ATTACHMENT H

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Comments on the Riverbend Groundwater Assessment and Supplemental Groundwater Assessment Reports

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Geo-Hydro, Inc (GHI) has reviewed the Groundwater Assessment and Supplemental Groundwater Assessment Reports that were prepared for Duke Energy Carolinas, LLC by HDR Engineering, Inc. of the Carolinas, dated May 31 and June 21, 2013, respectively. Our comments and observations are referenced to the specific sections of the reports that discuss various issues.

General Comment

The Groundwater Assessment Report takes a shotgun approach to attempt to explain away the exceedances of the applicable 2L Standards observed since 2010. The report attempts to invoke a wide variety of explanations other than the obvious observation that infiltration of water out of the unlined waste disposal units are altering the local groundwater flow system and adding metals to groundwater in concentrations sufficient to exceed water quality standards. Of particular concern is the fact that neither water table nor potentiometric surface maps showing the groundwater elevation at the water table or deeper within the aquifer are provided. Determination of the direction and magnitude of the horizontal hydraulic gradient at the water table is a fundamental element of any assessment of groundwater condition that is ignored in these documents. The groundwater assessment report instead references general statements describing topographic driven flow in undeveloped areas that account for neither the presence of the ash basins, nor the presence of the ash storage area. This fundamental understanding has either not been achieved or has been deliberately omitted from the submitted reports. Failure to adequately characterize the direction of groundwater flow should be considered a fatal flaw of the groundwater assessment.

Groundwater Assessment Comments

1. **Section 2.5, Page 6, Groundwater Monitoring System, 3rd paragraph** – This section describes monitoring wells MW-7SR and MW-7D as being "considered by Duke Energy to represent background water quality". This statement may be telling in that it does not say that wells MW-7SR and MW-7D **are** background wells, only that Duke Energy considers them to be background wells. This may explain why no water table or potentiometric maps included in the report. Inclusion of such maps would highlight the hydraulic gradient from the ponds toward well MW-7SR and MW-7D described above in the general comment. Based on the available information it appears that there may be no wells in the monitoring system capable of characterizing unimpacted background conditions.

2. **Section 4.1.2, Page 13, Hydrologic Framework, last paragraph** - The last paragraph on page 13 indicates that based on water level elevation measurements and ground surface topography, groundwater flow direction appears to be predominantly from the ash basins to the north and west toward Mountain Island Lake. This statement ignores the hydraulic gradients from the ponds toward monitoring wells on the south and east that are indicated by water elevations shown on Figure 4.1-2. On a regional scale it is correct to say that groundwater flow is toward the lake, however, local groundwater appears to flow radially away from the waste disposal facilities, including toward the "background" wells.

3. **Section 4.1.2, Page 14, Hydrologic Framework, first paragraph** – There is no data provided that indicates that a perched water condition is present in the vicinity of the basins. A perched groundwater condition would require that unsaturated conditions be present between the general water table and the perched water. It is much more likely that leakage from the unlined ponds have created a groundwater mound beneath the impoundments that drives flow radially away from the impoundments in all directions, including toward the "background" monitoring wells. This condition is consistent with observed artesian conditions in wells located at lower elevation locations between the ponds and lake.

4. **Section 4.1.4, Table 4.1.1** – The hydraulic conductivity values provided on Table 4.1-1 combines an unknown number of values from other Carolina sites with site-specific data from the Riverbend site. Regional values should only be used where site-specific values are not available and cannot be generated.

5. **Section 4.3, Page 22, Basin Water Quality,1st paragraph and 1st bullet** – The observation that the ionic composition of groundwater sampled at the "upgradient" monitoring will is different than the composition of the TOWER sample is not surprising. The groundwater at the "upgradient" locations likely reflects mixing of natural waters with pond water that is driven away from the impoundments by the high hydraulic gradient. Water that is collected from monitoring points on the "downgradient" side of the ponds consists of a greater proportion of pond water and therefore more closely approximates the chemistry of pond water.

6. **Section 4.4, Page 24, Lake Water Level Data, entire section -** This section provides a good description of the close connection between the level of Mountain Island Lake and groundwater beneath the unlined ponds and ash storage area. The description of a very rapid increase in water elevation in MW-13 as lake level increased confirms that the groundwater is highly permeable and connected to the lake. Contaminants released from the unlined waste storage areas will be readily transported into the lake. It is likely that exceedances of 2L Standards would be greater without this type of periodic flushing of the groundwater.

7. **Section 4.5, Page 26, Background Monitoring Wells, entire section** – This section describes monitoring wells MW-7SR/D and MW-8S/I/D as representing background groundwater quality on the basis of their location and surface topography. Groundwater flows in response to the hydraulic gradient, not the surface topography. An accurate understanding of the direction of groundwater flow is fundamental knowledge needed to evaluate the adequacy of background monitoring locations.

   Figure 4.1-2 shows elevations of water in the ponds and in some monitoring wells measured in early 2013. These data show the elevation of water in the primary ash basin at 721.42 feet. Groundwater elevations in "background" wells (MW-7SR and MW-8S) are indicated to be 714.51 and 707.63 feet. These elevations indicate 6.91 and 13.79 feet, respectively, of head difference between the primary ash basin and the "background monitoring wells. No data is provided on the elevation of leachate within the ash storage area. These data indicate that a substantial hydraulic gradient exists between the ponds and the wells that have been assumed to be background monitoring points. The concentrations the various parameters reported present in the assumed background wells likely include groundwater impacts from pond and/or ash storage cells rather than natural groundwater quality. All comparisons of groundwater quality at downgradient monitoring points to "background" wells discussed in the report are suspect due to likely pond water impacts. Also see comment #1.

8. **Section 4.5, Page 27, Background Monitoring Wells, entire section -** Water level fluctuations in "background wells" of two to three-feet over the period of record are not unusual. They indicate that the hydraulic gradient between the ponds and "background" monitoring wells fluctuate with seasonal changes in head. The small fluctuations noted at wells located to the north and west of the ponds provides another piece of evidence indicating that groundwater beneath the ponds is in good communication with the elevation controlled lake.

9. **Section 4.5, Page 27, Background Monitoring Wells, last paragraph** – The statement that topographic data and water elevation data suggest that monitoring wells MW-7SR and MW-7D adequately represent background water quality at the site indicates a fundamental lack of understanding of groundwater flow. Groundwater flows in response to the hydraulic gradient, not the surface topography. See Comments #1, 2, 5 and 6.

10. **Section 4.7, Page 30, Exceedances Against Background Wells, entire section** – Comparison of exceedances against "background " wells that themselves may be impacted by pond water is an exercise that can only identify which wells are most significantly impacted rather than identifying excursions from unimpacted locations. Installation and sampling of unimpacted background wells

would be necessary to adequately compare groundwater quality in impacted wells against unimpacted conditions. See Comments #1, 2, 5 and 6.

11. **Section 4.8, Page 35, Exceedances Against Turbidity, entire section** – There is no question that sample turbidity can impact analytical results for manganese and iron. Low-flow sampling techniques have been used for decades at sites where turbidity is a potential issue. It is the responsibility of the operator of the site to assure that monitoring results reported to the State accurately reflect groundwater chemistry. Apparently the operators of Riverbend facility have not utilized proper sampling techniques until very recently. Unfortunately the graphs showing both turbidity and sample concentrations referenced in the text indicate that several of the monitoring wells continue to show exceedances of 2L standards for iron and manganese, even after recent implementation of low-flow sampling techniques. All wells should continue to be sampled using low-flow sampling techniques in order to eliminate further questions on the role of turbidity on sample results.

12. **Section 4.9, Page 36, Sampling Flow Rates, entire section** - Modification of sample collection flow rates is simply another method of minimizing sample turbidity. See comment #11.

13. **Section 4.10, Page 37, Collect Filtered Samples, entire section** - Field filtering of groundwater samples prior to acidifying the sample in the sample container is commonly done to eliminate potential impacts to sample results from well or formation sediments. Comparison of results of filtered and unfiltered sample analyses from select monitoring wells presented in Table 4.10-1 shows that even filtered samples continue to show concentration of iron and manganese at or above the 2L standards. Groundwater impacts above the 2L standards appear to be the result of release from the unlined impoundments rather than a sampling artifact.

14. **Section 4.11, Page 39, Collect Reduction/Oxidation Parameters, entire section** – This section provides a nice description of the distribution of ORP and DO measurements made on water from site monitoring wells and points out that deep wells commonly exhibit lower ORP and DO than more oxygenated shallow wells. Under natural conditions wells located near Mountain Island Lake would be expected show high ORP and DO values due to the regular influx of highly oxygenated lake water as discussed in Section 4.4. The report indicates that wells located "downgradient' of the ash basin generally had lower ORP and DO measurements compared to the "background" wells. This observation is consistent with release of low ORP and DO leachate that has migrated from the accumulate waste at the bottom of the waste disposal ponds and ash storage area into the upper portion of the aquifer, thus providing another indication of groundwater impacts from the facility. Introduction of strongly reducing waters released from the ponds could induce liberation of additional metals from the soils, thus adding to the concentration of metals

already migrating with the released leachate. The root cause of the metals detected in groundwater "downgradient" of the ponds appears to be the release of leachate from the site.

15. **Section 4.12, Page 42, Statistical Analysis, entire section** – Inter-well statistical analysis on wells that have been sampled at least 8 times showed that wells MW-8S, MW-8I, MW-8D, MW-9, MW-10, MW-11SR, MW-13, and MW-15 showed statistically significant increases above "background" concentrations for iron, manganese, or both. Intra-well analysis showed that wells MW-8I, MW-8D, MW-9, MW-11DR and MW-13 consistently have results in excess of the 2L Standards for iron, manganese, or both. Statistically significant increases are confirmed even though "background" wells MW-7RS/D are located hydraulically downgradient of the ponds and are themselves likely impacted by pond water. Statistically significant increases in iron and manganese are confirmed by this analysis.

16. **Section 5, Page 45, Conclusions and Recommendations, entire section** – Despite all evidence to the contrary this section repeatedly cites well location and information provided in Section 4 (specifically sample turbidity and oxygenation state) as rationale for attributing exceedances in iron and manganese concentrations to naturally occurring sources. The assertion that well location (locations that Duke Energy considers representative of background groundwater quality) indicates that wells must be impacted by natural processes is refuted by examination of the hydraulic gradient rather than surface topography. Turbidity of samples can have impacts on water chemistry, especially iron, but analysis of field filtered samples reported results that were above 2L Standards, thus eliminating turbidity as the source of impacts. The report acknowledges that significant reducing conditions were not documented in the field in most wells. In wells where reducing conditions were identified the report concludes that this is a natural condition unrelated to releases from the impoundments. This argument ignores the information presented in Section 4.4 that indicates that areas "downgradient" of the site are in communication and regularly flushed with highly oxygenated lake water. The reader is asked to believe that the presence of unlined impoundments and waste storage area, conveniently undefined hydraulic gradients, poor sampling technique, statistical verification of significant differences from 'background", and groundwater modeling that predicts concentrations above 2L Standards all add up to indicate that the observed exceedances are naturally occurring. The report essentially asks the reader to ignore the available information and believe the story that Duke Energy chooses to tell.

Supplemental Groundwater Assessment Comments

17. **Section 5, Page 11, Groundwater Modeling Results, entire section** – The results of groundwater modeling conducted at wells MW-9, MW-10, and MW-13 predicted that concentration of iron and manganese at the compliance boundary would in each case be above the

2L Standards for those parameters. This method again reinforces the opinion that release of leachate from the unlined impoundments is driving exceedances of 2L Standards at the compliance boundary.