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MEMORANDUM

TO: Keith Hetrick, General Counsel, Florida Home Builders Association
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FROM: Damann L. Anderson, P.E.

DATE: May 23, 2007

RE: Review of Phase 1 Wekiva Basin Nitrate Sourcing Study

My comments on the MACTEC Report of March 2007, entitled "Phase 1 Report Wekiva River Basin Nitrate Sourcing Study", are summarized in this memo. These comments are based on my review of the report documentation as well as the presentation on the report made at the May 17, 2007 TRAP meeting in Orlando.

This report is an attempt to document sources of nitrate nitrogen ***inputs*** to the Wekiva Basin, and to then estimate the potential nitrate ***loading*** from these sources to ground and surface waters in the basin. The report is based on a literature review of existing documents and data, and is not based on field work specifically conducted in the Wekiva Basin by the project team. A second phase of work on the project is proposed, which could include field work to further refine the estimated nitrate loading presented in this report.

Overall the report is well done considering the time and budget available. Considerable effort was expended trying to find literature documenting the sources and quantity of nitrate in the basin. I believe the nitrogen input quantities presented in the report are reasonable for the most part, although I have comments on some of them which are noted below. However, I do not agree with the loading estimates made in the report, and feel that there was considerable inconsistency in the methodology used to generate them. My specific comments are provided below.

General Comments

1. I support the use of the Wekiva Basin as the study area boundary, since it is the hydrologic boundary that is of importance to the river and springs. However, use of

the Wekiva Basin in contrast to the Wekiva Study Area (WSA) boundary that was used in previous studies, may cause confusion between the various parties involved in studying the Wekiva area. Consensus needs to be obtained so that all parties are talking about the same study area.

2. The term "Septic Tanks" as a source should be changed to Onsite Wastewater Treatment Systems (OWTS). Septic tanks are only one component of an OWTS and the use of the term septic tanks is generally perceived negatively by the public and others. The term is similar to calling a wastewater reclamation facility a "sewer plant".

3. Nitrate may be the principal nutrient of concern in the Wekiva Basin, but the study needs to address sources of other forms of nitrogen in the basin as well, especially organic and ammonia nitrogen. Organic, ammonia and other nitrogen forms that are applied to land can be transformed to nitrate via the nitrification process, therefore all forms of nitrogen should be considered in quantifying inputs.

Nitrogen Inputs to the Basin

Nitrogen inputs to the Wekiva Basin were estimated by source based on available data, previous studies, and scientific estimates. Inputs represent an estimate of the total amount of nitrogen going to the Wekiva Basin, and as mentioned previously, should include all nitrogen species due to the transformation of nitrogen that can occur when applied to land and water.

The nitrogen ***inputs*** are important to understand, because they represent the data used to subsequently estimate the nitrogen ***loadings*** to waters of the Wekiva Basin. In addition, the estimated nitrogen inputs give an idea of the magnitude of each source, and allow evaluations of nitrogen source reduction strategies. If specified nitrogen reduction goals can be achieved at the source (i.e. reduced inputs), then it would be likely that a reduction in nitrogen loading to the waters of the basin would also be achieved (i.e. reduced loadings). While an accurate estimate of nitrogen loadings is desirable, they are much more difficult to obtain and typically require extensive field work within the study area to determine.

My specific comments regarding the nitrogen inputs are as follows.

1. ***Fertilizer*** – the fertilizer nitrogen input of approximately 7000 MT/year seems reasonable to me. It is based on IFAS recommended rates of application yet it is considerably less than the total nitrogen of the fertilizer sold in Lake, Orange, and Seminole Counties in 2005 based on data from the Florida Department of Agriculture and Consumer Services (FDACS), which makes sense.

2. ***Domestic Wastewater Discharges*** – I disagree with the estimated domestic wastewater nitrogen inputs. First, I recommend putting the reclaimed/reused effluents in with the other domestic wastewater discharges, so that the source of the nitrogen is known to be domestic wastewater. This will increase the domestic wastewater input by at least 109 MT/year. Also, I do not believe that reclaimed water has much, if any, impact on fertilizer use in the residential sector. It may have an impact on agricultural and golf course fertilizer use. If this can be documented,

fertilizer use could be reduced by the reclaimed N amount and the reason noted. If we separate nitrogen from its source it will be more difficult to evaluate sources for nitrogen reduction strategies.

Second, the nitrogen inputs from domestic wastewater do not make sense relative to other wastewater sources. Based on an estimated value of 11.2 grams N per person per day as the nitrogen contribution to wastewater (U.S. EPA, 2002), the following calculation can be made based on the populations served from the MACTEC report:

Sewer: 265,000 people x 11.2 g N/person/day = 1083 MT N / year

OWTS: 160,000 people x 11.2 g N/person/day = 654 MT N / year

These raw input numbers would need to be reduced based on treatment performance, but since most of the wastewater treatment plants in the basin are not currently designed to remove nitrogen, the relative magnitude of the domestic wastewater input compared to the OWTS input should be similar. I think the problem is related to the fact that only nitrate-nitrogen was used in the calculation for domestic wastewater discharges whereas total nitrogen was used for OWTS. This is inconsistent and I believe total nitrogen should be used in both cases since land application of wastewater effluents will generally result in nitrification of the organic and ammonia nitrogen to nitrate nitrogen in the receiving environment. Also, elimination of many of the smaller treatment plants where data was not available may be underestimating the domestic wastewater input. Based on the raw nitrogen input calculation shown above, it is difficult to believe that domestic wastewater inputs of nitrogen are less than OWTS inputs.

3. ***Onsite Wastewater Treatment Systems (Septic Tanks)*** – I agree with the estimate for nitrogen inputs from OWTS, however, as mentioned above, this estimate is based on total nitrogen, not nitrate nitrogen. If nitrate was used to calculate the OWTS input, as was done for domestic wastewater discharges, the input from OWTS would be negligible, and this illustrates the inconsistency of the approach.

4. ***Atmospheric Deposition*** – I disagree with the estimated nitrogen input from atmospheric deposition. The Orlando metropolitan area is a large urban area, not unlike others in the state. The airshed for Orlando probably includes the entire Wekiva Basin, and there should be studies available to document this. My point is that I do not think a rural deposition rate such as that for the Indian River Lagoon site near Sebastian, is applicable to the Wekiva Basin. In addition, I believe the atmospheric deposition input estimate should include all nitrogen forms, not just nitrate. Similar to the discussion above, non-nitrate nitrogen from atmospheric deposition would be nitrified to nitrate in most receiving environments, especially that which fell on land. Last, the Conceptual Model of Nitrate Inputs (Figure 2-2) shows nitrogen from Atmospheric Deposition only being transported to surface water. I believe that nitrogen from deposition would also infiltrate pervious land and be a source of nitrogen to groundwater as well.

   Considerable study, including field monitoring of atmospheric deposition of nitrogen has been conducted in the Tampa Bay region, as part of the Tampa Bay National

Estuary Program. It was estimated that the nitrogen contributions from atmospheric deposition in the Tampa Bay watershed are 7.3 (±1.3) kg/ha/year, including both wet and dry deposition and nitrate and ammonia nitrogen (Poor, Pribble, and Greening; 2001. Atmospheric Environment 35, p. 3947). I believe this may serve as a reasonable estimate for the Wekiva Basin N-deposition as well.

Nitrogen Loadings to Waters of the Basin

Only a portion of the nitrogen inputs to the Wekiva Basin eventually reach groundwater or surface waters of the Basin. Therefore, each of the nitrogen input estimates in the report were further evaluated in an attempt to quantify that portion of each source that reached waters of the basin. The estimated mass of nitrogen that reached waters of the basin for each source was referred to as the nitrogen loading from that source. The loading estimates were based on the portion of each input that reached surface waters or the water table (surficial aquifer), and were not meant to represent the loading to the Floridan aquifer or the springs. Although this is explained in the report, it is not clear that this is the case for all sources, and I believe this should be clarified, especially in the executive summary. The nitrogen inputs pie chart should also appear in the executive summary.

While the nitrogen inputs were, for the most part, based on available data, previous studies, and scientific estimates, many assumptions were needed to estimate the nitrogen loading to waters of the basin from each source. Since specific studies in the Wekiva area were lacking, there is considerable uncertainty surrounding these loading estimates, and this uncertainty is discussed in Section 3.3 of the report. It is emphasized that additional work and considerable field monitoring would be needed to reduce these uncertainties and more reliably estimate the loadings from each source.

Table 1 below shows the nitrogen inputs estimated for each source, the amount of each input that was estimated to reach waters of the basin (the nitrogen loadings), and the percent difference between input and loading for each source. As the table shows, the difference between input and loading ranges from 0% for Domestic Wastewater to 92% for Atmospheric Deposition. Since all nitrogen inputs are applied to the same basin, with the same hydrology, and mostly applied to land, it is difficult to believe that there could be this range of differences between inputs and loadings. It appears to me that similar mechanisms would be responsible for reducing the source inputs: plant uptake, volatilization, denitrification, and flow out of the basin. While there are likely some differences in how these mechanisms apply to each source, I would not think that differences between 0 and 90+% would occur in the same basin. Therefore, I believe these differences may result from inconsistency in how the nitrogen loadings were derived from the nitrogen inputs.

A simple example will illustrate what I mean. The residential fertilizer nitrogen loading to groundwater was calculated using an assumed groundwater concentration below the areas designated as residential land use. The assumed groundwater concentration was based on several experimental studies of turfgrass fertilization. A value of 3 mg N/L was derived from these studies after applying them to a range of lawn care practices (see MACTEC report p. 2-18 to 2-20). In addition, the loading was calculated based on the estimated recharge rate to the Floridan Aquifer. This method seems reasonable, but includes losses in nitrogen from all the mechanisms mentioned previously, as well as some dilution if these experiments

Table 1. Comparison of Nitrogen Inputs to Loadings in the Wekiva Basin
(from MACTEC Report)

SOURCE	INPUT TO BASIN		LOADING TO WATERS		% DIFF
	Mass (MT/yr)	% of Total	Mass (MT/yr)	% of Total	
Fertilizer	7050	75%	972	54%	- 86%
Livestock	1128	12%	108	6%	- 90%
OWTS	564	6%	396	22%	- 30%
Atm. Deposition	470	5%	36	2%	-92%
Domestic WW	189	2%	189	10%	0%
Natural	- -	- -	108	6%	na
TOTALS	**9400**	**100%**	**1800**	**100%**	**- -**

were performed in the field. A nitrogen mass reduction of 86% from input to loading for residential fertilizer was obtained using this methodology.

In contrast, the OWTS (septic tank) nitrogen loading was calculated based on the total mass of nitrogen released from septic tanks and a 30% reduction factor to account for an estimate of nitrogen that reaches the top of the shallow groundwater (the water table) directly below the area of the OWTS drainfield. These two methods are grossly inconsistent with each other, however the residential fertilizer methodology probably yields a better estimate of the actual loading that potentially impacts Wekiva Springs and River.

If this same methodology was used for OWTS, the following worst-case nitrogen loading from OWTS could be estimated the same way. Assuming an average drainfield size of 450 square feet, and a total nitrogen concentration of 40 mg/L in the shallow groundwater directly below the drainfield area (on the high end of the range reported in previous studies), the following nitrogen loading could be calculated assuming a 10.6 inches per year average weighted recharge rate for residential areas in the Wekiva Basin (from MACTEC report):

$$\frac{65{,}399 \text{ OWTS} \times 450 \text{ ft}^2 \text{ drainfield area} \times 10.6 \text{ in/year} \times 40 \text{ mg N / L}}{4.244 \times 10^8 \text{ (conversion factor)}} = 29.4 \text{ MT N/year}$$

This is far less than the 396 MT N/year used as OWTS loading in the report. As this example shows, if the methodology used for determining residential fertilizer loading was applied to nitrogen from OWTS, a similar reduction (90%+) from input to loading would be obtained.

There are numerous other examples of inconsistencies in the way loadings were derived from inputs in the report. For the most part, the data needed to accurately determine loadings from inputs is not available. Therefore, to recommend load reduction strategies based on these loading calculations is inappropriate. Far too much effort and expense may be applied to sources that do not contribute significantly to the problem. As I have said before, we have limited financial resources available to address the nitrogen loading problems in the Wekiva Basin. These resources should be applied to those solutions that yield the largest nitrogen load reduction per dollar spent.

I believe that relatively accurate estimates of nitrogen inputs to the Wekiva Basin can be made. As stated above, I also believe that the relative distribution of nitrogen inputs will reflect the distribution of nitrogen loadings, with minor deviations between sources. For these reasons, the relative contributions of each nitrogen source should be based on estimated inputs until such time that field data is available to more accurately calculate loadings from each source in a consistent fashion. In the meantime, strategies to reduce nitrogen inputs can be developed for those sources that make the largest contribution to nitrogen in the Wekiva Basin. It is likely that reductions in these inputs will yield corresponding reductions (on a percent of load basis) in nitrogen loading to waters of the basin.

I would be happy to assist in any way I can to improve the nitrogen input and/or loading estimates for the Wekiva Basin. I believe my experience in land treatment of wastewater and groundwater hydrology could prove useful, at least for refining the estimates for wastewater sources. A team effort in developing these estimates would save time, potentially lead to buy-in from stakeholders, and reduce controversy over the nitrogen sources and their corresponding loads in the basin.