Assessment of Environmental Data and Draft Regulatory Changes Regarding the C&H CAFO, Including the Present Draft Permit

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A. *Background*

I have a B.Sc. degree in Animal Ecology from Iowa State University, a M.Sc. degree from the University of Rhode Island, and a Ph.D. from Michigan State University. An accurate copy of my curriculum vitae is attached. Presently I am a William Neal Reynolds Distinguished Professor at North Carolina State University, and hold joint appointments in the Department of Applied Ecology and the Department of Plant and Microbial Biology. I am also an affiliate professor in the Department of Marine, Earth, and Atmospheric Sciences. My research interests include the acute and chronic effects of eutrophication and associated pollutants on aquatic ecosystems. I am working as an environmental consultant in submitting this assessment.

I am an expert in water pollution assessment and water quality monitoring and research in freshwaters and estuaries. I have more than 30 years of experience in research on nutrient pollution and its effects on aquatic ecosystems, including peer-reviewed publications on the impacts of concentrated (confined) swine and poultry feeding operations (CAFOs) on surrounding natural resources. For the past ~23 years my laboratory has been state-certified for measurement of nutrients, suspended solids, and more recently, fecal coliform bacteria and *Escherichia coli* in environmental water samples; thus, I am familiar with the strict quality control/quality assurance requirements needed for high-quality data.

I was asked to comment on the draft "no discharge" permit being considered for approval by the Arkansas Department of Environmental Quality (ADEQ) for the C&H Hog Farms (actually, not farms but, rather, an industrialized swine production operation known as a CAFO or confined animal feed operation). Here the operation is referred to as the C&H CAFO. This CAFO has capacity for 6,500 swine, and it generates ~2.6 million gallons of swine wastes or more per year. Liquid wastes are temporarily held in waste ponds to allow some of the solids to settle out, and then are distributed onto nearby fields. More specifically, I was asked to comment on the draft "no discharge" permit after evaluating the available data for the harmful fecal bacterium, *Escherichia coli*, near the C&H CAFO.

My overall evaluation is that, based on the available data, this CAFO is contaminating the surrounding natural resources with harmful *Escherichia coli* bacteria. Therefore, it should not be given a "no discharge" permit from ADEQ. These findings were expected; they are similar to findings of impacts from other CAFOs on surrounding natural resources (Burkholder et al. 2007 and references therein). *The approach to waste management of industrial swine production operations such as this CAFO, including use of cess pits (waste ponds, often close or at the groundwater table) to allow solids to settle, and fields planted with Bermuda grass or other*

plants that receive sprayed applications of the liquid wastes, cause unavoidable water, soil, and air pollution (see U.S. EPA 1998, 2013).

The most recent state permit under Regulation 6 (under the national pollution discharge elimination system, NPDES) for the C&H CAFO expired in October 2016 (see ADEQ Permitting Section at http://www.adeq.state.ar.us/home/pdssql/pds.aspx#dis). The company has applied for a new permit from ADEQ but, this time, under Regulation 5 as a "no discharge" operation. The C&H CAFO is already permitted to apply the equivalent amount of untreated sewage effluent (~2.6 to 2.8 million gallons of manure, process water, and litter; ADEQ Annual Report Forms for the C&H CAFO) as would be contributed by a population of about 25,000 people (derived from U.S. EPA 2004) to adjacent fields that lie very close to receiving surface waters. ADEQ gave tentative approval for the permit in February 2017. If approved, the new permit would allow the C&H CAFO to operate permanently in the Buffalo National River watershed as a "no discharge" facility. This permit would allow ongoing major pollution from the C&H CAFO to surrounding natural resources in perpetuity. Moreover, the state has already approved a separate area known as EC Farms to spread up to 6.4 million gallons of waste from the C&H CAFO onto 30 different land parcels (total area more than 500 acres) within the Buffalo National River watershed (see above website). Based on the analysis below, this CAFO is contaminating adjacent public trust waters with swine waste pollutants, meaning that it is discharging pollutants. It *should not* be classified as "no-discharge," based on U.S. EPA (2004).

Here I summarize the findings from my review of available *E. coli* data in waters adjacent to and near the C&H CAFO. This information is followed by recommendations about the permit for the C&H CAFO. The information given in Section B1-3 below is taken from an assessment contributed in other comments. It is needed here in preface to data interpretation.

B. *Supporting Rationale*

1. *The "upstream" BCRET site is compromised with respect to contamination with* E. coli*, in part because the site likely is receiving airborne and groundwater-borne contamination from the C&H CAFO; and the downstream BCRET site is somewhat buffered or protected from swine wastes by two fields that do not receive swine wastes. Nevertheless, comparison of the "upstream" versus downstream data strongly indicates that the C&H CAFO is contaminating adjacent waters with* E. coli *and other pollutants.*

The BCRET study of possible surface water quality impacts from this CAFO on Big Creek is based on comparison of the one "upstream" station and the one downstream station. BCRET data show that the upstream station waters are degraded, with higher *E. coli* densities on average than the "downstream" station. In the most recent monitoring year 2016, for example, the mean *E. coli* concentration was 708.9 MPN/100 mL (n = 34), whereas the mean downstream *E. coli* density was 555.1 MPN/100 mL (n = 38). Data collection by the BCRET in 2013, several months before swine wastes began to be applied to sprayfields by the C&H CAFO, show that the upstream station has been degraded since at least 2013, and poor water

quality in the upstream station likely has been exacerbated by the C&H CAFO. Fields with heavy swine waste applications (#15 and #17; also field #16 – see, for example, BCRET 2015b, p.36) are west/northwest from the "upstream" station and, given the karst character of the area, could easily be contaminating it with swine wastes via the airshed and groundwater. These pathways have been shown to be important in polluting nearby areas with swine pollutants (U.S. EPA 1998, 2013; Aneja et al. 2013; Mallin et al. 2014).

In contrast, the downstream station is somewhat protected from the C&H CAFO's swine wastes considering that fields #5 (now called #5a) and #6, which do not receive swine waste applications, are nearest to and just upstream from the downstream station. Field #5a additionally was compromised by another pollution source before the C&H CAFO began operation. Thus, the selection of the upstream and downstream stations relative to fields with versus without swine waste applications makes valid interpretations difficult if based only on a simple comparison of the upstream and downstream data.

Nevertheless, other information provides evidence that Big Creek downstream from the C&H CAFO are being contaminated pollutants from animal wastes. First, the data from the BCRET quarterly progress reports (BCRET 2014a-d, 2015a-d, 2016a-d) show that the median of *E. coli* densities above excessive levels, considered here as 410 colonies per 100 mL (taken from the Arkansas standard for primary contact recreation during May-September), at the upstream station is much lower than the median of *E. coli* densities from data $\geq$ 410 colonies/100 mL at the downstream station. For example, considering BCRET data from January through November of 2016 (BCRET 2016d), the median of excessive *E. coli* densities at the upstream station was 986.7 (n = 8). During the same year, the median of excessive *E. coli* densities at the downstream station was much higher, 1,732.9 colonies/100 mL (n = 7). Fecal bacteria such as *E. coli* tend to adsorb ("stick") to sediment particles and, thus, settle out of the water column to the bottom sediment as the water moves downstream (Burkholder et al. 1997 and references therein). Thus, if the only source of *E. coli* to the downstream station was contamination upstream from the C&H CAFO, the median of excessive *E. coli* densities would be much lower at the downstream site than at the upstream site. Instead, the median of excessive *E. coli* densities at the downstream site is nearly double that of the upstream site. These data indicate that the C&H CAFO is discharging *E. coli* bacteria which are contributing to the pollution of Big Creek in the CAFO area and downstream waters.

Second, along with fecal bacteria, nitrate is a major pollutant (among various others) known to be discharged by swine CAFOs with waste ponds and sprayfields for waste management (Burkholder et al. 1997, 2007). Nitrate concentrations at the upstream site have been consistently lower than at the downstream site on nearly all BCRET sampling dates since swine waste applications from the C&H CAFO began (BCRET 2014a-d, 2015a-d, 2016a-d) (Figure 1). During January – November 2016, for example, paired upstream/downstream data showed that nitrate was substantially lower at the upstream station than at the downstream station on 40 of 41 sampling dates; concentrations were comparable on the remaining one date. Elevated nitrate levels near/downstream from swine CAFOs are commonly used as an indicator

of swine waste discharge; the wastes initially are high in ammonia, but over short distances during transport the ammonia is oxidized to nitrate (Dewi et al. 1994). Nitrate levels at the downstream site typically have been two- to three-fold higher than at the upstream site; sometimes the difference has been as high as 25-fold. For comparison, surface flowing waters in the area should have approximately 30 µg nitrate-N/L (or 0.03 mg NO_3^-N/L) or less as a minimally impacted ("reference" or unpolluted) condition (U.S. EPA 2000 – level III nutrient sub-ecoregion 38). Median concentrations over a ~decadal period in the Buffalo National river near Big Creek during surface runoff events was 140 µg NO_3^-N/L (0.14 mg nitrate-N/L) (White et al. 2004).

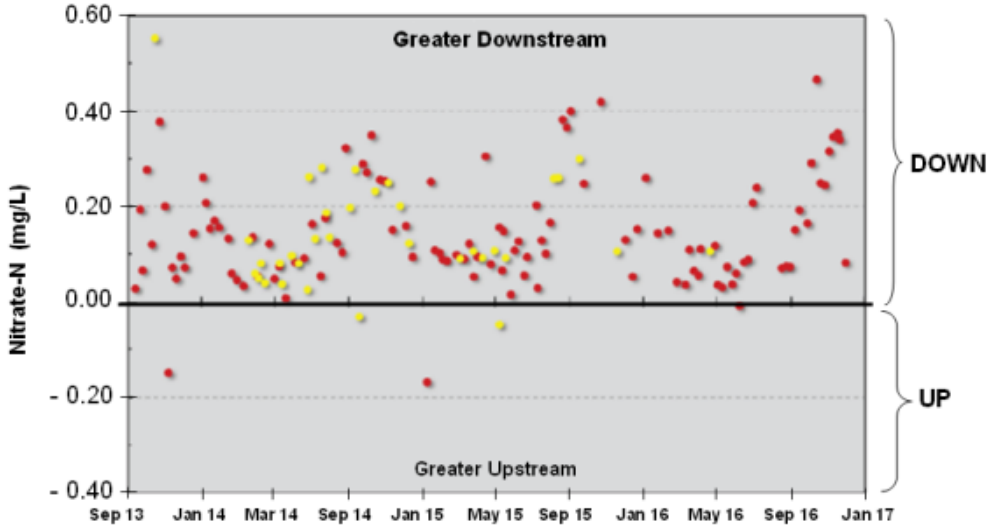

Figure 1. Difference in NO_3^-N concentration in Big Creek up- and downstream from the C&H CAFO. Following the "upstream vs. downstream" comparative criterion that is the basis of the BCRET study, the data clearly indicate that the C&H CAFO is contaminating Big Creek with nitrate. From BCRET (2017a; note that explanation was not given for the yellow versus red color-coding).

The data clearly indicate that the C&H CAFO is contributing swine waste pollution to adjacent public trust waters. The nitrate levels downstream from this CAFO commonly are levels that have been shown in other research to be toxic to sensitive aquatic life (Camargo et al. 2005, Guillette et al. 2005). The nitrate signal is stronger than the *E. coli* signal because nitrate does not adsorb to sediment particles and settle out (Stumm and Morgan 1996); instead, nitrate is highly soluble and is transported rapidly from swine CAFOs to receiving surface and groundwaters (Evans et al. 1984, Stone et al. 1998, Ham and DeSutter 2000, Mallin 2000, Krapac et al. 2002), the latter problem being exacerbated in underlying karst geology (Mellander et al. 2012, Knierim et al. 2015) which is characteristic of the region that includes the C&H CAFO (Hudson et al. 2001, 2011).

2. *The C&H CAFO is contaminating ephemeral streams, and surface runoff from fields to which swine wastes are applied, with* Escherichia coli *and other pollutants.*

Ephemeral streams, which flow for only part of an annual cycle, are generally small and represent the majority of river miles in the U.S. (U.S. EPA; see http://water.epa.gov/type/rsl/streams.cfm). The U.S. EPA (above website) described them as "the very foundation of our nation's great rivers." They play a significant role in the hydrological and ecological integrity of river ecosystems, and provide critical habitat for certain important fauna (McDonough et al. 2011). Earlier BCRET data (2014, 2015) demonstrated that a "culvert" ephemeral stream in the C&H CAFO area was highly contaminated *by Escherichia coli* and other pollutants known to be in swine wastes. A second ephemeral stream sampled by the BCRET in 2016 was also shown to be contaminated on about one-third of sampling dates by excessive *E. coli* bacterial densities (Table 1). Note that only three dates were sampled during the summer season when *E. coli* contamination would be expected to be greatest (Clark and Norris 2000, Knierim et al. 2015, McCulloch 2015). Thus, these data conservatively describe *E. coli* contamination of the ephemeral stream by the C&H CAFO. The other data in Table 1 are shown for comparison. Note the excessive nitrate concentrations, often exceeding 0.5 mg/L and as high as 1.76 mg/L. Also note the excessive total coliform bacteria, up to 241,920 per 100 mL. Historic studies conducted by the U.S. Public Health Service, for example, reported adverse human health effects when total coliform density was ~2,300 per 100 mL (Stevenson 1953).

Table 1. Nitrate concentrations, *Escherichia coli* densities, and total coliform bacterial densities in samples taken from the ephemeral stream at the C&H CAFO by the BCRET during 2016. Red – exceedances of the state standards (Arkansas Pollution Control and Ecology Commission 2011).

Date sample collected	Nitrate-N	E. coli	Total coliform
	mg/L	--- MPN/100 mL ---	
1/5/2016	0.883	32.7	686.7
1/25/2016	0.762	1.0	816.4
2/24/2016	0.195	387.3	4870.0
3/10/2016	0.918	648.8	8840.0
3/16/2016	0.520	88.0	461.1
3/24/2016	0.531		
3/31/2016	1.211	16160.0	198630.0
4/4/2016	0.462	12.0	727.0
4/20/2016	0.517	44.3	21430.0
5/2/2016	0.468	118.7	5380.0
5/10/2016	0.649	579.4	241920.0
5/18/2016	0.479	34.1	2419.2
5/26/2016	0.858	22470.0	241920..0
6/2/2016	0.494	770.1	1986.3
6/7/2016	0.5	2419.2	7980
8/16/2016	1.365	137.6	154945.0
10/13/2016 (grab sample)	1.760	>2419.2	21430.0

Surface runoff from fields during/after swine effluent application likely contains high concentrations of fecal bacteria, but the BCRET has not sampled for fecal bacteria in nearly the entire study (more than three years, ongoing). For example, on 10 March 2016, runoff from field #12 contained 410.0 colonies of *E. coli* per 100 mL; on 10 May 2016, runoff from field #12 contained 663 colonies of *E. coli* per 100 mL. These were the only data for *E. coli* in surface runoff from waste-applied fields during 2016; no measurements are available for the rest of the year, including the summer when *E. coli* densities generally are much higher than in other seasons. In 2014-2015, the surface runoff from fields #1 and #12 contained excessive levels of other pollutants from swine wastes including up to 1.17 mg of dissolved P/L, nearly 1 mg of ammonia/L, 0.7 mg nitrate-N/L, 125.9 mg total suspended solids/L, and 164.7 mg dissolved organic carbon/L. Fecal bacteria such as *E. coli* were not measured by the BCRET

in these important samples throughout 2014-2015; nor are any data for fecal bacteria available from nearby shallow groundwaters.

3. *The C&H CAFO is contaminating groundwater in the C&H CAFO area with* Escherichia coli *and total coliform bacteria.*

A house well at the C&H CAFO has been sampled by the BCRET since 2014, and weekly to monthly data show that the well is commonly contaminated with high nitrate and coliform bacteria (Table 2). In 2016, the house well was sampled 30 times and there were 4 violations based on *Escherichia coli* and 13 violations based on total coliform bacteria (13% and 43% of the time, respectively) (Table 3).

Table 2. Data from 2014-2015, compiled from BCRET quarterly reports, showing contamination of the house well by *Escherichia coli* (red) and total coliforms (brown). The data indicate that violations of

Date	Nitrate-N	*Escherichia coli*	Total coliforms
4/2/2014	0.500	7.5	117.2
4/22/2014	0.494	9.8	770.1
5/1/2014	0.467	<1	116.9
5/13/2014	0.458	<1	18.9
5/19/2014	0.489	11	123.6
9/3/2014	0.475	56.3	59.1
9/18/2014	0.494	35.0	6940
9/23/2014	0.494	8.5	866.4
9/30/2014	0.501	2.0	43.5
10/8/2014	0.486	1.0	69.1
10/13/2014	0.496	28.1	2750
10/22/2014	0.497	5.2	81.3
11/24/2014	0.452	<1.0	5.2
3/19/2015	0.467	1.0	31.1
3/25/2015	0.450	18.5	30.1
4/2/2015	0.477	39.3	9060.0
4/9/2015	0.499	4.1	325.5
4/15/2015	0.475	9.6	80.9
4/23/2015	0.496	18.5	35.0
4/29/2015	0.517	248.1	5040.0
5/7/2015	0.512	3.1	59.4
5/18/2015	0.529	5.2	13.4
5/26/2015	0.514	9.5	2419.2

Table 3. Data for samples collected from the house well during 2016 by the BCRET, showing (red) violations of the federal drinking water standards (Federal Register 1989).

Date sample collected	E. coli	Total coliform
1/5/2016	<1.0	1.0
1/25/2016	<1.0	<1
2/10/2016	<1.0	<1.0
2/24/2016	<1.0	<1.0
3/10/2016	<1.0	<1.0
3/16/2016	<1.0	<1
3/24/2016		
3/31/2016	1.0	26.2
4/4/2016	<1.0	1.0
4/20/2016	1.0	1.0
4/28/2016	<1.0	<1.0
5/2/2016	<1.0	<1
5/10/2016	<1.0	24.9
5/18/2016	<1.0	<1.0
5/26/2016	1.0	7.4
6/2/2016	<1.0	<1.0
6/7/2016	<1.0	<1.0
6/15/2016	<1.0	<1.0
6/22/2016	<1.0	<1.0
6/29/2016	<1.0	<1.0
7/6/2016	<1.0	13.5
7/13/2016	<1.0	<1.0
7/20/2016		
7/27/2016	<1.0	<1.0
10/13/2016	<1.0	23.3
10/13/2016	<1.0	19.7
10/27/2016	<1.0	5.2
11/03/2016	1.0	2.0
11/10/2016	<1.0	1.0
11/17/2016	<1.0	1.0
11/21/2016	<1.0	<1.0
11/29/2016	<1.0	<1.0

The BCRET reports do not contain information about sampling procedures, or about the potential for sources other than the C&H CAFO that could be contributing to the contamination of the well water. The close proximity of the well to the animal holding units and the swine waste holding ponds, considered together with the data showing high leakage of the waste holding ponds, indicate that the C&H CAFO is a major contaminant source.

C. *Recommendations*

The following recommendations are submitted toward the goal of addressing citizens' concerns about the draft "no discharge" permit for C&H CAFO and waste management by this CAFO.

- The C&H CAFO is clearly discharging swine waste pollutants, *E. coli* and others, into adjacent public trust waters. It is not a "no-discharge" facility and should not be granted a permit for a no-discharge system.

- Swine wastes at the C&H CAFO should be managed using more environmentally protective approaches. Such approaches are especially needed because the sensitive land area is underlain by karst geology (see the USDA Natural Resource Conservation Service's Agricultural Waste Management Field Handbook, Part 651, Chapter 10, available at: https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch10.pdf). As stated above, the approach to waste management of industrial swine production operations such as the C&H CAFO, including use of shallow cess pits (waste ponds, often close or at the groundwater table) to allow solids to settle, and fields planted with grass or other plants that receive sprayed applications of massive amounts of liquid wastes year after year, cause unavoidable water, soil, and air pollution (U.S. EPA 1998, 2013; Burkholder et al. 2007). Examples of more environmentally protective approaches could include use an off-farm anaerobic digester for the solid wastes, water recycling/reuse, and storage of wastes in concrete or other impermeable material to avoid the leakage-related impacts of waste ponds.

- The state of Arkansas (revised Regulation 6, Section 6.602) has imposed a partial moratorium until September 2020 in the Buffalo National River watershed for new CAFOs or expansion of CAFOs with 750 or more swine each weighing 55 pounds or more, or for 3,000 or more swine that weigh less than 55 pounds each. The waste management approach presently in practice (waste ponds, spray fields), however, is contaminating surface- and groundwaters, soils, and the airshed. Unless there is a complete change in procedure to eliminate pollution of surrounding natural resources (e.g, through use of environmentally superior technologies), the valuable, sensitive natural resources of the Buffalo National River watershed should be protected from additional CAFO pollution through a permanent moratorium.

D. ***References Cited***

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