July 31, 2012

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)		
	)	Docket Nos.	52-029-COL
Progress Energy Florida, Inc.	)		52-030-COL
	)		
(Combined License Application for	)		
Levy County Nuclear Plant, Units 1 and 2)	)	ASLBP No.	09-879-04-COL

PRE-FILED REBUTTAL TESTIMONY OF
JAMES O. RUMBAUGH, III, P.G.
ADDRESSING INTERVENORS' INITIAL PRE-FILED TESTIMONY REGARDING THE ADEQUACY OF THE REGIONAL GROUNDWATER MODEL USED IN EVALUATING THE ENVIRONMENTAL IMPACTS FROM ACTIVE GROUNDWATER WITHDRAWALS DURING CONSTRUCTION AND OPERATION OF THE LEVY NUCLEAR PLANT, UNITS 1 & 2

I. BACKGROUND

Q1: Please state your name and business address.

A1: My name is James O. Rumbaugh, III. My business address is Environmental Simulations, Inc., 300 Mountain Top Rd., Reinholds, PA, 17569.

Q2: Please state your employer and position.

A2: I am President of Environmental Simulations, Inc., a hydrogeological consulting company, engaged by Progress Energy Florida, Inc. (PEF) in support of the permitting and licensing of the Levy Nuclear Plant, Units 1 and 2 (LNP).[1]

Q3: Have you previously submitted testimony in this proceeding?

A3: I previously provided sworn direct testimony in this proceeding, Pre-Filed Direct Testimony of James O. Rumbaugh, III, P.G. On the Design and Calibration of the Regional Computer Model Used in Predicting the Effects on Local and Regional Water

[1] PEF105 defines selected acronyms used in my Pre-Filed Rebuttal Testimony for ease of reference.

Resources from Active Groundwater Withdrawals During Construction and Operation of the Levy Nuclear Plant, Units 1 & 2 (PEF100).

Q4: In addition to your work in support of the LNP project described in your Pre-Filed Direct Testimony, what have you done to prepare this Pre-Filed Rebuttal Testimony?

A4: I have reviewed the Intervenors' Initial Written Statement of Position Regarding Contention 4 (Corrected July 6, 2012), as well as the Initial Pre-Filed Testimonies of Mr. Gareth Davies (INT001R), Dr. Tim Hazlett (INT101R), Mr. David Still (INT201R), and Dr. Sydney Bacchus (INT301R). I have also reviewed the Nuclear Regulatory Commission (NRC) Staff Initial Statement of Position and the NRC Staff Testimony Concerning Contention 4A. Lastly, I have reviewed the Pre-Filed Rebuttal Testimonies of Dr. Mitchell Griffin (PEF016), Mr. Jeffrey Lehnen (PEF218), and Dr. Paul Rizzo (PEF700).

Q5: What is the purpose of your Pre-Filed Rebuttal Testimony?

A5: The purpose of my Pre-Filed Rebuttal Testimony is to address certain portions of the Initial Pre-Filed Testimonies of Mr. Davies (INT001R) and Dr. Hazlett (INT101R) regarding the groundwater modeling reviewed by the NRC Staff when preparing the Final Environmental Impact Statement (FEIS).[2]

II. GROUNDWATER MODELING

Q6: Do you agree with the assertion in the Initial Pre-Filed Testimonies of Mr. Davies (INT001R at pp. 16-17) and Dr. Hazlett (INT101R at p. 3) that "a reasonable degree of scientific certainty" is the appropriate standard for evaluating the results of groundwater modeling?

---

[2] The NRC Staff reviewed two groundwater models when preparing the FEIS. NRC Staff Initial Statement of Position at pp. 23-24. The first groundwater model (ER Model) was originally prepared in connection with the Florida Site Certification and the Environmental Report submitted with PEF's NRC Combined License Application and is described in greater detail in TMEM-074, PEF212. The second groundwater model (Recalibrated Model) was prepared at the request of the NRC Staff and is described in greater detail in TMEM-123, PEF210.

A6: Yes, although in my professional opinion the predictions of the ER Model and Recalibrated Model meet this standard. As explained in my Pre-Filed Direct Testimony, PEF100 at pp. 7-8, groundwater modeling inevitably involves a degree of uncertainty because of our lack of complete subsurface data. As a result, a "reasonable degree of scientific certainty" in connection with groundwater modeling cannot mean absolute certainty. Instead, a more appropriate understanding of this standard is whether the groundwater model has been designed and calibrated properly, and has demonstrated an ability to provide reliable predictions over the course of time.

The District Wide Regulation Model, Version 2 (DWRM2) regional model and the Focus Telescopic Mesh Refinement (FTMR) software meet this more appropriate standard. As explained in my Pre-Filed Direct Testimony, PEF100 at pp. 12-15, the DWRM2 model was designed in accordance with American Society for Testing and Materials (ASTM) standards and the best available hydrostratigraphic (relating to the delineation of a body of rock into more or less permeable units to aid in the understanding of a flow system) data. The DWRM2 was calibrated in two stages against data taken from 1,039 wells over an eight-year period. The Southwest Florida Water Management District (SWFWMD) itself has used the DWRM2 and the FTMR software in its review of Water Use Permit (WUP) applications since their introduction in 2007, and the SWFWMD's experience has confirmed the reliability of their groundwater predictions. Additionally, a peer review[3] of the DWRM2 and FTMR software commissioned by the SWFWMD concluded that these products were "well suited to

---

[3] The peer review panel consisted of two licensed geologists (Dr. Joseph Hughes (USGS) and Dr. Mark Stewart (University of South Florida)) and a licensed engineer (Mr. Patrick Tara (INTERA, Inc.)). The panelists had extensive experience in groundwater modeling and in the hydrology of the SWFWMD's jurisdictional area. INT105 at p. 9.

evaluate ground-water withdrawal impacts to the [Upper Floridan Aquifer]." INT105 at p. 7.

Because the two groundwater models (the ER Model and Recalibrated Model) reviewed by the NRC Staff were derived from the DWRM2 using the FTMR software, the similar predictions of these respective models are in my professional opinion known to a "reasonable degree of scientific certainty." PEF100 at pp. 18-21.

Q7: Are integrated groundwater/surface water computer models (integrated models) of the sort that Dr. Hazlett implies[4] (INT101R at pp. 2, 5-8, 10) would have been appropriate for use in preparing the FEIS generally used in connection with the evaluation of individual WUP applications?

A7: No. Integrated models are not used routinely in evaluation of the effects of specific groundwater withdrawals on aquifer levels and regional aquifer flowrates. Because integrated models require significantly more data and man-hours to produce than a groundwater model, their design, calibration, and use is very expensive and difficult. As a result, they are generally only used in areas where limited groundwater resources require dependence on surface water. As explained in the Pre-Filed Rebuttal Testimony of Mr. Lehnen, PEF218 at pp. 3-5, this is not the case in the area surrounding the LNP site.

To my knowledge, the SWFWMD has only attempted two integrated models in its history, neither of which covered the area in the vicinity of the LNP site. The most recent has been a research project looking at the Peace River Basin. The second is a cooperative effort between the SWFWMD and Tampa Bay Water that was intended for use in permitting activities within a portion of the SWFWMD well south of the LNP site.

---

[4] Dr. Hazlett's testimony asserts that he is an expert in "integrated groundwater-surface water modeling." INT101R at p. 1. Although Dr. Hazlett does not explicitly recommend the substitution of an integrated model for the DWRM2, many of his criticisms of the DWRM2 relate to the purported advantages of integrated groundwater models.

The integrated approach was chosen by the SWFWMD/Tampa Bay Water because some of the covered area's supply comes from surface water, demanding a model that could simulate the effects of changing supply strategies on both surface and groundwater. The SWFWMD has been working on both of these integrated models for many years and neither model has been finished yet.

Q8: In your professional opinion, would an integrated computer model of the sort Dr. Hazlett (INT101R at pp. 2, 5-8, 10) implies would best account for alleged interactions between the stormwater runoff, Cross Florida Barge Canal (CFBC), the Gulf of Mexico, and the groundwater at the LNP site and the surrounding area have been appropriate for use in connection with the evaluation of the effects of LNP active groundwater withdrawals on aquifer levels and regional aquifer flow rates?

A8: No. As explained above, no integrated model exists for the area in the vicinity of the LNP site, and creating one from scratch would be very difficult and expensive. Additionally, it would be unnecessary because LNP active groundwater withdrawals are simply not large enough to justify the creation of a new integrated model. An integrated model allows the modeler to evaluate changes in surface water flow from a proposed groundwater withdrawal. Conservative estimates for the surface water baseflow rate at the CFBC and outfall from Lake Rousseau are approximately 125 million gallons per day (mgd), and 95 mgd, respectively. Although these values are conservative because they account only for the groundwater contribution to the basin and do not include runoff from individual rainfall events, they are still 60-80 times the LNP active groundwater withdrawals. Consequently, the reduction in surface water baseflow from LNP active groundwater withdrawals would be so insignificant as to be undetectable.

Although Dr. Hazlett is correct that the DWRM2 peer review panel recommended additional calibration efforts to better capture interactions between the surficial aquifer and surface waters in some areas, INT101R at p. 6, this comment is most relevant within the southern part of the SWFWMD where the surficial aquifer is hydraulically separated from the Upper Floridan Aquifer. In that area, surficial aquifer water levels simulated by the DWRM2 were sometimes above land surface, indicating that recharge was too high. This is not the case in the area in the vicinity of the LNP site because the surficial aquifer is well connected to the Upper Floridan Aquifer.

Additionally, Dr. Hazlett suggests that the new MODFLOW2005 Unsaturated Zone Flow Package (UZF) should have been used. INT101R at p. 6. Although the peer review panel for the DWRM2 did suggest that UZF be evaluated for use in future revisions of the District Wide Regulation Model (DWRM), this software package is still very much untested. To my knowledge, the first groundwater model to incorporate the UZF in Florida was just released by the United States Geological Survey (USGS) this month and has yet to be tested in practice. The UZF is also designed for more of an integrated approach to groundwater/surface water interaction which is not necessary for this site, as explained above and in the Pre-Filed Rebuttal Testimony of Mr. Lehnen. PEF218 at pp. 17-18.

Q9: Do you agree with Dr. Hazlett (INT101R at pp. 5-7) that the DWRM2 was designed for regional evaluation of the effects of water consumption and not for localized groundwater modeling of the impacts of LNP active groundwater withdrawals?

A9: No. Dr. Hazlett is incorrect in his assertion that the DWRM2 was not designed for localized water modeling. An important part of my efforts in developing the DWRM2 from the beginning was the creation of software incorporating a technique (called Focus Telescopic Mesh Refinement) for creating localized groundwater models from the DWRM2 regional model. PEF100 at pp. 13-15. The SWFWMD is confident in the accuracy of predictions obtained using this approach, and the SWFWMD uses it in connection with its review of individual permit applications. Additionally, the peer review of the DWRM2 and FTMR software commissioned by the SWFWMD concluded that the FTMR software was “innovative” and that its use with the DWRM2 was “well suited to evaluate ground-water withdrawal impacts to the [Upper Floridan Aquifer].” INT105 at pp. 6-7.

Q10: Do you agree with the assertion of Dr. Hazlett (INT101R at pp. 1-2, 5-8) that the NRC Staff should have used a transient groundwater model in connection with the evaluation of the effects of LNP active groundwater withdrawals?

A10: No. Dr. Hazlett’s claim that the DWRM2 (and models based on the DWRM2) is a steady-state model is incorrect. The DWRM2 model is run in both steady-state and transient modes when evaluating WUP applications. Here, the ER Model and Recalibrated Model were run in transient mode to obtain their predictions regarding the effects of LNP active groundwater withdrawals. PEF210 at p. 3; PEF212 at p. 4.

Q11: Did the NRC Staff consider the results of a groundwater model in which seasonal or long-term variation in system conditions (e.g., rainfall) had been accounted for by a transient calibration?

A11: Yes. Although Dr. Hazlett assumes that the NRC Staff considered only the results of the Recalibrated Model when preparing the FEIS, the NRC Staff actually considered the results of both the ER Model and the Recalibrated Models. NRC Staff Initial Statement of Position at pp. 23-24. As explained in my Pre-Filed Direct Testimony, the ER Model inherited the transient calibration of the DWRM2 model. PEF100 at pp. 12-13, 15-16. This calibration involved the assignment of recharge rates (a measure of the amount of precipitation that infiltrates an aquifer over time) based on continuous rainfall records provided by the SWFWMD over the course of eight years from 1995-2002. PEF100 at pp. 12-13. In my professional opinion, the transient calibration of the DWRM2 and ER Model properly accounted for seasonal or long-term variation in system conditions such as precipitation.

Additionally, Dr. Hazlett is incorrect when he claims that the Recalibrated Model results are inaccurate because the Recalibrated Model had not been calibrated in transient mode to account for time-varying rainfall. INT101R at pp. 7-8. A model calibrated in the manner demanded by Dr. Hazlett is not necessary in evaluating the impacts from LNP active groundwater withdrawals. The purpose of a groundwater model is to compute drawdown (how much the water table will be lowered relative to a non-pumping condition in the area surrounding a withdrawal point). If you run a groundwater model that assumes time-varying rainfall as proposed by Dr. Hazlett and another transient model that assumes a long-term average rainfall rate such as the Recalibrated Model, the amount of reduction in the water table will be exactly the same in both models. This is why the three water districts closest to LNP (the Suwannee River Water Management District (SRWMD), the St. Johns River Water Management District (SJRWMD), and the SWFWMD) all calibrate the respective groundwater models used in their permitting decisions against long-term average recharge.

The only time you would see any difference would be if evapotranspiration (the sum of the rate of water loss to evaporation and transpiration in vegetation) was included. DWRM2 does not simulate evapotranspiration directly. Rather, the recharge rates applied in DWRM2 have been computed such that evapotranspiration has been removed from total infiltration of rainfall at land surface. This is called using effective recharge (the amount of recharge that actually makes it to the water table). If DWRM2 were to include the effects of evapotranspiration, the drawdown computed for a model would actually be less than that computed in the LNP groundwater modeling. This happens because as the water table drops further from land surface, evaporation is reduced and the ability of plants to remove groundwater is also reduced. This effectively increases recharge and reduces drawdown. Thus, the DWRM2 assumptions are conservative from a drawdown calculation perspective.

Q12: Do you agree with the assertion in the Initial Pre-Filed Testimony of Dr. Hazlett (INT101R at pp. 3-5) that the data sets used in calibrating the DWRM2, the ER Model, and the Recalibrated

Model were inadequate to provide realistic predictions of the effects of LNP active groundwater withdrawals?

A12: No. In my experience, the groundwater models used by the Florida water management districts in their permitting activities are generally based on more and better-quality data than those groundwater models used in other areas of the country. The Florida water management districts maintain large networks of monitoring wells and gage pumping wells, and they measure spring flow, monitor surface water flow, and store this information for use in calibrating their groundwater models. The SWFWMD is no exception. As explained in my Pre-Filed Direct Testimony, PEF100 at pp. 12-13, the calibration of the SWFWMD's DWRM2 regional groundwater model was exhaustive, involving data collected over the course of eight years from a total of 1,039 wells (including 14 wells located within 10 miles of the LNP site) and 54 springs located throughout the SWFWMD. The SWFWMD itself has used the DWRM2 in its review of WUP applications since its introduction in 2007, and the SWFWMD's experience has confirmed the reliability of the DWRM2's calibration. PEF100 at pp. 14-15.

Because the ER Model reviewed by the NRC Staff in preparing the FEIS inherited the calibration of the DWRM2, its predicted drawdowns and regional aquifer flowrates are realistic. PEF100 at pp. 15-16. Although the Recalibrated Model incorporated slightly different water level elevation data than that used in the calibration of the ER Model, the fact that the Recalibrated Model produced similar results means, in my professional opinion, that its calibration was accurate as well. PEF100 at pp. 18-19.

Q13: Do you agree with the assertion in the Initial Pre-Filed Testimonies of Mr. Davies (INT001R at 11-13) and Dr. Hazlett (INT101R at pp. 4-5) that the averaged values used for hydraulic properties in the ER Model and Recalibrated Model do not yield realistic predictions regarding the effects of LNP active groundwater withdrawals?

A13: No. Groundwater modeling across large model domains inevitably requires the use of averaged values for hydraulic properties such as hydraulic conductivity (a measure of the ability of water generally to move through rock and soil) and transmissivity (the product of hydraulic conductivity and the thickness of the aquifer) which may differ from one another by an order of magnitude. First, the lack of subsurface data that is inevitable in groundwater modeling means that groundwater modelers have to assign some value in areas where measurements were not taken. The use of averages for this purpose is a standard technique in groundwater modeling to reduce the uncertainty involved in groundwater modeling. Second, even if a groundwater modeler did somehow know the hydraulic properties for every point in a model domain, the scale of groundwater models requires the use of averaged values. For example, the model domains in the ER Model and Recalibrated Model reviewed by the NRC Staff when preparing the FEIS were each 400 square miles, with individual grid cells in each model measuring 250 feet on each side for a total area of 62,500 square feet per cell. Third, the fact that some of these averaged values for hydraulic properties assigned within a groundwater model differ from one another by several orders of magnitude is inevitable, as certain hydraulic properties values can differ greatly within a relatively small area.

The averaged values for hydraulic conductivity and transmissivity assigned within the DWRM2 were the result of an exhaustive data review and calibration. The averaged hydraulic conductivity values used in the DWRM2 were obtained from large-scale pumping tests, and were carefully evaluated by myself and the SWFWMD before they were approved for use in the DWRM2. The DWRM2 assigned these values in the grid cells where the tests were conducted. In areas between tests, averaging was employed as part of the calibration process to constrain the values assigned. This approach was accepted without comment by the DWRM2 peer review panel and is consistent with standard technique among groundwater modelers, as well as ASTM standards. INT105 at pp. 13-15. The SWFWMD has found the results of this approach to produce reliable predictions of the effects of active groundwater withdrawals. PEF100 at pp. 13-15.

Q14: Does general practice among hydrogeologists discourage the assumption of porous geologic formations in areas in which karst could be present when evaluating the effects of groundwater withdrawals?

A14: No. The general practice among hydrogeologists is to assume that fractured media behave as a porous media at the scale of the model grid cell. This assumption is used for several reasons. First, it is virtually impossible to determine the exact number, orientation, and properties of individual fractures or solution channels. Second, there are very few standard models available for solving this type of problem, and to my knowledge none are available for the area in the vicinity of the LNP site.

I am unaware of any water management authorities inside or outside Florida that routinely use non-porous media assumptions in their permitting activity. The two water districts in Florida that have the most significant and extensive karst aquifers are the SRWMD and the South Florida Water Management District (SFWMD). Both districts use MODFLOW (which employs porous media assumptions) in their regional and local analyses of permitting issues even though karst features are abundant within their jurisdictions. The USGS also employs porous media assumptions when modeling the Floridan Aquifer System. The USGS has created many models within the Floridan Aquifer System, including a model covering the LNP site (Sepulveda, 2002) and all of them assume that at the scale of the model grid cell the Floridan Aquifer System behaves as a porous medium.

Q15: Do you agree with assertion in the Initial Pre-Filed Testimony of Mr. Davies (INT001R at pp. 2, 9, 11-13) that the assumption of porous geologic formations in groundwater modeling evaluating the effects of LNP active groundwater withdrawals is inappropriate?

A15: No. As stated earlier in my Pre-Filed Rebuttal Testimony, I am unaware of the USGS or any of the water management districts in Florida (even those with more highly karstic terrain than the SWFWMD) employing anything but porous media assumptions in their activities. Additionally, as explained in the Pre-Filed Rebuttal Testimonies of Mr. Lehnen (PEF218 at pp. 5-6) and Dr. Rizzo (PEF700 at pp. 6-7), the hydrogeology of the area in the vicinity of the LNP site is resistant to the formation of preferential conduits described by Mr. Davies. Also, the DWRM2 peer review panel did not identify any problem with the use of porous media assumptions within the DWRM2. INT105. Additionally, as explained in the Pre-Filed Rebuttal Testimony of Mr. Lehnen, PEF218 at p. 6, the use of porous media assumptions is actually a more conservative approach than the approach the Intervenors recommend. The presence of preferential conduits within the LNP production wellfield would create very high hydraulic conductivity, thus reducing the area experiencing drawdown as a result of LNP active groundwater withdrawals.

Q16: Do you agree with the assertion in the Pre-Filed Direct Testimony of Mr. Davies (INT001R at pp. 15-18) that the presence of karst in the geologic formation underlying the LNP site and the surrounding area demanded a larger model domain than the 400 square-mile domain of the ER Model and Recalibrated Model?

A16: No. The LNP production wellfield is projected to withdraw only 1.58 mgd during normal operations. The cone of depression around such a modest pumping volume is significantly smaller than the 400 square-mile domain of the ER Model and Recalibrated Model. When constructing telescoped models from the DWRM2 (such as the ER Model and Recalibrated Model), the goal is to have a model where the outer boundaries of the model are not affecting the predictions made at the center of the domain where the pumping occurs. The only times that the SWFWMD recommends expanding the model beyond the 400 square-mile area are when (1) the proposed permit is close to or overlapping one of the water use caution areas or the Most Impacted Area (MIA) around Tampa, or (2) when the proposed pumping rate is very large (generally, over 10 mgd). There are no special water use caution areas anywhere near the LNP site and LNP active groundwater withdrawals are well below the 10 mgd threshold used by the SWFWMD.

Q17: Do you agree with the assertion in the Initial Pre-Filed Testimony of Dr. Hazlett (INT101R at p. 7) that the number of surficial aquifer wells of other users incorporated into the ER Model and the Recalibrated Model resulted in unrealistic predictions of drawdown levels and regional aquifer flowrates resulting from LNP active groundwater withdrawals?

A17: No. From a modeling perspective, the surficial aquifer is virtually irrelevant to the predictions of these models. LNP active groundwater withdrawals occur in the Upper Floridan Aquifer. Drawdown is not affected very much by the hydraulic conductivity within the surficial aquifer because the surficial aquifer is relatively thin and generally has a lower hydraulic conductivity than the Upper Floridan Aquifer. The DWRM2 assumes that the surficial aquifer and Upper Floridan Aquifer are hydrologically connected at the LNP site so that the drawdown computed for the Upper Floridan Aquifer and the overlying surficial aquifer will be of equal magnitude. When pumping from the Upper Floridan Aquifer in these circumstances, it is impossible for the surficial aquifer to have more drawdown than the Upper Floridan Aquifer. Consequently, the ER Model and Recalibrated Model, in my professional opinion, use more conservative assumptions than those recommended by Dr. Hazlett.

I, James O. Rumbaugh, swear under penalties of perjury that this document is my true and accurate testimony.

[signature]

Signature

7-31-12

Date