NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD
Before Administrative Judges:
Alex S. Karlin, Chairman
Dr. Anthony J. Baratta
Dr. Randall J. Charbeneau

In the Matter of:	)	
PROGRESS ENERGY FLORIDA, INC.	)	
(Levy County Nuclear Power Plant, Units 1 and 2)	)	Docket Nos.
	)	52-029-COL, 52-030-COL
	)	
	)	July 31, 2012

PRE-FILED REBUTAL TESTIMONY OF GARETH DAVIES IN SUPPORT OF CONTENTION C-4 REGARDING ENVIRONMENTAL IMPACTS OF LEVY UNITS 1 AND 2 ON WATER RESOURCES AND ECOLOGY

Q1. Please state your name.

A.1. I am Gareth Davies.

Q.2. What is your educational background and experience?

A.2. My educational background and experience are described in response to Question 2 of my Prefiled Direct Testimony (Exhibit INT0001R), which was served on the Atomic Safety and Licensing Board (ASLB) and the parties on June 26, 2012. In addition, a copy of my curriculum vitae is attached to my Prefiled Direct Testimony as Exhibit INT003.

Q.3 What is the purpose of your Rebuttal Testimony?

A.3. The purpose of my Rebuttal Testimony is to respond to the Prefiled Direct Testimony submitted by witnesses for Progress Energy Florida (PEF) and the NRC Staff on June 26, 2012.

Q.4. Could you please provide a summary of your overall conclusions?

A.4. Yes. Overall, there is agreement between the NRC Staff and me that the existing model is not sufficiently realistic to provide reliable predictions about the effects of the proposed

groundwater withdrawal upon wetlands. Furthermore, experts for PEF do not dispute that the LNP area is karstic, although they mischaracterize the nature of the karst. Because of this mischaracterization, the witnesses for PEF incorrectly conclude that the existing hydrological model, called DWRM2, in its original calibration, reasonably predicts groundwater behavior. In fact, however, neither calibration of that model provides any useful predictions of the impact of the flow blockage that will be caused by the nuclear island and neither calibration can predict the local effects of the proposed groundwater withdrawals. The combined impacts of both of these disturbances to the existing flow regime could include destruction of wetlands, cutting off of spring flow, accelerated development of sinkholes, and diverting water flows in conduits in unexpected ways. These impacts could occur much more quickly than predicted by the FEIS or PEF because the speed of water flow in conduits is orders of magnitude greater than in the porous medium that is assumed in the existing DWRM2 model. Therefore they could occur at a much greater distance than currently anticipated. Impacts will also be anisotropic,[1] i.e. aligned along the direction of flow of conduits.

There is also no dispute among any of the experts that significantly more site characterization would be needed to enable a more realistic model to be created. In addition to additional boreholes, this characterization would include flow tracing and mapping of the conduit system. Finally, with such additional characterization, a reasonably accurate model could be produced that would predict the impacts of the proposed changes to the existing groundwater regime much more accurately. Such a model ~~would allow design alternatives, such as not using local groundwater, to be considered, and it~~ could be used to derive appropriate mitigation for the residual impacts.

1 Anisotropic means directionally non-uniform.

Q.5. Does the NRC Staff's or PEF's testimony contain any new information regarding the environmental impacts of LNP that affects your initial testimony?

A.5. No, although the witnesses for PEF and the NRC Staff do expand to some extent on the analysis that was presented in the FEIS, my initial testimony remains entirely valid. Their testimony simply confirms that the authors of the FEIS have not taken adequate account of the karstic nature of the geology in the vicinity of Levy Nuclear Power Plant and its implications with respect to the behavior of groundwater at the LNP site and vicinity.

Q6. PEF'S expert, Dr. Dunn, predicts that drawdown during operation of LNP will be essentially symmetrical and radial, spreading out evenly over a period of years (Exhibit PEF300 ,A.18). Is this prediction realistic?

A6. It should be assumed that there are conduits present and that would mean that drawdown will unlikely be radial. The drawdown would be expected to be significantly aligned parallel or sub-parallel to the direction of each conduit or other preferential flow pathway. In addition, the impact of the pumping will propagate through the conduits far faster than predicted because the flow velocities in the conduits are much greater than the predicted velocities in the porous medium.

Q7. NRC Staff testimony states that active and passive dewatering would decrease the discharges at the two largest springs in the vicinity of the LNP site, Big and Little King springs, by about 0.05 Mgd or about 1 percent of their total simulated flux. The Staff concludes that this reduction is a "small percentage" of the springs' flow and therefore active and passive dewatering would have an insignificant impact (Exhibit PEF300, A.18). Do you agree?

A.7. No, because it appears that the only way the Staff experts have evaluated the impacts to the Big and Little Springs is by assuming the aquifer behaves like a porous medium and therefore there were no conduits in the subsurface. Such an evaluation would ignore more than 99% of the flow feeding the springs. Because this flow is in conduits, it could be affected by anything that interferes with the flow along those conduits, such as active or passive dewatering.

Thus, the impact to the springs cannot be evaluated without knowledge of the conduit network that feeds the springs.

Q8. Could Big and Little King, or any other springs, be affected by the change in flow induced by the construction of the nuclear island and the proposed groundwater extraction?

A8. In general, springs in karst are directly connected to conduits and over 99% of the flow feeding the springs is in those conduits. Therefore, if a conduit is intercepted, almost all the discharge of that water could be interrupted or pirated. Both springs (Big and Little King springs) are located far from where the coast was located during the last glacial maximum (20,000 years Before Present) when sea level was 130m lower than at present. They are probably what are referred as overflow type springs, and conduits associated with them also exist deeper and adjacent to the conduits that actually discharge via the two springs. The LNP construction could still pirate water from the associated conduits because steepening of the gradients during pumping could result in water that was flowing in the conduits supplying both springs then flowing to other conduits. Overflow type springs have discharges that vary significantly and often stop discharging when stage (i.e. water level) falls. It must be realized that the flow system in these carbonates is related to the extent of the basins that existed when the flow system developed, probably in the Miocene or older (Oligocene or Eocene) (tens of millions of years ago) and not to the landscape today. The base-flow springs discharging this flow system 20,000 years ago must have been far out into the Gulf of Mexico near the coastline that existed then. This flow system would be like that of other coastal settings in Florida, where even large springs at the coast are still overflow types meaning that there must be offshore springs that continue to discharge even when the springs at the coast stop discharging (e.g., The Spring Creek group of springs in the Wakulla-Leon Sinks system, which reverse, or stop flowing

regularly).

Unfortunately, the FEIS and the testimony of the NTC Staff and PEF do not provide sufficient information to predict to a reasonable degree of scientific certainty what the effect of construction and pumping on these springs would be. To make such predictions a more realistic groundwater flow model is needed.

Q9. Is it reasonable for the Staff to consider the effect of drought conditions for salt drift but not for groundwater dewatering? (Staff testimony, A.200)

A.9. No, of course not. Drought can have just as great an effect on dewatering effects as on salt drift. To be consistent the staff should consider the cumulative effect of both salt drift and groundwater pumping during drought conditions.

Q10. Please describe the assumptions about the geology of the region made in PEF's witnesses' assessment of the environmental impacts of construction and operation of LNP. Do any of these assumptions differ from the assumptions that you criticized in your initial testimony? If so, please discuss whether you agree with them and the reasons for your opinion.

A.10. PEF's witnesses make some misleading statements about the nature of karst in an attempt to justify their failure to include the karstic nature of the local geology in the model used to predict impacts from the project. For example, on page 9 of Mr. Lehnen's testimony (**Exhibit PEF200, A.13**), he makes several statements about karst and karst development. In particular, Mr. Lehnen refers to the nature of the mantle of sediments and describes them as permeable. However, further on he says that the mantle over this mature karst will inhibit further development of the karst below (even though the mantling sediments are described as permeable). No reference to this phenomenon is made by Mr. Rumbaugh (he does not mention karst). Dr. Dunn refers to Mr. Lehnen in his testimony. Mr. Lehnen provides no literature references to back up these statements and neither he, nor Dr. Dunn, nor Mr. Rumbaugh, seems

to have the expertise in karst to make such statements (I can say that they do not come from any karst publication that I can think of that was published in the last many decades). I believe this illustrates that none of PEF's witnesses understands how karst behaves.

Another example that demonstrates confusion is that in Mr. Lehnen's testimony he refers to mature karst and ancient karst. The term ancient karst is entirely new to me, but there is a commonly used term paleokarst. I presume he is using the terms ancient karst and mature karst synonymously to describe a fully developed karst terrain. This type of karst would have active sinkholes and be the most active karst terrain. i.e. would be most responsive to changes in groundwater flow. This is the opposite of what is claimed in Mr. Lehnen's, and Dr. Dunn's testimony where in both cases they suggest that mature karst would have only inactive sinkholes and inactive karst features. Also, Mr. Lehnen says that the mantle of sediments would make the site and the area resistant to the further development of karst features. Again, this is very confusing, because the area is already acknowledged a karst terrain and if the mantle of covering sediments is permeable as they say it is it would not prevent further development.

As a karst expert, I believe that neither Dr. Dunn, nor Mr. Lehnen fully understands what they have said in their testimony. It is not internally consistent to maintain that it is mature karst (which by definition would be the most well-developed and most active) but then Mr. Lehnen says the development of "new karst phenomena would be inhibited" (**Exhibit PEF200, A.13**). Would the "phenomena" (such as sinkhole and conduit formation or expansion) not already be in place in a mature setting? This is not merely an argument about semantics. PEF witnesses fail to understand that sinkhole formation, for example, is a possible consequence of the proposed changes to the groundwater flow regime, because this is an active karst area. In other words, just because the karst is mature does not mean it is inactive or unresponsive to change.

Q11. Mr. Lehnen States at page 8 of his testimony that: "Unlike some of the counties in the region, the area in the vicinity of the LNP site does not overlie the relatively easily-dissolved limestone and phosphate deposits within the Suwannee and Ocala Formations." Do you believe this to be true? If so, how would this affect the karstic characteristics of LNP?

A.11. No. The suggestion that the dissolution characteristics of dolomite under the Levy site are significantly different than the dissolution characteristics of calcite in other areas (**Exhibit PEF200, A.11**) is challenged by the fact that the longest tracer test done in North America was done in a dolomite, or dolomitic limestone, nearly 70 km, from Mountain View, MO, [a collapsed sewage lagoon] to Big Spring MO. (Tom Aley, personal communication). The test was repeated several times and the conduit pathways must have passed beneath several rivers or large streams. The travel time was at the scale of a few weeks, not years or decades. Moreover, even if the quoted statement were correct, there should be no change in the karstic characteristics as long as there are unconfined carbonate rocks at the surface (Davies and Quinlan, 1993).

Q12. At page 9 of his testimony, Mr. Lehnen states: "Because permeability is a measure of a geologic formation's ability to transmit water throughout an aquifer, high permeability results in high capacity aquifers capable of yielding large quantities of water with very little drawdown." Do you agree?

A.12. This should be true on average, but it fails to take account of the spatial variability of the aquifer properties. I show in my initial testimony that because more than 99% of the groundwater flow is expected to be in conduits, the flow through the porous medium is relatively insignificant. In addition, randomly drilled wells, would only have a 10-17% probability of intersecting conduits (Benson and La Fountain, 1984), and could therefore be tapping less than 1% of the groundwater flow. In such circumstances localized drawdowns would be far greater than currently predicted. In the alternative, if a conduit is intersected, then fresh water could be preferentially pirated from more specific locations fed by the conduit flow, such as springs.

Q13. Staff testimony A.151 asserts that "area wetlands may therefore not be as responsive to groundwater impacts as would be expected in well developed karst systems containing large-scale fracture networks an/ or dissolution channels in direct hydraulic connection with overlying wetlands." Does the Staff take sufficient account of the presence of preferential flow paths in the local geology?

A13. No, although at times the Staff's assessment acknowledges the complexity introduced by the karstic nature of the geology, the Staff's predictions about impacts are inherently based on the contradictory assumption that the geologic medium is porous. At other times the Staff seeks to minimize this contradiction. For example, although the staff assumes a lack of "large-scale fracture networks and/or dissolution channels" in the quoted statement, such features are almost certainly present at the site, but have not yet been identified or mapped. The wetlands in the area are therefore likely to be far more responsive to groundwater withdrawal and other flow changes than the NRC Staff currently believes.

Q.14. Do you swear in accordance with 28 U.S.C. § 1746, under penalty of perjury, that this testimony is true and correct?

A.14. Yes I do.

Executed in accord with 10 C.F.R. § 2.304(d)

Electronically signed by
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