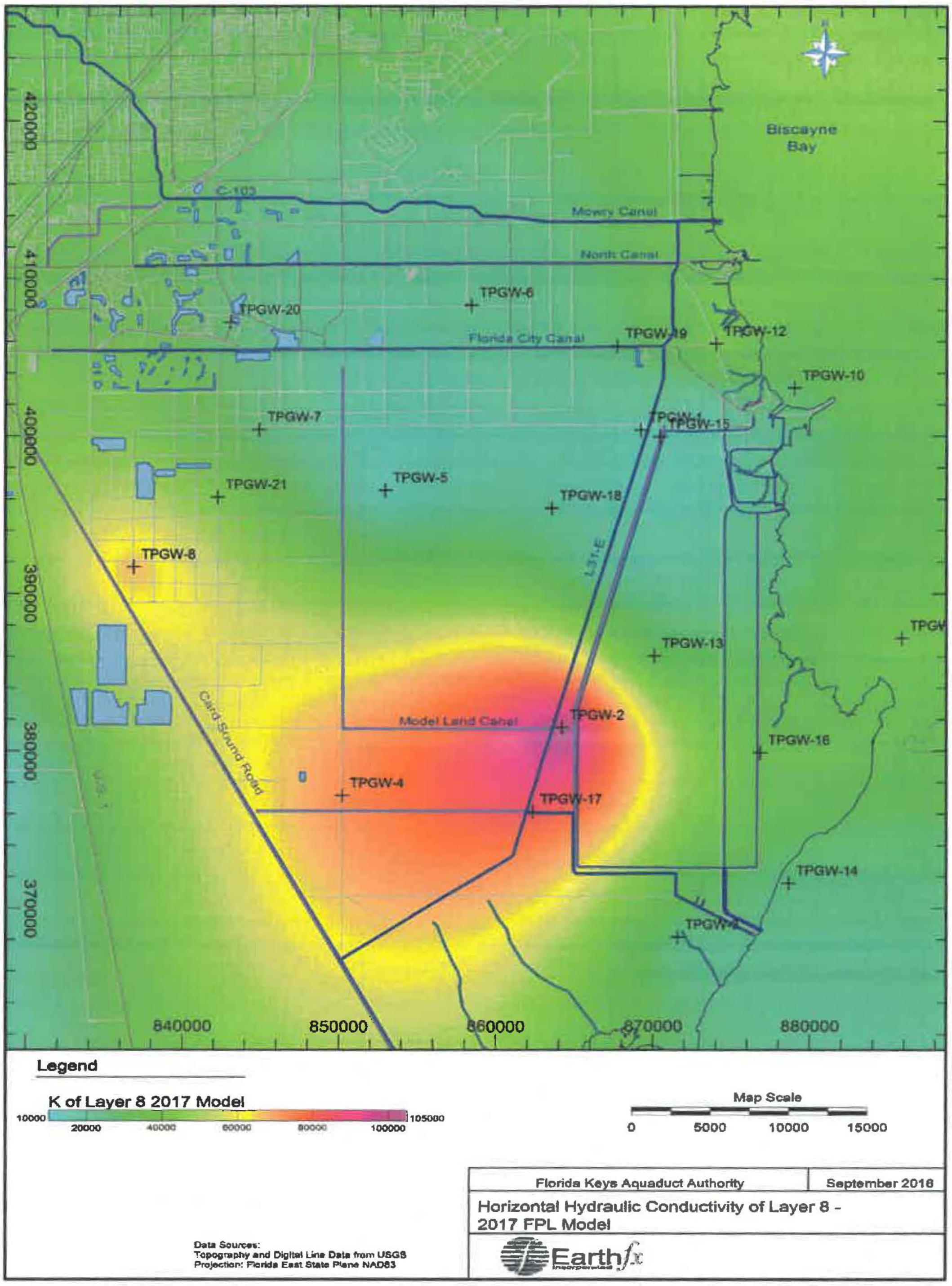

Figure 4: Hydraulic conductivity values assumed for Layer 8 (Lower High Flow Zone) in the Tetra Tech (2017) model.

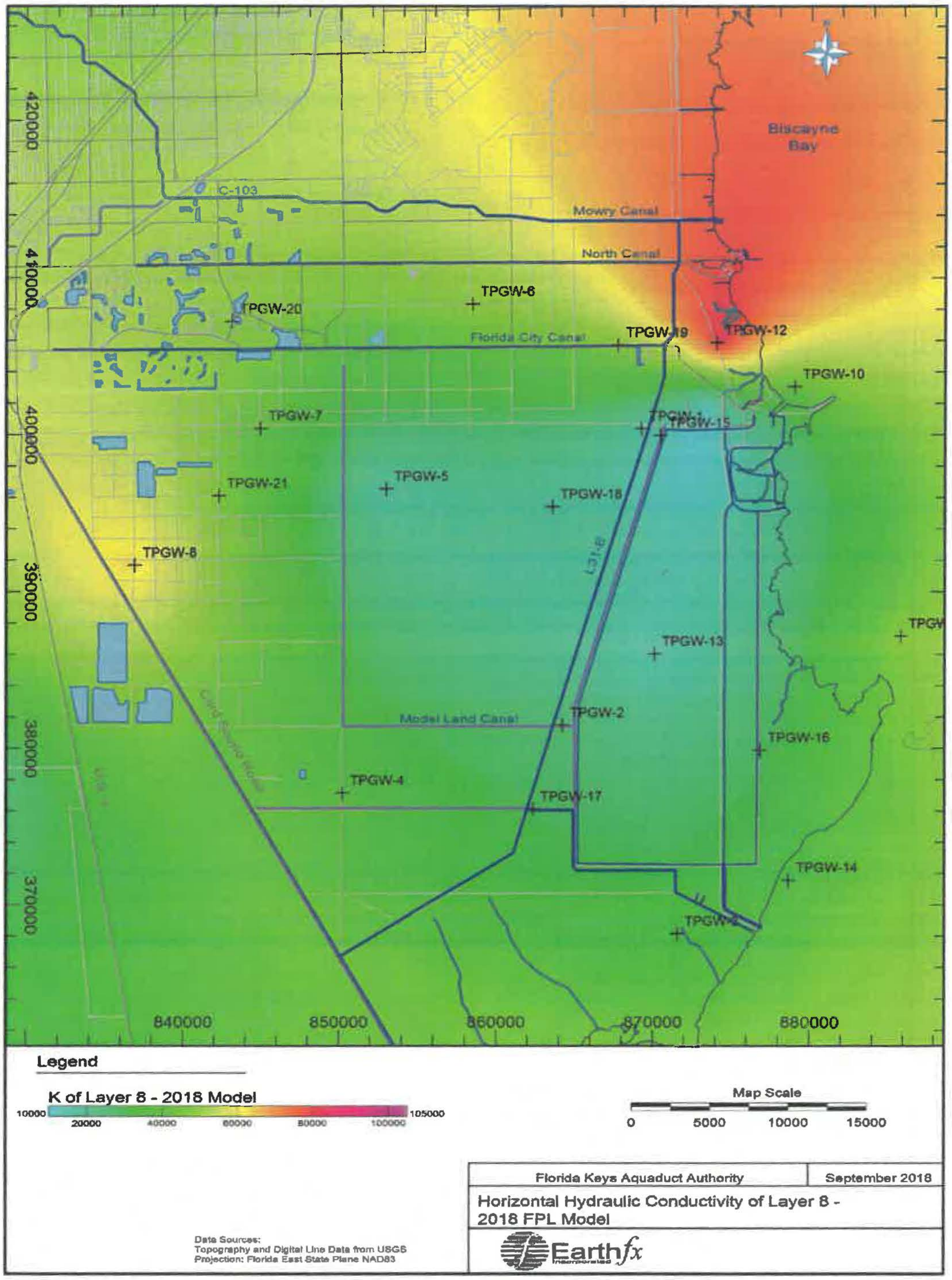

Figure 5: Hydraulic conductivity values assumed for Layer 8 (Lower High Flow Zone) in the Tetra Tech (2018) model.

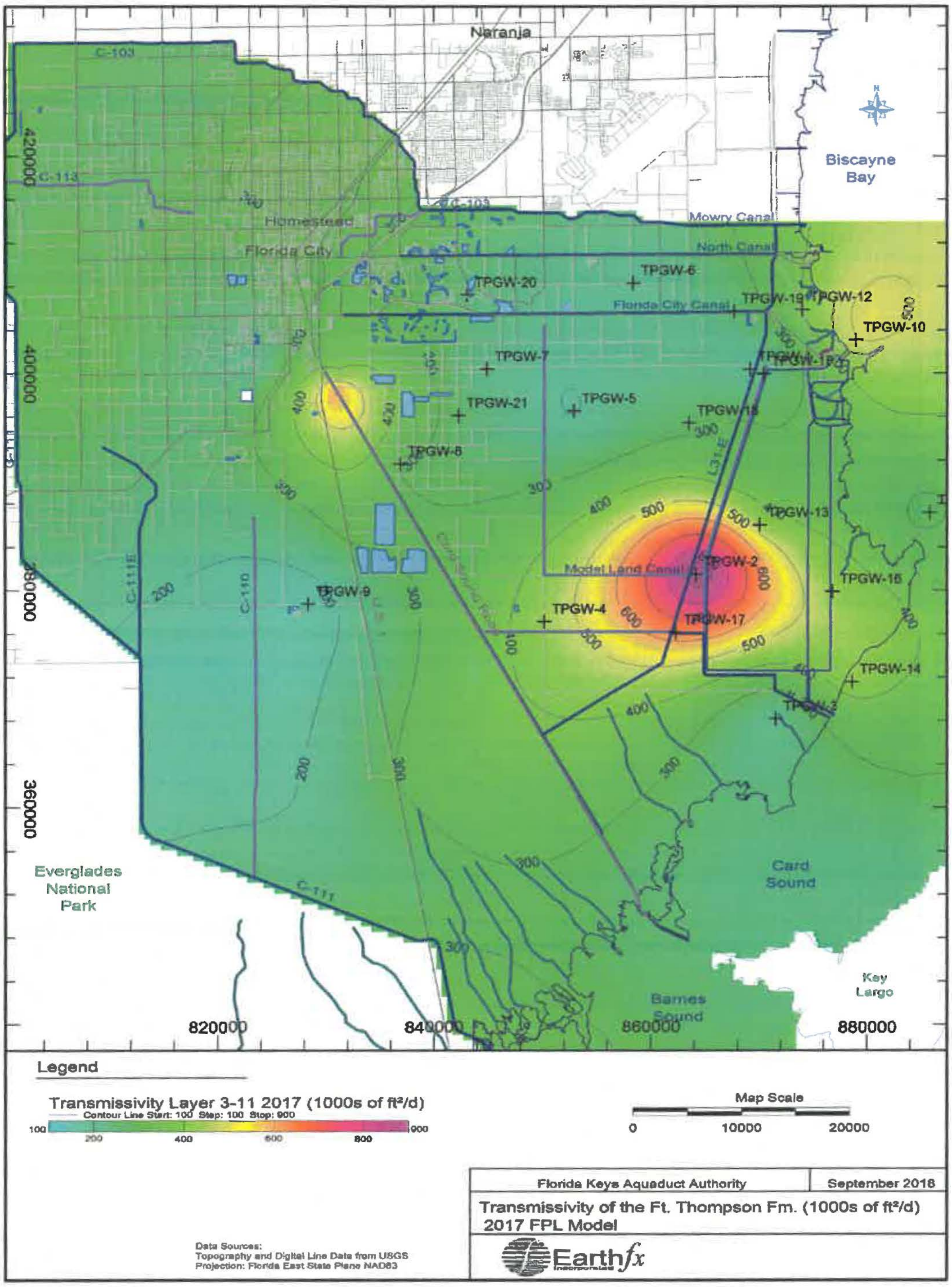

Figure 6: Calculated transmissivities for the Ft. Thompson Formation using the hydraulic conductivity values assumed for Layers 3 to 11 in the Tetra Tech (2017) model.

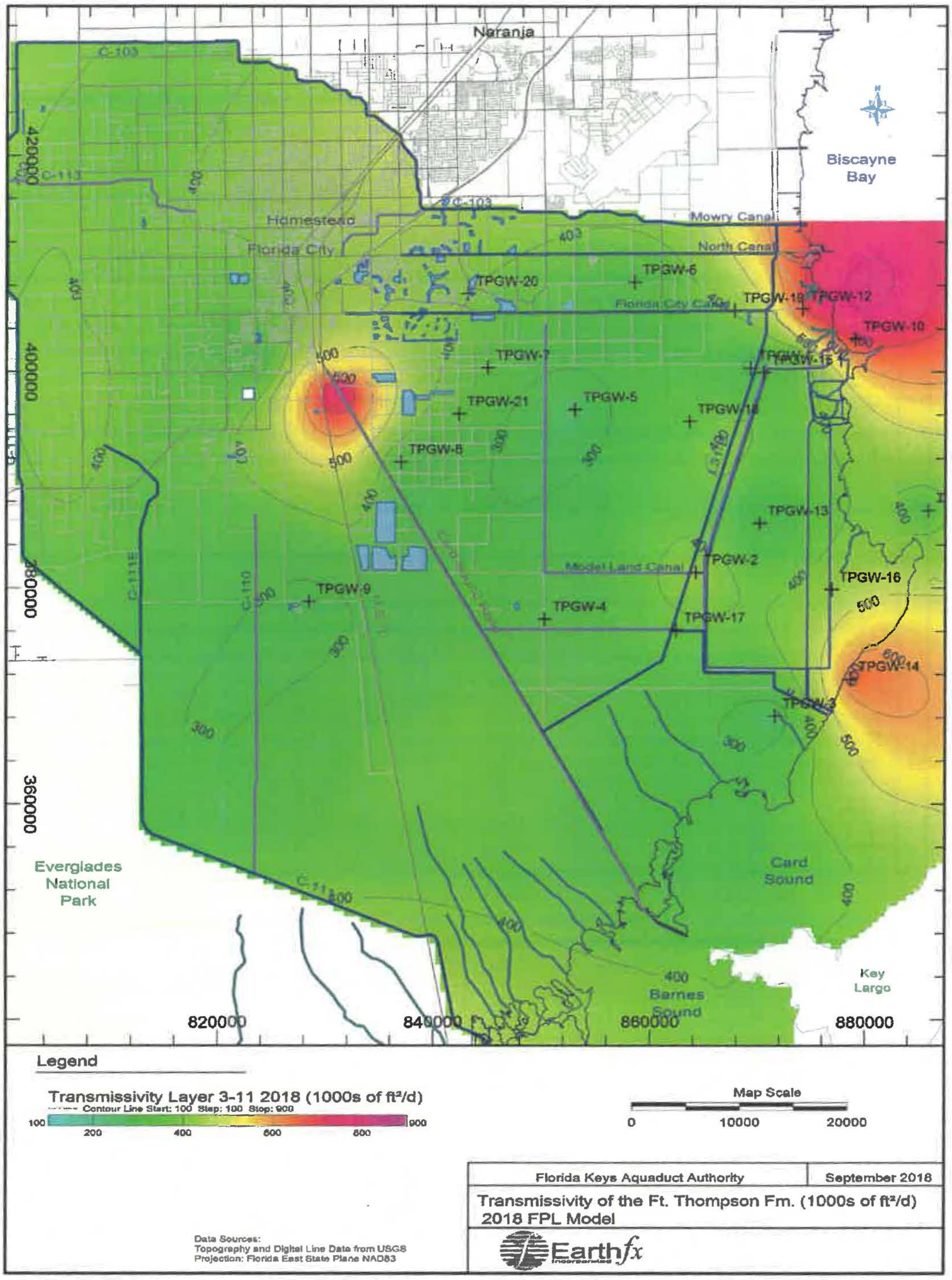

Figure 7: Calculated transmissivities for the Ft. Thompson Formation using the hydraulic conductivity values assumed for Layers 3 to 11 in the Tetra Tech (2018) model.

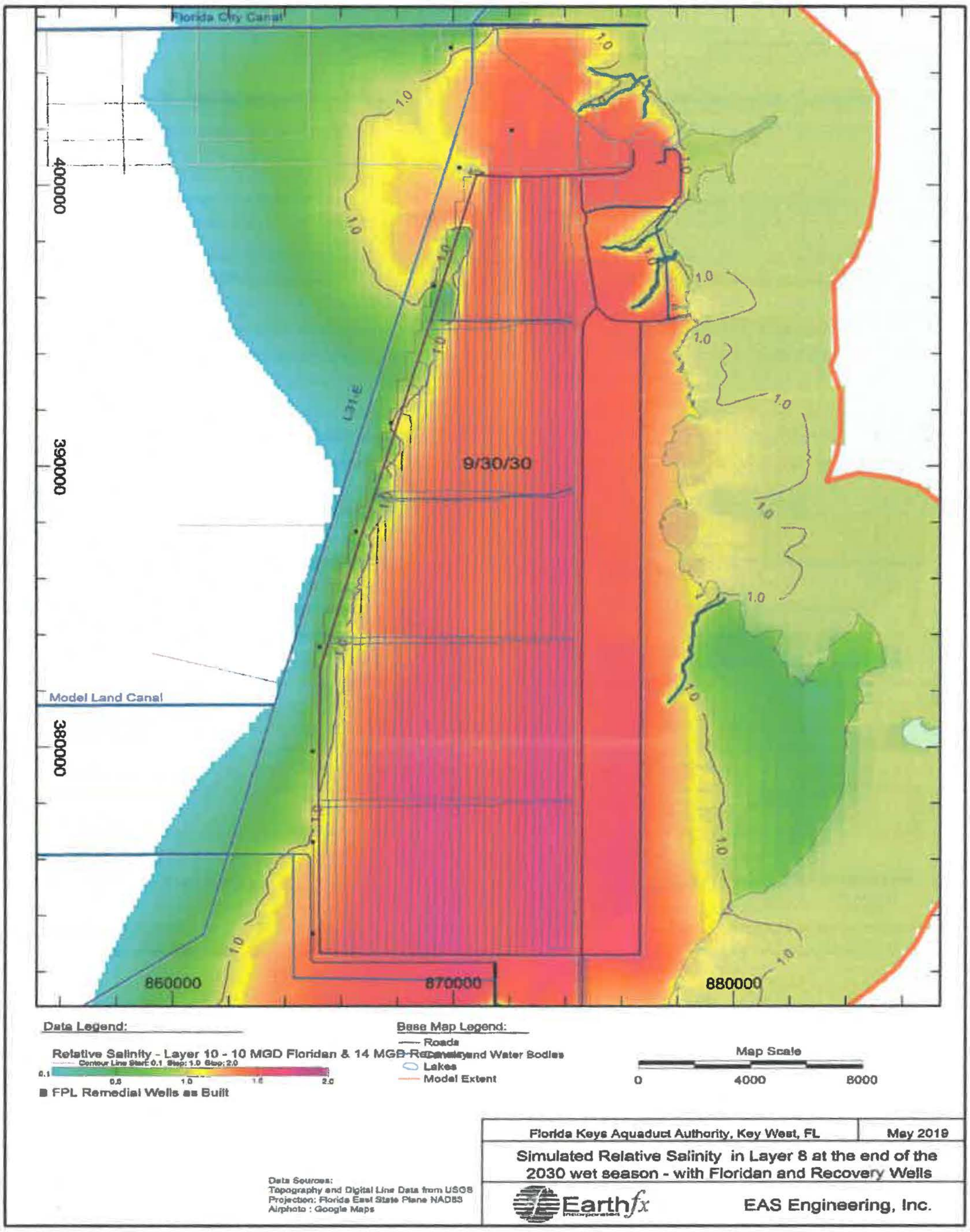

Figure 8: Simulated relative salinity values in the new Earthfx model in Layer 8 (between -30 to -35 NGVD, roughly equivalent to Layers 5/6 in the Tetra Tech models) at the end of the 2030 wet season. Note that relative salinity is greater than 1.0 (> 35 PSU) over most of the CCS. Areas of low salinity occur along the west boundary due to the effects of adding Floridan Aquifer water and due to pumping of the recovery wells. Small plumes of lower salinity occur in the northern part of the CCS due to the addition of Floridan water at these locations.

E. J. Wexler, M.Sc., M.S.E., P.Eng.

Vice-President and Director of Modeling Services

BIOGRAPHY

E.J. Wexler is Vice-President and Director of Modeling Services at Earth*fx* and has over 35 years of experience in groundwater modeling, contaminant hydrogeology, geostatistical analysis, and model code development. He has taught graduate courses in groundwater at universities in Canada, FL, and NY. He worked as a research hydrologist and groundwater modeling specialist for the USGS in Reston, VA, Long Island, NY, and Miami, FL. Mr. Wexler is a licensed engineer in the Province of Ontario, Canada.

EDUCATION

- B.E. Civil Engineering, City University of New York (1977)
- M.S.E. Civil Engineering, Princeton University (1978)
- M.Sc. Earth Science, University of Waterloo (1988)

PROFESSIONAL EXPERIENCE

Director of Modeling Services, Earthfx Inc. ***2002 - Present***

Mr. Wexler is the Director of Modeling Services at Earth*fx* where he leads a team of surface and groundwater modelers. Mr. Wexler's experience at Earth*fx* includes:

- Directing groundwater flow and contaminant transport studies, with an emphasis on integrated groundwater/surface water modeling using GSFLOW.
- Technical Manager for Source Water Protection studies in southern Ontario. This included regional groundwater flow modeling studies for aquifer and wellhead vulnerability assessment and hydrologic modeling for water quality and water quantity risk assessment.
- Technical Manager for Lake Simcoe Protection Plan studies in southern Ontario. These subwatershed studies assessed regional groundwater flow, delineated ecologically significant groundwater recharge areas, and quantified the impact of land development, drought, and climate change on watershed function.
- Project Manager for an Integrated Catchment Management Plan for in Northern Oman.
- Member of Scientific Peer Review team for evaluating the Tampa Bay Water/SWFWMD North Tampa Bay integrated model.
- Conducted integrated GW/SW modeling study for a large-land development in Ft. Meyers, FL and a study of FW/SW interface movement in the Homestead, FL area.
- Project Manager for hydrogeologic data analyses in South Florida related to the Comprehensive Everglades Restoration Program (CERP)
- Developed geostatistical analysis codes (3-D kriging and variogram analysis) for VIEWLOG and advanced water quality analysis modules for SiteFX.

Hydrogeologist/Hydrologist, Gartner Lee Limited ***1990 - 2002***

As a senior hydrogeologist at Gartner Lee, Mr. Wexler directed groundwater modeling, groundwater resources management and contaminant hydrogeology studies in Canada, Florida and the Middle East. Selected projects where he was principal investigator include:

- Development of a groundwater flow and contaminant transport model for a low-level radioactive waste disposal site and evaluation of remedial measures.
- Development of a groundwater flow model for St. Thomas, U.S. Virgin Islands used to investigate the source of volatile organic compounds affecting water supply wells.
- Development of surface water and groundwater models to assess the impact of artificial recharge on the water balance, groundwater flow patterns and salt water intrusion in the arid coastal regions of Northern Oman.
- Co-development of MODNET, a surface water and groundwater model based on the USGS MODFLOW model and the USACE UNET surface water model for SFWMD.

Research Hydrologist, U.S. Geological Survey, Miami, Florida 1986 - 1990

Mr. Wexler researched and developed models for simulating groundwater/surface water interaction. He also investigated the effects of density-dependent groundwater flow and solute transport on the feasibility of freshwater storage and recovery in saline aquifers (ASR) at Cape Coral, FL. He developed a coupled, regional-scale/fine-scale flow and transport model for simulating leachate migration at landfills in West Palm Beach, FL. He served as the Groundwater Discipline Specialist and Digital Modeling Specialist and was responsible for technical review and quality control for other surface water and groundwater modeling investigations.

Hydrologist, U.S. Geological Survey, Long Island, New York 1981 - 1985

Mr. Wexler was the Project Chief of a groundwater contaminant transport study at a sanitary landfill site. He investigated the local hydrogeology and studied the physical and geochemical controls on the transport of groundwater solutes. He developed flow and transport models for the study area and simulated long-term contaminant migration.

Research Hydrologist, U.S. Geological Survey, Reston Virgina 1979 - 1981

Mr. Wexler was responsible for developing and testing finite-element models for simulating groundwater flow, solute transport and parameter estimation. E.J. consulted on field application of these models to sites in Maine, Kansas, and California.

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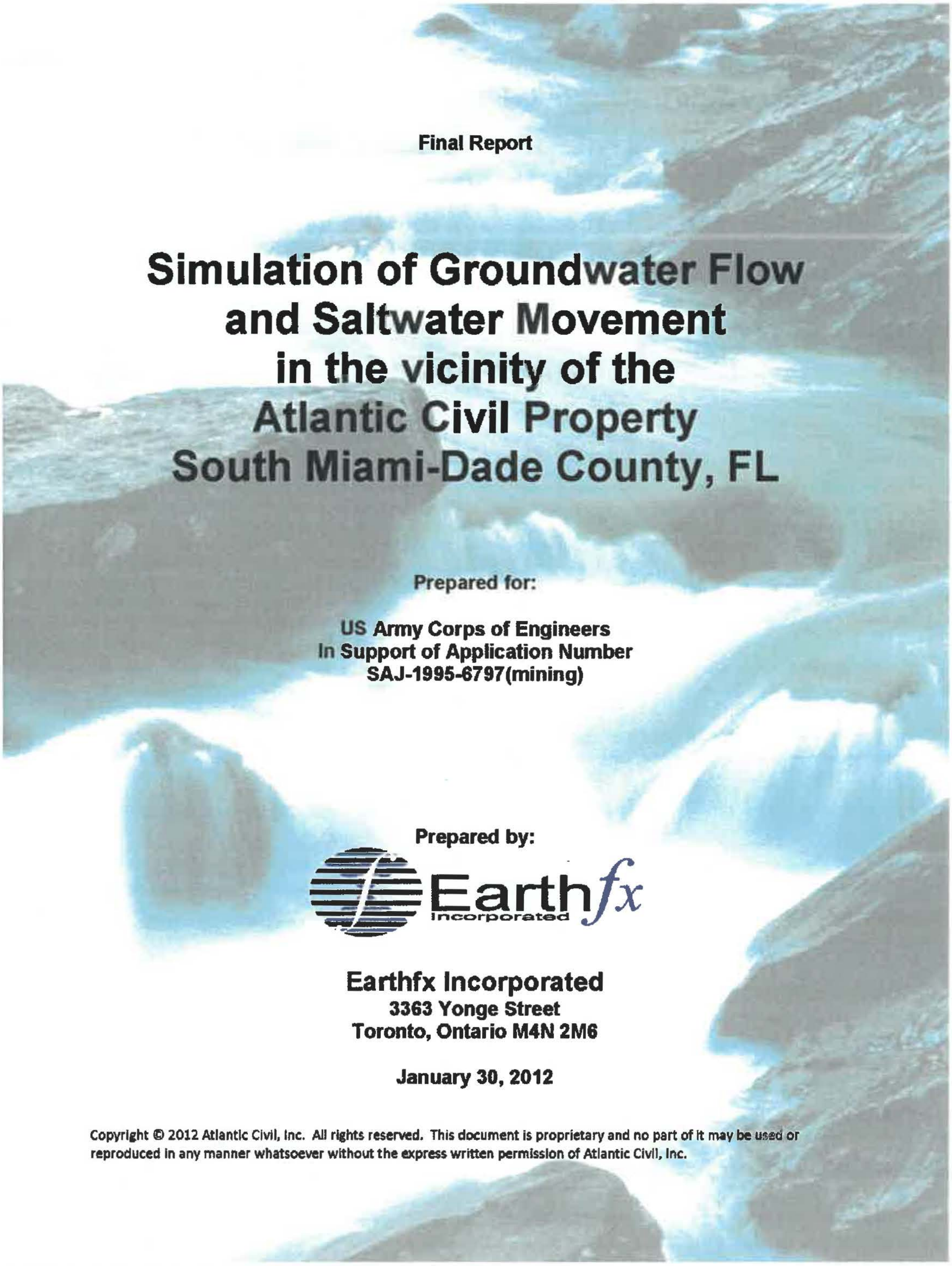
ATTACHMENT 2: Copy of Final Report. Body of report can be found at https://ln.sync.com/dl/e4cd41a00/3vnz83dz-fnhq7ckt-8derr2cy-cfypuwqp as ACI_14Saltwater_v22_ejw.doc



Final Report

Simulation of Groundwater Flow and Saltwater Movement in the vicinity of the Atlantic Civil Property South Miami-Dade County, FL

Prepared for:

US Army Corps of Engineers
In Support of Application Number
SAJ-1995-6797(mining)

Prepared by:

Earthfx Incorporated

Earthfx Incorporated
3363 Yonge Street
Toronto, Ontario M4N 2M6

January 30, 2012

ATTACHMENT 3: Copy of Final Report. Body of report can be found at https://ln.sync.com/dl/03f2ebd40/ncn2jyny-exmnphds-wnxgb525-ap2jsgfu

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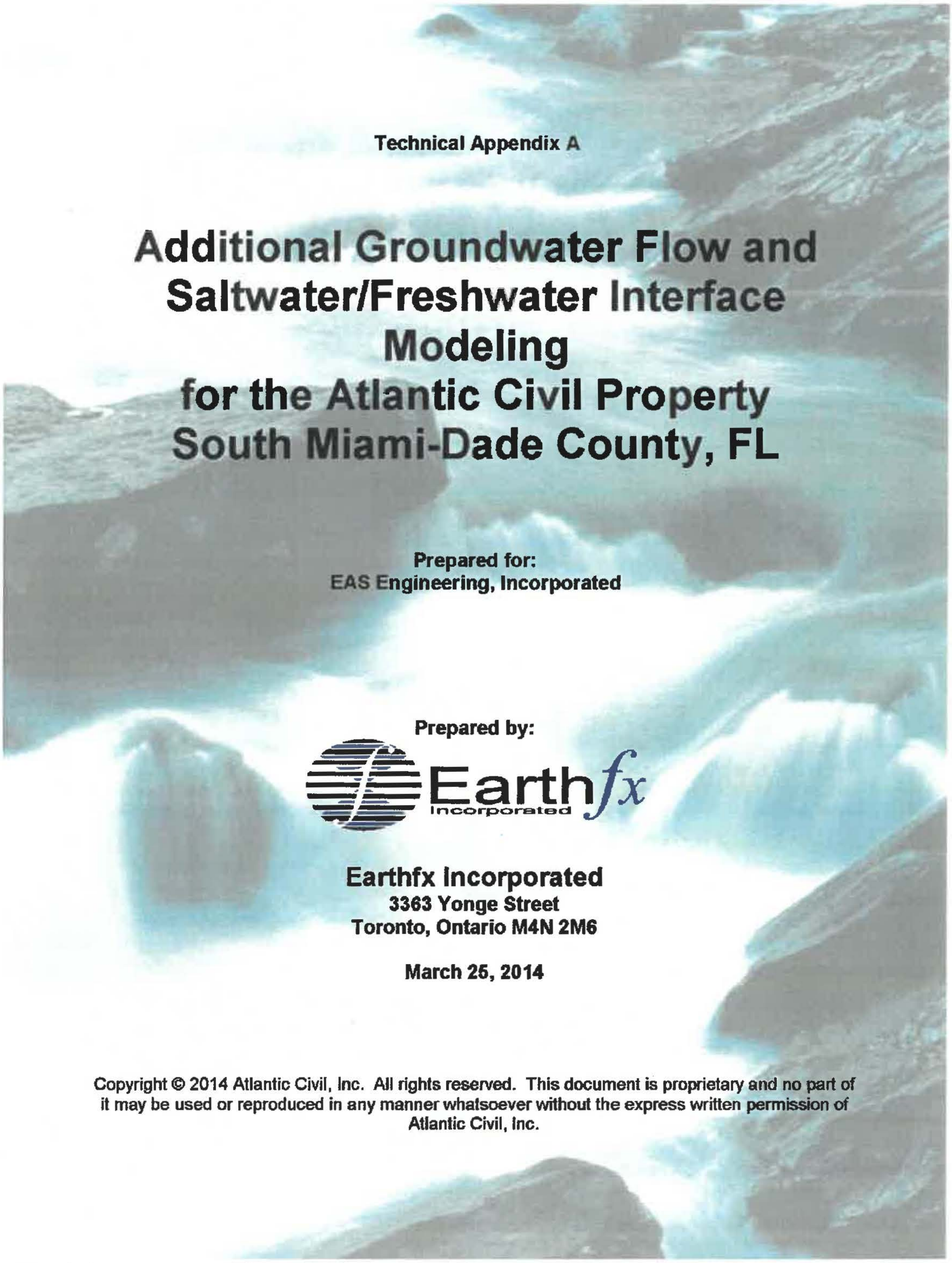

Technical Appendix A

Additional Groundwater Flow and Saltwater/Freshwater Interface Modeling for the Atlantic Civil Property South Miami-Dade County, FL

Prepared for:
EAS Engineering, Incorporated

Prepared by:

Earthfx Incorporated
3363 Yonge Street
Toronto, Ontario M4N 2M6

March 25, 2014

ATTACHMENT 4: Copy of Final Report. Body of report can be found at https://ln.sync.com/dl/cadeec6a0/p2sxyieq-ufeaqzsx-6husjfg2-fqe4fenx
As FPL_3DModel Review V5.docx

Privileged and Confidential

Review of the FPL Three-Dimensional Groundwater Flow and Saltwater Transport Model

Prepared for:

Lewis, Longman, and Walker, P.A.
EAS Engineering, Incorporated

Prepared by:

Earthfx Incorporated
3363 Yonge Street
Toronto, Ontario M4N 2M6

June 5, 2016

Exhibit D

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket No. 50-250-SLR
	)	Docket No. 50-251-SLR
(Turkey Point Nuclear Generating Station, Unit Nos. 3	)	
and 4)	)	June 24, 2019
	)	

EXPERT REPORT OF WILLIAM NUTTLE, PH.D, PEng (Ontario)

I have been retained by the Intervenors in this matter to offer expert testimony. The following is my written report.

My opinions are based on data on hydrogeology, hydrology, hydraulics, and water quality of both surface water and groundwater available to me as of June 23, 2019. In particular, I have compiled data related to the water and salt budgets for the CCS. Florida Power and Light (FPL) conducts monitoring and reports these data annually under an agreement with the South Florida Water Management District, which acts as a point of distribution to other agencies and the public. . I compiled daily values for components of the water budget from spreadsheet files that I obtained through this pathway. The spreadsheet files cover separate but overlapping periods of

time: September 2010 through November 2015,[1] June 2015 through November 2016,[2] Jun 2016 through May 2017,[3] and June 2017 through May 2018,[4] Figure 1.

OPINIONS

Opinion 1:

New information provided by Miami-Dade County points to material and significant changes to the hydrology of the Turkey Point region as the result of water management decisions since Florida Power & Light (FPL) submitted its Environmental Report,[5] on January 2018.

On June 28, 2018, the Florida Department of Environmental Protection issued a permit modification[6] with a stipulation that FPL set and maintain the 40 EMB weirs at 1.8 feet NGVD. This action was challenged by Miami-Dade County (County) with the claim that, in the words of

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[1] File contents are identified by this title on the "README" tab, "Water and Salt Balance Model of the Florida Power & light Cooling Canal System (CCS)," and this statement on the "Key" tab: "This model is based on the previously calibrated balance model (September 2010 through May2015) saved with filename Water&Salt_Balance_Thru_May2015_report.xlsx." The author of the file is identified as James Ross.

[2] File contents are identified by this title on the "README" tab, "Water and Salt Balance Model of the Florida Power & light Cooling Canal System (CCS)," and this statement on the "Key" tab: "This model is based on the previously calibrated balance model (September 2010 through May 2016) saved with filename Balance_Model_May2016_draftfinal_v2.xlsx." The author of the file is identified as James Ross.

[3] File contents are identified by this title on the "README" tab, "Water and Salt Balance Model of the Florida Power & light Cooling Canal System (CCS)," and this statement on the "Key" tab: "This model is based on the previously calibrated balance model (September 2010 through May 2016) saved with filename Balance_Model_May2016_draftfinal_v2.xlsx." The author of the file is identified as James Ross.

[4] File contents are identified by this title on the "README" tab, "Water and Salt Balance Model of the Florida Power & light Cooling Canal System (CCS)," and this statement on the "Key" tab: "This model is based on the previously calibrated balance model (June 2015 through May 2017) saved with filename Balance_Model_May2017_v3_draftfinal.xlsx" The author of the file is identified as James Ross.

[5]Applicant's Environmental Report – Subsequent Operating License Renewal Stage – Turkey Point Nuclear Plant Units 3 and 4." January 2018. 762 p. ADAMS Accession No. ML18037A836.

[6] Florida Power and Light Permit No. 0193232-182, Everglades Mitigation Bank Phase II Modification and Credit Release.

the County, the permit modification "may adversely impact water resources," "is not sustainable over the long term," and "interferes with protecting water quality in the L-31E canal from chloride contamination and addressing the existing inland migration of the salt intrusion front [from the cooling canal system] in this area."[7] Further, the County noted that the permit modification "may exacerbate the existing water quality violations that FPL is otherwise working to abate and remediate, thus hindering the progress of those efforts and harming wetlands . . . ."

At issue is the amount of fresh water discharged as surface water from the freshwater wetlands, known as the Model Lands Basin, which bound the Turkey Point cooling canal system (CCS) to the west. The Model Lands Basin comprises about 21,000 acres of wetlands fully enclosed by SW 344 Street (and the associated Florida City canal) to the north, the L-31E canal and levee to the east and southeast, Card Sound Road (and associated canal) to the southwest, and Florida City (US Route 1) to the west. Surface water drains out of the Model Lands Basin through a series of culverts (the EBM culverts) located along the L-31E canal, south of the CCS. The inflow of fresh water to the Model Lands Basin is limited by rainfall; essentially no surface water flows into the basin and inflow of groundwater is small relative to rainfall. Outflow is regulated by adjusting the height of weirs set in the culverts.

Lowering the elevation of the weirs increases the discharge of freshwater from the Model Lands Basin, and this has benefits for freshwater wetlands south and east of the L-31E canal and levee, i.e. outside of the Model Lands Basin. FPL manages the area outside the basin as a wetland mitigation bank, for which it receives credits from FDEP. The freshwater wetlands east and south of the L-31E are exposed to periodic inundation and by saline water from Biscayne Bay, during periods of extreme tides and storm surge, as well as the chronic encroachment by saline water driven by sea level rise. The input of fresh water discharged from the Model Lands Basin mitigates the negative impact of salt water on the fresh water vegetation.

[7] Letter from Miami-Dade County DERM to Florida DEP dated July 18, 2018. (RE: Request for an Extension of Time in accordance with Section 120.57, …)

The benefits to the wetlands outside the basin of increased discharge through the weirs come at the expense of direct negative consequences within the Model Lands Basin for hydrological conditions needed to sustain the freshwater wetlands and water supplies for communities adjacent to the basin. The letter from DERM to FDEP documents the technical and scientific basis for concern that these consequences are being realized as a result of FDEP's stipulations in the recent permit modification.

Lowering the elevation of the weirs drains water out of the basin, which has the effect of lowering the watertable throughout the basin. Lowering the watertable directly impacts the wetlands in the basin, degrading their ecological functioning. Lowering the watertable indirectly impacts the wetland by opening pathways for the infiltration of saline groundwater into the L-31E canal. From here, the saline water can move throughout the basin through the network of interconnected drainage canals, which threatens the freshwater wetlands with further degradation. Lowering the watertable also reduces the natural hydraulic barrier against the intrusion of saltwater into the basin through the Biscayne aquifer from Biscayne Bay and water discharged into the aquifer from the CCS. Salt water intrusion threatens to degrade water supply wells adjacent to the Model Lands Basin.

Opinion 2

FPL's compliance with this modified permit exacerbates impacts from operating the CCS on groundwater, surface water, and ecological resources in the Model Lands Basin.

Decreased water levels in the Model Lands Basin exacerbate impacts in the basin from the CCS in two ways. First, decreased water levels reduces the seaward gradient in hydraulic head that provides a barrier to the intrusion of salt water into the aquifer. Second, decreased water levels open a pathway for the vertical movement of CCS water into the L-31E canal and thus throughout the basin through the network of drainage canals that connect to the L-31E canal. The first mechanism, related to the horizontal movement of saline water into the aquifer, appears to be generally recognized. However, the second mechanism is not; therefore, the following is a brief discussion of the principles involved and an analysis to demonstrate that it feasible under the conditions present at the CCS.

Stable density stratification in a coastal aquifer involves stability against vertical flow as well as horizontal flow. Water in the Biscayne aquifer west of the CCS is stratified. A layer of freshwater, fed by rainfall and groundwater flow from the west, overlies the plume of hypersaline water fed by flow out of the CCS. This plume extends west beneath the ID and the L-31E canal.

The stability of the interface between the freshwater and salt water in a coastal aquifer implies that the watertable above the freshwater in the aquifer occurs above mean sea level. The Ghyben-Herzberg relationship[8] estimates the depth to the interface between freshwater and salt water, z, as the height of the freshwater water-table above sea level, h, multiplied by a factor computed from the densities of freshwater (nominally 1000 kg/m^3) and seawater (1025 kg/m^3);
$z = \frac{\rho_f}{(\rho_s - \rho_f)} h$. For freshwater and sea water the multiplier is 40. In the situation of the L-31E canal and the hypersaline plume from the CCS, water level in the CCS plays the role of sea level. The water level in the L-31E canal is, on average, 0.3 feet above the level of the CCS; therefore the depth to the interface below the canal is computed to be 12 feet. However, the density of hypersaline water in the CSS and its plume can be higher than that of sea water; density of water with a salinity of 60 psu, roughly the long-term average for the CCS, is 1042 kg/m^3. Using this higher density, the multiplier is 24, and the estimated depth to the interface below the L-31E canal is 7 feet.

The interval 7 to 12 feet coincides exactly with the depth of the L-31E canal.[9] Therefore, conditions exist for the upper portion of the CCS plume to intersect with the bottom of the L-31E canal.

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[8] https://en.wikipedia.org/wiki/Saltwater_intrusion#Ghyben%E2%80%93Herzberg_relation

[9] "The depth of the L-31E canal is around 9 feet." Janzen, J., and S. Krupa, 2011. Water Quality Characterization of Southern Miami-Dade Nearby FPL Turkey Point Power Plant. Technical Publication WS-31, South Florida Water Management District, July 2011.

Operation of the ID exacerbates the infiltration of CCS water into the L-31E. Water is pumped out of the ID for the purpose of maintaining a hydraulic barrier to westward movement of CCS water in the shallow groundwater. Pumping lowers the water level in the ID and in the wetlands immediately adjacent to it. This decreases the height of the water-table in the freshwater lens, which also decreases the depth to the freshwater/salt water interface. Therefore, by lowering the watertable, ID operations also promote the vertical flow of the CCS water in the hypersaline plume upward into the upper area of the Biscayne aquifer.[10]

Operation of the ID represents a large, undocumented demand on the water budget of the Model Lands Basin. Water pumped out of the ID is a mixture of saline water discharged from the CCS and fresh groundwater flow from the west. The amount of freshwater withdrawn by ID operations can be estimated from the ID pumping rate and salinity data collected for the ID and the L-31E canal. The impact of pumping on the water table in the wetlands west of the CCS is exacerbated by the fact that pumping from the ID occurs predominantly during the dry season, January through May. This is when the amount of freshwater in the aquifer is at its seasonal low, and hydraulic gradients conducive for flow from the CCS into the L-31E canal exist.

On any single day, the amount of water pumped from the ID, Q_{ID}, is the sum of an amount of water that has entered the ID from the west, from Q_{L31}, and an amount of water recycled from the CCS, Q_{RW};

$$Q_{ID} = Q_{L31} + Q_{RW}. \qquad \text{Equation 3}$$

Similarly, the amount of salt in the water pumped from the ID is the sum of an amount carried into the ID in groundwater flow from the west and in the flow of recycled water from the CCS;

[10] The July 18, 2018 letter from DERM to FDEP presents evidence for the influence of ID pumping on water level in the L-31E canal and for groundwater inflow as the cause of salinization of the L-31E, especially in recent years. Evidence for vertical migration of the plume was discussed at a meeting at the South Florida Water Management District in February 2017; PowerPoint presentation by Jonathon Shaw, Turkey Point Power Plant Interceptor Ditch Operations, Joint Agency Meeting – SFWMD/DEP/DERM, February 9, 2017.

$$Q_{ID}S_{ID} = Q_{RW}S_{CCS} + Q_{L31}S_{L31}. \quad \text{Equation 4}$$

From these two equations, one can derive the following formula to calculate the portion of the total daily ID pumping that is fed by groundwater flow from the west:

$$Q_{L31} = Q_{ID}[(S_{CCS} - S_{ID}) / (S_{CCS} - S_{L31})] \quad \text{Equation 5}$$

The daily rate of pumping from the ID, Q_{ID}, and the salinity of water in the ID, S_{ID}, are measured. The salinity measured in the L-31E canal can be taken as representative of the salinity of water flowing into the ID from the west. Shallow groundwater west of the CCS is not totally fresh, as a consequence of infrequent flooding of the wetlands there by water from Biscayne Bay. The salinity of water below the CCS is taken to be 60 gm/l, which reflects the long-term, stable average of salinity measured in a shallow well in the center of the CCS.[11]

Based on these data, calculations reveal that ID pumping removes about 3.5 mgd of mostly fresh groundwater from the Biscayne aquifer west of the CCS. This is the average of the amount of freshwater extracted calculated using Equation 5 applied with daily values of pumping rate and salinity. The pumping rate varies from day to day, and salinity in the ID tends to be higher on days with higher rates of pumping.

This rate of extraction is large relative to other withdrawals from the aquifer. Nearby well fields operated by public water utilities[12] withdraw 2 mgd (Florida City), 11 mgd (Homestead), and 17 mgd (FKAA). The withdrawal of freshwater as a consequence of ID operations is not documented in current regional water supply plans.

The recovery well system began operation in June 2018, and it is likely that the recovery well system will have a similar effect stimulating the infiltration of CCS water into the L-31E canal. The recovery well system (RWS) removes around 14 mgd of water from the aquifer, about half

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[11] TPGW-13

[12] Water use figures from Table A-8, 2013 Lower East Coast Water Supply Plan Update: Appendices, October 10, 2013.

of this amount is groundwater removed from the Model Lands Basin. This is hypersaline groundwater removed from the base of the aquifer, but the removal of this water from the aquifer impacts the freshwater water budget of the basin because the groundwater removed at depth must be replaced by infiltration from above.

The County estimates that the amount of water removed from the basin annually by the RWS is equivalent to one foot of surface water, about 20% of the annual input from rainfall, across the wetlands of the entire basin. According to information provided by the County, the impact of water removed by the RWS on the freshwater balance of the Model Lands Basin is similar to the reduction in weir elevation that is the subject of the County's challenge to FDEP.

Opinion 3

New information on mechanisms of drought in south Florida provides evidence that "more favorable climatic conditions" that are being relying on to meet salinity targets in the CCS are unlikely to occur.

Under the terms of the Consent Order,[13] FPL must "maintain average salinity in the CCS at or below 34 psu." To achieve this, FPL has adopted the strategy of adding about 14 mgd of low-salinity water from the Upper Floridan aquifer on a continuous basis to augment rainfall, the major source of freshwater. Confidence in this strategy is provided by simulation modeling[14] based on the same models that have proven successful in calculating components of the water and salt budgets, which constitute part of the annual report from the monitoring program. The proof of concept is a plot showing salinity being reduced over a 12-month period from about 60 psu down to about 35 psu, and then from 35 psu to 25 psu after a second year of water additions.

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[13] Consent Order 2016. State of Florida Department of Environmental Protection v. Florida Power & Light Company, OGC File No. 16-0241.

[14] Tetra Tech, May 9, 2014, Evaluation of Required Floridan Water for Salinity Reduction in the Cooling Canal System – Technical Memorandum; and Tetra Tech, March 13, 2015, Evaluation of L-31E Water Addition Impacts on CCS Salinity Reduction – Technical Memorandum.

The reductions in salinity achieved from actually adding fresh water to the CCS have, so far, not been able to replicate the results of the model simulation. The freshening program of adding 14 mgd of Floridan water on a continuous basis began on November 28, 2016; however, water additions, using various amounts from a variety of other sources, for the purpose of reducing salinity were first made in response to a spike in salinity in 2014, Table 1. During the period beginning in 2014, in only one year has the reduction in salinity matched the results of the model. This occurred during calendar year 2015, when salinity dropped from about 70 psu on January 1 to about 35 psu at the end of December, Figure 1. However, the amount of additional water required to achieve this result was about double the prescribed 14 mgd, Table 1.

Table 1: Average water balance fluxes by calendar year compiled from the FPL's annual monitoring reports. Inflow from "other sources" includes smaller amounts pumped from the interceptor ditch, plant blowdown in all years, and larger volumes added to reduce salinity in 2014, 2015, 2016 (briefly) and 2017. In 2017, the amount from other sources includes input from storm surge during Hurricane Irma.

Year	**Inflow (mgd)**		**Outflow (mgd)**	
	Rainfall	Other sources	Evaporation	Net Discharge to Groundwater
2011	19.4	7.6	36.0	-9.0
2012	23.4	4.5	32.5	-4.8
2013	21.0	4.9	38.2	-12.8
2014	14.8	9.9	41.9	-17.5
2015	25.0	36.0	41.4	15.0
2016	21.3	4.4	36.6	-5.8
2017	22.2	28.0	38.0	12.3

In the DSEIS,[15] NRC staff review the analysis of the CCS's response to freshening by FPL's modelers. The discussion offered by FPL's modelers focuses on the variability in rainfall as the main confounding factor. From this, NRC staff draw that conclusion, "The modelers anticipate that under more favorable climatic conditions (e.g., less severe dry seasons), the addition of Upper Floridan aquifer water should help to reduce CCS water salinities to 34 PSU."

[15] Generic Environmental Impact Statement for License Renewal of Nuclear Plants, 4 Supplement 5, Second Renewal, Regarding Subsequent License Renewal for Turkey Point 5 Nuclear Generating Unit Nos. 3 and 4, Draft Report for Comment (NUREG–1437).

I have reviewed the model calculations that lead to selecting 14 mgd of Floridan water as the preferred design.[16] These calculations were based on climatic conditions measured by the monitoring program during the period November 2010 through October 2014. Within this period, the modelers refer to the period November 2010 through October 2012 as reflecting "normal weather patterns," and the period November 2013 through October 2014 as reflecting "dry weather patterns," but no justification is given for these characterizations.

A new study,[17] published in May 2019, investigates the occurrence of wet periods and drought in south Florida. The authors examined monthly regional rainfall data from 1906 to 2016, and they draw the following conclusion: "Historical drought evaluated in different time windows indicated that there is a wet and dry cycle in the regional hydrology, where the area is currently in the wet phase of the fluctuation since 1995 with some drought years in between." "Overall, the long-term rainfall variability in the [south Florida] region is strongly associated with AMO [Atlantic Multidecadal Oscillation]. However, the emergence of a negative phase of AMO has been reported. As a result, the current wet phase of the hydrologic regime could gradually decline to below average.

In other words, considering the historical pattern of rainfall drought and surplus, one should anticipate that the years ahead will be dryer than recent years and not expect a return to the "normal weather patterns" on which FPL's strategy for salinity reduction appears to depend.

Opinion 4

The ongoing dispute between the County and FDEP over setting the elevation of the weirs along the L-31E canal is evidence that achieving compliance with requirements for remediation

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[16] Tetra Tech, March 13, 2015, Evaluation of L-31E Water Addition Impacts on CCS Salinity Reduction – Technical Memorandum; and its application in Golder and Associates, March 29, 2106, Water Supply Alternatives Analysis; Report for Florida Power & Light Company

[17] Anteneh Z. A., A. M. Melesse, and W. Abtew, 2019. Teleconnection of Regional Drought to ENSO, PDO, and AMO: Southern Florida and the Everglades. Atmosphere 10(6) DOI: 10.3390/atmos10060295

established by DERM and FDEP[18][19] does not reliably predict future compliance with state and local water quality requirements.

Section 4.5.1.2 of the current DSEIS reads, in part, "NRC staff has concluded that the site-specific impacts for this issue at the Turkey Point site are MODERATE for current operations [due to the presence of hypersaline water from the CCS in the aquifer], but will be SMALL during the subsequent license renewal term as a result of ongoing remediation measures and State and county oversight, now in place at Turkey Point." However, the State and county are in dispute over a matter that critically affects FPL's remediation measures.

The County has filed a Petition for Administrative Hearing[20] (MDC 2018a [petition for administrative hearing]) challenging the FDEP's permit modification requiring FPL to lower the weirs. The outcome of this dispute will affect the impact that the operation of the CCS will have both on the groundwater, surface water and ecological resources in the Model Lands Basin and on the efficacy of FPL's efforts to remediate the CCS groundwater plume and to protect potable water supply wells. But, this will not be the last such dispute.

Hydrologic conditions in the Model Lands Basin in general, and the elevation of the weirs along the L-31E canal in particular, are at the nexus of overlapping goals and responsibilities of several federal, state, and county agencies. In some cases, these goals conflict. For example, the permit modification issued by FDEP reverses one of the actions prescribed in the consent agreement between the County and FPL for remediation at Turkey Point, required FPL to raise the elevation of the weirs. The County's letter to FDEP identifies other ways in which FDEP's recent action

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[18] Consent Agreement Concerning Water Quality Impacts Associated with the Cooling Canal System at Turkey Point Power Plant. October 6, 2015. ADAMS Accession No. ML15286A366

[19] Consent Order, OGC File Number 16-0241, between the State of Florida Department of Environmental Protection and Florida Power & Light Company regarding settlement of Matters at Issue [Westward Migration of Hypersaline Water from the Turkey Point Facility and Potential Releases to Deep Channels on the Eastern and Southern Side of the Facility]." June 20, 2016. ADAMS Accession No. ML16216A216.

[20] Petition for Administrative Hearing before the State of Florida Department of Environmental Protection filed by Miami-Dade County vs Department of Environmental Protection on September 17, 2018.

conflicts with goals for management of hydrologic conditions in the Model Lands Basin established for projects of the U.S. Army Corps of Engineers and by FDEP, itself.

Therefore, NRC staff should reassess their conclusion that cooperation of between FDEP and DERM will shepherd FPL's remediation measures to a successful result.

QUALIFICATIONS

My resume is attached hereto as Exhibit B and contains my qualifications and a list of all publications that I have authored.

SIGNATURE

William K. Nuttle
June 23, 2019

Figure 1: Daily values of the components of the CCS water budget reported from FPL's monitoring program for the period September 2010 through November 2017. Upper panel: average salinity in CCS. Bottom panel: daily values of rainfall and water inputs from other sources.