January 22, 2020

RE: PUBLIC COMMENT FOR APC&EC REGULATIONS 5 AND 6

I support a Permanent Moratorium on Hog CAFOs in the Buffalo National River Watershed.

The Big Creek Research Extension Team's (BCRET) Final Report October 24, 2019, **MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED**, provides scientific documentation that supports the need for this Permanent Moratorium. The report documents water quality impact from the only hog concentrated feeding operation (CAFO).

BCRET acknowledges in this final report the statistically significant changes over the 5-year monitoring period in nitrates (N) and phosphorus (P) downstream from C&H Hog Farms (C&H***): "Phosphorus and N concentrations in Big Creek were greater downstream than upstream of the C&H Farm. For example, the 5-year mean nitrate-N concentration was 0.13 mg/L at the upstream site and 0.29 mg/L at the downstream site."*** Graphs for both N and P, covering BCRET's monitoring period are clearly seen in BCRET Final Report Chapter 7 graphics.

Other indicators of negative water quality impact were BCRET monitoring stations near the C&H production facility and holding lagoons. Raw hog waste "by design" (Facility Engineers pre-construction) that could leak as much as 4,938 gallons per day for the two waste lagoons into the subsurface in fragile karst terrain. That design was approved by the state of Arkansas who granted a permit for this CAFO. In 2016 the state paid for the extensive and costly, Harbor Drilling Study of 2016, as related to the potential threat of this permitted subsurface.

IMPLICATIONS OF KARST ON NUTRIENT FATE AND TRANSPORT

"The effective connection of surface with groundwater environments by high-permeability, dissolution-enhanced conduits, create rapid groundwater velocities and high volume and mass-transport capacities. This coupled with groundwater recharge bypassing the overlying soil and regolith, limit any filtration, and processing capacity within the karst framework, combine to render groundwater in karst hydrologic systems, very susceptible to contamination from various land uses. Studies of various agricultural land uses including CAFOs in karst terrain have shown that waste lagoons and manure application fields can be sources of groundwater contamination (Brahana et al., 2014, 2016; Chapman et al., 2015; Ham, 2002; Kelly et al., 2009; Hutchins et al., 2012). Contaminants include nutrients N and P, bacteria, steroid hormones, heavy metals, antibiotics, and pharmaceuticals (Hong et al., 2013; Mallin and Cahoon, 2003; Lapworth et al., 2012; Roland, 2016)." BCRET Final Report Page 40.

KARST GEOLOGY AND THE BIG CREEK WATERSHED

BCRET Final Report "KARST GEOLOGY AND THE BIG CREEK WATERSHED", pages 40 of 286 through 49 of 286 are extremely important and help to visualize the fragile nature of karst landscape, complicated groundwater transport of water and potential to move nutrients in unpredictable directions.

The BCRET Final Report offered a great deal of insight into the data obtained during the 5-year monitoring period. This section was taken from the Page 33 of 286 and Page 34 of 286 of the BCRET Final Report. I feel the "schematic" and description are **extremely important in visualizing the "unseen" potential threat to groundwater** in karst landscape. This is very typical of a large portion of the Buffalo River National Watershed. Engineers, permit writers, directors, legislators all, please think about it before approving permits or regulations that might threaten the subsurface where a significant amount of our water is stored. **This supports the need for a Permanent Moratorium of Hog CAFOs in the Buffalo National River Watershed.**

"Figure 2. Schematic representation of karst features that influence the fate and transport of nutrients in the landscape' and which can increase speed and unpredictability of nutrient flows (from Currens, 1995)."

Background

"The Big Creek Watershed below the C&H Farm and application field locations, lie within a karst hydrologic system of great complexity exhibiting intimate connection of surface-water and groundwater regimes. These characteristics endow the hydrologic system as an important recreational resource locally and regionally, but also render the system vulnerable to contamination. The complexity of karst prevents easy understanding of flow regimes, challenging effective protection and management. Karst hydrologic systems are defined by the heterogeneous distribution of high-permeability solution channels that have developed in soluble, carbonate rock and the connectivity of these channels with the land surface (Figure 2).

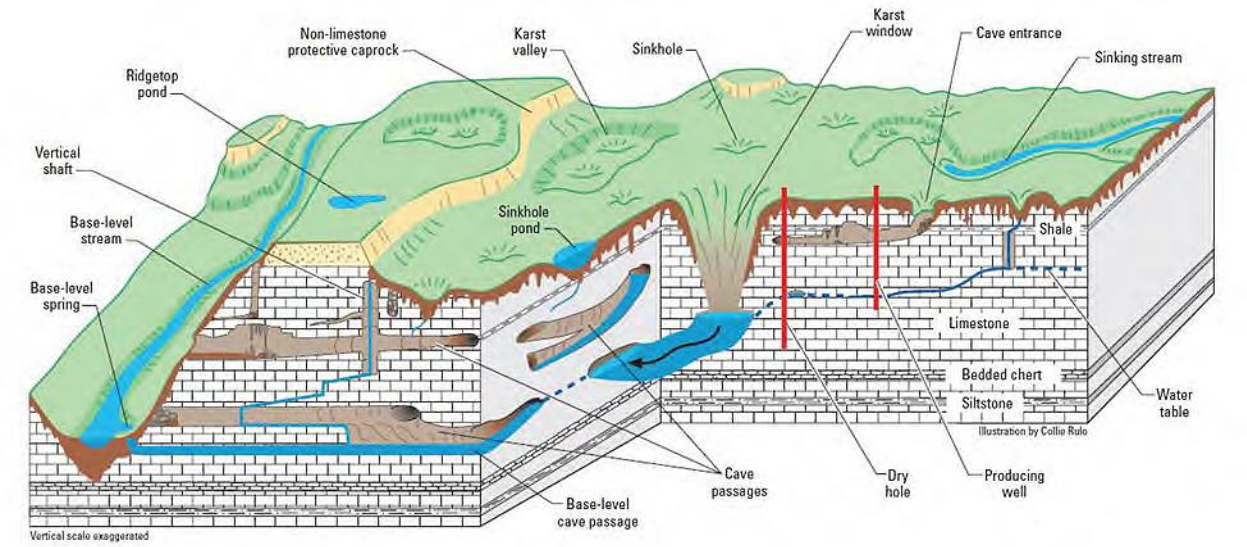

Figure 1. Schematic representation of karst features that influence the fate and transport of nutrients in the landscape; and which can increase the speed and unpredictability of nutrient flows (from Currens, 1995). This connectivity results in rapid transport of surface water, as well as surface-derived contaminants, into the groundwater environment, bypassing soils, regolith, and granular rock strata, where any

attenuation of contaminants may occur. Karst groundwater flow paths often cross surface topographic divides and are dynamic, frequently changing dominant conduits and flow direction, as well as changing recharge-area boundaries with changing hydrologic conditions." Karst terrane is often typified karst features representing locations on these solution-channel paths; e.g., sinkholes, springs, caves, and losing streams. In the Big Creek Watershed, these surface expressions of karst are often subdued or covered by a regolith mantle. Mantled karst is characteristic of the Springfield Plateau, the physiographic section in which the Big Creek Watershed is largely located."

John Murdoch

Geologist

Wesley, Arkansas

PEER-REVIEWED ARTICLES - discussing findings in fragile karst of the Big Creek and surrounding area that provides additional scientific findings that support the need for the Permanent Moratorium for the Buffalo National River Watershed. The publications are contemporary with the BCRET (CAFO) monitoring period and location.

Kosič Ficco K., Thaler E., Brahana JV., Ficco M., Helms T., 2018, Strengths and limitations of karst groundwater vulnerability mapping methodologies: in Younos, T., Schreiber, M. and Ficco, K. K. Eds., Karst Water Environment: Advances in Research, Management and Policy: Karst Water Environment, The Handbook of Environmental Chemistry, v. 68, p. 91-132. Springer International Publishing, (DOI: https.//doi.org/10.107/978-3319-77368-1_4).
Brief Summary: Peer-reviewed chapter of a management and policy book published by Springer International Publishing. Discusses strengths and drawbacks of models and methodologies of assessing karst vulnerability, with examples from the area of the Buffalo National River).

Brahana, Van, Bitting, Carol, Kosic-Ficco, Katarina, Turk, Teresa, Murdoch, John, Thompson, Brian, and Quick, Ray, 2017, Using fluorescent dyes to identify meaningful water-quality sampling locations and enhance understanding of groundwater flow near a hog CAFO on mantled karst—Buffalo National River, southern Ozarks: *in* Kuniansky, E.L., and Spangler, L.E., eds., U.S. Geological Survey Karst Interest Group Proceedings, San Antonio, Texas, May 19-23, 2017, U.S. Geological Survey Scientific Investigations Report 2017-5023, p. 147-160.
Brief Summary: Peer-reviewed chapter of the Karst Interest Group national meeting of the U.S. Geological Survey held in 2017. The report summarizes intensive dye-trace studies that show dispersive flow near C&H Industrial Hog Farm and its waste-spreading fields. Among other results, positive dye trances from input to output springs flowed beneath surface-water drainage boundaries, including one spring [Mitch Hill Spring] that lies on the opposite side of the Buffalo that flows directly into the Buffalo]. Other positive dye traces were documented [and verified by professional dye tracers unaware of recovery locations] in contiguous surface-water basins to Big Creek, as well as within Big Creek basin, verifying the complexity of the karst groundwater flow paths.

Brahana, V., Nix, J., Kuyper C., Turk, T., Usrey. F., Hodges, S., Bitting, C., Ficco, K., Pollock, E., Quick, R., Thompson, B., and Murdoch, J., 2016, Geochemical processes and controls affecting water quality of the karst area of Big Creek near Mt. Judea, Arkansas: Journal of the Arkansas Academy of Science, v. 70, p. 45-58.
Brief Summary: Peer-reviewed report published by the Arkansas Academy of Science. This summarizes findings of trace constituents with relation to distance from C&H Industrial Hog Farm and its waste-spreading fields. Findings focused on the Boone Formation, and reflected that the closer to the source of hog feces and urine, the greater the concentration of indicator trace constituents in the springs.

Murdoch, John, Bitting, Carol, Brahana, John Van, 2016, Characterization of the karst hydrogeology of the Boone Formation in Big Creek Valley near Mt. Judea, Arkansas—Documenting the close relation of groundwater and surface water: Environmental Earth Sciences, v. 75;1160, 16 p. (DOI 10.1007/s12665-016-5981-y).
Brief Summary: Peer-reviewed journal article [Environmental Earth Sciences] that focused on the hydrogeology of the Boone Formation near the southernmost waste-spreading fields used by C&H Industrial Hog Farm. Continuous monitoring of precipitation and water levels in response to large rainfall events were reflected in distinct groundwater-recession curves, responding initially within one hour of rainfall. The recession of the groundwater levels indicated hydraulic characteristics of karstified limestone layers bound by insoluble chert layers [occurring as couplets] were consistent with surface water stage in Big Creek, indicating that only evaluating surface water in the region missed significant groundwater transport within the hydrologic cycle of Big Creek.

Faulty Phosphorus Index (Another flaw that endangered the Buffalo River Watershed from CAFO and has potential to do the same in karst landscapes with nutrient overloading)

Credits go to Emily Walkenhorst and Arkansasonline.com for use of the exerts below:

Critics: Arkansas Phosphorus Index faulty; it gauges fertilizer on fields but omits terrain factor, they say

*by **Emily Walkenhorst** | January 6, 2019 at 4:30 a.m.*

https://www.arkansasonline.com/news/2019/jan/06/critics-phosphorus-index-faulty-2019010/

"…Where the Buffalo River is located, for example, the index doesn't take into account all of the ways phosphorus can get into waterways, critics say. The area is karst, which often features cracks, fissures and sinkholes that allow substances to trickle down and move underground…"

"…The index was put together by Andrew Sharpley, a professor in the Department of Crop, Soil and Environmental Sciences at the University of Arkansas, Fayetteville; Haggard; and others from the University of Arkansas System and employees of the Arkansas Natural Resources Commission and the U.S. Department of Agriculture."

"… Last fall, the Arkansas Department of Environmental Quality denied a new operating permit for C&H Hog Farms in Newton County in part because of concerns about karst, phosphorous levels and the impairment of the nearby Buffalo River."

…

"But the index was developed as a way to analyze surface runoff risks, not subsurface risks, Sharpley said. "That is not what this is designed to do," he said."

"C&H Hog Farms' permit application did not account for karst, which the Department of Environmental Quality decided was ultimately needed, among other things, in order to issue the permit."