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, Unit Nos. 3 and 4)	)	June 28, 2019
(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 A.
2. I have been retained to offer expert opinions on behalf of Intervenors in this proceeding. I am offering an updated version of my June 24, 2019 report in this matter to remove information that may be subject to copyright.
3. The facts in my Expert Report 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.

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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. 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 my earlier work but differed in critical areas that limit its effectiveness as a predictive tool especially in the western part of their model. I conducted a critical review of the Tetra Tech (2016a) model. In particular, it was noted that 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 my earlier results. 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, I 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 (2019) 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

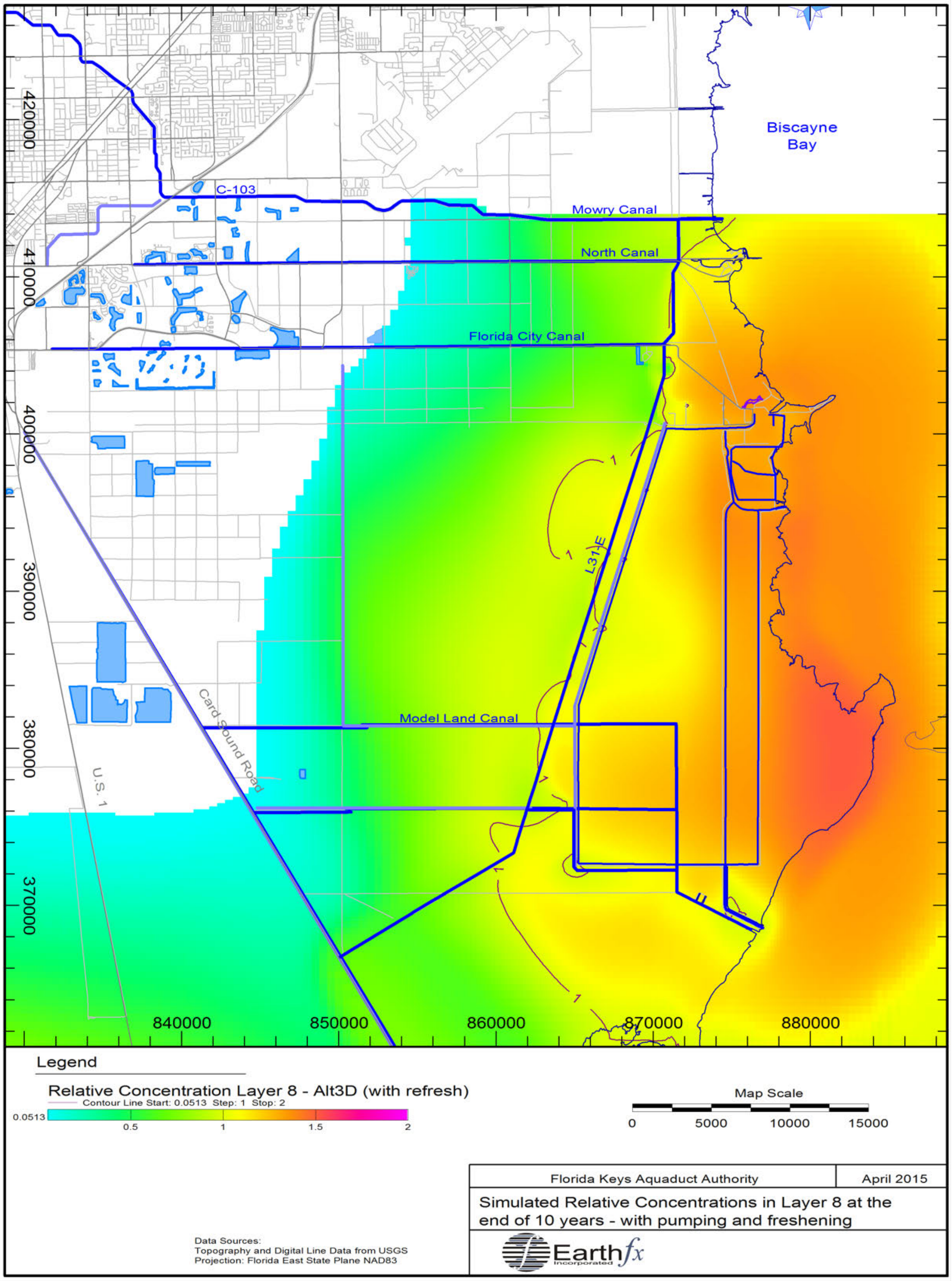

Figure 1: Simulated relative salinity values (with 1.0 equivalent to seawater) in Tetra Tech (2017) model Layer 8 (the "Lower High Flow zone") after 10 years of pumping the recovery wells and with freshening of the CCS to 35 PSU (relative salinity of 1). Note that the 1.0 contour has generally drawn 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.

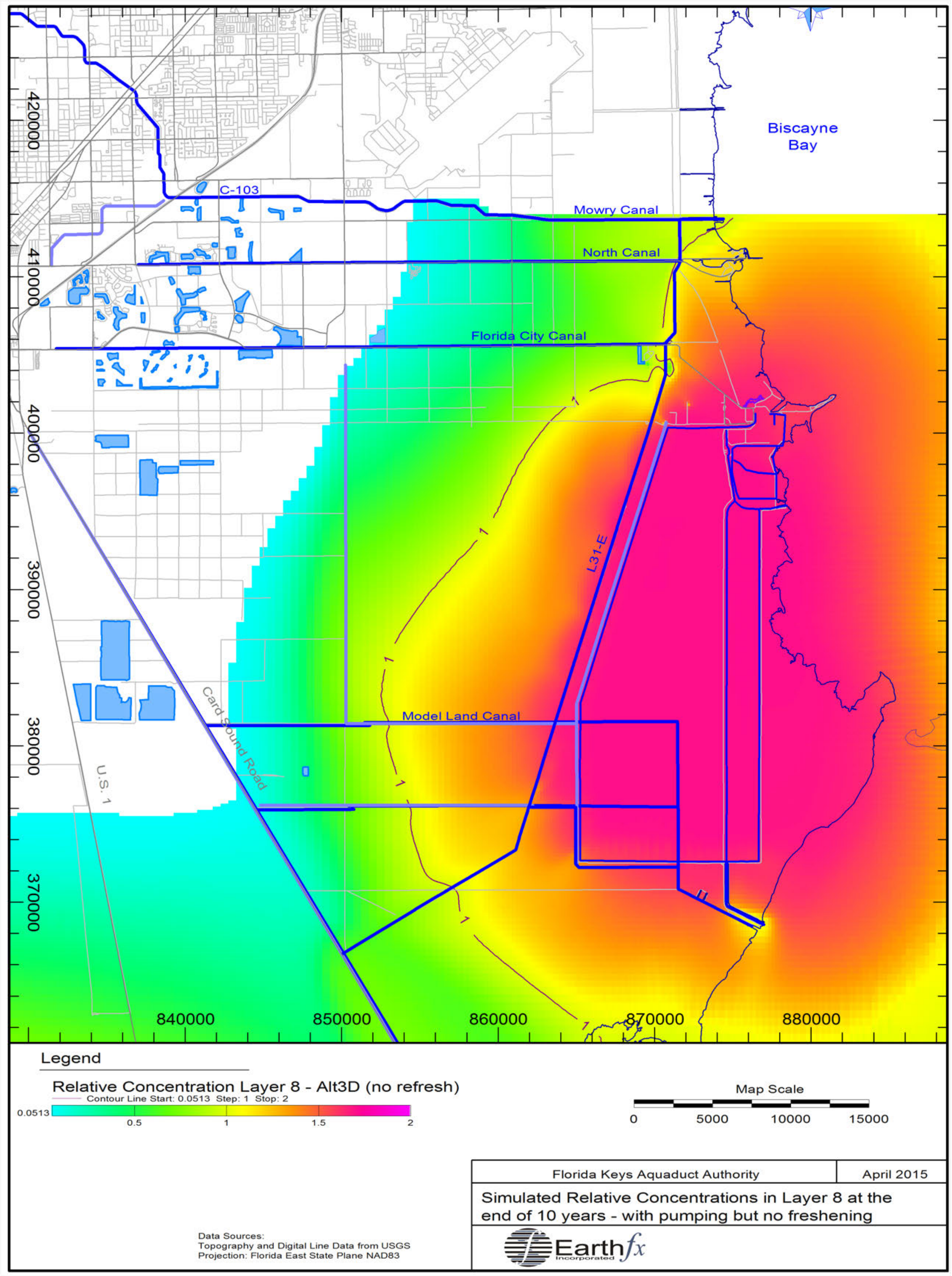

Figure 2: Simulated relative salinity values (with 1.0 equivalent to seawater) in Tetra Tech (2017) model Layer 8 (the "Lower High Flow zone") after 10 years of pumping the recovery wells and with the CCS at 60 PSU (relative salinity of 1.71). Note that the 1.0 contour is up to 12,000 ft west of the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

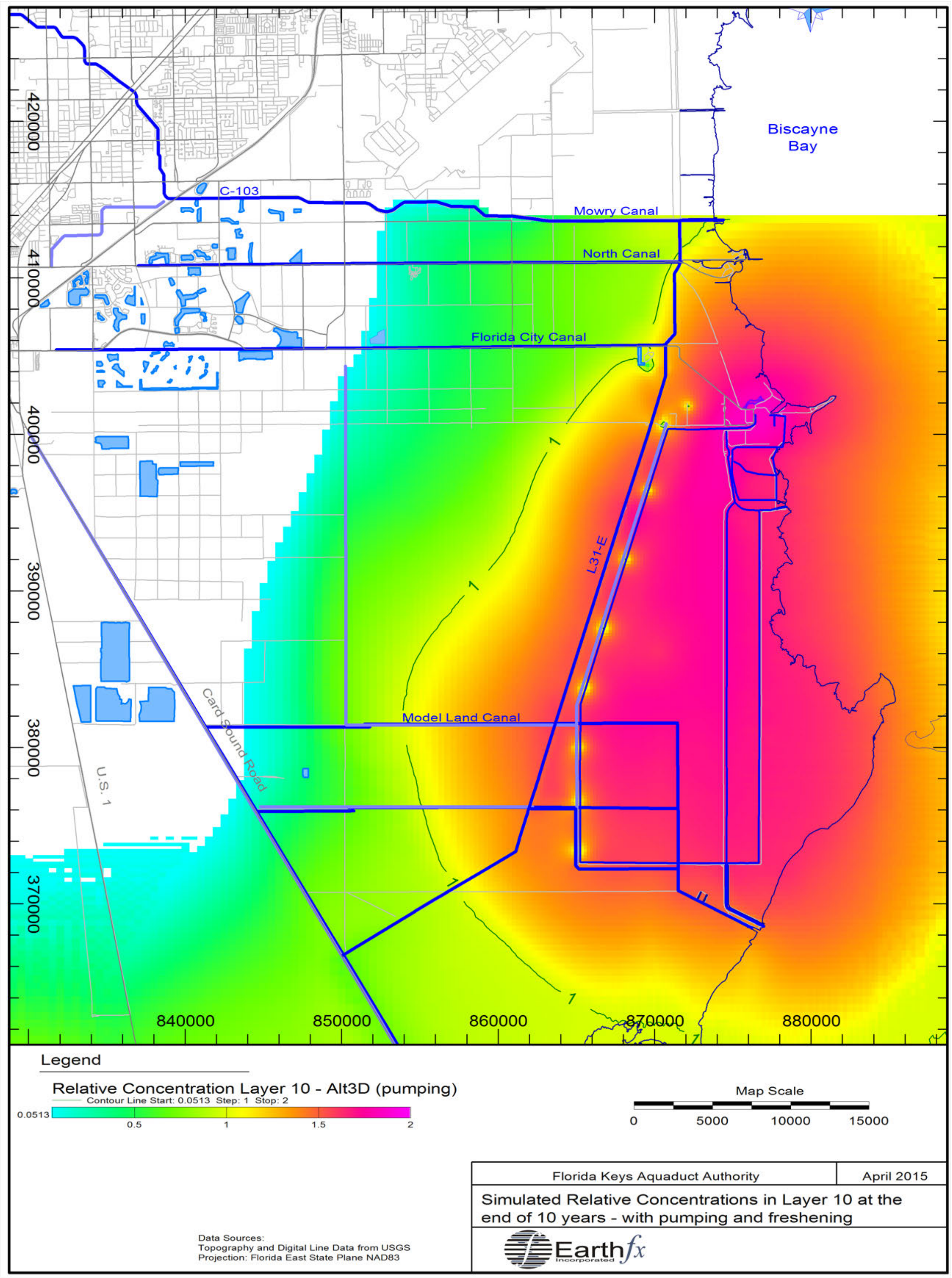

Figure 3: Simulated relative salinity values (with 1.0 equivalent to seawater) in Tetra Tech (2017) model Layer 10 (near the base of the Biscayne Aquifer) after 10 years of pumping the recovery wells and with the CCS at 35 PSU (relative salinity of 1.0). Note that the 1.0 contour is located over 10,500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

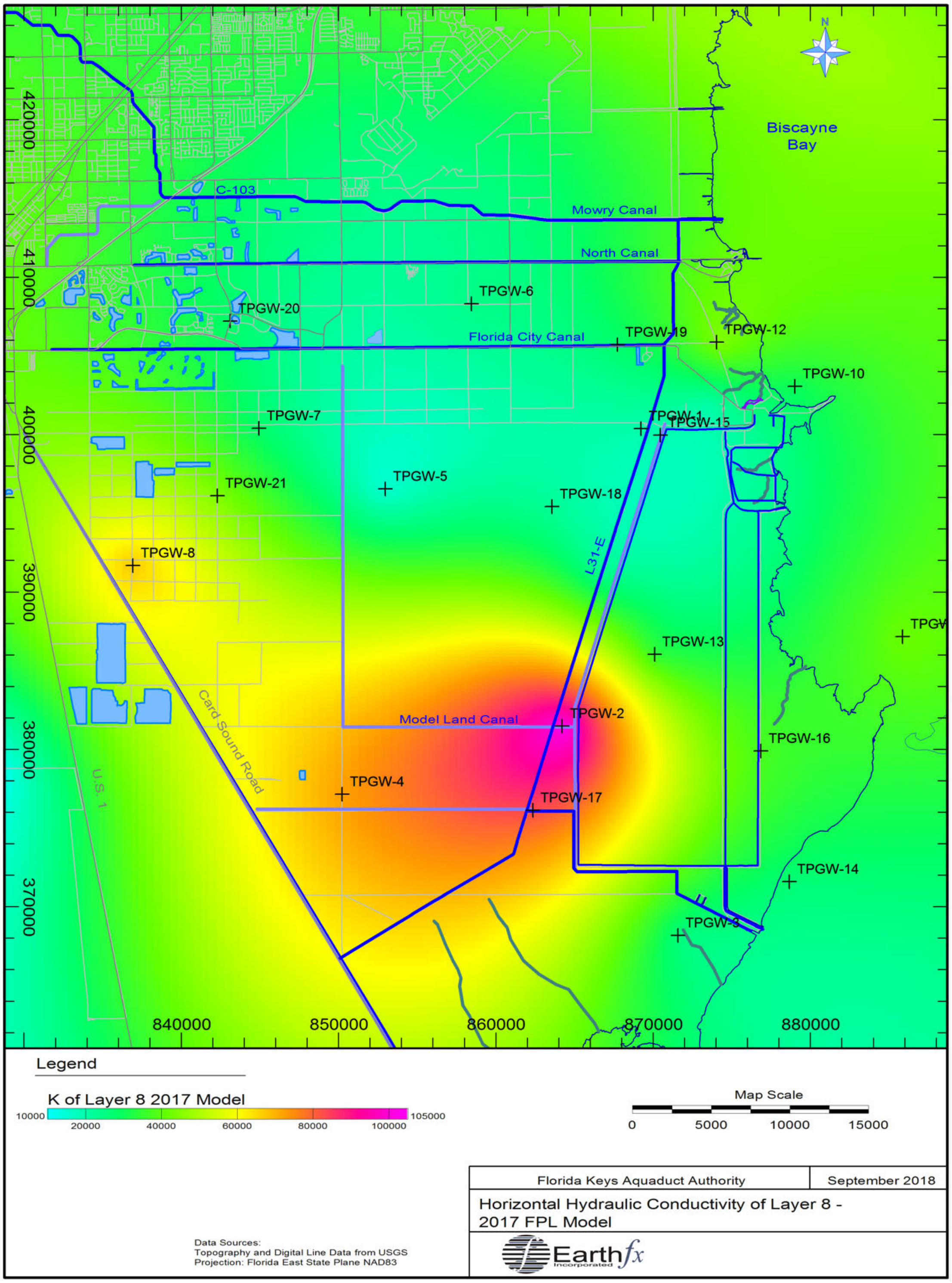

Figure 4: Hydraulic conductivity values assumed for Layer 8 (Lower High Flow Zone) in the Tetra Tech (2017) model.

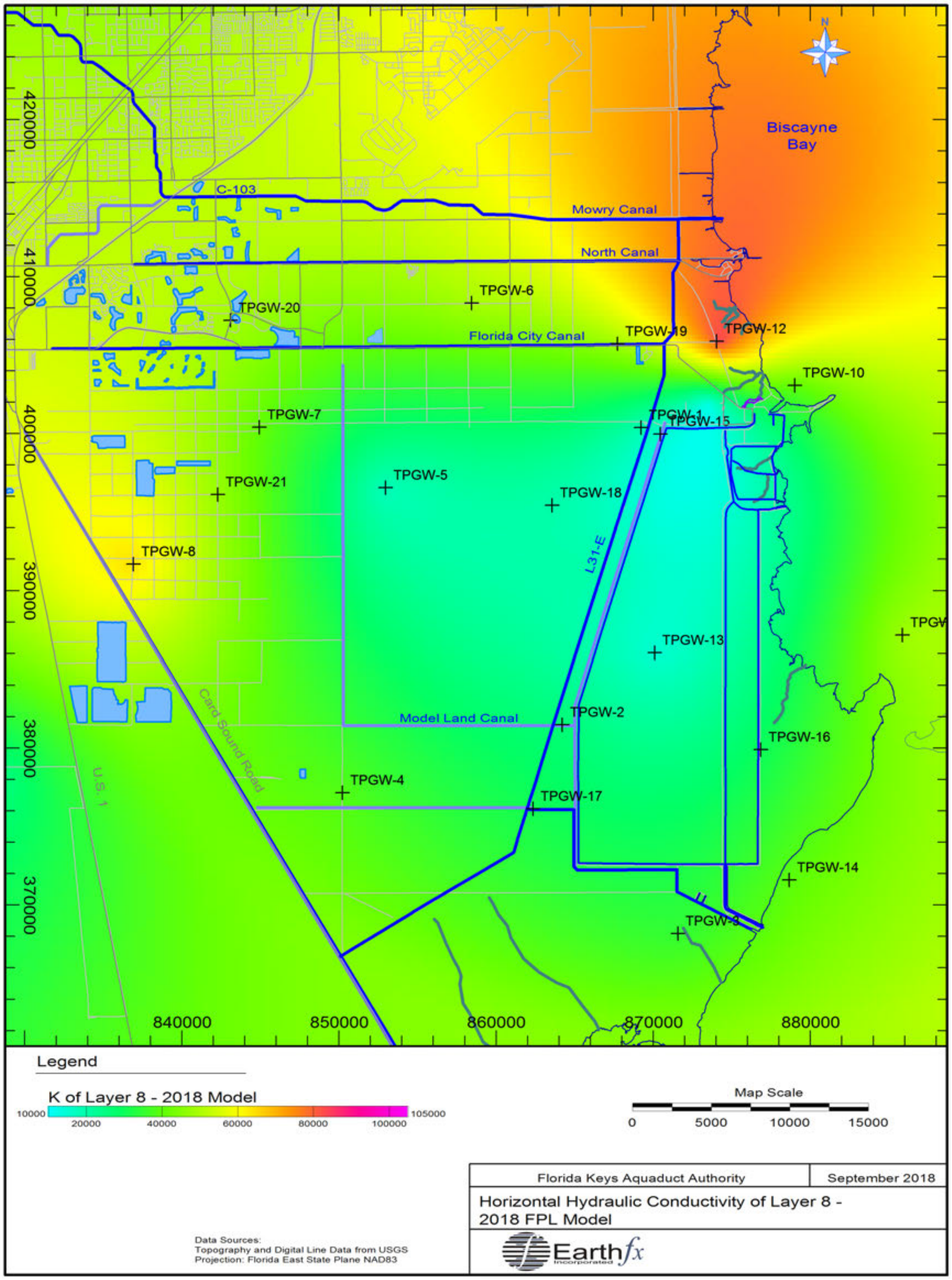

Figure 5: Hydraulic conductivity values assumed for Layer 8 (Lower High Flow Zone) in the Tetra Tech (2018) model.

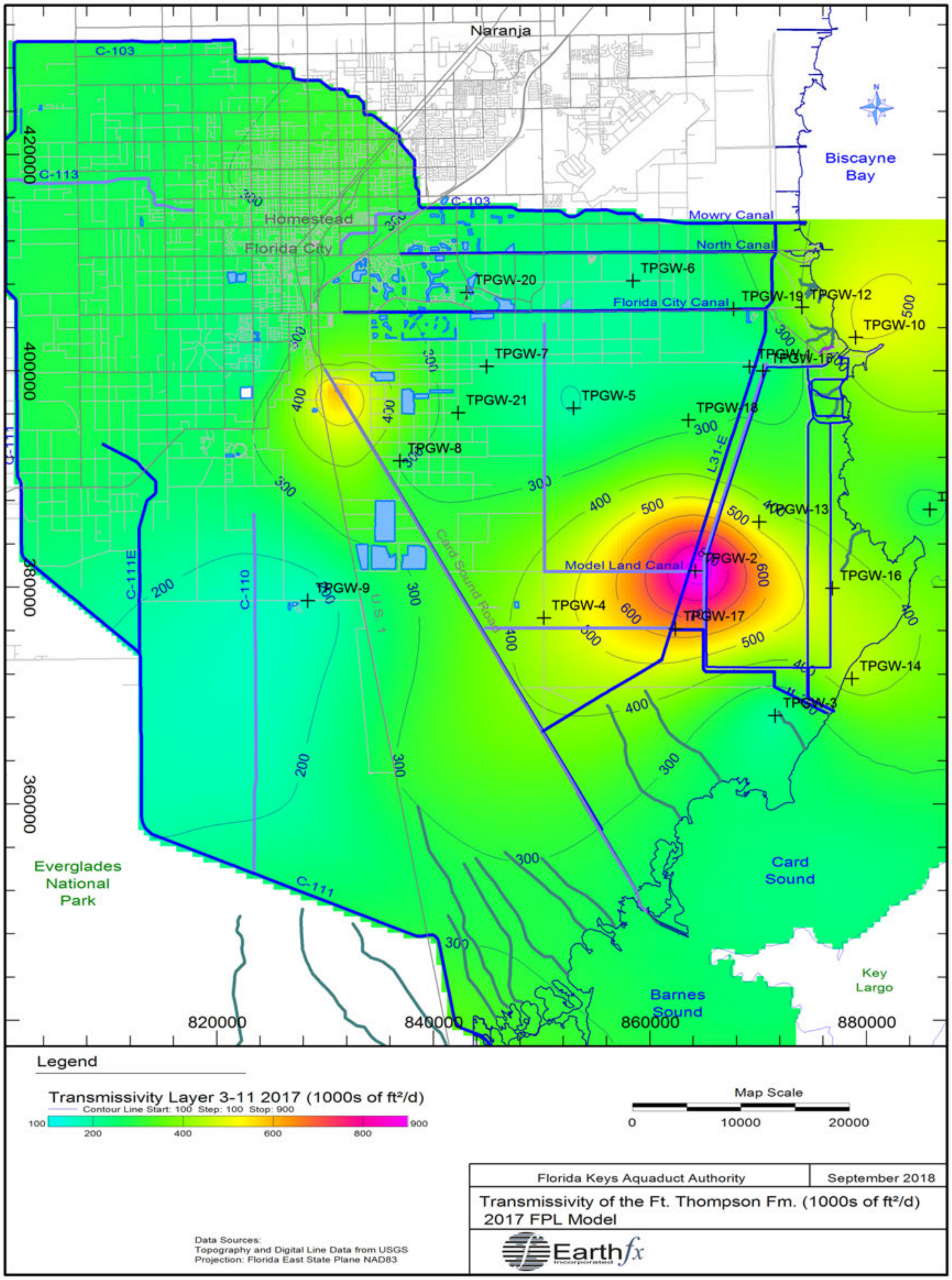

Figure 6: Calculated transmissivities for the Ft. Thompson Formation using the hydraulic conductivity values assumed for Layers 3 to 11 in the Tetra Tech (2017) model.

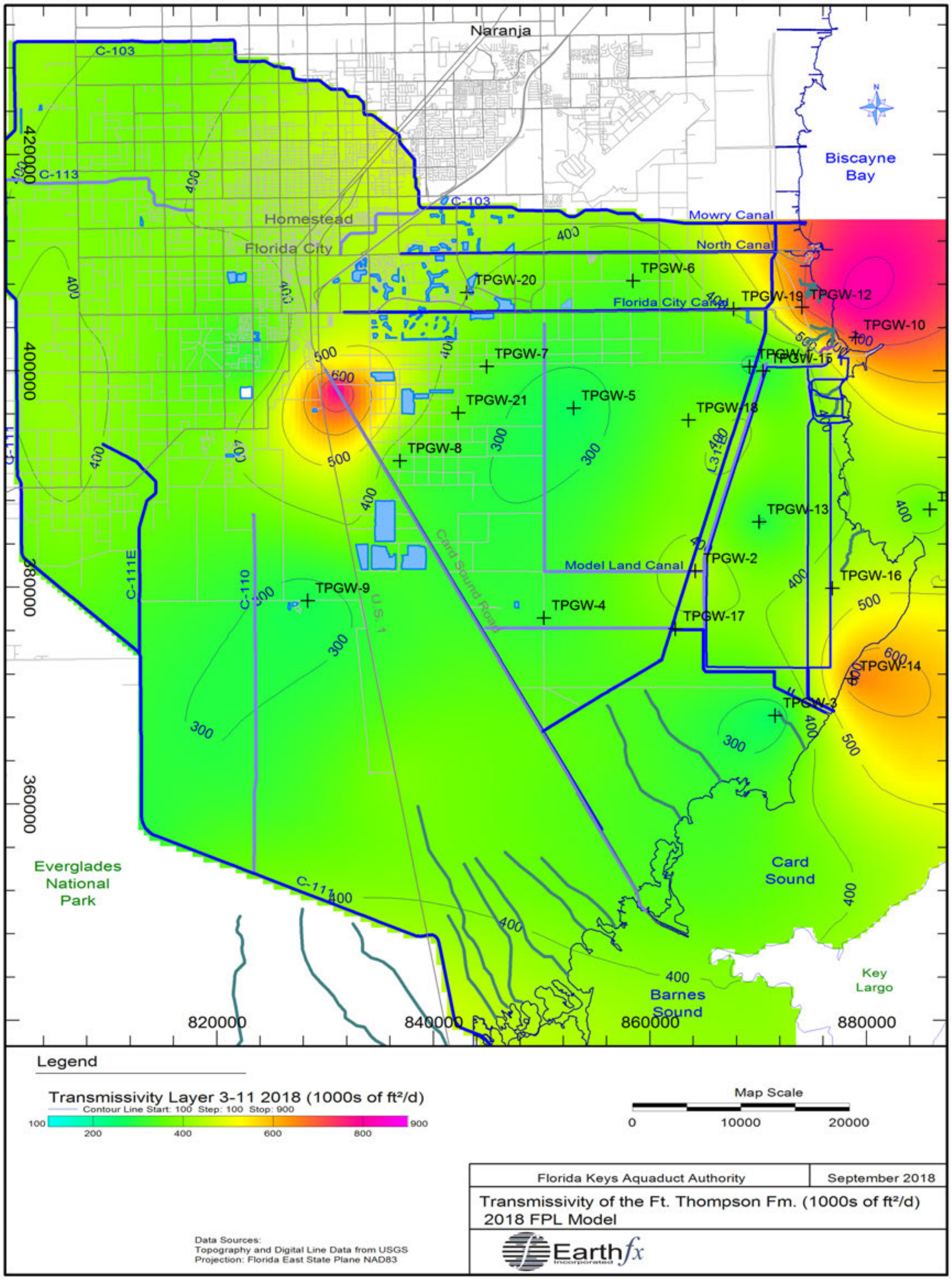

Figure 7: Calculated transmissivities for the Ft. Thompson Formation using the hydraulic conductivity values assumed for Layers 3 to 11 in the Tetra Tech (2018) model.

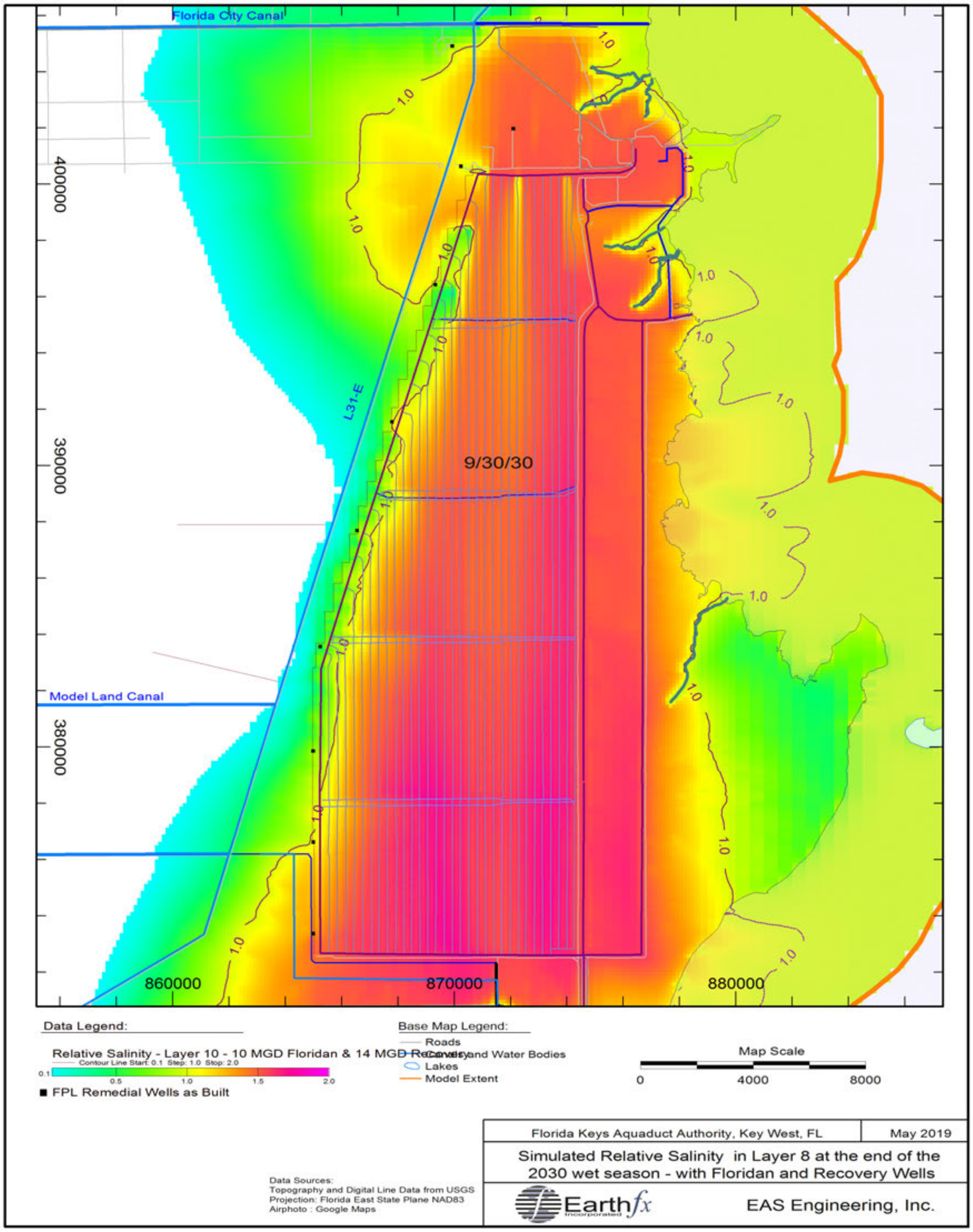

Figure 8: Simulated relative salinity values in the new Earthfx model in Layer 8 (between -30 to -35 NGVD, roughly equivalent to Layers 5/6 in the Tetra Tech models) at the end of the 2030 wet season. Note that relative salinity is greater than 1.0 (> 35 PSU) over most of the CCS. Areas of low salinity 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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