

Buffalo River Watershed Alliance

Comments on C&H Reg 5 Permit Application

Appendices in separate document

Position Summary:

In the 1960s there was a protracted ten year effort by ordinary citizens to prevent the U.S. Army Corp of Engineers from damming one of the last free flowing rivers in the continental United States. The Buffalo River was established as the nation's first "national river" on March 1st, 1972 by an act of Congress. The Buffalo was saved *for* Arkansans *by* Arkansans. It accommodates three wilderness areas and one wildlife management area. Images of its pristine waters backdropped by majestic painted bluffs adorn the state's maps and promotional materials. The Buffalo National River is iconic to the Arkansas identity.

The Buffalo River Watershed Alliance (BRWA) was formed after a large concentrated animal feeding operation (CAFO) was permitted and constructed in the watershed without adequate public notification. BRWA steadfastly opposes the location of this large CAFO due to the obvious risks it presents both environmentally and economically, but also because of the precedent it sets that would allow additional large CAFOs to be sited within the geologically sensitive watershed of a national river.

The following comments discuss the disproportionality of the risks, the lack of appropriate investigation, the weakness in the engineering, and the evidence of ongoing degradation in the Big Creek tributary.

It is the unequivocal position of the *Buffalo River Watershed Alliance* that the application for the Regulation 5 permit for this CAFO be denied and that a permanent moratorium on all such facilities be immediately established in the Buffalo National River watershed.

Part A - Permit risk: The high cost of consequences

Businesses that work with hazardous materials mitigate contamination risks through technical planning every day. None the less, failures resulting in contamination occur at facilities where the engineering has been performed to lawful requirements. An example is the 2015 Animus River mine spill resulting from a berm failure where mitigation efforts are currently estimated upwards of \$28B. Another is the Duke Energy Coal Ash berm failure Feb 2nd, 2014 with mitigation costs reaching upwards of \$10B. Closer to home is the catastrophic collapse in May 2015 of a pond at the “Top of the Rock” Big Cedar golf course, located just 56 miles north of the C & H facility.



This page could easily be filled with similar examples. Below is a list of risks and a corresponding list of consequences as they pertain to potential failure for C & H farms:

Risks to be mitigated:

1. *Gradual degradation through spreading fields, several of which are in the flood plain of Big Creek. Degradation occurring through both surface and ground water.*
2. *Gradual degradation through pond leakage.*
3. *Damage through over-topping.*
4. *Sudden catastrophic damage through pond berm failure due to saturation/ overtopping.*

5. *Sudden catastrophic damage through pond floor collapse into an underground cavity typical of geologic karst formations in that area.*

Consequences of risk mitigation failure:

1. *Whether the event is gradual or catastrophic, the Buffalo National River, an extraordinary resource water (ERW) could suffer permanent ecological damage from pollution.*
2. *A tourism economy worth \$62.2M in 2015 supporting 910 jobs could be damaged or even destroyed depending on the nature of the failure.*
3. *A catastrophic failure could easily result in tens of millions in mitigative clean-up and economic relief.*

Comment A1 - This permit should be denied because preventive investigative measures are not proportional to the risk

A common theme of the most spectacular failures is that the efforts applied to mitigate the risk were not proportional to the enormity of the consequential costs. For agricultural waste management facilities, the *Agricultural Waste Management Field Handbook* (AWMFH) provides the engineer with a broad selection of investigative and design suggestions, yet also allows latitude to choose whether or not to act on those suggestions. Engineering firms have a natural competitive incentive to minimize costs for clients and may be inclined to not exceed the basic requirements that satisfy the law. Yet engineering to minimal lawful requirements may not be proportional to the enormity of a failure. There is a remedy provided in the law that is intended to ensure that special circumstances with significant consequences are engineered appropriately, and that remedy lies within the latitude provided to the *Arkansas Department of Environmental Quality* (ADEQ). ADEQ's capability to apply independent oversight is illustrated by the following quote on the water division web page:

"An individual permit is tailored specifically for each application and allows ADEQ to put specific conditions on each permitted facility or activity depending on its unique conditions."

Without question, this permit application has "unique conditions" that ADEQ should recognize and in turn require additional investigative and engineering due diligence. By failing to acknowledge the enormous cost of possible

consequences, ADEQ is in effect abandoning its mission to “*protect, enhance and restore the natural environment for the well-being of all Arkansans*”.

Comment A2 - This permit should be denied because compliance with detailed investigative requirements triggered by “*complex geologic conditions*” as suggested in AWMFH were ignored

Regulation 5.402(A) states:

Designs and waste management plans shall be in accordance with this Chapter and the following United States Department of Agriculture Natural Resource Conservation Service technical publications:

- 1. Field Office, Technical Guide, as amended***
- 2. Agricultural Waste Management Field Handbook, as amended***

The *Agricultural Waste Management Field Handbook* (AWMFH) 651.0704 *Site Investigations for planning and design* states the following:

The intensity of a field investigation is based on several factors including:

- 1. quality of information that can be collected beforehand***
- 2. Previous experience with conditions at similar sites***
- 3. complexity of the AWMS or site***

The Springfield Plateau and the known prevalence of karst geology is well understood and it is readily available background information typical of what is suggested in point #1 above. It is reasonable to assume that any experienced engineering firm will view complex karst geology as a risk factor to be carefully considered in the investigative process and that there is a corresponding likelihood of additional “detailed investigative” steps as described in AWMFH 651.0704(b). However, the presence of karst terrain in the vicinity of the facility and its application fields was not addressed in the investigation. That karst geology is not disclosed or even alluded to is an indication that the engineers who conducted the investigation either lacked sufficient prior experience with the complexities of karst environments, or that there was an intent to avoid additional investigative steps, otherwise the presence of karst and its attendant risks would have at least been mentioned if not directly addressed. As such, the quality of the geologic information collected and studied beforehand is suspect and was inadequate and not sufficiently reliable to meet the requirements of a *preliminary geologic investigation* per 651.0704(a) of the AWMFH. Karst terrain alone presents sufficient “*complexity of geology*” to the site, its waste management system, and the spreading fields that had it been acknowledged, a

detailed geologic investigation per 651.0704(b) would have been triggered and should have been conducted.

651.0704(b) Detailed Investigation

“The purpose of a detailed geologic investigation is to determine geologic conditions at a site that will affect or be affected by design, construction, and operation of an AWMS component. Determining the intensity of detailed investigation is the joint responsibility of the designer and the person who has engineering job approval authority. Complex geology may require a geologist. Detailed investigations require application of individual judgment, use of pertinent technical references and state-of-the-art procedures, and timely consultation with other appropriate technical disciplines.”

Note that the components of a “detailed investigation” have the potential to significantly increase costs. Many of the following comments relate to the specifications of a detailed geologic investigation and show that, had a proper investigation been conducted, this site would have been found to be inappropriate and an alternative location would have been required or the permit denied.

Comment A3 - This permit should be denied because the economics of the risk is to be borne by the public, not the business. Financial assurances are lacking and, due to inordinate risk, should be required of the operator.

Looking beyond obvious ecological considerations, what would be the economic costs of a failure at C & H? In the case of a sudden catastrophic release of contamination, tourism would likely be severely curtailed. Affected businesses supported by tourism would request disaster relief. A year’s worth of business losses would amount to \$62.2M based on the 2015 estimate of economic output. Let’s assume for the purposes of this example that a conservative relief package of one third that amount is approved. This would not include clean-up costs to restore the watershed, so let’s assign a conservative figure of roughly \$30M giving us a rounded amount of about \$50M for total mitigation. Who would pay? The corporate integrator would immediately separate themselves from liability due to the fact that the facility itself is a contract operation. The scope of the costs would be well beyond that of the operator’s resources and its owners would have little choice but to declare bankruptcy. At the end of the day, mitigation costs would fall on the backs of the Arkansas taxpayer.

The figures in this example might be debated, but the take-away is that the costs of a failure would be considerable and must be given serious consideration in the context of this permit. The operator feels strongly that he has an inherent right to make a living from his property, yet the businesses who depend on tourism have a similar lawful right, not to mention the public's right to enjoy a national river. To balance these rights, there is the option of insuring the operation with a policy specifically designed to cover environmental risk. Such policies are available for exactly these sorts of circumstances where the costs of environmental consequences are potentially very high. Rather than the taxpayer being the de facto insurer, the operator would assume the responsibility to insure against environmental damage of up to \$50M or whatever the mitigation costs for potential damage would be estimated to be. The true economic cost of the risk-to-consequence equation would be determined by a professional actuary. Likewise, an environmental insurer would be motivated to provide constructive guidance for the the operator on how risks might be reduced. If the risks are truly low as the operator's advocates insist that they are, then the cost of the policy will be low as well. Monetizing the risk and having the business (the operator) shoulder the cost places the responsibility where it belongs and clarifies the discussion to that of a simple business case.

Part B - Application Fields

For a map of proposed spreading fields, see Appendix B1.

Comment B1 - This permit should be denied because the buffer zones are incorrectly designated. Buffers of spreading fields to Big Creek do not accommodate Extraordinary Resource Waters

On page 5 of the application *Nutrient Management plan*, the engineer recognizes the needs for buffers on intermittent streams of 100 ft as well as the buffer for extraordinary resource waters of 300 ft as stated in Regulation 5.406(D). The mappings of the various proposed application fields recognize all buffers near

water bodies to be 100 feet via blue crosshatching making the assumption that ERW buffers of 300 ft are not applicable.

BRWA contends that for the proposed spreading pastures the buffer should be 300 ft recognizing the integral role of Big Creek as a source for an extraordinary resource water (ERW). The rationale being that Big Creek is a water body that is hydrologically contiguous and is essentially *as of one* with the Buffalo National River which is a designated ERW. Regulation 2.302 on designated ERW uses says the following:

“Extraordinary Resource Waters - This beneficial use is a combination of the chemical, physical and biological characteristics of a waterbody and its watershed which is characterized by scenic beauty, aesthetics, scientific values, broad scope recreation potential and intangible social values.”

The uses as described above are directly impacted by the inflow and intermingling of homogeneous waters and therefore in the interest of maintaining said uses, they cannot reasonably be treated separately. One cannot declare that the water in the glass is superior to that of the pitcher. In addition, the phrase “*waterbody and its watershed*” as used above, implicitly includes Big Creek as a part of the Buffalo’s ERW designation. As a result, all precautions required for an ERW must therefore apply to inflowing homogeneous waters contained within the ERW’s watershed. An argument can be made that separate portions of a waterbody may be designated differently, and indeed this argument works for *downgrading* the status of a downstream segment. That argument is not applicable to Big Creek as its waters must be maintained to the standard of the ERW into which it flows and intermingles. These additional suggested precautionary buffers are ***directly proportional*** to the unique circumstances of this permit in regard to mitigating risk. The following fields should be buffered at 300 ft from the bank of Big creek. The maps should be corrected and the spreadable acreage recalculated.

- | | |
|-------------------|--------------------|
| - Field 5 9.7ac | - Field 9 25.2ac |
| - Field 7 64.3ac | - Field 8A 1.4ac |
| - Field 7A 28.3ac | - Field 10 14.1ac |
| - Field 23 28.1ac | - Field 10A 16.4ac |
| - Field 24 8ac | - Field 12 11.4ac |
| - Field 32 10ac | - Field 16 15.2ac |

Comment B2 - This permit should be denied because the application methods proposed for flood prone soils do not conform to AWMFH and are not proportional to risk

The permit application proposes a large number of application fields in the Big Creek floodplain. The permit includes a “soils map overview” in which each of the fields is labeled with a number indicating a general soil type. The proposed fields in the floodplain adjacent to Big Creek are listed as the following soil types:

- 48 - Razort Loam, occasionally flooded
 - Field 5
 - Field 7
 - Field 7A
 - Field 23
 - Field 24
 - Field 32
- 50 - Spadra Loam, occasionally flooded
 - Field 9
 - Field 8A
 - Field 10
 - Field 10A
 - Field 12
 - Field 16

See Appendix B2 for mapping of soil types and photos of flooded spreading fields. A Water Resources Management Plan published by David Mott and Jessica Laurans of the National Park Service (2004), describes the effect of high precipitation events in the watershed:

***“Water levels in the Buffalo and its tributaries are considered ‘flashy’
, with rapid rises and falls in the hydrograph on daily and monthly scales, as indicated in Figure 12. ...during heavy rains, the steeper slopes and shale bedrock result in faster-rising floods on the Buffalo River than in other Ozark streams.”***

Reg 5.406 notes that:

“Land application of waste/wastewater shall not be undertaken when soil is saturated, frozen, covered with ice or snow, or when significant precipitation is reasonably anticipated in the next twenty-four hours.”

The *Agricultural Waste Management Field Handbook* (AWMFH) on 651.0504(f) *Soil Characteristics* page 5-9 notes the following:

“Flooding events transport surface-applied agricultural wastes off the application site or field and deposit these materials in streams, rivers, lakes, and other surface water bodies”.

Part (f) goes on to define “occasionally flooded” (mentioned as the soil type above) as “5 to 50 times in 100 years”. This is likely low as Big Creek as a wild tributary inundates fields nearly every spring (see photos Appendix B2).

“Occasionally flooded” is noted as a “*moderate limitation*”. The AWMFH then goes on to describe appropriate application methodology for these soil types:

“Agricultural wastes should be applied during periods of the year when the probability of flooding is low. Liquid agricultural waste should be injected, and solid agricultural waste should be incorporated immediately after application. Incorporating agricultural wastes and applying wastes when the probability of flooding is low reduce the hazard to surface water.”

The proposed permit *Nutrient Management Plan* on page 5 under Operation and Maintenance notes the planned application methodology:

“C & H Hog Farms, Inc. is requesting that manure and wastewater from either storage pond (Pond 1 or Pond 2) be transported via liquid tanker trucks or an irrigation system and applied to all fields included in this plan.”

Surface application via liquid tanker trucks or an irrigation system does not meet the application methodology requirement for soil types 48 and 50. Soil types 48 and 50 fall under the *moderate limitation* definition where liquids are to be injected and solids incorporated. “*Incorporation*” in regard to fertilizers means that material broadcast on the surface must then be incorporated via tillage or some other method to place the nutrients below the soil surface. However, injection or incorporation is problematic on these fields due to their shallow, rocky nature (see comment B4). As a result, it is not possible to reasonably comply with AWMFH guidance and these fields should be excluded from the nutrient management plan.

Comment B3 - This permit should be denied because the application methods proposed for slopes from 8 to 15% do not conform to AWMFH and are not proportional to risk

The permit application on page 4 of the *Engineering Plans and Review* notes in

regard to proposed application fields, the following regarding grades and slopes:

“Field Application Areas: Areas viewed were pasture and hay land that were either not subject to flooding or only subject to occasional flooding. Slopes, after buffering, are within specified limits of 15% or less.”

This 15% buffer corresponds with what is stated in Regulation 5.406:

“Waste/wastewater shall not be applied on slopes with a grade of more than fifteen percent (15%) or in any manner that will allow waste to enter waters of the State or to run onto adjacent property without the written consent of the affected adjacent property owner.”

The AWMFH 651.0504(m) *slope* page 5-12 concurs with Reg 5.406, but discusses additional limitations when spreading on slopes from 8 to 15%:

“Slope is the inclination of the soil surface from the horizontal expressed as a percentage. The slope influences runoff velocity, erosion, and the ease with which machinery can be used. Steep slopes limit application methods and rates and machinery choices. Runoff velocity, soil carrying capacity of runoff, and potential water erosion increase as slopes become steeper.”

“Limitations for the application of agricultural wastes are slight if the slope is less than 8 percent, moderate if it is 8 to 15 percent, and severe if it is more than 15 percent. Agricultural wastes applied to soils that have moderate limitations should be incorporated. This minimizes erosion and transport of waste materials by runoff, thus reducing the potential for surface water contamination.”

The permit application illustrates all sloped areas in the proposed spreading field maps that exceed 15% by red crosshatching. Slopes from 8% to 15% are not mapped as they are considered by the engineering plan (page 6) to be available for spreading. Reg 5 does not prohibit waste from being applied to slopes of 8 to 15% but it does direct the operator to follow the AWMFH guidelines which call for injection and incorporation for these soils to reduce runoff. The proposed permit *Nutrient Management Plan* on page 5 under Operation and Maintenance notes the planned application methodology:



“C & H Hog Farms, Inc. is requesting that manure and wastewater from either storage pond (Pond 1 or Pond 2) be transported via liquid tanker trucks or an irrigation system and applied to all fields included in this plan.”

Surface application via liquid tanker trucks or an irrigation system does not meet the application methodology requirement for slopes that meet the *moderate limitation* of 8 to 15%.

AWMFH 651.0504(m) *slope* page 5-12 indicates that soils of *moderate limitation* require *incorporation* as part of the application methodology. “*Incorporation*” meaning that material broadcast on the surface must be incorporated via tillage or some other method to place the nutrients below the ground surface. The fields in question will tend to be upland with a lot of stone and chert that would make incorporation difficult and likely worsen erosion. As the AWMFH recommended application method is not a practical alternative to reduce runoff on fields from 8 to 15%, these slopes should be excluded from the nutrient management plan. Fields affected include but are not limited to the following where 15% grades are confirmed in the application mappings:

- | | | |
|------------|-------------|-------------|
| • Field 1 | • Field 13A | • Field 21A |
| • Field 2 | • Field 13B | • Field 21B |
| • Field 4 | • Field 14 | • Field 22 |
| • Field 6 | • Field 15 | • Field 34 |
| • Field 6A | • Field 15A | • Field 35 |
| • Field 11 | • Field 15B | • Field 36 |
| • Field 13 | • Field 20 | |

The maps of the application fields should be modified to include all slopes from 8 to 15%.

Comment B4 - This permit should be denied because the soils of application fields are too thin for described waste application methodology according to AWMFH

An electrical resistivity survey commissioned by the Big Creek Research and Extension Team (BCRET) under the authorization of ADEQ was performed on three of the spreading fields under the Reg 6 General permit. As part of this study Dr. Todd Halihan’s Oklahoma State University team performed a *Soil Structure Analysis*. The following discussion from the reporting results (6.2.1) Fields, Halihan (2016) will reference fields as they were numbered under their prior Reg 6 permit. An excerpt from the analysis:

“The soil structure analysis consists of soil thickness and soil properties. Soil thicknesses for each site were picked and confirmed through hand dug borings on site conducted during previous University of Arkansas work on these fields. The borings were dug to refusal, or where the soil turns to epikarst (significantly weathered bedrock).”

The following are excerpts from the soils analysis of the three distinct fields. The reader should take note of the thinness of soils particularly to references under 40” in depth and also under 20” in depth.

Field 5a analysis:

“Field 5a is a low-lying grazing area with low relief and an uneven topsoil surface. Field 5a exhibits average soil thicknesses of 0.5 to 4.5 meters (1.5 to 14.75 feet). Soil thickness on Field 5a varies throughout. There is a significant resistivity difference between the highly to very resistive north and more electrically conductive southern portion (Figure 10). A broad topographic mound is situated northwest of the center of Field 5a; the soil thickness is thinner to the far north and far west of the field (see Appendix 3). This trend is consistent with the direction to which the alluvium would be deposited nearest to the stream. Soils on transects MTJ06 and MTJ07 (Figure 12A) are electrically conductive features, which thin to near zero soil thickness toward the far north.”

Field 12 analysis:

“Field 12 exhibits similar average soil thicknesses at 0.7 to 4 meters (2.25 to 13 feet). Soil thickness on Field 12 is not as variable as Field 5a, but there is a very resistive region of the site in the shallow soil area of the southwest portion of the investigation area (Figure 11). Field 12 is flatter and the soil thins to the west (see Appendix 3). MTJ12 (Figure 13A) shows thinning where the electrically conductive features become thicker as the image gets closer to the stream. This trend is consistent with the direction to which the alluvium would be deposited nearest to the stream. Areas where the soil profile is thinner on the images are consistent with the rocky soils encountered when electrodes were placed for data collection.”

Field 1 analysis:

“Field 1 is a grazing area situated on a hillside east of the stream. It has low to moderate relative relief and an uneven topsoil surface. Field 1 shows an average soil thickness of 0.5 meters (1.5 feet) determined from the ERI surveys of MTJ111 and MTJ112 (Figure 17) and soil sampling. Hand dug confirmation borings were not conducted on this field. This site was not studied extensively enough to determine differences in resistivity correlations across the entire field. Field 1 has thinner and rockier soils than either Fields 5a or 12.”

The AWMFH 651.0504(d) *Soil Characteristics, depth to bedrock* states the following in regard to thin soils:

“The depth to bedrock or a cemented pan is the depth from the soil surface to soft or hard consolidated rock or a continuous indurated or strongly cemented pan. A shallow depth to bedrock or cemented pan often does not allow for sufficient filtration or retention of agricultural wastes or agricultural waste mineralization by-products. Bedrock or a cemented pan at a shallow depth, less than 40 inches, limits plant growth and root penetration and reduces soil agricultural waste adsorptive capacity. Limitations for application of agricultural wastes are slight if bedrock or a cemented pan is at a depth of more than 40 inches, moderate if it is at a depth of 20 to 40 inches, and severe at a depth of less than 20 inches.”

“Agricultural wastes continually applied to soils that have moderate or severe limitations because of bed-rock or a cemented pan can overload the soil retention capacity. This allows waste and mineralization byproducts to accumulate at the bedrock or cemented pan soil interface. When this accumulation occurs over fractured bedrock or a fractured cemented pan, the potential for ground water and aquifer contamination is high. Reducing waste application rates on soils that have a moderate limitation diminishes ground water contamination and helps to alleviate the potential for agricultural waste overloading. If the limitations are severe, reducing waste application rates and split applications will lessen overloading and the potential for contamination.”

Field 1’s average depth falls into the *severe limitation* range. Field 5a has areas that include both *moderate* and *severe* limitations and field 12 has areas that fall under the *moderate limitation*. In addition, it is a serious concern that the point of refusal is epikarst which means that unabsorbed nutrients applied to thin soils will filter directly into fractured limestone pathways. The Oklahoma State study identifies epikarst beneath the soil layer for all three fields:

6.2.2 Epikarst Structure

“The epikarst zone consists of the weathering profile of the underlying competent bedrock. Epikarst is visible on Field 5a (Figure 12), Field 12 (Figure 13), and Field 1 (Figure 17) as a more resistive to electrically conductive region below the base of the soil and above the highly resistive competent bedrock zones. No confirmation borings are available to evaluate rock properties in these zones on any of the sites. The thickness of the epikarst zone is highly variable (thicknesses range from 2 to 23 meters or 6.5 to 75.0 feet) throughout each field but averages 4 to 7 meters (13 to 23 feet) thick.”

AWMFH 651.0703(2) page 7-15 *Factors affecting groundwater considered in planning* states the following regarding shallow soils over epikarst:

“Deeper soil increases the contact time a contaminant will have with mineral and organic matter of the soil. The longer the contact time, the greater the opportunity for attenuation. Very shallow (thin to absent) soil overlying permeable materials provides little to no protection against groundwater contamination.”

Authors of the permit application must acknowledge the scientific soil analysis performed with public funds by the Oklahoma State team by mapping these three fields for light and split applications as recommended by the AWMFH 651.0504(d). Likewise, these limitations need to be specifically called out in the nutrient management plan and spreading areas limited and mapped accordingly.

Comment B5 - This permit should be denied because the application buffers for fields 7 and 3 do not sufficiently consider activity areas of nearby high school

The fields appear to be outside the 500 ft range of buildings as Reg 5 requires, however they are well within 400 feet of school property and the athletic track where children will be present.



Field 7 distance is 314 ft.

Field 3 distance is 389 ft



The seasonality and weather in which children are likely to be active corresponds with ideal conditions for spreading. ADEQ has the ability to apply conditions to a permit for unique situations like this where the health of children are a consideration.

The 500 foot buffer should not only accommodate children's outdoor activity areas at the high school, but ADEQ should exercise their legal prerogative to act on this as a special condition and expand the buffers to school property to 1,000 feet. The maps should reflect the expanded buffer with the spreadable acreage recalculated.

Comment B6 - This permit should be denied because the proposed fields do not have 100 foot buffers completely surrounding ponds

Regulation 5.406(D) states:

“Application of waste/wastewater shall not be made within 100 feet of streams including intermittent streams, ponds, lakes, springs, sinkholes, rock outcrops, wells and water supplies”

Buffers appear to be only partially applied around ponds. The engineer may be considering down gradients but Regulation 5 does not offer such exceptions. Ponds need to be fully buffered by 100 ft on all sides. Incomplete pond buffering occurs for the following fields which should be remapped and spreadable acreage should be recalculated:

- Field 1, 17.7 ac
- Field 6a, 17.5 ac
- Field 9, 29.6 ac
- Field 13A, 36.9 ac
- Field 13B, 15.5 ac
- Field 14, 15.1 ac
- Field 15B, 21 ac
- Field 15, 28.2 ac
- Field 18, 29.6 ac
- Field 19, 13.3 ac
- Field 20, two ponds, 24.8 ac
- Field 21, two ponds, 49.8 ac
- Field 33, 5.9 ac
- Field 35, 16.5 ac
- Field 36, 12.1 ac

Example:



Comment B7 - This permit should be denied because the geologic assessments of spreading soils are inadequate and not proportional to risks

The comments in Part A discuss the special circumstances of this permit in regard to the disproportionately high consequences of contamination. The degree of risk introduced by the permit calls for higher investigative due diligence. Comment B4 discusses the thin soils underlain by epikarst as outlined by the Oklahoma State University Electronic Resistivity Study (Fields, Halihan, 2016). Only three fields were checked in the study, yet two of them had soils falling into the *severe limitation* range and one of them had soils falling into the *moderate limitation* range. All three fields were determined to be underlain with highly porous epikarst. The AWMFH 651.0504(d) *Soil Characteristics, depth to bedrock* states the following in regard to thin soils:

“The depth to bedrock or a cemented pan is the depth from the soil surface to soft or hard consolidated rock or a continuous indurated or strongly cemented pan. A shallow depth to bedrock or cemented pan often does not allow for sufficient filtration or retention of agricultural wastes or agricultural waste mineralization byproducts. Bedrock or a cemented pan at a shallow depth, less than 40 inches, limits plant growth and root penetration and reduces soil agricultural waste adsorptive capacity. Limitations for application of agricultural wastes are slight if bedrock or a cemented pan is at a depth of more than 40 inches, moderate if it is at a depth of 20 to 40 inches, and severe at a depth of less than 20 inches.”

“Agricultural wastes continually applied to soils that have moderate or severe limitations because of bed-rock or a cemented pan can overload the soil retention capacity. This allows waste and mineralization byproducts to accumulate at the bedrock or cemented pan soil interface. When this accumulation occurs over fractured bedrock or a fractured cemented pan, the potential for ground water and aquifer contamination is high. Reducing waste application rates on soils that have a moderate limitation diminishes ground water contamination and helps to alleviate the potential for agricultural waste overloading. If the limitations are severe, reducing waste application rates and split applications will lessen overloading and the potential for contamination.”

AWMFH 651.0703(2) *Factors affecting groundwater considered in planning* page 7-15 states the following regarding depth of soil:

“Deeper soil increases the contact time a contaminant will have with mineral and organic matter of the soil. The longer the contact time, the greater the opportunity for attenuation. Very shallow (thin to absent) soil overlying permeable materials provides little to no protection against groundwater contamination.”

As only three of 38 fields were tested, it is reasonable to expect that many if not most of the other proposed spreading fields will have similar thin soil limitations that need to be identified in the nutrient management plan. The upland fields will be especially prone. All fields should be inspected and tested via electronic resistivity by a qualified geologist. AWMFH 651.0202(c) *Inventory of resources*, page 2-8 states the following:

“...variations in depth to bedrock or in soil depth, potential for sink- holes, and fractured or cavernous rock often eliminate use of some types of AWMS components. Geologic information, including depth to the water table and geologic reports, should be reviewed for any given site. Onsite geologic investigations with the assistance of a qualified geologist should be given a high priority...”

In addition, the on site geologist should evaluate for “stoniness”, particularly the upland fields. These should be assigned into one of the three classes as outlined in AWMFH 651.0504(g) *Fraction greater than 3 inches in diameter-Rock fragments, stones, and boulders*, page 5-10.

“Rock fragments, stones, and boulders can restrict application equipment operations and trafficability and affect the incorporation of agricultural wastes. Incorporating agricultural wastes that have high solids content may be difficult or impractical where:

- Rock fragments between 3 and 10 inches in diameter make up more than 15 percent, by weight, (10 percent, by volume) of the soil***
- Stones and boulders more than 10 inches in diameter make up more than 5 percent, by weight, (3 percent, by volume) of the soil***
- The soil is in stoniness class 2 or higher***

Because of this, agricultural wastes applied to these areas may be transported offsite by runoff and have the potential to contaminate the adjacent surface water. Local evaluation of the site is required to determine if the size, shape, or distribution of the rock fragments, stones, and/or boulders will impede application or incorporation of agricultural wastes.”

The survey for “stoniness” is particularly important for the fields mentioned in Comment B3 where fields contain grades between 8 and 15% and incorporation

is suggested but likely impractical. These limitations need to be identified, mapped, and planned for in the nutrient management plan.

Comment B8 - This permit should be denied because it allows application of waste in excess of agronomic need

Section 651.0201(d) of the AWMFH states:

“If wastes are applied to agricultural fields, the application must be planned so that the available nutrients do not exceed the plant’s need or contain other constituents in amounts that would be toxic to plant growth.”

Arkansas Regulation 5.405(a) states:

“The waste management plan shall be developed in accordance with Reg. 5.402 and shall address the timing of land application of wastes with respect to the nutrient uptake cycle of the vegetation found on the land application site(s)...”

Reg 5.402 referenced above is the requirement for compliance with the AWMFH. The regulation identifies the source of guidance in regard to agronomic “uptake cycle” and that guidance is clear about nutrient exceedance.

Current fields used under the existing permit ARG590001 have “*above optimum*” levels of phosphorus, based on the most recent soil tests performed in December 2015, and no additional applications of phosphorus are recommended. In addition, the fields proposed to be added under 5264-W have not been soil tested since April, 2014 and at that date many were also “*above optimum*” for P (phosphorus), with no further applications of P recommended. It is safe to assume that these new fields have likely received fertilizer applications since April, 2014 and at the least, new soil tests should be required for those added fields. Any applications of P will be in excess of the vegetation’s nutrient uptake ability and will exceed agronomic need which will increase the risk of runoff and/or percolation into groundwater. Winter applications of waste, a modification approved by ADEQ, is clearly in excess of agronomic need as little if any plant uptake occurs during winter dormancy periods.

M.D. Smolen, PH.D. who has 35 years of experience in water quality management as affected by agricultural waste management states it this way in a report (Smolen, 2017). For the following, refer to Appendix B8, column: “P-Nutrient Status”:

Nutrient Management and Waste Disposal

“The C &H Hog Farms nutrient management plan (NMP) is based on Nitrogen, resulting in excess Phosphorus application. This amounts to disposal of Phosphorus as most of the fields already have medium to very high soil test P levels. Table 1 shows the P-status of each field in the Permit Application with its most recent Soil Test Phosphorous (STP) and the Phosphorus (P2O5) fertilizer recommendation from the Arkansas Cooperative Extension Service. According to these recommendations these fields need very little or no P2O5. Note virtually all the fields included in the NMP, particularly those that were used previously have “Above Optimum” P-status.”

“In my opinion, application of wastes to fields with P-Status higher than “Above Optimal” should be considered waste disposal, making them subject to storm water rules . Considering the number of fields at Optimal or Above Optimal STP, using a P-basis for nutrient management would severely reduce the amount of land available for waste application without additional BMPs”.

The Arkansas Phosphorus Index (API) is intended to assess risk posed to waters of the state by excessive phosphorus applications, yet it inadequately accounts for soil tests for phosphorus and allows for applications in excess of agronomic need. The API is a waste disposal tool and its use is not appropriate when considering the risk factors as outlined in Part A.

Comment B9 - This permit should be denied because the Arkansas Phosphorus Index (API) fails to account for karst

As per the University of Arkansas Division of Agriculture document FSA9531 <https://www.uaex.edu/publications/PDF/FSA-9531.pdf>:

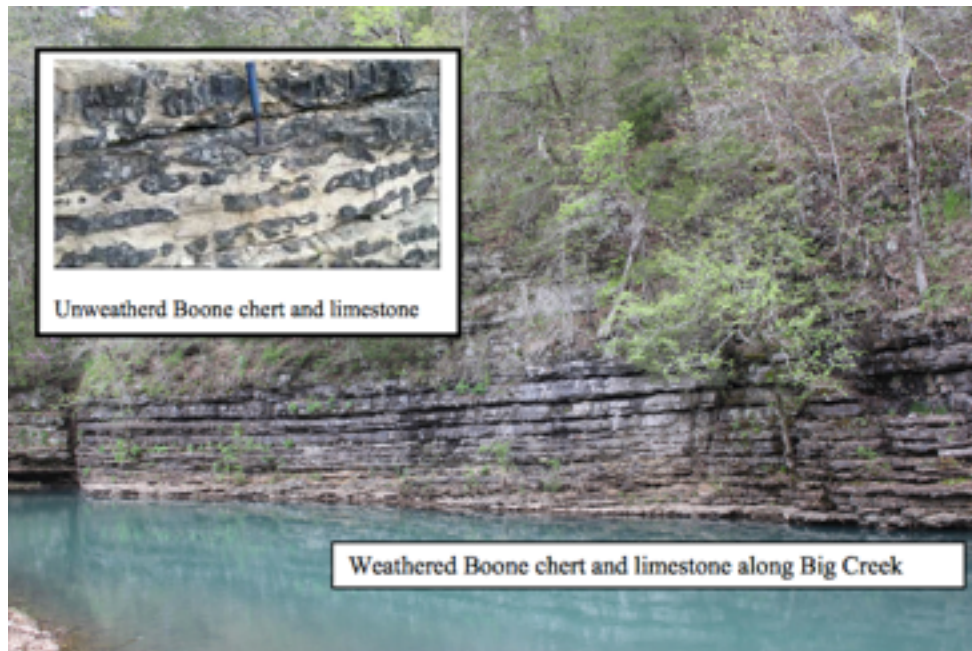
“The Arkansas Phosphorus Index (API) is used to assess the risk of phosphorus (P) runoff from pastures and hayland as part of farm nutrient management plan (NMP) development” (emphasis added)

The API addresses surface runoff *only* and does not consider risks to groundwater. A significant weakness of the API is its failure to consider karst or any subsurface geological risk factors when determining the risk of waste applications to waters of the state.

According to geologic maps of the area:

http://www.geology.ar.gov/maps_pdf/geologic/24k_maps/Mount%20Judea.pdf

C&H and the spreading fields are located in what is widely and scientifically accepted as a significant karst environment. The presence of karst is not subjective, but obvious to the casual observer from the weathered dissolution features in exposed formations throughout the Mt. Judea area.



For more in depth discussions and references to studies in regard to dye tracing, hydraulic subsurface flows relative to storm events, and evidence of karst see Comments: E2, C2, C11, C12. See also Mott, 2016 which states, "The waste storage ponds and land application sites are predominantly underlain by the Boone Formation; therefore, karst geohydrology." Further, a report titled "Surface-Water Quality In The Buffalo National River, 1985-2011" by the Watershed Conservation Resource Center, 2017 states:

"The Ordovician through Mississippian rocks [which characterizes the Buffalo River watershed geology] host a complex karst terrain where losing streams, sinkholes, springs, and caves dominate much of the landscape. Most of these rocks are carbonates, either limestone or dolomite. They are particularly susceptible to dissolution. These rocks are highly permeable to the movement of groundwater. Subsurface flow directions and rates of groundwater flow are difficult to predict and may rapidly change based upon the hydrologic events."

Smolen (2017) had this to say in regard to limitations of the API in regard to various aspects including subsurface flows:

Arkansas PI Shortcomings (API)

“The API, as used in planning the NMP, has several severe shortcomings. First, although it purports to address risk of degrading water quality, it does not address some important factors affecting transport to the receiving waters. In reality it only compares the source term of the Index not the risk of polluting the receiving waterbody. The PI was derived from a series of rainfall simulator studies of runoff produced from application of a synthetic rainstorm on a small area of soil. This makes it very sensitive to application rate and characteristics of the waste, but not to many other physical factors such as karst, surface drainage, gravel bars, or management factors that affect delivery to the stream.”

“Because it was developed from very short-term, micro-studies, it cannot address the larger- scale effects of season, groundwater pathways, or weathering, leaching, or eroding of enriched soils.”

“The API does not address the risk due to increased runoff due to soil compaction from livestock hoofs or increased drainage efficiency due to subsurface gravel bars, karst geology, or increased drainage efficiency through surface or subsurface features.”

Karst and fast moving ground water presents a significant risk factor which should be taken into account when assessing risk yet is altogether ignored by the applicable risk assessment tool; the API. If karst was properly factored into the API, it is highly likely that the risk categories for most if not all of the C&H fields would exceed that allowed under the terms of the permit.

Comment B10 - This permit should be denied because of the extreme difficulty of complying with the application buffer zones and because compliance is impractical to monitor or enforce

Many of the fields, particularly the upland ones, include buffer zones which are so fractured, convoluted and circuitous that the chances of applying waste outside the buffer areas are very high. Many of the fields, such as fields 13, 15, 16, and 21, are broken into multiple segments by the buffer zones. Fields 1, 2, 4, 6, 8, 10, 13, 14, 15, 19, 20, 21, 22, and 35 include multiple 50 and 100-foot buffers and some 500 foot buffers to avoid adjacent streams, drainage areas, ponds, steep slopes, rock outcroppings as well as adjacent homes and property lines. Flagging or other marking has not been observed demarcating any exclusion zones and, even if proper flagging was present, the logistics of navigating and applying swine waste from “honey wagons” to these fields is difficult at best and the risk of applying waste inside the buffer zones is

inordinately high. There are no provisions other than “self-reporting” to determine if waste is being applied in accordance with the buffer zones and the remote locations of the fields and lack of visible flagging makes it impossible for concerned citizens to observe and report any violations that might occur.

M.D. Smolen, PH.D. who has 35 years of experience in water quality management as affected by agricultural waste management states it this way (Smolen, 2017). Please refer to Appendix B8, column: “Suitability for waste Application”, and Appendix B10 - Unrealistic Buffer Zones:

Suitability of Fields for Waste Application

“The last column of Table 1 also shows my assessment of each field’s suitability for waste application based on shape and steepness. Most fields in the NMP have reasonably good shape, with large open areas where a spray rig could maneuver easily to follow boundaries of buffer zones. Some, however, have few restricted areas, or at least areas that are easy to identify. Several fields, however, are so contorted, with buffer areas and steep slopes, it would be difficult or even impossible to follow. Examples of fields with severe limitations include fields 2, 4, 6A, 11, 13B, 20, and 21B. Figure 4 shows the example of Field 21A, where an operator would have difficulty. These six fields include 71.5 acres that should be removed from the permitted application area.”

Comments submitted by the Arkansas Department of Health in regard to buffer zones https://www.adeq.state.ar.us/downloads/WebDatabases/PermitsOnline/NPDES/PermitInformation/5264-W_ADH%20Comment%20Letter_20170307.pdf state:

“Permit requirements for best management practices and stream buffer zones should be strictly adhered to during the land application of swine wastes to prevent water-borne pathogens from leaving the sites.”

As noted, strict adherence with the exclusion zones is unlikely and the odds of pathogens leaving the approved application sites are unacceptably high, therefore this permit should be denied.

Comment B11 - This permit should be denied because the nutrient management plan (NMP) proposed application rates are overly optimistic in regard to current forage management

M.D. Smolen, PH.D. who has 35 years of experience in water quality management as affected by agricultural waste management and other aspects of watershed management discusses some assumptions in the nutrient management plan (Smolen, 2017).

“In writing the NMP, the planner used the API to set waste application rates that keep the PI in the Low to Medium range for each field. They analyzed only summer and spring seasons, although some winter application was reported each year under the previous permit, and winter application is the most Risk-prone season for waste application. The planner considered each field separately to set a maximum application rate for that field. This seems an acceptable approach to set upper limits for each field, but is not really a plan for distribution of waste.”

“The API analysis presented in the Permit Application is based on the most recent waste analyses and the most recent soil tests (about 2 years ago). The planner assumed in the API that all fields would be managed as rotational grazing at the highest possible forage yield and the best ground cover condition possible for the area. Many of these assumptions are not correct and certainly do not represent a worst- case assessment.”

A definition of “Managed intensive rotational grazing (MIRG)” reads as follows:

“Managed intensive rotational grazing (MIRG), also known as cell grazing, mob grazing and holistic managed planned grazing, describes a variety of closely related systems of forage use in which ruminant and non-ruminant herds and/or flocks are regularly and systematically moved to fresh rested areas with the intent to maximize the quality and quantity of forage growth.”

“One primary goal of MIRG is to have a vegetative cover over all grazed areas at all times, and to prevent the complete removal of all vegetation from the grazed areas (‘bare dirt’)”

Smolen confirms the above characterization of rotational grazing and comments on assumptions made in the NMP. Reference Appendix B11.

Conclusions Regarding Overall Planning of NMP

“The assessment of an upper limits for waste application rates from each source on each field in two seasons of the year is a reasonable approach to setting guidelines for each field, but some of the choices for parameters are not correct. For example, under Regulation 5 soil testing is only required once in five years, but STP it is likely to increase drastically in that time. A glaring error is the designation of “Rotational Grazing” as the use of each pasture. This assumption is based on a very high level of grazing management, where cattle are moved frequently from paddock to paddock to assure the forage is harvested uniformly and has ample opportunity for regrowth before cattle are returned. It gives the lowest PI of all options in the PI spread sheet. Observations by local residents (Figure 5) indicate some fields are overstocked from time to time, and grass cover is not maintained in the most healthy, protective state at all times. An aerial view of Fields 2 and 3 (Figure 6) shows the eroded condition of these fields in mid-

March 2016. In this case, Field 2 is among those that should not be included in the Permit.”

Smolen’s reference to “views” can be found as photos in Appendix B11. The photos show examples of poor management of forage production as well as evidence of “erodible conditions” from bare dirt. Smolen goes on to discuss API limitations from livestock use, soil compaction, and erosion:

“The API does not address the risk due to increased runoff due to soil compaction from livestock hoofs or increased drainage efficiency due to subsurface gravel bars, karst geology, or increased drainage efficiency through surface or subsurface features. Another limitation is the API’s treatment of erosion. Erosion is a very important mechanism for transporting Phosphorus. The P-content of eroded soil can be so high it can far exceed that predicted by the API. This is particularly important when assessing risk due to poor grazing management or overstocking.”

The examples in Appendix B11 are limited and not all of the fields have been examined to determine if best management practices regarding forage production have been in effect.

Smolen provides the following summary points regarding fields and forage management (2017):

- *Assumptions of forage production are too high for the area.*
- *Hay is not harvested from all fields so the nutrients are not removed efficiently.*
- *Assumptions of rotational grazing are not correct. In fact, grazing practices in the area are not as beneficial as planned, estimates of API are systematically low.*
- *A few fields get most of the waste as indicated by historical record.*
- *The effects of compaction, due to grazing are not recognized.*
- *the API does not account for erosion of pasture effectively - erosion is very effective in transferring P to receiving waters.*

Evidence of best management practices in regard to sound forage management should have a direct bearing on the evaluation of the permit. The fact that such a review is lacking and that optimal management is assumed speaks to the quality of the NMP in that it is not proportional to the risks described in Part A.

Comment B12 - This permit should be denied because the operation’s swine waste is phosphorus-rich and current

application rates will result in significant phosphorus build-up resulting in discharge into waters of the state

M.D. Smolen, PH.D. who has 35 years of experience in water quality management as affected by agricultural waste management and other aspects of watershed management discusses “nutrient imbalances” that can result from hog waste. From his report dated 2017.

The Problem of Nutrient Imbalance from applying Hog Waste to Agricultural Fields

“The final stage of treatment of manure wastes is the application of waste to the land as fertilizer to utilize the nutrients in an actively growing crop. Hog manure is rich in Nitrogen, Phosphorus, and Potassium, which are all essential plant nutrients, and organic matter that is beneficial to the soil. There may be as much as 60% loss of soluble Nitrogen during storage in the pond due to volatilization of ammonia and denitrification (Chastain, 1999). Consequently, when the waste is applied to a hay crop, the waste is relatively high in phosphorus and low in nitrogen relative to crop needs.”

“Because a hay crop needs fertilizer in a ratio of 8: 1: 1 (N: P: K), but the hog manure has a ratio of about 1: 1: 1, the crop leaves behind most of the P that is applied. With continued application of manure, the soil test P (STP) will increase rapidly. Studies have shown that on average STP increases about 20 lb for every 100 lb of excess fertilizer. Finally, it has been well documented that the concentration of P in runoff increases with STP, although the actual rate of increase depends on the soil (Vadas, 2005).”

“The effect of continued application of P-rich waste from 2012 through 2015 can be seen in the buildup of soil P in the C&H fields shown in Table 4 and in Figure 2 of the Appendix. In a three-year period, STP increased as much as 380%. The P-enriched soils will continue to be a source of P to the river for many years.”

“The problem of Soil-P-buildup is virtually assured in these fields because the crop is only harvested by grazing, which removes very little P. Most of this nutrient is consumed by cattle then redeposited in shady lounging areas and riparian areas. This exacerbates the water quality issues, first because much of the manure is deposited in environmentally sensitive areas and second because the P distribution is not optimal for the crop. As can be seen by the STP results in Table 4, these fields have more than enough P for grazing.”

Where Smolen mentions “Table 1”, refer to Appendix B8, column “P-Nutrient Status”. The U.S. Geological Survey says this about phosphorus effects when there is too much of it:

“Phosphorus is an essential element for plant life, but when there is too much of it in water, it can speed up eutrophication (a reduction in dissolved oxygen in water bodies caused by an increase of mineral and organic nutrients) of rivers and lakes.”

As the waters of Big Creek are homogeneous and intermingled with the Buffalo National River, an “Extraordinary Resource Water” (ERW), phosphorus build-up will at some point result in a violation of Reg 2.202 regarding the *anti-degradation of high quality waters* which reads as follows:

“Where the quality of the waters exceeds levels necessary to support propagation of fish, shellfish and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the State finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the State of Arkansas’ Continuing Planning Process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located.”

The operation has received no review as per Reg 2.202 in regard to “*important economic or social development*” in the area in which the waters are located that would allow for an exception to the statute. The phosphorus build-up potential of the permit is clearly out of line and disproportional to the risk factors as described in Part A. For this reason alone, the permit should be denied.

Furthermore, Mott, 2016, states:

“Soil phosphorus can be a potential source of contamination to surface water for both sediment-attached and soluble phosphorus in runoff (NRCS, 2012; Sharpley, 1993). Table 2 (below) was prepared from soil sample results contained in the NMP prepared for the NOI submitted prior to C and H Hog Farms conducting land application activities. Guidance from University of Arkansas states that fields are considered to be above the optimum level for phosphorus (P) when values exceed 50 pounds per acre (Espinoza et al., 2007). Only fields 12 and 15 were recommended by the University of Arkansas as needing additional phosphorus. All other fields were recommended to receive zero pounds per acre for a “full-cycle system” (DeHann, Grabs, and Associates, 2012). Based on the soil test recommendations, out of the 630 acres permitted to receive land application, only 85 acres actually required additional P, and the total recommended P for these 85 acres equates to 3,391 pounds. Furthermore, when the acres are looked at in total, these 17 fields contain an above optimum surplus of 21,815 pounds of phosphorus already existing on the landscape.”

“Long-term applications of organic P at rates that exceed the uptake rate of plants can result in saturation of the adsorption sites near the soil surface. This results in increased concentrations of both soluble and labile (easily altered) P. The excess soluble P can either leach downward to a zone that has more attachment sites, and then be converted to labile P or fixed P, or in karst environments, it could infiltrate conduits and subsurface drainage networks. Excess phosphorus can also be carried off the land in runoff water. If soils that have high labile P concentrations reach surface water as sediment, sediment particles will continuously desorb (release P in the soluble form) until equilibrium is attained. Therefore, sediment from land receiving animal waste at high rates or

Field Number	Usable Acres	Phosphorus level	P ₂ O ₅ lbs/field Recommended by University of AR	Concentration ppm (mg/L P ₂ O ₅)	Existing lbs/acre P ₂ O ₅	Excess P ₂ O ₅ on landscape (pounds)*
1	15.6	Above Optimum	0	83	166	1810
2	17	Above Optimum	0	72	144	1598
3	13.6	Optimum	0	42	84	462
4	8.8	Optimum	0	50	100	440
5	23.8	Above Optimum	0	65	130	1904
6	34.5	Above Optimum	0	76	152	3519
7	74.3	Above Optimum	0	178	356	22736
8	15.5	Optimum	0	46	92	651
9	41.2	Above Optimum	0	52	104	2225
10	33.2	Above Optimum	0	69	138	2922
11	20.7	Above Optimum	0	57	114	1325
12	23.7	Low	1,659	19	38	-284
13	61.6	Optimum	0	48	96	2834
14	18	Above Optimum	0	52	104	972
15	61	Very Low	6,100	15	30	-1220
16	79.6	Optimum	0	48	96	3662
17	88.7	Optimum	0	50	100	4435
Total	630		7,759 (3,391 lb P)			49,989 (21,815 lb P)
* Calculated by: (Existing lb/ac – 50 pounds optimum) • # acres; P ₂ O ₅ • 0.4364 = P						

Table 2: Soil test phosphorus results from the C and H Hog Farms nutrient management plan, analyzed in 2012 prior to application of swine waste.

over a long period of time will have a high potential to pollute surface water (NRCS, 2012)."

"Sandy soils, such as those common to alluvial deposits in the Big Creek floodplain, may not effectively retain phosphorus (NRCS, 2012). If the ground water table is close to the surface, the application of waste at excessive rates, or at nitrogen-based rates, will likely contaminate the ground water beneath those soils. However, ground water that is below deep, clay soils is not likely to be contaminated by phosphorus because of the adsorptive capacity of the clay minerals. Almost half (291 acres) of the application fields used by C and H Hog Farms have alluvial soils, which commonly have a higher sand content than in-situ developed soils."

"Because northwest Arkansas has a substantial CAFO industry, high phosphorus readings in pasture soils receiving animal waste is a common occurrence. Vast areas of the landscape could not accept phosphorus if soil test results and plant uptake requirements were the only criteria applied. To assist landowners and regulators with estimating the potential for phosphorus to impact waters of the State, Arkansas has developed the Arkansas Phosphorus Index (API) (Sharpley et al., 2010). This index uses various factors to estimate likelihood of phosphorus mobilization. However, this Index is not referenced in the NRCS (2012) guidance manual. Rather, the NRCS states "Waste must be applied in a manner that:

- Prevents runoff or excessive deep percolation of the wastewater,***
- Applies nutrients in amounts that do not exceed the needs of the crop, and***
- Minimizes odors from the waste being applied"***

"Estimated total waste water production was approximately 2.6 million gallons per year according to the 2014 and 2015 annual reports filed by C and H Hog Farms. The ongoing test results from the waste storage ponds and soils, and

results from recalculations of the Arkansas Nutrient Management Planner with 2009 Phosphorus Index, confirm earlier projections that phosphorus is being applied at rates in excess of annual plant consumption. Several scientific papers are accessible at the BCRET website detailing how long-term application of excessive phosphorus in watersheds results in a slow but steady build-up of legacy phosphorus in soils and ground water. Once phosphorus outmigration from the watershed becomes measurable, it can continue for a long time with lasting environmental consequences (www.bigcreekresearch.org). “

Part C - Geologic and Engineering Site Investigation Concerns

A clarification on relative site elevations:

Harbor Environmental submitted a work-plan in August of 2016 for drilling a single bore hole to investigate Dr. Todd Halihan’s west transect (Oklahoma State ERI study). Although Harbor Environmental provided geographical coordinates for the planned hole, they failed to provide an elevation. As a result, Harbor later submitted an addendum on Jan 9th, 2017 with an elevation of the bore hole certified by licensed professional surveyor Johnny R. Tweedle. The original “as built” engineering plans also show the elevation of the bore hole (see Appendix C12). These “as built” plans were certified by licensed professional engineer Nathana Pesta on April 5th 2013. Mr. Tweedle’s certified elevation is higher than Mr. Pesta’s certified elevation by 16.31 feet. We are unable to identify any nearby elevations at the facility that are at the height that Mr. Tweedle states.

Several of the comments below discuss elevations of the bore hole relative to the pond floors and are based on the “as built” elevations. The “as built” drawings are a term of the permit and are required to show accurate contouring and relative depths. The “as built” drawings agree with relative depths described in the permit narrative and are the best and only source that is provided for examining relative elevations.

Comment C1 - This permit should be denied because facility plans do not account for proximity of a waste impoundment to sensitive groundwater areas as suggested by AWMFH

AWMFH 651.0703 *Factors affecting groundwater quality considered in planning* page 7-15 describes a number of engineering considerations for siting and planning a facility. Under this on page 7-18(i) is *Proximity to designated aquifers, recharge areas, and well head protection areas* in which the following is stated:

State water management and assessment reports and the following maps should be reviewed to ascertain the proximity of sensitive groundwater areas:

- ***sole source or other types of aquifers whose uses have been designated by the State***
- ***important recharge areas***
- ***Wellhead protection areas***

Location within the recharge area of a major tributary of a national river, a designated ERW, qualifies as “a sensitive groundwater area”. Such considerations not only apply to seepage but to the possibility of containment failure. The original NOI and the current Reg 5 application do not address this. Nor does the original NOI provide any evidence that this was seriously considered. Evidence of due diligence in regard to alternative sitings as suggested in AWMFH 651.0202 *Conservation Planning Process step 6: Evaluate Alternatives* would at least suggest that the investigators considered the sensitivity of the watershed. AWMFH 651.0801 *Process in Chapter 8: Siting Agricultural Waste Management Systems* notes:

“During the planning process, it is critical to arrange and locate the various AWMS components so they are functional and compatible with the surrounding land- scape.”

No such alternatives were provided or alluded to. Chapter 7 of the AWMFH does not require a review for sensitive ground waters, but the circumstances for which these suggestions are provided are clearly present. The lack of such a review suggests that there has not been adequate due diligence demonstrated in the permit application that is proportional to the significant risk factors described in Part A.

Comment C2 - This permit should be denied because facility plans do not investigate groundwater flow direction as suggested by AWMFH

AWMFH 651.0703 *Factors affecting groundwater quality considered in planning* page 7-15 describes a number of engineering considerations for siting and planning a facility. On page 7-16(b) *Groundwater flow direction* reads as follows:

“A desirable site for a waste storage pond or treatment lagoon is in an area where groundwater is not flowing away from the site toward a well, spring, or important underground water supply”.

“The direction of flow in a water table aquifer generally follows the topography, with lesser relief. In most cases, the slope of the land indicates the groundwater flow direction.”

There are two improperly abandoned wells (no sealed liner) and one abandoned drilled well down gradient from the site. The first well is within 594 ft of the pond wall. The second (which we will refer to as B-39 in Brahana’s study) is 1,710 ft. The drilled well (which we will refer to as B-40 in Brahana’s study) is 2,066 ft. Although elevation shows a rise between the ponds and the wells for B-39 and B-40, the down gradient of flow will not be a straight line. See Appendix C2-A for well sitings and gradients. The original NOI notes the distance to the nearest watercourse in SECTION D: *SITE SPECIFIC INFORMATION*, but does not mention the wells. Likewise, a 2,000 ft radius map is provided in SECTION E: *FACILITY PLANS* (see Appendix C2-B), makes no reference to down gradient wells. 7-16(b) goes on to discuss alternative flow patterns:

“Radial flow paths and unusual subsurface geology can too often invalidate this assumption. Consider the case where secondary porosity governs the flow. A common example is bedrock in upland areas where the direction of groundwater flow is strongly controlled by the trend of prominent joint sets or fractures. Fracture patterns in the rock may not be parallel to the slope of the ground surface. Thus, assuming that groundwater flow is parallel to the topography can be misleading in terrain where flow is controlled by bedrock fractures.”

As the Boone formation is the predominant geology, epikarst and karst evidenced by fractures and weathered limestone are the more likely drivers of groundwater flow direction in regard to this Reg 5 application. Evidence of alternative flows are discussed in a study published by Dr. John Brahana: August 3rd, 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”. The study links rapid changes in well levels for B-39 and B-40 with precipitation events (see Appendix C2-A page 3). Note that the “hand dug well” in the appendix was not part of this study. Only wells B-39 and B-40 are referenced in the excerpt below.

“For the groundwater wells, time lag was essentially identical to the time lag of the surface- water stage, indicating that groundwater levels started rising no later than an hour after precipitation started. Rapid response of the groundwater level is an indicator that karst conditions facilitate rapid flow of precipitation into the ground. The magnitude of the water-level increases can be caused by several factors including: variation of permeability or porosity of the aquifer materials; variation in storage as the groundwater moves downgradient, variations in the epikarst (upper eroded zone) at the top of the Boone (BS-39); and variations in Big Creek alluvium and terrace deposits (BS-40) that directly overlie the Boone in Big Creek Valley (Braden and Ausbrooks 2003).”

“For the period of record, from May 1, 2015, through early June, 2015, 10 storms of varying intensity were recorded. Hydrograph records of the wells and streams indicate that water level rises rapidly after the onset of precipitation in Big Creek and contiguous basins, with little delay (less than an hour) between the wells and the streams (Figs. 13, 14, 15). This coincidence of the start of water- level rise in the hydrographs reflects the close relation of surface and ground water. The time to maximum crest of each hydrograph, however, indicates the duration the water takes to move laterally below ground through aquifers to the hydrologic drains. Variations in time-to-crest of each of the hydrographs indicate details of the rainfall intensity and variations in the underground flow system, including permeability, pre-storm water levels and hydrologic conditions, rainfall distribution, flow constrictions or constraints for intervening flow paths, and degree of karstification.”

This study and the corresponding hydrographs in Appendix C2-A page 3 suggest rapid subsurface water movement as evidenced by changes in down gradient well levels during storm events. This corresponds with the suggestion by AWMFH “that secondary porosity can govern flows” and that “Radial flow paths and unusual subsurface geology can too often invalidate assumptions”. Also see Watershed Conservation Resource Center, 2017, Brahana, et al, 2017, and Mott, 2016 regarding likely interbasin transfer of groundwater from one surface watershed to another.

The authors of the original NOI and the Regulation 5 permit application have not provided any evidence of due diligence in regard to groundwater flow direction for either of the down gradient wells or for karstic springs and seeps. Chapter 7 of the AWMFH does not require such an investigation, but the circumstances for

which these suggestions are provided are clearly present. The lack of a groundwater flow investigation suggests that there has not been adequate due diligence demonstrated in this permit application proportional to the significant of risk factors in Part A.

Comment C3 - This permit should be denied because permeability determination for liner material does not include particle analysis as per AWMFH guidance

The AWMFH appended 10D under soil properties page 10D-5 describes the criteria for determining permeability.

“The permeability of soils at the boundary of a waste storage pond depends on several factors. The most important factors are those used in soil classification systems such as the Unified Soil Classification System (USCS). The USCS groups soils into similar engineering behavioral groups. The two most important factors that determine a soil’s permeability are:

- 1. The percentage of the sample which is finer than the No. 200 sieve size, 0.075 millimeters. The USCS has the following important categories of percentage fines:***
 - Soils with less than 5 percent fines are the most permeable soils.***
 - Soils with between 5 and 12 percent fines are next in permeability.***
 - Soils with more than 12 percent fines but less than 50 percent fines are next in order of permeability.***
 - Soils with 50 percent or more fines are the least permeable.***
- 2. The plasticity index (PI) of soils is another parameter that strongly correlates with permeability.”***

To recap, point #1 is the particle analysis of the soil determining percent of “fines”. Point #2 is the *plasticity index* (PI). To review some of the testing documents in the original NOI, reference Appendix C3. The information in Appendix C3 looks at the geologic soil testing process in the original NOI that resulted from drilling 3 holes: B1, B2, B3. Only B2 and B3 are in proximity to the ponds so only these samples are used to evaluate liner material (see Appendix C6). Note that the number of holes drilled does not conform to AWMFH guidelines (discussed in Comment C6).

First page of Appendix C3 shows 3. Geologic Investigation page from the original NOI. The arrow pointing to the statement by the engineer regarding at what level the liner material will be sourced from bore holes B2 and B3. The chart on the

page shows the calculated *plasticity index* (PI) after it has been determined by lab analysis. The text identifies the unified soil classification system (USCS) designation as *CL - Fat Clay w/sand*.

Step 2: The boring log designates the sample numbers from the targeted depth of 7 to 11 ft where the liner material is to be sourced. The USCS designations are included here are all *CH - FAT CLAY*.

Step 3: The Plasticity Index(PI) is determined by the lab. For B2 sample 5 it is 55. The PI is one of the two suggested criteria (10D-5 above) for determining permeability.

Step 4: The unified soil classification system (USCS) designation is noted as determined visually.

Step 5: Note that the particle analysis has not been performed. All values in the percent passing column next to sieve size are listed as "N/A". Sieve and percent fine is the particle analysis and the 2nd of the two listed criteria (10D-5 above).

Step 6: Although an experienced engineer will likely do pretty well at determining the USCS visually, a precise determination is suggested by AWMFH via particle analysis. The USCS of CL in step 1 is different than the USCS of CH in the bore logs which suggests there are different people in the process making different estimations.

Conclusions: The engineer has determined only one of the two suggested criteria for permeability and that is the (PI) plasticity index. The engineer is also using his experience to estimate the USCS.

The lab determined PI of the samples between 7 & 11' which will be the depth of the material used in the liners:

1. Boring 2, sample 5, PI: 55
2. Boring 2, sample 6, PI: 41
3. Boring 3, sample 5, PI: 22
4. Boring 3, sample 6, PI: 37

AWMFH states that when the PI values are above 20, this suggests a flocculated (blocky) structure subject to high desiccation and shrinkage which also affects permeability. This high PI suggests a USCS closer to CH in the type IV

permeability group (see table 10D-4 in Appendix C3, page 5 (this document). For soil types III and IV the AWMFH appendix 10D page 10D-6 under *Permeability of soils* states:

“Some soils in groups III and IV may have a higher permeability because they contain a high amount of calcium. High amounts of calcium result in a flocculated or aggregated structure in soils. These soils often result from the weathering of high calcium parent rock, such as limestone. Soil scientists and published soil surveys are helpful in identifying these soil types. High calcium clays should usually be modified with soil dispersants to achieve the target permeability goals. Dispersants, such as tetrasodium polyphosphate, can alter the flocculated structure of these soils by replacement of the calcium with sodium. Because manure contains salts, it can aid in dispersing the structure of these soils, but design should not rely on manure as the only additive for these soil types.”

The facility is located atop the Boone formation which is karst limestone. The soil laboratory notes in the visual classification “chert fragments”. There is a likelihood that high calcium limestone is the parent rock of this soil. However, no tests for calcium levels were mentioned in the geological investigation. The lack of the particle analysis or determination of calcium levels in the liner source material suggests weakness in the geological investigation that is not proportional to the significant of risk factors in Part A.

Comment C4 - This permit should be denied because the laboratory compaction analysis to determine hydraulic conductivity uses only one sample

Though the engineers did not perform the particle analysis suggested in AWMFH, they did perform a laboratory compaction to determine hydraulic conductivity. The one sample used is described as a “grab sample” (see page 6 of Appendix C3). The testing documents indicate it came from bore #2 from 7 to 11 ft. There are several problems with using only a single grab sample.

- 1. Hydraulic conductivity can vary from 7 to 11 ft.** We know the PI varies between from 41 to 55 in bore #2. Also, the level of calcium in soils can affect permeability, though no calcium testing was performed (Comment C3). As soil levels approach the soil-to-epikarst transition zone, chert along with calcium levels will tend to rise. Tai Hubbard, the geologist who

participated in the Harbor Environmental study suggested the epikarst zone starts at about 13.5 ft (see Comment C11):

“The highly weathered limestone bedrock and unconsolidated clay intervals observed between 13.8 and 28.0 ft.bgs. appeared to have the characteristics of epikarst. With the understanding that epikarst is the weathered zone found at the interface of unconsolidated soils and bedrock, the Site setting would support this characterization.”

A single grab sample from 7 ft could have different calcium content resulting in different hydraulic conductivity than a sample from 11 ft.

- 2. Hydraulic conductivity can vary between bore hole locations.** First it should be mentioned that AWMFH suggests based on the area of the ponds that six bore holes should have been drilled (see comment C6). However, even with only two bore holes the samples have PI ranges that vary from 22 to 55. This PI variability can exhibit significantly different hydraulic conductivity.

In regard to the grab sample used, we don't know the exact depth from which it was taken and we don't know the calcium content. Likewise, the soils from Bore hole #3 which were also used in pond construction have very different PI readings which can result in variable hydraulic conductivity. M.D. Smolen, PH.D. who has 35 years of experience in water quality management as affected by agricultural waste management and other aspects of watershed management, had this to say in a report dated Jan 2nd, 2014:

“The liner design was based on a single sample of in situ clay that was used as a liner. With only one sample, there is no way to determine how consistent this clay is, and whether or not the conductivity measured is representative of the entire stock pile. The inspection report from July 23, 2013 indicates that “gravel to cobble-sized coarse content” was observed in the clay liner (073447-INSP.pdf). This suggests the final clay liner could be quite different from the sample tested, which was supposed to be “fat clay.” The presence of coarse particles can reduce the permeability of the liner. Cracks and rocks are visible in the photograph by ADEQ, Tony Morris 7/23/13, shown in Figure 1.”

See Appendix C5 for photos referenced above. The single grab sample was not sufficient to represent overall hydraulic conductivity. This was an engineering decision that was not proportional to the risks as described in Part A.

Comment C5 - This permit should be denied because type IV soils to be used for the liner suggest special considerations in AWMFH that were not addressed

Please review comments C3 and C4 for background. This discussion assumes that soils used for the liners were in or near the type IV soils group due to the high plasticity index (PI) determined by the laboratory analysis. There was no particle analysis performed to make an exact soil group determination. For soils types III and IV the AWMFH appendix 10D page 10D-6 under *Permeability of soils* states:

“Some soils in groups III and IV may have a higher permeability because they contain a high amount of calcium. High amounts of calcium result in a flocculated or aggregated structure in soils. These soils often result from the weathering of high calcium parent rock, such as limestone. Soil scientists and published soil surveys are helpful in identifying these soil types.”

“High calcium clays should usually be modified with soil dispersants to achieve the target permeability goals. Dispersants, such as tetrasodium polyphosphate, can alter the flocculated structure of these soils by replacement of the calcium with sodium. Because manure contains salts, it can aid in dispersing the structure of these soils, but design should not rely on manure as the only additive for these soil types.”

As the Boone formation is the predominant limestone geology in the region and evidence of chert is mentioned in the lab analysis, it is very possible that the soil has a high calcium content.

AWMFH suggests modification with soil dispersants to achieve permeability goals. More on dispersant recommendations discussed in AWMFH appendix 10-D page 10D-32:

Design and construction of clay liners treated with soil dispersants

“Previous sections of this appendix caution that soils in groups III and IV containing high amounts of calcium may be more permeable than indicated by the percent fines and PI values. Groups III and IV soils predominated by calcium usually require some type of treatment to serve as an acceptable liner. The most common method of treatment to reduce the permeability of these soils is use of a soil dispersant additive containing sodium.”

Unfortunately no particle analysis was performed and calcium levels were not determined either. No mention of a dispersant modification in the geological investigation of the NOI.

Under appendix 10D: *Construction considerations for compacted clay liners* under *Soil Type* on page 10D-20:

“The most ideal soils for compacted liners are those in group III. The soils have adequate plasticity to provide a low permeability, but the permeability is not excessively high to cause poor workability. Group IV soils can be useful for a clay liner, but their higher plasticity index (PI greater than 30) means they are more susceptible to desiccation. If clay liners are exposed to hot dry periods before the pond can be filled, desiccation and cracking of the liner can result in an increase in permeability of the liner. A protective layer of lower PI soils is often specified for protection of higher PI clay liners to prevent this problem from developing.”

The notation mentions plasticity levels > 30 . Three sources of the liner material are over > 30 . If used in equal parts the average PI will be 38.75.

1. Boring 2, sample 5, PI: 55
2. Boring 2, sample 6, PI: 41
3. Boring 3, sample 5, PI: 22
4. Boring 3, sample 6, PI: 37

There is no mention in the NOI engineering of a protective layer of lower PI soils as suggested in AWMFH. Note that high PI soils are generally highly flocculated (coarse granularity with clods). Although flocculation is suggested, we don't know for a certainty since there was no particle analysis. AWMFH Appendix 10D page 10D-23 states:

Macrostructure in plastic clay soils

“Clods can create a macrostructure in a soil that results in higher than expected permeability because of preferential flow along the interfaces between clods. Figure 10D–13 illustrates the structure that can result from inadequate wetting and processing of plastic clay. The permeability of intact clay particles may be quite low, but the overall permeability of the mass is high because of flow between the intact particles.”

This permeability concern with type IV soil is reiterated in AWMFH Appendix 10D under *Permeability of soils* page 10D-6:

“Soils in group IV usually have a very low permeability. However, because of their sometimes blocky structure, caused by desiccation, high seepage losses can occur through cracks that can develop when the soil is allowed to dry. These soils possess good attenuation properties if the seepage does not move through cracks in the soil mass.”

Desiccation, cracking, and coarse content consistent with type IV soils with suggested permeability risk is identified by an ADEQ inspector on July 23 2013. See Appendix C5 for accompanying photos:

“3.) The wastewater pond liners were observed to have erosion rills, desiccation cracks and gravel to cobble-sized coarse content within the liner clay. If the liner is to be exposed for extended periods of time, it should be protected from deterioration by erosion and desiccation.”

On Jan 23rd, 2014 (six months later), a second ADEQ inspection noted that the liner desiccation continued to be a problem. See Appendix C5 for photos.

“The holding pond embankments were not stabilized and erosion rills were found within the inside banks of the holding ponds. Stabilization of the embankments needs to occur to 1) prevent sediment from entering the holding ponds which may decrease the capacity of the holding ponds, and 2) ensure the integrity of the holding ponds are maintained. Please see Photographs 1 and 2.”

The inspector recognized deterioration characteristics consistent with type IV soils as an ongoing problem that should have been addressed immediately following construction as stated in this passage in AWMFH Appendix 10D under *Permeability of soils* page 10D-6:

“High plasticity soils like those in group IV should be protected from desiccation in the interim period between construction and filling the pond. Ponds with intermittent storage should also consider protection for high PI liners in their design.”

The AWMFH also suggests construction techniques for high PI soils:

Clods in borrow soil

“If borrow soils are plastic clays at a low water content, the soil will probably have large, durable clods. Disking may be effective for some soils at the proper water content, but pulverizer machines may also be required. To attain the highest quality liner, the transported fill should be processed by adding water and then turned with either a disk or a high-speed rotary mixer before using a tamping roller.”

The construction specification does not mention what techniques were used in laying down the clay liners. M.D. Smolen, PH.D. who has 35 years of experience in water quality management as affected by agricultural waste management and other aspects of watershed management, mentions that ponds will be subject to ongoing exposure issues that may have risk implications:

“The storage ponds at C&H are designed to be pumped down very close to the bottom periodically (at least once every 6 months). Consequently much of the clay liner will be exposed for long periods. This will lead to cracks developing in the liner, reducing the effectiveness of the seal. [Note cracking has already been observed during a site inspection on July 23, 2013 (see item 3 in letter from Jason Bolenbaugh, ADEQ, to Jason Henson in reference 073447-INSP.pdf).] The NRCS recommends protecting the clay liner from cracking by applying a layer of lower PI material over the clay, not allowing the liner to dry out, or using a more specialized system with dispersants or bentonite added. If the ponds are pumped dry and cracking occurs at the bottom, consequences could be very serious.”

Conclusion: What is known for sure is that the material used in the liners has a very high plasticity index (PI) with chert suggesting the possibility of high calcium content. No testing for calcium was done. One grab sample was used to determine hydraulic conductivity for the entire range of material used in the liners though PI was variable. No dispersant modifications are mentioned. No protective layer of lower PI soils is mentioned. Inspections confirm desiccation, cracking, and coarse content consistent with type IV soils. No protection or maintenance for the liner for at least six months prior to filling as suggested in AWMFH. Exposure of liner floor to drying after pump down risks cracking. Construction technique is not mentioned in specifications. These issues are all suggestive of a low level of due diligence that is not proportional to the high cost of potential consequences discussed in Part A.

Comment C6 - This permit should be denied because the pond subsurface investigation does not conform to AWMFH guidance

Regulation 5.404 Subsurface Investigation Requirements states:

“The subsurface investigation for earthen holding ponds and treatment lagoons suitability and liner requirements may consist of auger holes, dozer pits, or backhoe pits that should extend to at least two (2) feet below the planned bottom of the excavation.”

The AWMFH 651.0704(4) *Guide to detailed geologic investigation* page 7-21 goes further suggesting the following for sampling the subsurface where ponds

are planned. This is noted as to be particularly applicable for complex and inconsistent environments such as karst.

“For structures with a pool area, use at least five test holes or pits or one per 10,000 square feet of pool area, whichever is greater. These holes or pits should be as evenly distributed as possible across the pool area. Use additional borings or pits, if needed, for complex sites where correlation is uncertain. The borings or pits should be dug no less than 2 feet below proposed grade in the pool area or to refusal (limiting layer).”

The original NPDES Reg 6 NOI specifies pond area in section C2 “*design calculations*” as follows:

- Top of Waste Storage Pond 1 20,857 Square feet
- Top of Waste Storage Pond 2 35,262 Square feet

It should be noted that the Reg 5 permit application specifies different square footage areas for the two ponds than the original NOI. Likewise the application also specifies square footage for a total drainage area. None of these figures agree, but for the purposes of this comment they do not vary enough to make a difference.

The original NPDES Reg 6 NOI shows records for three borings in the *Geologic Investigation* document. These are numbered B-1, B-2, B-3. Only B-2 and B-3 were in the area of the ponds (see Comment C3). Using the guide from AWMFH page 7-21(4), there should have been at least 6 distributed borings if “pool area” is interpreted as encompassing both pools. More borings if “pool area” is interpreted as per pool. It is unclear how much latitude Chapter 7 provides the engineer regarding the detailed investigation. Certainly the risk factors were present to justify the AWMFH recommendations. The fact that the engineer recognized that drilling two holes was important but chose not to follow AWMFH guidance for the recommended number in the pond area suggests that the geologic investigation in this permit application is not proportional to the risk factors as discussed in Part A. The sensitivity of the watershed calls for the detailed geologic investigation to be revisited prior to the permit being granted.

Comment C7 - This permit should be denied because the berm subsurface investigation was not performed as per AWMFH guidance

The AWMFH 651.0704(4) Guide to detailed geologic investigation page 7-21 specifies the following for sampling the subsurface where ponds are planned:

“For foundations of earthfill structures, use at least four test borings or pits on the proposed embankment centerline, or one every 100 feet, whichever is greater. If correlation of materials between these points is uncertain, use additional test borings or pits until correlation is reasonable. The depth to which subsurface information is obtained should be no less than equivalent maximum height of fill, or to hard, unaltered rock or other significant limiting layer.”

The berm walls of the pits are on the opposite sides from the barn and come to roughly 335ft in length. There were no test borings recorded in the original NOI geologic investigation. There is a “core trench” noted in the *Engineering Plan Sheets* but this was a trench to be filled with material to reduce berm wall permeability; it was not a geological investigation. That the engineer chose not to follow the AWMFW detailed investigation guidance suggests that the geologic investigation in this permit application was not proportional to the risk factors as discussed in Part A. The sensitivity of the watershed calls for the detailed geologic investigation to be revisited prior to the permit being granted.

Comment C8 - This permit should be denied as SPAW modeling for overtopping has not been made available for peer review

“SPAW” stands for *Soil-Plant-Air-Water* and it is a modeling technique that considers pond sizing, waste generation, waste usage, anticipated precipitation, and other factors to analyze the likelihood of the waste levels overtopping the pond containment system. M.D. Smolen, PH.D. who has 35 years of experience in water quality management as affected by agricultural waste management and other aspects of watershed management, discusses the specific SPAW modeling done for C & H in a report dated Jan 2nd, 2014:

Review of SPAW Model Analysis

“As required in the AR rules, the designers have analyzed the likelihood of this waste system overtopping using the SPAW model. Their analysis uses 47 years of rainfall data from a nearby weather station. The data used are appropriate for this

analysis. It is unlikely the result would be different if 100 years of historic data had been available.

SPAW analysis by DHG suggests the two-pond system will not overflow if the wastes are pumped out every six months. Their simulation shows annual maximum pond depth to range from 7.0 to 10.8 ft in Pond 2, with average maximum depth 8.99 ft. The maximum allowable depth in Pond 2 is 11.7 ft (Sheet 15 of DGH Plan sheets). Pages 8 – 25 of Certification and QA-QC Section show the SPAW printout. Area of the pond(s) used in the SPAW analysis is shown as 0.70 acres., but the “As-Built” drawings show the top area of Pond 2 as 0.76 acres and Pond 1 is about 0.5 acres for a total of about 1.2 acres. In addition there is also some contributing area from berms surrounding the two ponds that must be considered. Therefore, there should be something more like 1.5 acres considered for rainfall input to the system, or twice the area shown as model input. This is important because all model calculations of water balance are computed in volumes (acre-ft) that are sensitive to the area factor.”

“Maximum volume used in SPAW is shown as 5.66 acre-ft (af), which is approximately the volume of Pond 2 (about 5.32 af depending on the actual depths considered for full and empty). Total volume of both ponds should be about 7.40 af. At the end of the SPAW printout, total values for sections of the water balance are presented on an average monthly basis. The total of all precipitation inputs is shown as 1.33 af. If this is adjusted for area (0.7 acres), the precipitation amount would be about 22.8 inches, or about 1/2 the average annual precipitation for the area (43.7 inches at Marshall, AR). The model also considers water input from Bank Runoff, Seepage from Banks, and the waste input from the barns and the water losses from evaporation, seepage through the liner, and pump down every 6 months. The modeler may have adjusted some of these inputs and outputs to reflect the system accurately, but it is difficult to determine this from the information presented.”

“The SPAW printout shows good water balance (this is an important check the model: on average water inflow must equal water outflow). According to the model, average annual input (precipitation plus wastewater) is about 10.45 a-f. Of this, 73% is pumped out and applied to fields, 11.7% evaporates, and 14.6% leaks.”

Above, Smolen makes suggestions in regard to whether the SPAW model inputs were the best choices. Below is Smolen’s recommendation regarding the model:

“I would recommend that the complete details of the SPAW simulation be requested to check the validity of the modeler’s conclusion that the embankment will not be overtopped. The SPAW simulation is particularly important for two reasons; (1) it is used to determine if the waste storage ponds can overflow, and (2) the design assumes there will NEVER be an overflow event. If overflow occurs, catastrophic failure of the embankment is likely, because the design does not include a stabilized emergency spillway.”

Smolen (2017) notes the following in regard to the need to set a “higher bar” for this particular pond design:

“The waste holding ponds should be designed and operated to a higher standard than the NRCS Agricultural Waste Management Field Handbook (AWMFH) because Regulation 5 requires “no discharge.” The C&H waste holding ponds are sized for discharge from a 25-yr 24-hr storm. This would be acceptable under a discharge permit like the Regulation 6 NPDES permit. Regulation 5, however, is a “No Discharge Permit” and should require a higher standard such as NOAA’s Probable Maximum Precipitation. The high recreational value of the Buffalo River should be a basis for designing to a higher standard, such as the PMP, or at least 40 inches of stormwater and freeboard combined.”

A peer review of the engineering details of the SPAW model are appropriate prior to the consideration of this Reg 5 permit. As Smolen mentions, incorrect assumptions in the model or flaws in the calculations have potentially serious consequence as it pertains to the risk level discussed in Part A.

Comment C9 - This permit should be denied because contingencies for storage pond overtopping are inadequate

AWMFH Appendix 10D, page 41 states the following:

“If overtopping can cause embankment failure, an emergency spillway or overflow pipe should be provided.”

M.D. Smolen, PH.D. who has 35 years of experience in water quality management as affected by agricultural waste and other aspects of watershed management, has the following to say regarding overtopping contingencies in a report dated 1/02/2014:

“If the embankment of Pond 2 were overtopped due to unusual weather or poor management, there would be erosion of the embankment with possible catastrophic failure. The waste storage ponds are built on the side of a hill with 10% slope, making stability of the embankment structure critical.”

Smolen elaborates in a later report dated 8/28/2015:

“The two waste storage ponds are situated on the side of a steep slope and designed to contain all waste, wash water, and rain water, including a 25-yr 24-hr design storm without discharging. The design meets the requirements of the CAFO permit and ADEQ, but does not consider the special nature of the Buffalo River. Because the waste pond design assumes there will be no discharge, the second pond in the series has no stabilized, emergency outlet. If the pond were to overtop the embankment due to a very large storm (much greater than the design storm) or a prolonged period of wet weather, or a combination of wet weather and extreme storm, there would be a danger of catastrophic failure of the embankment. Such failure could release as much as 2 million gallons of waste into the Buffalo River, a disaster not unlike the recent mine waste disaster in Colorado. In high risk areas, it is standard practice to include a stabilized outlet to allow discharge without failure of the embankment.”

“In addition, the waste system design assumes that overtopping can be avoided by pumping wastes from the waste storage ponds to a designated area, specifically Field 7. This plan is unrealistic, however, for two reasons. First, the farm does not appear to have a pumping system with sufficient capacity to pump down the waste storage ponds in an emergency (this is indicated by their request to use vacu-tankers for pumping down waste storage pond 2 in the Permit Modification Request), and second because the designated field, Field 7, is one of the worst places to use for emergency waste disposal because of its location directly adjacent to Big Creek and its high soil test P. Vacu-tankers or other wheel vehicles would not be suitable for waste application in extremely wet weather, and Field 7 is very likely to flood during such a period.”

Smolen again mentions the overtopping risk in comments in 2017:

“Considering the lack of an emergency spillway and the experience of unusually high rainfall in the Ozarks, the operator should be encouraged to maintain more than the minimum storage at all times. A picture from the ADEQ inspection report from 12/30/2015, shows that WSP2 is operated close to the maximum level with about three months to go before a significant pumpdown is expected.”

Photographer:	Jason Bolenbaugh	Date:	12/30/2015	Time:	
Witness:	Keith Waters	Photo #:	2		
Description:	WPS #2 showing adequate amount of freeboard and the depth gauge which marks (red line) the Must Pump Down level.				



The far side is the top of the 10% slope mentioned that has no stabilized emergency outlet.

Assumptions that overtopping will never occur is an example of how the engineering of the storage ponds was not proportional to the risks as discussed in Part A.

Comment C10 - This permit should be denied because containment ponds are located within 600 ft of an improperly abandoned well

AWMFH 651.0702(n) *Presence of abandoned wells and other relics of past use*
Page 7-15 states:

“The site and its history should be surveyed for evidence of past use that may require special design considerations of the site relocation. If there is an abandoned well on the site, special efforts are required to determine if the well

was sealed according to local requirements. An improperly sealed well can be a direct pathway for contaminants to pollute an aquifer.”

The AWMHB 651.1004(b) *Liquid and slurry manure storage* on page 10-23 states the following regarding agricultural earthen waste storage ponds:

“Earthen storage is frequently the least expensive type of storage; however, certain restrictions, such as limited space availability, high precipitation, water table, permeable soils, or shallow bedrock, can limit the types of storage considered. Table 10–4 provides guidance on siting, investigation, and design considerations.”

See Appendix C10-B shows a downgrade distance of 594 ft to a hand dug well.

AWMHB table 10-4 (Appendix C10) makes recommendations regarding AWMS storage ponds in proximity to improperly abandoned wells which can open an unlined column of water to geologic substrate. The table represents a “Vulnerability to Risk” matrix and clearly states that when planning AWMF waste storage, if it is within 600 feet of an improperly abandoned well, the vulnerability rating is **Very High** and that the planner should **“evaluate other storage alternatives** or *properly seal well and reevaluate vulnerability”*. The improperly abandoned well is not recognized in the SECTION D: *SITE SPECIFIC INFORMATION* of the original NOI. Likewise, a 2,000 ft radius map is provided in SECTION E: *FACILITY PLANS* (see Appendix C2-B), does not reference the well. AWMFH 651.0701 *Overview of geologic material and groundwater* page 7-2 states:

“Many rural domestic wells, particularly in upland areas, derive water from fractures and joints in bedrock. These wells are at risk of contamination from waste impoundment facilities if fractured bedrock occurs within the excavation limits, within feedlots or holding areas, and in waste utilization areas. Fractures in bedrock may convey contaminants directly from the site to the well and significantly affect water quality in a local aquifer.”

The geology is predominantly karst (see Comments C11, E2). This suggests a weakness in the investigation in that the pond locations are too close to this well. The original NOI investigation does not suggest adequate due diligence proportional to the significant risk factors discussed in Part A.

Comment C11 - This permit should be denied because geologic karst is clearly identified beneath the facility in the Harbor Environmental single drill hole study

The *Water Resources Management Plan* for the Buffalo National River prepared by David Mott and Jessica Laurans for the National Park Service in 2004, says the following about the presence and behavior of karst in the Buffalo watershed:

“Discrete recharge is a concentrated, rapid movement of water to the subsurface drainage network, most common in areas dominated by karst, which is typical in the Ozarks. Sinkholes and losing streams are examples of discrete recharge. Most sinkholes and losing streams (where a portion of the reach goes dry) are found to be underlain by the Boone formation in northwest Arkansas and most springs emerge in the Boone, as shown in Figure 19 (Aley, 1999). Groundwater pollution is most common in limestone and dolomite areas such as the Boone formation because discrete recharge does not allow for the effective filtration and absorption of pollutants. Faster travel rates provide less time for bacterial and viral die off as well. This is important for water quality management of the Buffalo River since almost 32% of the watershed is underlain by the Boone formation (Aley, 1982).”

At the C & H facility, Harbor Environmental drilled a single bore hole to a depth of 120 ft as a result of an electronic resistivity study (ERI) performed by Dr. Todd Halihan of Oklahoma State University published 2016. The slides (Appendix C11) that resulted from Dr. Halihan's study suggested conductive zones consistent with high moisture content. The mixture of conductive and resistive zones suggests karst typical of the Boone formation. Bore holes were suggested by Dr. Halihan to “ground truth” the results of the ERI transects.

The Harbor Environmental report unfortunately does not speak directly to the ERI transects, but it does strongly detail karst features. Here is their overview of the geology:

2.2.3 Geology

“The uppermost geologic formation below the site is the Mississippian-age Boone Formation (Haley, et al., 1993). The Boone formation consists of gray, fine- to coarse-grained fossiliferous limestone interbedded with chert. Some sections may be predominantly limestone or chert. The cherts are dark in color in the lower part of the sequence and light in the upper part. The quantity of chert varies considerably both vertically and horizontally. The sequence includes an oolite (Short Creek) member near the top of the Boone Formation in western exposures and the generally chert-free St. Joe Member at its base. The Boone Formation is well known for dissolutional features, such as sinkholes, caves, and enlarged

fissures. Thickness of the Boone Formation ranges from approximately 300 to 350 feet in most of northern Arkansas (McFarland, 2004)."

Note in the following passage in the Harbor report that water used in the drilling process as a lubricant was lost in the 20 to 28.5 ft zone indicating the open space of a fracture or void. Note the terms "weathered and fractured and increased fracturing". These are all indicative of karst.

Subsurface Conditions Encountered

"Yellowish red silty clay (CL) with chert and limestone fragments was encountered from the surface to a depth of 8 feet bgs. This material appeared to be fill soil placed during construction of the hog farm and adjacent waste ponds. Yellowish red fat clay (CH) was encountered from 8 feet to 13.5 feet bgs. Fine-grained, fossiliferous, gray limestone was encountered from 13.5 feet to 20 feet with a six-inch seam of fat clay as above occurring from approximately 18 feet to 18.5 feet bgs. Weathered and fractured, fossiliferous gray to buff limestone was encountered from 20 to 28.5 feet. The driller reported potable drilling water loss in this zone. Competent, fossiliferous gray limestone (consistent with the Boone Formation), with some minor fracturing and bedding planes was encountered at 28.5 feet bgs, which generally extended to the TD of 120 feet bgs. Zones of increased fracturing were encountered around 70 feet and 90 feet bags..."

The boring log selected entries are indicative of karst throughout:

-At 20 ft: "LIMESTONE, fine grained, weathered and fractured, gray (5Y 5/1) to buff, fossiliferous."

-At 28 ft: "LIMESTONE, competent w/ some fracturing and bedding planes, gray (5Y 5/1) to buff, fossiliferous."

-At 60 ft: "LIMESTONE, competent w/ some fracturing and bedding planes, gray (5Y 5/1) to buff, fossiliferous."

At 65 ft: "Fractured"

-At 85 ft: "Increased fractures"

-At 100 ft: "LIMESTONE:, competent, interbedded with thin to medium bes of shaley limestone, gray (5Y 5/1) fossiliferous."

The on-site geologist, Tai Hubbard, made this notation:

"The highly weathered limestone bedrock and unconsolidated clay intervals observed between 13.8 and 28.0 ft.bgs. appeared to have the characteristics of epikarst. With the understanding that epikarst is the weathered zone found at the interface of unconsolidated soils and bedrock, the Site setting would support this characterization."

The indication of epikarst at 13.8 to 28 ft below ground level confirms porous weathered rock at a depth that is above the floor of the ponds with the pond #2 invert at 20 ft below the surface of where the bore hole was drilled (See Appendix C12 for elevations). The AWMFH table 10-D in Appendix 10D (Appendix C-10 of this document) notes the following regarding karst in the *Vulnerability to Risk* matrix when siting a facility: “large voids e.g. karst, lava tubes, mine shafts) as a **very high** vulnerability suggesting that the engineer “**Evaluate other storage alternatives**”. No such alternatives were considered. As a result, this permit does not comply with AWMFH guidance.

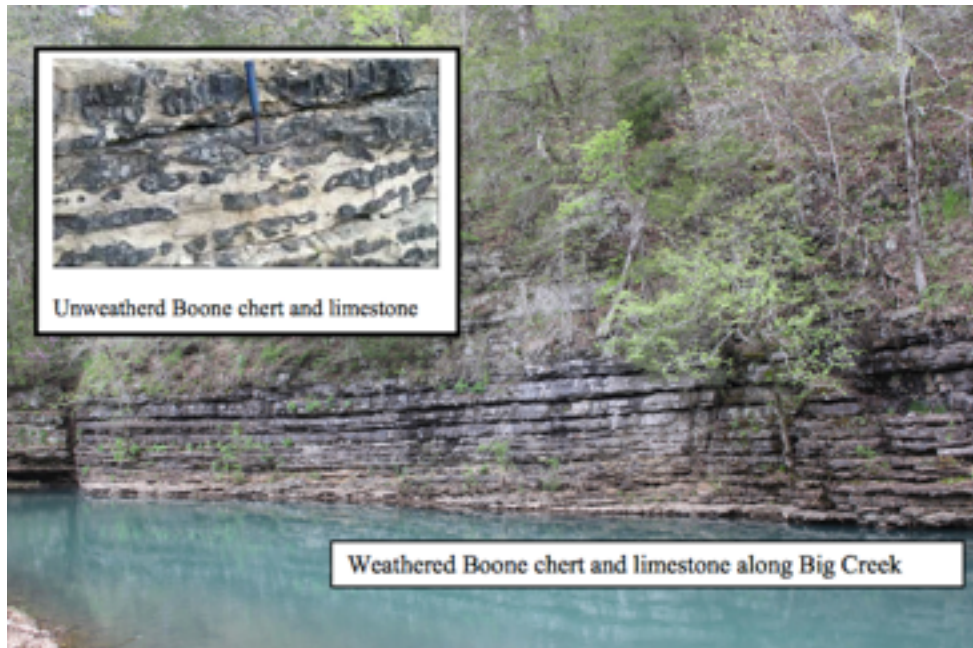
Comment C12 - This permit should be denied because containment ponds are located on a geologic foundation near voids and/or fractures

Harbor Environmental drilled a single bore hole to a depth of 120 ft as a result of an electronic resistivity study (ERI) performed by Dr. Todd Halihan of Oklahoma State University published in 2016. The transects that resulted from the study (Appendix C11) suggest conductive zones consistent with high moisture content. The concern that prompted the Harbor drilling exercise was possible leakage and/or fractures near the ponds. The comments and logs from the drilling process say on several occasions that “no voids were encountered”. However, there were some very noticeable events in the process of drilling and filling the bore hole that the members of the Harbor drilling team did not address. In 3.2 *Subsurface conditions encountered* it states:

“Weathered and fractured, fossiliferous gray to buff limestone was encountered from 20 to 28.5 feet. The driller reported potable drilling water loss in this zone.”

This loss of water is noted in the drilling log as well. The drilling process uses a 6” turning pipe with water pumped into the pipe and exiting around the sides. The water pumped in serves to a degree as a lubricant and it should all be recaptured as part of the process unless it is lost into an open subsurface space of some sort. The Harbor report does not indicate how much water was recovered vs how much was used, though it should have provided this as it is critically important. A large void will generally be noticeable during the drilling process, but not necessarily. A narrow fracture or cobble filled void that may be of considerable volume may not be noticeable by the driller. An example of

typical fractures in the Boone formation that would not easily be detected by a driller are illustrated in this cross section photo.



When filling the hole with cement there was a similar issue encountered discussed under 3.3 *Borehole Abandonment*:

“After completion of the drilling and sampling operations and geophysical logging, the borehole was abandoned in accordance with the Arkansas Water Well Construction Commission Rules and Regulations (May 2016) and ADEQ Interim Policy 96-4. The borehole was grouted to the land surface via tremie method (from bottom up) using Portland cement (no bentonite). Due to fracture zones encountered in the subsurface, the borehole took more grout than calculated for its volume (see boring log in Appendix B). Borehole volume was estimated at 23.6 cubic feet (176 gallons). Total estimated grout placed in the borehole was approximately 280 gallons. The borehole was grouted on Friday, 9/23/16; however, the driller ran out of grout and was unable to grout the borehole to the surface.”

It is important to note that the loss of grout occurred in the same zone as the loss of water which was between 20 and 28.5’ (“about 25’ ”). Experienced drillers will do a pretty good job at estimating the amount of grout to mix for filling a hole as they don’t want to find themselves short. As described above, they pumped all that they had Friday afternoon and stopped for the day, hoping that the fracture(s) were narrow enough that the grout pumped would set and seal the openings. On Monday, the fractures did apparently seal and they were able to

finish the process. What should be noted is that the fractures may have taken quite a bit more grout Friday had they chosen to mix additional grout and continue pumping at that time. The amount of extra grout used before they ran out was determined to be 23.6 cubic ft, about the size of a small closet. It would be much more indicative of the size of this subterranean opening if we knew instead how much water was lost, which was not provided. Experts indicate that to come across an underground opening like this is generally unlikely with a single drill hole. This raises some concern in regard to the extent of possible subsurface openings that may exist around the ponds. In fact Tai Hubbard, the onsite geologist noted the limited scope of the Harbor study:

“Evaluation of lithologic contacts and bed orientations are limited, both horizontally and vertically, due to the inability to correlate observations collected at a single location to any other bore holes.”

The extent of voids or fractures can't be known but to find one with only one bore hole suggests heightened risk. This indication of a subterranean opening tends to validate Dr. Todd Halihan's ERI transects which suggest fractures. What we know for certain is that there is at the very least 23.6 cubic ft area of subsurface open space at a depth of 20 to 28.5 ft where drilling water was lost and where the grout would not rise. The elevation of where the bore hole was drilled was about 914.3 ft (see Appendix C12 page 2) which means the subterranean opening occurred at an elevation between 894.3 and 885.8 ft (where water was lost) or 889.3 (where grout would not rise). The elevation of the floor of Pond #2 is 894.3 ft which places a clearly identified opening of some sort roughly even with the floor of pond 2 or a few feet below.

AWMFH table 10-4 (Appendix C10) that identifies *vulnerability to risk*, lists “Large voids (e.g, karst, lava tubes, mine shafts) OR highest anticipated ground water elevation within 5 ft of invert” as a “**Very high**” vulnerability and suggests **Evaluate other storage alternatives.**

In AWMFH Appendix 10-D under *When a liner should be considered* the following is stated:

“Some bedrock may contain large openings caused by solutioning and dissolving of the bedrock by ground water. Common types of solutionized bedrock are limestone and gypsum. When sinks or openings are known or identified during the site investigation, these areas should be avoided and the proposed facility located elsewhere.”

The evidence of subsurface openings discovered so readily this close to the pond inverts suggests that the impoundment locations present risk that is disproportional to the surrounding environment as discussed in Part A. Note that ADEQ has approved a modification allowing for the installation of synthetic pond liners, but they have not yet been installed. Synthetic membranes are inadequate to address the risk identified in the Harbor drilling investigation (see Comment E1). Had an proper subsurface investigation been conducted prior to construction, AWMFH guidance table 10-4 would clearly have directed that *“these areas should be avoided and the proposed facility located elsewhere”*.

Comment C13 - This permit should be denied due to evidence of perched groundwater close to pond inverts

Please review comment C12 regarding subsurface openings close to the Pond 2 invert.

The ERI transects resulting from Dr. Todd Halihan’s study were compiled as a result of two separate visits. On the 2nd visit, Dr. Halihan’s team produced ERI transects on field 1 and also generated four transects around the ponds. Note his description of the conditions that day:

“Precipitation previous to and during the investigation resulted in both sites having moist to saturated soil conditions. The site soil of Field 1 was saturated.”

Three of the ERI transects from the study around the ponds noted several highly conductive zones indicative of moisture in the 13’ to 28’ range.

The bore hole drilled by Harbor Environmental was drilled Sept 21st through the 23rd during and following dry conditions. As this hole was only drilled near the middle of the west ERI transect, the following discussion is limited to that area. The Harbor Environmental report noted loss of water at 20 to 25’ and they had difficulty grouting above 25’. We know for certain (Comment C12) that there is at least 23.6 cubic ft of subsurface open space at a depth of 20 to 28.5 ft. This corresponds with where the drilling water was lost and the grout would not rise.

Dr. Halihan’s west transect indicates moisture at this depth. We know that conditions were very wet and that field 1 which he had tested earlier was described as “saturated”. The conductivity in Halihan’s west transect suggests the possibility of perched groundwater in the same subsurface zone where

Harbor Environmental lost water and grout. See Appendix C13. Dr. Halihan describes in his report the likelihood of perched ground water in epikarst:

“In geologic settings like northern Arkansas, the epikarst zone is a significant source of water storage and transmission and many springs have been tapped to support local communities (Galloway, 2004). These types of groundwater systems can include perched water tables, which exist above regional water tables. These are called perched because they are places where low permeability soil or bedrock layers hold water above an unsaturated zone and often produce springs on the side of a bluff or sometimes in an open field if the relief is high enough to expose this feature.”

Tai Hubbard, the on-site geologist monitoring the drilling process for Harbor Environmental, described this exact zone as characteristic of epikarst which Halihan points out as a significant source of water storage:

“The highly weathered limestone bedrock and unconsolidated clay intervals observed between 13.8 and 28.0 ft.bgs. appeared to have the characteristics of epikarst. With the understanding that epikarst is the weathered zone found at the interface of unconsolidated soils and bedrock, the Site setting would support this characterization.”

The Harbor Environmental drilling log confirms subsurface conditions suggesting that perched groundwater might be supported by consolidated material at the 28' level.

- At 20 ft: ***“LIMESTONE, fine grained, weathered and fractured, gray (5Y 5/1) to buff, fossiliferous.”***
- At 28 ft: ***“LIMESTONE, competent w/ some fracturing and bedding planes, gray (5Y 5/1) to buff, fossiliferous.”***

AWMFH 651.0701 Overview of geologic material and groundwater under Aquifers page 7-7 says this about perched aquifers:

“A perched aquifer (fig. 7–8) is a local zone of unconfined groundwater occurring at some level above the regional water table, with unsaturated conditions existing above and below it. They form where downward-percolating groundwater is blocked by a zone of lesser permeability and accumulates above it. This lower confining unit is called a perching bed, and they commonly occur where clay lenses are present, particularly in glacial outwash and till. These perched aquifers are generally of limited lateral extent and may not provide a long-lasting source of water. Perched aquifers can also cause problems in construction dewatering and need to be identified during the site investigation.”

The elevation of where the bore hole was drilled was about 914.3 ft (see Appendix C12 page 2) which means the subsurface opening that likely contained perched groundwater during Halihan's ERI occurred at an elevation between 894.3 ft and 885.8 ft (where water was lost) or 889.3 ft (where grout would not rise). The elevation of the floor of Pond #2 is 894.3 ft which places a clearly identified open space of some sort (Comment 12) within 5 ft of elevation of the invert of pond #2.

AWMFH table 10-4 (Appendix C10) that identifies *vulnerability to risk*, lists "*Large voids (e.g, karst, lava tubes, mine shafts) OR highest anticipated ground water elevation within 5 ft of invert*" as a "**Very high**" vulnerability and suggests "**Evaluate other storage alternatives**".

The evidence of a subsurface opening combined with the saturated conditions during Halihan's ERI study and the conductivity shown in the west ERI transect suggest that the pond impoundment inverts are located within five ft of perched groundwater tables.

Comment C14 - This permit should be denied because the pond seepage limit in original NOI design is incorrect

In the original NOI for C & H, pond seepage was estimated for each pond (see chart below).

The soil proposed for the holding pond liner is Fat Clay w/sand and Fat Clay w/sand (CL) identified in the soils report at the depths of 7-11' feet in boring numbers 2-3.

Recompacted soil test were run to determine the Coefficient of Permeability using Darcy's Law. Results are included in this submittal.

Test Result	Test #1	Test #1
Test Location, (Pond/Basin)	Pond 1	Pond 2
Depth of Water at FB, (ft)	9.7	11.7
Thickness of Liner, (ft)	1.50	1.50
Coefficient of Permeability, (cm/sec)	5.0e-7	5.0e-7
Calculated Seepage Rate, (in./day)	0.13	0.15
Calculated Seepage Rate, (Gal/Acre/Day)	3,448	4,064

Currently it is recommended that the liner be constructed at 98% compaction +/-2% Optimum Moisture to meet seepage requirements.

The seepage rate of any compacted liner that will be used will be less than the maximum allowable seepage rate of 5,000 Gallons/acre/per day as required by Arkansas Department of Environment Quality.

M.D. Smolen, PH.D. who has 35 years of experience in water quality management as affected by agricultural waste and other aspects of watershed management, had this to say regarding the calculated seepage rate in a report dated Jan 2nd, 2014:

“The standard used by DHG for design of the waste storage pond clay liners at C&H was a seepage rate of 5,000 gal/acre/day, based on recommendation in the NRCS FOTG and AWMFH. As indicated earlier, these NRCS documents do not actually set standards but defer to state requirements. The NRCS AWMFH recommends, “In the absence of a more restrictive State regulation, assume an acceptable specific discharge of 5,000 gallons per acre per day.”

AWMFH states in Appendix 10-D under *Detailed Design Steps for Clay Liners*, page 10D-15:

“If no regulations exist, a value of 5,000 gallons per acre per day may be used. If a designer feels that more conservative limiting Agricultural Waste Management Field Handbook seepage is advisable, that rate should be used in computations.”

Seepage levels calculated in the original NOI (above) are somewhat lower than 5,000 per acre per day. Unfortunately, the figures are based on a hydraulic conductivity test using one grab sample which is hardly representative of liner materials whose PI ranged from 22 to 55 and calcium levels that are likely variable but were not tested for (see comments C4, C5).

M.D. Smolen PH.D. describes his concern in a report dated 8/28/2015:

“The ADEQ permit provides minimal protection from storage pond leakage, allowing as much as 5,000 gal/acre per day to leak through the clay liner. C&H’s clay liner was designed based on analysis of only one soil sample and there was no testing of the permeability of the final liner construction. The high shrink-swell potential of the liner materials have a tendency to crack when allowed to dry, increasing the potential for leakage during the cycle of filling and emptying the ponds. An EPA inspection conducted April 15-17, 2014 found that the upper edge of the clay liner were protected by erosion control fabric, but did not indicate any effort to prevent liner cracking.”

An important factor that allows seepage up to 5,000 gal per acre per day is the *manure sealing credit*. *Construction Guidelines for Impoundments Lined with Clay or Amendment-treated Soil*, page 10-D2 discuss the *manure sealing credit*:

“When credit for a reduction of seepage from manure sealing (described later in the document) is allowed, NRCS guidance considers an acceptable initial seepage rate to be 5,000 gallons per acre per day. This higher value used for design assumes that manure sealing will result in at least a half order of magnitude reduction in the initial seepage. If State or local regulations are more restrictive, those requirements should be followed.”

“If State or local regulations prohibit designs from taking credit for future reductions in seepage from manure sealing, then NRCS recommends the initial design for the site be based on a seepage rate of 1,000 gallons per acre per day. Applying an additional safety factor to this value is not recommended because it conservatively ignores the potential benefits of manure sealing.”

Dr. Smolen comments on the manure sealing credit on 1/2/2014:

“NRCS recommendations allow up to one order of magnitude reduction in permeability due to clogging of liner material by solids from the manure. Credit for manure sealing is not recommended by NRCS in the most vulnerable situations, such as areas with karst geology or high seasonal water tables (see Appendix.) “

Smolen refers to the *vulnerability to risk matrix* table 10-4 which can be found in Appendix C10 of this document. Below are the vulnerabilities we have identified in earlier comments that are listed in the above referenced table 10-4 which provides guidance for use of the *manure sealing credit*. Comment references are noted in parentheses on the right:

Very High Vulnerability

1. Voids (C12)
2. Karst (C11)
3. Highest groundwater within 5 ft of invert (C13)
4. <600 ft from improperly abandoned well (C10)

The recommendation for all risk options for very high vulnerability doesn't mention the *manure sealing credit* but simply states Evaluate other storage alternatives.

High Vulnerability

1. Bedrock (assumed fractured) within 2 ft of invert (C11,C12).
2. Highest anticipated groundwater elevation is between 5 and 20 ft of invert (C13).
3. 600 to 1,000 ft of an improperly abandoned well (C10)

The recommendation for all risk options for high vulnerability is No manure sealing credit

Moderate Vulnerability

1. Flocculated or blocky clays (typically associated with high Ca) (C5)
2. Highest anticipated groundwater elevation is between 21 and 50 ft of invert (C13).
3. 600 to 1,000 ft of an improperly abandoned well (C10).

The “Moderate Risk” selection applies here as the ponds are within 600 to 1,000 ft of an abandoned well. Recommendation is No manure sealing credit

Table 10-4 *vulnerability to risk* is clear that for this facility, the *manure sealing credit* should never have been used. That being the case “NRCS recommends the initial design for the site be based on a seepage rate of 1,000 gallons per acre per day”.

Smolen also noted on 8/28/2015:

“The EA indicates that C & H intends to install a HDPE plastic liner in the existing waste storage ponds. The original concerns for leakage could be alleviated by installation of such a liner, but retrofitting it to the C&H facility is not a simple matter. All seams must be carefully welded and tested, and there must be no organic matter decomposing under the liner as a gas bubble would cause the liner to float. Until I can be assured this liner is installed properly, my concern for leakage from the ponds remains.”

See Comment E1 on synthetic membranes - special risk factors.

Comment C15 - This permit should be denied because the pond liner leakage rate permitted in Arkansas is lax compared with other state standards making it particularly inappropriate for a location in geological karst

Smolen (2017) states the following regarding the Arkansas leakage standards compared to those of other states:

Comparison of leakage rate with the rate allowed in other states.

“The leakage rate allowed in Arkansas is higher than many other states. I reviewed eight state standards, and the “10-State Standard” for comparison. This analysis (see Appendix C15) showed that most of these states hold animal waste structures to a higher standard than Arkansas. In this comparison I looked at leakage rate based on a 6-foot depth. Ohio’s standard generally allows a leakage

rate of 277 gal/ac/day, but restricts leakage further in a karst area. Missouri restricts leakage to 500 gal/ac/day in a basin where potable groundwater might become contaminated, Oklahoma restricts leakage to 462 gal/ac/day and requires installation of monitoring wells. The 10-state standard restricts leakage to 500 gal/ac/day.”

That the Arkansas standard allows **ten times** the leakage of the 10-state standard is excessive under any circumstances, but to apply the Arkansas standard in a geologically sensitive karst environment is nothing less than irresponsible, particularly when considering the disproportionate risk factors as discussed in Part A.

Comment C16 - This permit should be denied because of the failure to adequately evaluate the impact of breach or accidental release or to provide an emergency action plan

AWMFH Section 651.0204(a) states:

“A substantive evaluation of the impact of sudden breach or accidental release from waste impoundments should be made on all waste impoundments.”

No such evaluation has been provided. Pond 2 lacks an emergency spillway or reinforced embankment and should the pond overtop due to excessive rain, rapid erosion of the pond bank could occur leading to catastrophic failure (Comment C9). This contingency should have been addressed as part of a substantive evaluation of the waste impoundments.

AWMFH Section 651.0204(a) further states:

“Development of an emergency action plan should be considered for waste impoundments where there is potential for significant impact from breach or accidental release.”

Smolen (2017) notes that in a situation where the ponds need to be pumped down quickly: *“In an emergency it would be very difficult to operate tank sprayer equipment”*, in that the pump-down process would be slow, and the vacu-tanker would be impractical for disposing it into saturated fields.

Due to the proximity of Big Creek, and the corresponding risk to the Buffalo National River, there clearly is the potential for significant impact should a breach or accidental release occur. Such an emergency action plan was not provided suggesting a low level of due diligence not proportional to the risks described in Part A.

Comment C17 - This permit should be denied because the original permit, ARG590001, was improperly issued

Failure to issue a construction permit

C & H obtained a discharge permit (NPDES General Permit ARG590001) but failed to obtain a construction permit. Arkansas law requires that a person seeking to construct and/or operate a disposal system that discharges industrial waste or sewage into waters of the State must apply for a state construction permit. § 8-4-201(4), Ark. Code. C & H Hog Farm is a “waste disposal” facility and “sewage” includes animal wastes, and “waters of the state” include underground waters. § 8-4-102, Ark. Code. Arkansas Regulation 6, which contains Arkansas NPDES regulations governing the permitting of C & H, requires a state construction permit for operation of wastewater facilities. Ark. Reg. 6.202(A). ADEQ must approve the application, and a permit be issued and effective before the activity applied for can begin. Ark. Reg. 6.202(A). The state permit is not an NPDES permit. Ark. Reg. 6.202(B). It is intended to ensure a satisfactory design and review of the treatment facility which must meet the basic design criteria set forth in the “Ten States Standards” unless an exception to those standards is justified. Ark. Reg. 6.202(B). Those standards are intended to protect both surface waters and ground waters. In its original application, C&H stated that it was applying for a permit for a new facility and for a construction permit, (NOI Form 1, p.2), and describes its treatment system, (NOI Form 1, p. 5, 13) as required by Ark.. Reg 6.202(A). However, no state construction permit was ever noticed or issued. C&H’s NPDES permit ARG590001 authorizes only discharges, not construction. C & H therefore has been operating without a state construction permit in violation of § 8-4-201(4), Ark. Code. Neither C&H’s application for a Regulation 5 no-discharge permit, nor ADEQ’s draft approval of permit 5264-W includes any reference to a construction permit and makes no effort to correct the aforementioned deficiency. Permit ARG590001 was improperly issued and therefore this permit, 5264-W, should be denied.

Failure to require a review by staff geologists

Comments on draft permit 5264-W have been submitted by Gerald Delavan who, until retirement in February 2014, worked for 30 years as a Geologist and Professional Geologist on staff with ADEQ. His comments are incorporated here by reference and state in part:

“The initial C&H permit application for a Regulation 6 General Permit was never reviewed by any of the Professional Geologists working in the Water Division or by any other ADEQ staff geologists, prior to the permit being issued...The C&H permit application was reviewed and approved exclusively by the ADEQ Engineers working in the Water Division. Consequently, any potential problems concerning the release of liquid waste into the local groundwater supplies from the manure holding ponds at C&H were never discussed or evaluated by ADEQ Geology staff. In addition, the potential for waste contaminated surface water runoff to be discharged into Big Creek and the potential for the infiltration of waste contaminates into ground water from the land application sites through the underlying karst limestone geology was never discussed or reviewed by any ADEQ Geology staff, prior to issuance of the C&H Farm’s initial permit...Given the sensitive geologic nature of this proposed hog farm location, the appropriate thing to do would have been for ADEQ Water Division to expand the permit application review process to include the ADEQ Professional Geologist staff in the review process...If ADEQ had given its Geologists an opportunity to review and comment on C&H’s permit application, it is highly unlikely any of the Professional Geologists performing the review would have signed off on or approved the proposed permit for the C&H holding ponds locations without requesting additional geologic data be gathered about the proposed holding pond locations and proposed land application sites.”

The fact that no ADEQ Geology staff were required to review the original C&H application, especially given the sensitive location in karst terrain and in the watershed of the Buffalo National River, reflects a lack of due diligence on the part of ADEQ when reviewing the application. Permit ARG590001 was improperly issued and therefore this permit 5264-W, which relies almost entirely on the previous permit review, should be denied.

Part D - Degradation of Big Creek noted by State and Federal Agencies

Comment D1 - This permit should be denied because Big Creek Research & Extension Team (BCRET) testing of Big Creek immediately downstream of the facility shows degradation for nitrates

Nitrates are being measured by the *Big Creek Research and Extension Team* (BCRET) of the *University of Arkansas Division of Agriculture* both upstream and downstream of the facility and nearby spreading fields Figure 1.

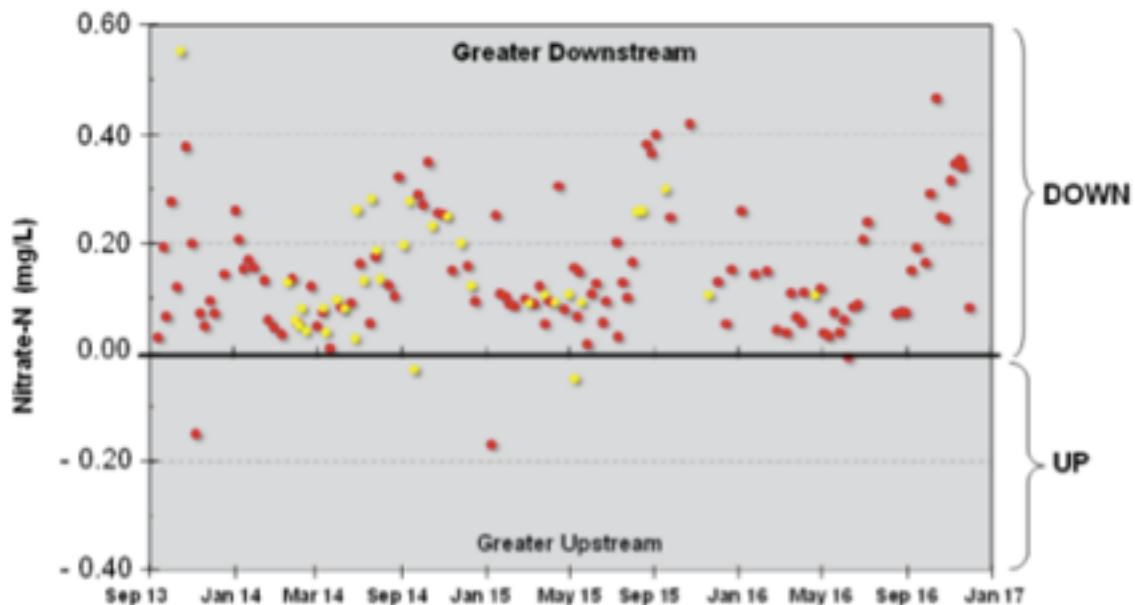


Figure 1. Difference in $\text{NO}_3^- \text{N}$ concentration in Big Creek up- and downstream from the C&H CAFO. Following the “upstream vs. downstream” comparative criterion that is the basis of the BCRET study, the data clearly indicate that the C&H CAFO is contaminating Big Creek with nitrate. From BCRET (2017a; note that explanation was not given for the yellow versus red color-coding).

Regarding this data illustration, Burkholder (2017) states:

“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).”

Reg. 2.202 on anti-degradation of high quality waters reads as follows:

“Where the quality of the waters exceeds levels necessary to support propagation of fish, shellfish and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the State finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the State of Arkansas’ Continuing Planning Process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located.”

There has been no such finding of economic or social development “accommodation” published by ADEQ or APC&EC. The statute does not specify a minimum level of acceptable *degradation*, so technically the above data which reports a periodic and consistent finding of increased nitrates downstream of the facility indicates a violation of the statute. See also Mott, 2016 regarding further interpretation of BCRET data showing elevated nitrates. Burkholder (2017) goes on to say:

“Nitrate concentrations at the downstream site have been consistently higher than at the upstream 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 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”

As elevated nitrates are very likely due in whole or in part to discharge from C & H, this permit should be denied.

Comment D2 - This permit should be denied because Big Creek Research & Extension Team (BCRET) testing of Big Creek immediately downstream of the facility shows degradation for *E.coli*

In a report prepared for BRWA titled, *"Assessment of Environmental Data and Draft Regulatory Changes Regarding the C&H CAFO, Including the Present Draft Permit, JoAnn M. Burkholder, Ph.D., 27 March 2017"* Dr. Burkholder, an expert in water pollution assessment and water quality monitoring and research in freshwaters and estuaries with 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, states:

"...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. "

Elevated *E.coli* introduces a health risk into a tributary that is intermingled and homogenous with an extraordinary resource water (ERW). In the interest of public health and safety, this permit should be denied.

Comment D3 - This permit should be denied because the National Park Service has notified ADEQ of Big Creek Impairment

In a letter dated October 6, 2015, Kevin Cheri, Superintendent for the National Park Service (NPS) to Director Keogh of ADEQ noted the following (excerpt):

"NPS has also been monitoring the United States Geological Survey (USGS) sites collecting dissolved oxygen data on tributaries to the Buffalo River. Two of these sites have chronically been below the allowable limits in Regulation 2.505. These are Bear Creek near Silver Hill (USGS Site 07056515) (ADEQ site- BUFT12) (Figure 2) and Big Creek at Carver (USGS Site 07055814) (ADEQ site- BUFT06) (Figure 3).

These streams have had minimum dissolved oxygen values of 3.9 and 4.5 mg/L, respectively, well below the standards.”

“As dissolved oxygen is very important for aquatic life, particularly for species such as freshwater mussels, and such species are part of the suite of scenic and scientific resources Congress expected to be conserved when the Buffalo National River was established, NPS needs the assistance of ADEQ in determining the sources of low dissolved oxygen and reducing or eliminating these sources. We feel that both of these streams should be placed on the "Impaired Waterbodies" list pursuant to Section 303(d) of the Clean Water Act.”

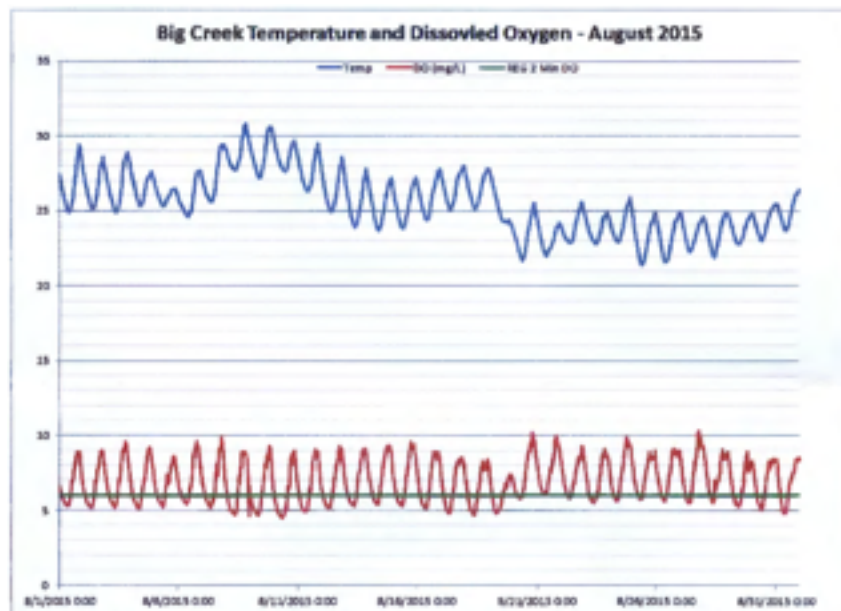


Figure 3: Dissolved Oxygen data for Big Creek (BUFT06) during August of 2015. (Source USGS)

In a letter dated February 25, 2016, Kevin Cheri, Superintendent for the National Park Service (NPS) to Director Keogh of ADEQ noted the following (excerpt):

“On October 6, 2015 I sent a letter (Attachment 2) to Arkansas Department of Environmental Quality (ADEQ) asking that you consider placing three tributaries of the Buffalo River on the Impaired Waterbodies List pursuant to Section 303(d) of the Clean Water Act. To date, I have not received any formal correspondence relative to my request. My staff has reviewed the draft 303(d) streams list published on your website (ADEQ,2016) and see that these three streams are not in the draft list. I would like to receive documentation explaining why these streams were not listed in the draft 303(d) list.”

The above two letters focus on low dissolved oxygen levels as the justification for an impairment listing. An additional letter was sent on March 16, 2016 to director Keogh where there is a concern expressed in regard to *E. coli* (excerpt):

“Assuming that Big Creek is not part of an Extraordinary Resource Water, Ecologically Sensitive Waterbody, or Natural and Scenic Waterway (ERW, ESW, or NSW) the upper E. coli limit is 410 colonies per 100 ml (410 col/100ml). Data from BCRET (Big Creek Research & Extension Team), during the primary contact period in 2014, shows E. coli exceeded 410 col/100ml in six of twenty-two samples for a 27% exceedance. According to Regulation 2.507, for assessment of ambient waters as impaired by bacteria, the E. coli standard shall not be exceeded in more than 25% of samples in no less than eight samples taken during the primary contact season.”

The full March letter can be found in Appendix D3. In summary, NPS has pointed out impairment evidence in regard to both low dissolved oxygen as well as elevated E. coli.

Since the submission of the above letters, the National Park Service has commissioned a report, *"Permitted Concentrated Animal Feeding Operation Assessment Buffalo National River, Arkansas"* by David N. Mott November 2016. This report includes extensive discussion of impairment of Big Creek, and potentially the Buffalo National River, due to elevated nutrients and bacteria in Big Creek.

Considering that Big Creek waters are contiguous and intermingled with waters of a designated ERW, the high level of ecological and economic risk as discussed in Part A justifies a delay of a requested Reg 5 permit until the degradation issues in regard to Big Creek are fully resolved. Full compliance with Reg. 2.202 on anti-degradation of high quality waters should be enforced. If it is determined that C & H contributes in whole or in part to the impaired status of Big Creek, the permit should be denied.

Comment D4 - This permit should be denied because the Arkansas Game and Fish Commission concurs with National Park Service recommendation of Big Creek impairment

Chris Racey, Chief - Fisheries Division, Arkansas Game and Fish Commission wrote to Jim Wise of ADEQ on March 16, 2016 (excerpt):

“AGFC Biologists are also concerned with the Dissolved Oxygen levels of Big Creek, a Buffalo River tributary in Newton County near Gene Rush Wildlife Management Area. Summer algal blooms, likely caused by excess nutrient levels,

appear to be impairing this creek. Smallmouth bass require 6.0 mg/L DO for optimal growth, and this water quality standard is not being met for several months of the year, per the USGS gage station at Big Creek. We concur with the recommendations of the National Parks Service that Big Creek should be considered for the list of 303(d) streams.”

Comment D5 - This permit should be denied because the U.S. Geological Survey study indicates impairment of Big Creek

On December 15th, an *Assessment Methodology* session was sponsored by ADEQ at their N Little Rock headquarters to review with selected stakeholders the process for producing the 303(d) list. During this meeting, Billy Justus and Lucas Driver of the *U.S. Geological Survey (USGS) Lower Mississippi-Gulf Water Science Center* presented a slide presentation entitled: *An Evaluation of Continuous Monitoring Data for Assessing Dissolved-Oxygen in the Boston Mountains*. Big Creek was one of five waterbodies reviewed in the presentation. Notable was the slide listed in Appendix D5 showing dissolved oxygen at 20.5% of unit values below 6mg/L. The exceedance level over which impairment is indicated is 10% at 20 degrees centigrade. These USGS statistics show a clear indication of impairment.

Considering that Big Creek waters correspond to waters of a designated ERW, the high level of ecologic and economic risk as discussed in Part A justifies a delay of a requested Reg 5 permit until the impairment issues on Big Creek are fully resolved. Reg. 2.202 on anti-degradation of high quality waters must be given precedence over this permit. If it is determined that C & H contributes in whole or in part to the impaired status of Big Creek, the permit should be denied.

Part E - Miscellaneous Concerns

Comment E1 - This permit should be denied because synthetic flexible membranes for ponds can no longer be safely installed and they present a special set of risks for the circumstances of this particular permit

On June 5th, 2014, ADEQ approved a modification to permit the retrofit of a synthetic membrane liner which the operation owners hoped would assuage public concerns. That modification for a retrofit, yet to be implemented, carries a unique set of risks. They are as follows:

1. Once the liquid is removed, fecal sludge must also be removed from the pond floors before liners can be installed. Sludge removal will inevitably disturb the existing clay liners and likely the underlying soil and groundwater increasing the possibility of subsurface contamination.
2. When the liners are installed over the clay which contains embedded residual organic waste, decomposition can produce methane and other gasses. This gas accumulation beneath the liner can cause it to displace and float to the surface. This can result in rupture, seam failure, or leakage.
3. Seam failure, punctures, and mechanical damage have caused liners to fail and leak. Once liners are in place there is no way to tell if they have been compromised and leaks could occur for years without detection.
4. Retrofitting liners over actively used ponds is an entirely different and more complex challenge than installing them in a newly constructed pond. This has never been attempted in the state of Arkansas and it is likely there are few qualified personnel that could ensure a successful result. Tom Aley, a licensed Arkansas geologist and karst expert states that: "inadequate preparation of the ponds for liners will compromise the leakage integrity of the synthetic liners even if they are well installed".
5. There is evidence of epikarst close to the ponds above the pond inverts, and fractures and/or voids with evidence of perched groundwater within a depth of five ft of the inverts.

The points illustrate clear technical differences between installing a liner on a freshly constructed impoundment, as opposed to a retrofit which has never been done in the state of Arkansas. The *Technical Field Guide for Arkansas* as identified in Reg 5.402 identifies under the *USDA-Natural Resources Conservation Service, Practice 521A - Pond Sealing or Lining, Flexible Membrane* identifies the estimated costs and needed skills for installing a synthetic membrane, but the standardized nature of these estimates imply that

they are applicable to newly constructed pits. Retrofitting a synthetic membrane over fecal saturated clay liners presents an entirely different set of technical challenges not to mention additional costs. There are no known installers in Arkansas that have performed this uncommon operation, and there is no identified best practice in the *Technical Field Guide for Arkansas* references for performing this kind of retrofit.

The approved pond liner retrofit is of notable concern as it is possible that ADEQ will view this as a solution to the comments in Part C regarding geological issues, and also Part D regarding degradation. Unfortunately, not only does a synthetic liner at this stage present unique risks, it would not satisfy the very serious vulnerabilities identified by comments: C10, C11, C12, and C13. It has been *subsequent* to the pond liner modification approval that indications of subsurface karst, epikarst, voids, fractures, and perched groundwater have been revealed by Dr. Halihan's ERI transects and validated by the Harbor Environmental drilling exercise. These risks were unknown at the time ADEQ approved the synthetic liner permit modification in June of 2014. When the circumstances of each of these four comments (C10 thru 13) are applied to the AWMFH Appendix 10D *vulnerability to risk matrix* (Appendix C10 of this document) the vulnerability is identified as "**very high**" and the recommendation is: -"**Evaluate other storage alternatives**". The 10D *vulnerability to risk matrix* is not suggesting mitigation of the impoundment, but that it never should have been constructed at that location based on the risk factors present.

The take-away is that ADEQ's approved synthetic liner modification is now outdated because of what has come to light in recent studies. The approval of the pond liner modification should be rescinded.

If this was a new facility in a different location, BRWA would contend that synthetic membranes should be a required term of the permit, not merely an allowed modification. However, given what is now known about the location, a synthetic membrane will not address the risk factors identified, not to mention that the technology presents its own unique risks in regard to the challenges of a retrofit. Synthetic liners are not appropriate at this stage when considering the risk in Part A. For this reason alone, the permit should be denied.

Comment E2 - This permit should be denied because karst as a predominant and well known geological risk factor in the Springfield Plateau and topographic vicinity of the facility and its spreading fields, is not recognized or investigated adequately in either the prior or current permit application

The AWMFH devotes the entirety of Chapter 7 to guidance around “*Geologic and Groundwater Considerations*”. AWMFH 651.0702 *Engineering Geology Considerations in Planning* states the following under Part (I) Topography:

“Karst topography is formed on limestone, gypsum, or similar rocks by dissolution and is characterized by sinkholes, caves, and underground drainage. Common problems associated with karst terrain include highly permeable foundations and the associated potential for groundwater contamination, and sinkholes can open up with collapsing ground. As such, its recognition is important in determining potential siting problems.”

The original Environmental Assessment (EA) with a finding of no significant impact submitted by the Farm Services Agency (United States Department of Agriculture) on Sept 26th 2012, does not discuss any topographic concerns. The words “karst” and “groundwater” are conspicuously absent. Neither does the original permit or the new permit application mention karst as a risk factor. The original EA of 2012 was challenged as insufficient and a court order was filed 12/2/2014 by U.S. District Judge D.P. Marshall finding that Farm Services Agency (FSA) and Small Business Administration (SBA) violated the provisions of the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA) and that they “arbitrarily and capriciously guaranteed the loans” to C & H Hog Farms. The court required the agencies to re-do their “cursory and flawed” Environmental Assessment.

A new Environmental Assessment was submitted by FSA in August of 2015. The rewritten EA provided responses to concerns regarding the original EA, one of which was that the original EA did not consider karst. The response of the 2015 EA on the subject of karst topography was as follows (excerpt page 22 under “Karst”):

“As stated in Section 3.3 of the EA, the soluble nature of limestones gives rise to karst terrain in the southern Ozarks region. Highly soluble conditions in certain areas of the Buffalo River watershed, distant from the C&H Farms, including the

western and north-central parts of the watershed, have produced pervasive occurrence of karst features, including caves, sinkholes, springs, and sinking streams (Hudson et al. 2001 and Soto 2014). However, the C&H Hog Farms site and vicinity do not exhibit strongly developed karst landforms as demonstrated by a review of the Mt. Judea USGS 7.5 Minute Topographic Quadrangle Map and aerial photograph information. Our topographic and aerial photography review indicates that limited numbers of karst ponds are located on upper reaches of floodplains, where a separation of shallow perched groundwater in alluvial and epikarst (Hudson et al. 2013) from deeper groundwater in the Boone Formation may explain development of sinkhole ponds in overburden, due to dewatered secondary porosity in the underlying bedrock.”

Expert testimony specifically directed to this topographic overview in the 2nd EA was provided on 8/27/2015 by Tom Aley, a professional licensed geologist specializing in karst in Arkansas as well as in the Mt. Judea area (the EA writers were not licensed in AR):

“In karst areas the adjective “Dry” is commonly applied to streams and valleys where the proportion of surface water lost to the groundwater system is exceptionally great. The vicinity of the C&H Hog Farm is characterized by an exceptionally large proportion of the surface water being lost to the groundwater system as illustrated by the following:

- Dry Creek, a stream with a topographic basin of 7.23 square miles, is located along the southern margin of the hog farm operations. Three of the manure disposal fields (Fields 15, 16, and 17) are topographically tributary to Dry Creek.***
- Dry Branch, a stream tributary to the Left Fork of Big Creek at a point 11,600 ft west of Field 5.***
- Dry Branch, a northward flowing stream tributary to Big Creek. The small community of Mt. Judea is on the ridge between Dry Branch (to the east) and Big Creek (to the west) and roughly parallels Big Creek. Dry Branch is within 2200 ft of Field 1 and is 3,500 to 6,100 feet from Fields 5,6,7,9, and 10.***

The hog farm operation is bordered on the west, south, and east by streams named Dry Creek and Dry Branches. The hog farm operation is on the Mt. Judea 7.5 minute topographic quadrangle map. There are few if any other 7.5 minute quadrangle maps in the karst areas of north Arkansas that have three separate streams with the adjective “Dry” in the name. The hog farm is clearly in the middle of a well developed karst area.”

Dr. Todd Halihan of Oklahoma State University who performed an Electrical Resistivity Study (ERI) on three of the facility spreading fields entitled: *Electrical Resistivity Surveys of Applied Hog Manure Sites, Mount Judea, AR (2016)*. Dr. Halihan characterized observations of the three fields in the *Executive Summary* of his report:

Several datasets were collected and the following observations were made from the ERI data:

- ERI provided delineation of boundaries between soil, epikarst, and competent bedrock.**
- The potential for rapid transport pathways in the underlying bedrock as joints or potential karst features were observed as conductive electrical features in a resistive background.**
- Soil depth was measured to range from 0.5 to 3.5 meters (1.5 to 11.5 feet). On Fields 5a**
- and 12, the thickness of soil increases moving toward the stream and thins towards higher elevations. This is consistent with the thickening of the alluvium as it is deposited closest to the stream.**
- The average epikarst thickness is highly variable, ranging from 2.0 to 23.0 meters thick (6.0 to 75.0 feet).**

Tai Hubbard, the on-site geologist monitoring the drilling process for Harbor Environmental, described a specific zone as characteristic of epikarst between the barns and the holding ponds:

“The highly weathered limestone bedrock and unconsolidated clay intervals observed between 13.8 and 28.0 ft.bgs. appeared to have the characteristics of epikarst. With the understanding that epikarst is the weathered zone found at the interface of unconsolidated soils and bedrock, the Site setting would support this characterization.”

Likewise the Harbor Environmental drilling log uses geologic terminology to describe features encountered at increased depths; terms that include: “fractures”, “increased fracturing”, “weathered fractures”, and “bedding planes”, all terms indicative of karst. M.D. Smolen, PH.D. who has 35 years of experience in water quality management as affected by agricultural waste and other aspects of watershed management, had this to say (2017):

“Recent electrical resistance study by Halihan and Fields suggested, and follow-up drilling by Harbor Environmental confirmed, that the ponds and the application fields are all underlain by Boone Formation limestone. This limestone, clay, and chert geology is noted for fractures and karstic groundwater features. Although leakage from the ponds has not been confirmed to date, any seepage or direct leakage from the ponds would be transmitted to groundwater and ultimately to the Buffalo River. The fact that Harbor Environmental did not confirm any ground water contamination is not conclusive because they only drilled one hole.”

David Mott in a 2016 report for the National Park Service states:

"The waste storage ponds and land application sites are predominantly underlain by the Boone Formation; therefore, karst geohydrology".

Further, a report titled "Surface-Water Quality In The Buffalo National River, 1985-2011" by the Watershed Conservation Resource Center, 2017 states:

"The Ordovician through Mississippian rocks [which characterizes the Buffalo River watershed geology] host a complex karst terrain where losing streams, sinkholes, springs, and caves dominate much of the landscape. Most of these rocks are carbonates, either limestone or dolomite. They are particularly susceptible to dissolution. These rocks are highly permeable to the movement of groundwater. Subsurface flow directions and rates of groundwater flow are difficult to predict and may rapidly change based upon the hydrologic events."

Dr. Van Brahana produced a peer reviewed report (in press 2017) entitled: *"Utilizing 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"*. Dr. Brahana's dye tracing results can be observed topographically in Appendix E2. In this appendix illustration the swine facility and many of the primary spreading fields lie directly in the path between the dye introduction point and the corresponding dye detection points. Dr. Brahana's conclusions were as follows:

Based on the results of the dye tracing described herein, the following observations of groundwater flow in the Boone Formation in the Big Creek study area can be used for designing a more reliable and relevant water-quality sampling network to assess the impact of the CAFO on the karst groundwater and to gain further understanding of the karst flow.

- 1. Although the study area is mantled karst, subsurface flow is very important, and forms a significant part of the hydrologic budget.***
- 2. Groundwater velocities in the chert/limestone portion of the middle Boone Formation were conservatively measured to be in the range of 600-800 m/d.***
- 3. Conduits in pure-phase limestones of the upper and lower Boone have flow velocities that can exceed 5000 m/d.***
- 4. Groundwater flow in the Boone Formation is not limited to the same surface drainage basin, which means that anomalously large springs should be part of the sampling network (Brahana, 1997).***
- 5. Because the Buffalo National River is the main drain from the study area, and the intensive contact of the river water by uses such as canoeing, fishing, swimming, and related activities, large springs and high- yield wells should be included in the sampling network.***
- 6. Maximum potential transport times of CAFO wastes from the land surface appear to be greatest during and shortly after intense precipitation events. Minimum groundwater flow occurs during droughts. Sampling should accommodate these considerations.***

The history of both the old and new permit applications and the corresponding EA (both old and new) appear to have avoided the discussion of karst as a risk factor and have only acknowledged it vaguely when forced to respond directly, despite the fact that the AWMFH devotes extensive guidance on its recognition as it pertains to risk factors and design considerations. This failure to acknowledge even the possibility of the presence of karst suggests a low level of investigative due diligence that is not proportional to the high cost of potential consequences discussed in Part A.

Comment E3 - This permit should be denied because ADEQ failed to comply with specific standards as defined in Regulation 2.505 in the issuance of the original NPDES permit, demonstrating a lack of oversight that is not proportional to risk

Under the Clean Water Act (U.S.C 33 Section 1362 (14)), CAFOs are defined as point sources. The original C & H permit# ARG590001 was a Regulation 6 NPDES permit under which CAFOs are considered a point source discharge. As a result, Regulation 2.505 applies for determining effluent discharge limits. The applicable part of the regulation reads as follows:

For purposes of determining effluent discharge limits, the following conditions shall apply:

(A) The primary season dissolved oxygen standard is to be met at a water temperature of 22°C (71.5°F) and at the minimum stream flow for that season. At water temperatures of 10°C (50°F), the dissolved oxygen standard is 6.5 mg/L.

(B) During March, April and May, when background stream flows are 15 cfs or higher, the dissolved oxygen standard is 6.5 mg/L in all areas except the Delta Ecoregion, where the primary season dissolved oxygen standard will remain at 5 mg/L.

(C) The critical season dissolved oxygen standard is to be met at maximum allowable water temperatures and at Q7-10 flows. However, when water temperatures exceed 22°C (71.6°F), a 1 mg/L diurnal depression will be allowed below the applicable critical standard for no more than 8 hours during any 24-hour period.

ADEQ in a stakeholder discussion regarding the Assessment Methodology which covers the same standards (as above), indicated that this is a standard

methodology to be employed *prior to approving a permit on streams that have a point source discharge*. As this would have been a step required of ADEQ prior to approving the original permit ARG590001, data or evidence of a model run on Big Creek (Newton Co) using these effluent standards has been repeatedly requested. ADEQ has been unresponsive.

The Regulation 5 permit that is presently being applied for is a “no discharge” permit, so Regulation 2.505 is no longer applicable. What is notable is that ADEQ has not consistently followed Arkansas laws and regulations in regard to permitting this facility. As noted in comment A1 regarding risk, ADEQ has a critical role to play to ensure that special circumstances with significant consequences are engineered appropriately. When ADEQ demonstrates a disregard for the regulations in the permitting process, their ability to act in a role of independent oversight must be examined, particularly considering the risk factors as outlined in Part A.

Comment E4 - This permit should be denied because an increase in the permitted number of swine at the facility violates the moratorium as defined in Regulation 5.901(D)

Reg 5.901(D) states, “*A permit renewal, permit modification, or new permit issued pursuant to Reg. 5.901(C) shall not increase the number of swine permitted at a facility.*” The current C&H NPDES permit allows for 2,500 sows and 4,000 pigs. The new draft permit includes 2,672 sows, an approximately 7% increase in gestating and lactating sows. But the number of pigs has been reduced from 4,000 to only 750, based on the estimated average present at any time. However, annual production is more meaningful and common sense indicates that an increase in the number of sows will result in an increase in the number of pigs (in this case 78,000 per year) and consequently the amount of waste produced annually. According to “The National Hog Farmer”, <http://www.nationalhogfarmer.com> a gestating sow on average will have 2.6 litters per year and produce 29.1 piglets per sow per year surviving through weaning. Weaning takes up to 24 days, producing a weight of around 14 pounds. Using these numbers, the average number of piglets on the farm at any one time would be 4,309 and the total number of swine would be 6,987. This is calculated as follows:

6 boars @ 450 lbs = 2,700 lbs

2,252 gestating sows @ 425 lbs = 957,100 lbs
420 lactating sows @ 400 lbs = 168,000 lbs
4,309 nursery pigs @ 14 lbs = 60,326 lbs

Total = 1,188,126 lbs

This represents an increase from the original authorized number by 7.4%. Relative to weight of pigs this represents an increase of 18.9%. By volume of manure produced this is an increase of 17.4%. This increase violates both the spirit and the letter of the moratorium as described in Reg 5.901(D) and this permit should be denied.

Comment E5 - This Regulation 5 permit should be denied because Regulation 6 is the applicable regulation for the C&H Permit Application

C&H has applied to ADEQ for a permit under Regulation 5, claiming to be a no-discharge facility. Any discharge from the facility is prohibited under the proposed permit. In fact, C&H is a discharger of hog wastes and is a “point source” under the Federal Clean Water Act regulations. Consequently, a Regulation 6 NPDES permit is the appropriate regulation for evaluating C&H’s application.

C&H commenced operations in 2012 under NPDES permit No. ARG590001. C&H has applied for and received a draft permit pursuant to APCEC Regulation 5. In the Statement of Basis, ADEQ uses the terms “no-discharge facility” and “no-discharge permit” repeatedly. (See, e.g. Second sentence in Statement of Basis -- “This draft permit decision is for the issuance of a **no- discharge facility** under draft permit number 5264-W and AFIN 51-00164.” Paragraph 3 of the Statement of Basis -- “The permittee submitted a permit issuance application for a **no-discharge permit** . . .” “It is proposed that the water **no-discharge permit** be issued.” Paragraph 12 – “The [ADEQ] has made the determination to issue a draft permit for the **no-discharge facility** described in the application and NMP.”)

Moreover, the draft permit plainly states, “Waste shall not be discharged from this operation to Waters of the State or onto land in any manner that may result in . . . runoff to Waters of the State.” See Part II, Specific Condition 2. The permit goes on to define Waters of the State:

‘Waters of the State’ means all streams, lake, marshes, ponds, watercourses,

waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, public or private, which are contained within, flow through, or border this state or any portion of the state as defined by the Act. See, Part IV, *Definitions*.

C&H's Nutrient Management Plan (NMP) submitted with its permit application however, makes it clear that it contemplates discharges to Waters of the State:

Purpose of Plan – The goal of nutrient management is to effectively and efficiently use the nutrient resources to adequately supply soils and plants with the proper amount of nutrients to produce food, forage, fiber, and cover while minimizing transport of nutrients to ground and surface water and environmental degradation. (emphasis added).

C&H concedes in its NMP that there will be “transport of nutrients to ground and surface water” and that its “goal” is to “minimize” these discharges. The NMP is incorporated into and made a part of the permit. See, Part II, Specific Conditions, para. 2. ADEQ fails to explain how it can issue a no-discharge permit to a no-discharge facility prohibiting the discharge of waste to Waters of the State when both the permit application and facility design contemplate discharges of wastes to Waters of the State. Moreover, the BCRET work actually documents discharges. BCRET set up a flume to measure flow from waste fields and sample discharges. The results of sampling from this discharge point reflect the presence of nutrients and bacteria.



The waste holding ponds were designed and constructed to permit waste leakage to Waters of the State. The final design documents estimate leakage rates of 1,090 gallons per acre per day for Pond 1 and 1,334 gallons per acre per day for Pond No. 2. Pond 2 is also designed to permit a discharge in the event of a large (25 year 24 hour) precipitation event (“the storm volume is only encroached during a 25 year 24 hour storm event.”). C&H NMP at p. 14. The recent “Drilling Report” concludes that the waste ponds sit atop karst features. Karst features provide a mechanism for rapid transport of wastes that leak from the ponds to ground and surface waters.

Water quality monitoring downstream of the facility indicates an increase in nutrient concentrations as well as e coli bacteria. There is evidence that shows it is more probable than not that a portion of these contaminants are from waste

generated at C&H. The contribution of nutrients and harmful bacteria from C&H causes or contributes to degradation of water quality in Big Creek and the Buffalo National River.

Because the facility is causing or contributing to the degradation of water quality in both Big Creek and the Buffalo River, it is violating state and federal anti-degradation provisions. See, APCEC Reg. 2, Chapter 2, the Clean Water Act § 303 (33 U.S.C. § 1313) and 40 CFR § 131.12.

The prohibition both in Regulation No. 5 and the draft permit against discharging wastes to Waters of the State will be violated if this permit is granted. That the facility is discharging wastes to Waters of the State is plain both from the permit application and accepted scientific work, including work done by BCRET. Furthermore, it cannot be disputed that waste discharges to Waters of the State will continue to occur unless the permit is denied.

Because the facility will result in discharges of waste to Waters of the State, and because this CAFO meets the definition of a point source under the Clean Water Act § 502(14) (33 U.S.C. § 1362(14)) a no-discharge permit per Regulation 5 is improper. Because the facility is causing or contributing to water quality degradation in the Buffalo National River, a state ERW, federal ONRW and Tier 3 waterbody, any permit that would result in or allow a discharge that causes or contributes to a degradation in water quality is improper.

Notwithstanding that C&H has no known surface discharge of wastes from the waste holding ponds at the present time, there is a general scientific consensus that one or both of the two waste holding ponds are discharging liquids through the pond liners. In fact, it is generally agreed that the ponds are expected to discharge up to 5,000 gallons/day/acre. Furthermore, some of the fields that are used for land application of hog wastes are in the floodplain of Big Creek or its tributaries, and there are indications that wastes have entered Big Creek from those fields.

Without question, those liquids are “sewage”, “biological materials”, and “agricultural wastes” within the definition of “pollutants under 28 U.S.C.A. §1362(6). In addition, a confined animal feeding operation (CAFO) (including all of its component parts) such as C&H is consider a “point source” under 40 C.F.R. §122.23. There is evidence from sampling conducted in the area of the Big Creek tributary to the Buffalo River that a discharge is occurring from C&H or its land application fields due to the presence of elevated levels of components of hog wastes.

Dr. JoAnn Burkholder, an expert in water pollution assessment and water quality monitoring, states,

"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)." (Burkholder, 2017)

Dr Burkholder concludes, referring to her following report,

"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)." (Burkholder, 2017)

The permit application review under Regulation 5 is improper and it should have been reviewed under Regulation 6 of the Commission.

Comment E6 - The Harbor Environmental study does not provide scientific support for this permit and in fact yields evidence that it should be denied

Harbor Environmental drilled a single bore hole to a depth of 120 ft as a result of an electronic resistivity study (ERI) performed by Dr. Todd Halihan of Oklahoma State University in 2015. The transects that resulted from the Halihan study (Appendix C11) suggest conductive zones consistent with high moisture content. The concern that prompted the Harbor drilling exercise was possible leakage and/or fractures near the ponds. The Harbor Drilling Study work plan described the following as its "goals":

- ***Evaluate the lithology/geology below the waste storage ponds; and***
- ***Assess potential subsurface impact from the waste storage ponds.***

It is possible that ADEQ may consider the Harbor Environmental study as supportive of the applied regulation 5 permit. To that end, the BRWA expresses the following concerns (A, B, & C):

A) The Harbor Study was scientifically limited

These are some, but not all of the concerns with how the study was conducted from a scientific standpoint:

1. Several experts suggested that at least three holes be drilled in order to arrive at a supportable conclusion regarding subsurface conditions. Dr. Tai Hubbard the on site geologist stated the limitation as follows: *“Evaluation of lithologic contacts and bed orientations are limited, both horizontally and vertically, due to the inability to correlate observations collected at a single location to any other bore holes.”*
2. The drilling method damaged the rock core extracts, inhibiting the ability to examine fracturing that would have shed light on subsurface karst formations. Dr. Tai Hubbard the on site geologist stated a similar concern as follows: *“The drilling method employed during this investigation consisted of a rotosonic drill rig without a high speed rotation implement used for typical rock coring. This limitation resulted in poor rock core quality, preventing the calculation of Rock Quality Determination (RQD) as proposed.”*
3. The rotosonic drilling process used a 6” turning pipe with water pumped into the pipe and exiting around the sides. The water pumped in served to a degree as a lubricant and it was recaptured and stored in barrels as part of the process. A noticeable volume of water was lost at about 25’ indicating open subterranean space near the ponds, which suggests a significant risk factor (see Comment C12). The volume of water lost (pumped vs recaptured) was critical information for determining the total cubic footage of a confirmed subterranean void that Harbor did not provide.
4. Chlorinated municipal drinking water was pumped in during the drilling process. Chlorine and other chemicals are used specifically to eliminate *E. coli* and other contaminants. As *E. coli* was one of the elements being examined, chlorinated water could have significantly influenced the results. There were two other drilled wells located on the site which could have been accessed to provide untreated water for the drilling process.
5. When Harbor Environmental provided an initial report on Dec 1st, 2016 the presentation was attended by the public, geologists, hydrologists, and others who had a professional interest in reviewing the results.

No interactive questions were accepted. Interactive questioning which is considered part of the normal scientific protocol in vetting technical studies was not permitted by Harbor or ADEQ. All questions were directed to be submitted in writing with answers to be returned in summary form.

B) The Study does not serve as a means to satisfy Reg. 5.404

Regulation 5.404 *Subsurface Investigation Requirements* reads as follows:

“The subsurface investigation for earthen holding ponds and treatment lagoons suitability and liner requirements may consist of auger holes, dozer pits, or backhoe pits that should extend to at least (2) feet below the planned bottom of the excavation.”

Likewise, Reg. 5.402 *Design Requirements* states the following:

Designs and waste management plans shall be in accordance with this Chapter and the following United States Dept of Agriculture Natural Resources Conservation Service Technical Publications:

- (1) Field Office Technical Guide, as amended***
- (2) Agricultural Waste Management Field Handbook (AWMFH), as amended***

Review of the AWMFH identifies the following shortfalls in the subsurface investigation which the Harbor Environmental drill study will not satisfy:

1. Comment C2 - Facility plans do not investigate groundwater flow direction as suggested by AWMFH.
2. Comment C6 - Pond subsurface investigation does not conform to AWMFH guidance. *“For structures with a pool area, use at least five test holes or pits or one per 10,000 square ft of pool area, whichever is greater”.*
3. Comment C7 - Berm subsurface investigation was not performed as per AWMFH guidance. *“for foundations of earth fill structures, use at least four test borings or pits on the proposed embankment centerline, or one every 100 ft.”*
4. Comment C3 - Permeability analysis for liner material does not include particle analysis as per AWMFH guidance.
5. Comment C4 - Laboratory compaction analysis to determine hydraulic conductivity uses only one sample.

6. Comment C5 - Type IV soils to be used for the liner, suggest special considerations in the AWMFH that were not addressed

C) Risk factors identified by the study support permit denial

The Harbor Environmental single drill hole study in conjunction with the Oklahoma State University ERI study by Dr. Todd Halihan's team have turned up geological anomalies since the date in which first Regulation 6 permit was granted. These anomalies suggest that the Regulation 5 permit should now be denied.

1. Comment C11 - ADEQ single bore hole investigation provides information that confirms the facility is located over geologic karst
2. Comment C12 - Containment ponds are located on a geologic foundation near voids and/or fractures
3. Comment C13 - Evidence of perched groundwater close to pond inverts.

Comment E7 - This permit should be denied because it does not include An Expiration Date

The proposed Permit does not contain an expiration date. Under Regulation 6, the permit would be required to have a fixed term not to exceed five years. While Regulation 5 does not have a stated time for the effective life of a permit issued under that Regulation, there is nothing in Regulation 5 that would prohibit ADEQ and the Commission from including an expiration date in the permit even if ADEQ persists in using Regulation 5 as its authority.

There are numerous sound policy reasons for requiring a termination date, requiring the permittee to apply for the renewal of the permit. The fact that the permit will be subject to renewal in a stated period of years would be a motivating factor for the permittee to strictly adhere to the terms and conditions of the permit, and to address problems on their own volition. In addition, requiring periodic renewal gives ADEQ and the public an opportunity to review the operations of C&H and for the public to be heard on the quality of those operations and their effect on the environment. Also, periodic renewal allows for the consideration and use of new technology to remedy or prevent problems that may be affecting the public and the environment. These are among the reasons why NPDES permits are subject to periodic renewal.

Smolen (2017) notes risk of STP buildup:

“...under Regulation 5 soil testing is only required once in five years, but STP it is likely to increase drastically in that time.”

Considering the potential for serious environmental harm from swine CAFO operations, a Reg 5 permit limited to an effective period of three (3) years should be required for such facilities.

Comment E8 - The permit should be denied because criteria for location of a CAFO in karst geology are not adequately developed or implemented

The standards that are being applied to the location of the C&H facility are the same as those that would be applied to any location in Arkansas. The standard ignores the fact that the C&H facility is located in a karst geology, which greatly exacerbates the potential for migration of any contaminants that are or may be released from the facility, and the difficulty of containing or even locating any such contaminants, once released.

The AWMFH provides the entirety of Chapter 7 as guidance to the engineer regarding karst and groundwater as a risk factor, and yet the engineering documents do not acknowledge or allude to fast moving ground water as a concern, though the circumstances identified in Chapter 7 regarding karst geology were certainly present.

ADEQ did not conduct or require *an enhanced geological and hydrological assessment of the facility site*. It is important to know the nature and extent of the geology; the degree to which the underlying rock formations have been fractured; the potential routes of migration of contamination in the event of a release; the environmentally-sensitive areas that might be affected from a surface or sub-surface release due to groundwater flow direction; and other related facts. ADEQ has the legal authority and the mandate to require additional conditions or investigations where special risk factors are present, yet they chose not to do so for this permit application in the sensitive geologic watershed of a national river.

The fact that private and public institutions have *both failed* to recognize the need for a higher standard of investigation in a karstic rapid groundwater environment

indicates that there is a need for a *legal delineation of standards designed specifically for permits that are proposed for geologic karst locations*. This delineation is particularly important in the state of Arkansas as a large portion of the state is underlain by karst geology. Simply put, karst geology and hydrology present an entirely different set of risks than south Arkansas Mississippi bottom land soils.

This permit should be denied as the current standards are inadequate in that they do not take karst into consideration.

Comment E9 - This permit should be denied as experts agree that Big Creek is a “losing stream” in that it loses significant water volume into groundwater

David Mott, an engineering geologist, former hydrologist with NPS, former regional hydrologist with the U.S. Forest Service, and having held various leadership positions with the USGS, produced a report entitled *“Permitted Concentrated Animal Feeding Operation Assessment, Buffalo National River, Arkansas”* dated: November 2016. In the report’s Executive Summary Mott mentions the following data sources:

“Water quality and stream discharge information were analyzed from the in-park monitoring station on Big Creek at Carver, located 4-miles downstream from the BCRET sampling site below the CAFO and 1/2 mile above the confluence with the Buffalo River. These data came from BNR, USGS, and special studies being conducted by the University of Arkansas Geosciences Department and Ouachita Baptist University.”

Among other results listed, Mott points out that the data show that Big Creek is a “losing stream” (page 11):

“Discharge data from the USGS gaging stations at Big Creek near Mt. Judea and Big Creek at Carver revealed the intervening reach is a losing stream segment. It is likely that water entering the subsurface karst conduits in this losing reach of Big Creek resurfaces in the Buffalo River channel in a previously identified gaining reach below the confluence of Big Creek and the Buffalo River.”

A “losing stream” is one that loses significant water volume into groundwater as it flows downstream. Mott, 2016 states:

“...the discharge at Big Creek at Carver was sometimes less than the discharge at the upstream USGS gage, Big Creek near Mt. Judea, AR...In 2003 USGS staff conducted a flow gain and loss study and water quality sampling run along the length of the Buffalo River, including measuring flow and water quality at tributaries (Moix and Galloway, 2004). When examining flow patterns in the Buffalo River below Carver, USGS found discharge increased by 35 percent (7 cubic feet per second) in a 3-mile reach (Figure 34). Conductance also increased in this reach, and water temperature decreased, indicating ground water was discharging directly to the main channel of the Buffalo River. One possible source of this ground water recharge is the losing reach of Big Creek located between the two USGS gaging stations. This implies water with high nitrate concentration as observed at the BCRET sampling site downstream of the NMW could be entering the karst bedrock of either the Ordovician aged Fernvale/Plattin Limestone, or the Everton Formation, or both (Braden and Ausbrooks , 2003). Once in the subsurface drainage network, the water could travel through conduits and discharge directly to the Buffalo River main stem, bypassing the Big Creek at Carver sampling site.”

Losing streams are sources of groundwater recharge and are characteristic of karst environments. See comments E2, C2, C11, C12 regarding karst. Also refer to Comment C1 regarding critical recharge areas. AWMFH 651.0703 *Factors affecting groundwater quality considered in planning* page 7-15 describes a number of engineering considerations for siting and planning a facility. Under this on page 7-18(i) is *Proximity to designated aquifers, recharge areas, and well head protection areas* in which the following is stated:

State water management and assessment reports and the following maps should be reviewed to ascertain the proximity of sensitive groundwater areas:

- sole source or other types of aquifers whose uses have been designated by the State***
- important recharge areas***
- Wellhead protection areas***

Waters lost from “losing streams” often re-enter surface flows via springs and can also affect residential wells and water sources which are common in this rural area. The fact that Big Creek is a “losing stream” corroborates the overwhelming evidence of karst and the presence of rapid groundwater flows. The presence of numerous springs throughout the area confirms this characterization. Chapter 7 of the AWMFH does not require a review for sensitive ground waters, but the circumstances for which these suggestions are provided are clearly present. That this “losing stream” is not considered in the permit demonstrates a lack of investigative due diligence that is not proportional to the significant risk factors described in Part A.

Comment E10 - ADEQ should deny C&H a permit because the conditions put in place by ADEQ in the 1992 moratorium have not been met

ADEQ imposed a moratorium for Regulation No. 5 permits in the Buffalo River watershed in 1992 (see Mott 2016, Appendix A). This moratorium specifically mandated the completion of site specific studies, and the use of those studies to inform regulatory changes to protect the watershed prior to the moratorium being lifted. C&H was designed and is managed in a similar manner to the previous swine CAFOs studied by ADEQ from 1994 – 2002, but the operation functions on a much larger scale. Not only did ADEQ fail to complete the requirements of the previous moratorium, the agency never provided public notice that the 1992 moratorium was to be lifted. ADEQ did not disclose the modifications and corrections it made, if any, based on the results of its own studies and investigations. Because lifting this moratorium would have been a major environmental decision with potential to impact the Buffalo National River, and the outstanding national resource designation by the State of Arkansas, public notice and analysis of this decision was warranted.

By not announcing that it was lifting the moratorium, ADEQ effectively circumvented public participation in protecting and maintaining the water quality of the Buffalo National River. ADEQ should deny this permit because it has yet to fulfill the mandates of the moratorium. ADEQ has not yet gone through the public notice and public comment process, nor has the agency explained to concerned citizens of the state of Arkansas how it addressed the requirements of the moratorium. The goal of this effort as stated in the moratorium was to adjust the regulatory, mitigation, and evaluation requirements of Regulation No. 5 permits issued in the Buffalo River watershed. Until ADEQ addresses the concerns identified in its own studies, ADEQ is in violation of the 1992 moratorium.

Comment E11 - BCRET monitoring program is not effectively measuring or reporting on water quality problems in their study of the C&H facility and therefore misleads decision makers and the public.

In 2014, a panel of experts reviewed the operational and monitoring activities taking place at C&H and analyzed BCRET's study design and implementation

(https://bigcreekresearch.org/project_reports/docs/Review%20Panel%20Report%20-%20May%2019%202014.pdf). In their Summary of Findings the panel stated “The complexity of the landscape and the farming operation presents a challenging task for the Team.” They began their review by noting that conclusively demonstrating the impact of C&H on water quality is made difficult by “the fact that limited data on water quality are available prior to the onset of the farming operations. Additionally, within the Big Creek watershed there are a number of other ongoing land management and land use activities that can impact water quality.”

The panel immediately recognized the significance of monitoring storm events and stated “extreme events are often the driver of hydrologic responses to environmental stressors and **we recommend that more effort be directed at sample collection during high-flow events.**” The panel also “recognized three major potential threats to water quality associated with C&H. These include: 1) leakage from the two onsite waste storage ponds, 2) contamination of surface and subsurface water due to land application of the wastes, and 3) potential long-term buildup of soil nutrient levels (primarily soil phosphorus) due to application in excess of crop needs and removal.”

Following is a list of specific recommendations made by the panel, and an assessment of the actions BCRET has taken in response to panel concerns:

1. A short-term, detailed water balance study should be conducted to determine the actual seepage rate of the storage ponds.
 - A water balance study has not been undertaken and pond seepage rates/volumes remain unquantified.
2. Water quality samples should continue to be collected from the house well on a routine basis. In addition, the Panel recommends that the detailed well driller’s log be obtained and that a slug test, pump test, or both be conducted on this well to determine characteristics of the aquifer from which water is drawn.
 - Water samples continue to be collected from the well but it was not apparent that aquifer testing was conducted. Well sample results showed problems with bacteria contamination and nitrate values are higher than in surface water samples.
3. A detailed walking survey of the slope down gradient from the waste ponds should be conducted to identify potential seeps and springs from perched aquifers. If perched aquifers are noted based on the driller’s log or by the identification of hillside seeps, one or more shallow monitoring wells should

be installed to the depth of the perched aquifer within as short a distance as feasible from the storage ponds. If springs or seeps are noted on the hillside, these should be monitored on a routine basis to establish baselines and trends in water quality.

- Not able to verify walking survey, no monitoring wells were installed. Because BCRET installed trenches below the pond, it might be assumed that seeps were found below the ponds during prolonged dry weather indicating perched water. In karst environments the pond seepage could be migrating vertically through solutionally enlarged fractures to the subsurface drainage network, and then discharge to springs and or surface streams. BCRET has not provided a peer reviewed report describing their trench study methods and results.
4. An inventory of the entire reach of Big Creek between the upstream and downstream sampling points with geo-referenced notes made on any significant changes in water flow due to tributaries or major springs. This inventory should include karst features located within the contributing area.
 - A karst inventory of the pond and spreading field areas could be useful, however the work of Halihan and Fields (2014) clearly shows the mature karst just below the spreading fields and near the ponds, and the fractures and conduits normally associated with karst terrain, and directly supports the AWMFH concerns for citing CAFOs in such terrain. The recommended seepage runs in #6 below is a superior way to quantify and assess “changes in water flow” in Big Creek.
 5. A detailed land use map that identifies all land uses within the contributing area of the watershed. This should include surveys of farmers to gauge land management practices, with particular emphasis on animal stocking practices, fertilization, and manure applications.
 - A land-use analysis has been conducted for the contributing watersheds to support the BCRET study objectives (bigcreekresearch.org). The analysis used GIS and remote sensing acquired sources. Unfortunately, the watershed boundary assumptions may be in error in this karst settings. A detailed inventory and survey of farmers as suggested by the panel would be expensive and time consuming and more appropriate to developing a stand-alone water quality model.
 6. A seepage survey to include stream profile measurements and estimations of discharge. The stream survey should be repeated under high (if feasible), medium, and low flow conditions to capture the potential variability in

groundwater recharge and discharge to the riparian zone, valley alluvium, and karst features (if present).

- Sometimes referred to as a gain and loss flow study, seepage surveys are a critical recommendation. A seepage run in this karst setting would yield quantifiable and reproducible results concerning ground water/surface water interactions. Seepage study design should incorporate water quality measurements and sample collection. A seepage survey has been performed on the entire length of the Buffalo River (Moix and Galloway, 2004). Completion of a seepage run by BCRET was not identified.
 - Karst influence on surface flow is pronounced in Big Creek as this stream channel is often dry where it passes the C&H's spreading fields and waste storage ponds during base flow conditions. It is dry during these times because, as commonly happens, the karst drainage network in the Boone Formation has pirated surface flow. By the time Big Creek reaches the upstream sampling site it has flowed across the Boone Formation for two miles. It is likely significant stream flow has already been lost to the subsurface drainage network before it reaches the upstream sampling site. This is confirmed by the times in the BCRET sampling record when the upstream site is dry while the downstream site is still flowing.
 - At the downstream site, it is likely karst hydrology is having the opposite effects on stream flow. The downstream site is located near the base of the Boone Formation. In the Big Creek valley, the lower Boone contains a relatively high quantity of chert (Braden and Ausbrooks, 2003). Chert is composed mainly of silica, and therefore is insoluble. Chert also interacts in complicated ways with the soluble limestone in which it is inter-bedded to affect hydrologic ground water flow processes (Brahana et al., 2016). At the downstream sampling site, it is likely these chert layers form a continuous aquitard of undefined spatial distribution, disrupting the subsurface drainage network and forcing flow back into Big Creek's surface channel. Instead of losing flow as happens at the upstream site, the downstream sampling site is likely capturing water from other basins, such as Dry Creek east of Mt. Judea, for example (bigcreekresearch.org).
7. Develop rating curves between water level and discharge at both the upstream and downstream sites.
- This recommendation reflects the importance of being able to match water quality results to stream discharge and calculate loads or flow-weighted concentrations. Rating curves allow stream stage to be converted to stream discharge. A stream gage has been installed by the USGS at the BCRET downstream site. The upstream site lacks a rating

curve, stream gage, and discharge measurements. This lack of discharge information is uncommon for such studies and will be discussed at length in association with panel recommendations #11 and #15.

- Discharge data for the BCRET upstream site has not, and is not currently being collected. Even when BCRET technicians are on-site collecting water quality samples, they do not measure discharge.
 - At sampling sites lacking discharge data, storm loads cannot be developed. Only the BCRET downstream sampling site, co-located with the USGS gage at Big Creek near Mt. Judea, will have the requisite flow data to allow loads to be calculated. The lack of discharge at the upstream site in this upstream/downstream study of the effects of agricultural runoff is not a typical study design.
 - The use of the watershed area ratio to estimate flow and loads at the upstream site is likely not applicable because the flow relationship between the two sites is not linear due to karst surface water/groundwater interactions affecting surface flow. Without discharge at the upstream site, verification of the accuracy of the watershed ratio method, or development of nonlinear relationships between flow at the upstream and downstream sites, is not possible.
8. Conduct traces with multiple dyes. The first set of traces should be qualitative to identify the potential connections between points of recharge and discharge. Once established, quantitative traces should be conducted with both conservative and non-conservative dyes to establish travel times and dispersion characteristics. Results of the traces, for example from the sinkhole in Field #1 to the spring downslope, may help revise the area for manure application.
- Dye tracing studies have not been conducted by BCRET. Dr Van Brahana has attempted to partially fill the need identified by this recommendation, but is not receiving funding from BCRET to assume what is their responsibility, and his studies were limited. His results and interpretations are currently in press. BCRET states that dye tracing through the waste storage pond liners is not considered feasible.
 - BCRET has used GIS techniques to delineate the watersheds contributing to their monitoring sites. These estimates are likely in error because this simplistic view of watersheds often does not apply to karst basins with extensively developed subsurface drainage networks (Aley, 1982; Aley and Aley, 1989; Aley, 1999; Aley and Aley, 2000; Mott et al.,

2000). This is especially applicable to the BCRET downstream sampling site. The actual recharge area for the upstream and downstream sampling sites, and Left Fork of Big Creek, should be delineated using common dye tracing techniques.

- BCRET has not delineated the recharge area for the spring they are monitoring. Information from this spring is telling us what about the C&H use of the nearby pasture as a waste application site? What else is happening in the recharge area of this spring? What is the spatial extent of this recharge area? Is this spring pirating an upgradient surface stream? Does the spreading field even contribute recharge to this spring? Basic questions like these should have been answered prior to sample site selection and the start of sample collection.
9. The Dry Creek watershed includes an estimated 1/3 of the proposed land area approved for manure application from C&H. An automated sampling and gauging station should be installed as close to the confluence with Big Creek.
- Between November, 2014, and May, 2015, Dry Creek was sampled seven times.
10. The Panel recognizes the need to monitor surface runoff and recommends that more emphasis be placed on a sampling protocol to better capture flow-weighted samples during runoff events.
- The BCRET sampling strategy does not appear to have changed in any notable way to increase emphasis of surface runoff sampling. There is limited surface runoff data from three flumes. Only two of the fields draining to the flumes receive swine waste.
 - See discussion in #15.
11. Use commonly available geophysical techniques to characterize the subsurface conditions that could potentially contribute to preferential flow of water and contaminants from fields receiving swine waste applications. If these procedures document significant subsurface features that can affect water flow, subsurface investigations (i.e., drilling) should be conducted to confirm these observations.
- Ground penetrating radar and electrical resistivity methods have been employed by BCRET collaborators. Follow-up investigations of karst features using borehole investigations at the spreading fields showed many profiles dominated by sand and gravel. One borehole was drilled

near the waste storage ponds, this borehole confirmed the presence of a karst preferential flow path (a solutionally enlarged fracture).

- The electrical resistivity surveys identified concerns related to preferential flow paths in the subsurface karst, as discussed previously. Identified concerns based on karst hydrology were not used by the permit planner or the draft permit approver to appropriately condition waste storage and application as required by the AWMFH (NRCS, 2012).
12. If buildup of soil phosphorous levels is noted, the results of the manure solids and liquid separation trials that are being conducted as part of the project may offer an opportunity to better match waste applications to specific crop and soil fertility needs. In general, the manure solids will have a lower N:P ratio than the liquid fraction. Ideally, the dryer solid fraction could be applied to fields where soil P levels are low or transported out of the watershed altogether. In light of C&H's use of additives to enhance the function of the waste storage ponds, a regular sampling of storage ponds is important to understand the effects of the additives and to determine variability in nutrient concentrations.
- Buildup of phosphorus levels in soils has been noted by BCRET in recent years (bigcreekresearch.org)
 - ADEQ studies of CAFO facilities in the Buffalo River watershed in the 1990s and early 2000s identified sludge build up and disposal as the most significant concern at Regulation No. 5 permitted facilities.
 - Dr. Sharpley's efforts to study ways to ameliorate high P levels in the waste stream have been abandoned.
 - The current NMP and permit do not address sludge buildup or waste stream treatment, or the need to refine NMP calculations based on "as applied" testing results.
13. Source tracking of nutrients and bacteria. While this is time consuming and can be prohibitively expensive to conduct on a routine basis, if elevated contaminant levels are noted at the downstream site relative to the upstream monitoring locations, source tracking using isotopic or PCR methods may provide additional information needed to establish whether activities associated with C&H are a contributing factor.
- No evidence was found that any source tracking methods have been employed by BCRET even though their data shows statistically

significant increases in several parameters at the downstream site (Mott, 2016).

14. Supplemental chemical parameters. The study of watershed hydrology and geochemistry is regularly enhanced by combining a multi-parameter approach. For example, the use of multiple water quality parameters may provide additional information on flow paths, residence times, and sources that may otherwise be difficult to interpret on limited sources of data. Therefore, the Panel recommends that the Team consider, if practical, the following additional analytes: - Principal ions - Alkalinity - Appropriate trace metals - Environmental isotopes (including C/N ratios) - Ammonia, Nitrite, and Nitrate fractions of total N - Emerging contaminants (caffeine, hormones, antibiotics, etc.).

- Several parameters were added based on the review team's recommendations. However, some obvious parameters are still lacking such as dissolved oxygen and quantification of discharge concurrent with sample collection.
- The base flow database BCRET has developed is substantial and lab reports reflect high standards of quality. Unfortunately, the other short comings of the study design and execution limit the intended use of the base flow data to interpret the impacts of C&H.

15. Storm event sampling. Wide-ranging studies of watershed processes and contaminant transport demonstrate the importance of storm events. In this particular investigation, the transport of waste offsite may be strongly correlated to periods of overland flow on application fields. While the Panel is encouraged to see instrumentation specifically designed to capture this overland flow, it would be beneficial to capture more than a single composite sample, particularly for long lasting storms.

- The Big Creek sampling strategy employed by BCRET primarily utilizes an upstream of C&H activities and below C&H activities (upstream/downstream) approach. Their stated purpose of this monitoring is to assess potential declines in water quality occurring in the intervening reach where the production facility, swine excrement holding ponds, and swine excrement land application fields are located (bigcreekresearch.org). Samples are collected on a set weekly basis independent of hydrograph considerations. In agricultural basins, it is well known that nonpoint source contamination is rainfall generated, and transport to surface streams is primarily in conjunction with storm hydrographs, as the review panel noted. In a report prepared for the EPA looking at studies from across the country (<https://>

www.bae.ncsu.edu/programs/extension/wqg/issues/loadestimation.pdf) the relationship between parameter concentrations and storm loading is discussed.

“Especially for particulate pollutants of non-point origin, the flux varies drastically over time, with fluxes during snowmelt and storm runoff events often several orders of magnitude greater than those during low flow periods. It is not uncommon for 80 to 90% or more of the annual load to be delivered during the 10% of the time with the highest fluxes, as is illustrated in Table 1. Clearly it is critical to sample during these periods, if an accurate load estimate is to be obtained.”

Table 1. Delivery of pollutants in Lake Erie tributaries, during selected periods of time with the highest fluxes. Data from Baker (1988).

Parameter	Percent of time	Percent of annual load delivered				
		Raisin	Maumee	Sandusky	Rock	Cuyahoga
Suspended solids	0.5	17.8	17.3	24.3	42.7	28.3
	1.0	26.9	27.1	36.4	59.5	38.1
	10.0	79.6	81.6	87.7	97.6	81.5
	20.0	91.2	93.9	95.4	99.0	90.9
Total Phosphorus	0.5	14.8	9.8	14.8	30.9	13.2
	1.0	23.9	17.2	22.8	47.2	18.0
	10.0	67.9	67.5	77.3	93.9	51.3
	20.0	81.3	85.6	90.2	97.2	64.8
Nitrate + Nitrite	0.5	5.3	5.0	6.9	17.9	3.0
	1.0	9.5	8.7	12.3	28.8	5.2
	10.0	54.2	52.2	56.7	81.0	25.9
	20.0	76.4	75.4	77.2	91.4	40.5

- Table 2 compares base flow median instantaneous loads (flux) at BCRET’s downstream sampling site compared to flux during a period of storm flow at the same site. The results show the critical nature of analyzing storm flow loads as prescribed by the expert panel, EPA, USGS, and other researchers is very applicable to the study of C&H. It is literally tens, hundreds or even thousands of times as important to accurately quantify the storm loads as compared to the base loads. BCRET collects approximately 80 percent of its stream samples from periods of base flow water quality, and 20 percent of its samples are collected from storm runoff periods (bigcreekresearch.org). BCRET prepares quarterly update reports based on these data and presents this information on their website (bigcreekresearch.org), but there is no analysis of loads presented. Not only is it critical to sample during times of storm runoff, the data collection and analysis must be conducted in a specific manner to calculate accurate, scientifically accepted, loads (Haggard et al., 2003;

- <https://toxics.usgs.gov/pubs/of-2007-1080/methods.html>
- <https://pubs.usgs.gov/tm/2005/tm4A5/pdf/508final.pdf>;
- <https://pubs.er.usgs.gov/publication/sir20115172>).

	Ortho-P mg/s	TP mg/s	NO3 mg/s	TN mg/s	TSS mg/s
Median Base-flow flux	5.43744	15.40608	151.7952	165.1056	1019.52
May 11, 2015 flux	1870	31970	4283	67560	16739244
Increase (times)	344	2,076	28	409	16,411

Table 2: Comparison of median base-flow flux values to storm flow flux values at BCRET downstream sampling site (Ortho-P = orthophosphorus; TP = total phosphorus; NO3 = nitrate+nitrite-N; TN = total nitrogen; TSS = total suspended solids; mg/s = milligrams per second).

After 3.5 years of monitoring, BCRET has not subjected their data or interpretations to independent peer review. ADEQ has not asked BCRET to prepare such an analysis prior to making its permit decision. The BRWA believes a peer review of the BCRET study would reveal that:

- *BCRET and USGS should coordinate sampling and prioritize storm event data collection and analysis with the goal of quantifying the offsite impacts of C&H on the water quality of Big Creek, the Buffalo River, and the karst aquifer.*
- *Does BCRET plan to compare their load estimates at the downstream site to the USGS loads at Carver? How will these loads be comparable if USGS uses different sampling techniques and load development procedures?*
- *BCRET is not planning to sample storm event runoff in Big Creek at intervals throughout the rising and falling limbs of a storm hydrograph(s) to allow for integration analysis.*
- *BCRET flags storm and base flow samples in their databases. These flag sometimes contradict behavior of the USGS hydrograph at Mt. Judea gage.*
- *BCRET data may show increasing nitrates in base flow over time. This result has not been detected or reported by BCRET in their quarterly reports. BCRET should use more commonly accepted and refined water quality assessment techniques and peer review processes to interpret data and state conclusions.*
- *E. coli concentrations are not measured from storm samples collected with ISCO samplers.*

BRWA is concerned by the findings of the expert review panel, as the review appears to show the water quality monitoring approach being employed by BCRET missed many fundamentally important aspects of a carefully designed study tailored to “the complexity of the landscape and the farming operation.” BRWA has reviewed the BCRET data and the BCRET sampling activities and concluded that BCRET has not adequately responded to the recommendations made by the expert review panel and others to focus on Big Creek and karst aquifer monitoring, especially during storm flow periods. ADEQ should deny the C & H permit until a proper scientific assessment of its impact is designed, conducted, and reported on through acceptable scientific peer review processes. This would allow ADEQ to make an informed decision regarding the level of water quality impacts to Big Creek, the Buffalo River, and the karst aquifer caused by C&H.

In Conclusion:

The Buffalo River Watershed Alliance reiterates our position that this Regulation 5 permit for this CAFO should be denied and that a permanent moratorium on all such facilities should be immediately established in the Buffalo National River watershed.

These comments are submitted on behalf of the Buffalo River Watershed Alliance. The Buffalo River Watershed Alliance also incorporates by reference the comments of the National Parks Conservation Association, the Arkansas Canoe Club, the Arkansas Public Policy Panel, National Parks Service, Friends of the North Fork and White Rivers, Dane Schumacher, Marti Olesen, Carol Bitting, Jessie J. Green, Teresa Turk, John Murdoch, Chuck Bitting, Gerald Delavan, and any other person or entity who opposes the proposed C&H Hog Farm permit that is the subject of these comments.

References for Comments:

Arkansas Department of Health, March 7, 2017, Letter to ADEQ regarding necessity for strict compliance with buffer zones. https://www.adeq.state.ar.us/downloads/WebDatabases/PermitsOnline/NPDES/PermitInformation/5264-W_ADH%20Comment%20Letter_20170307.pdf

Brahana, J.V., Bitting, C., Kasic-Ficco, K., Turk, T., Murdoch, J., Thompson, B., Quick, R., in press 2017, Utilizing 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; U.S. Geological Survey Scientific Investigations Report

Brahana, J. V., Nix, J., Kuyper, C., Turk, T., Usrey, F., Hodges, S., Bitting, C., Ficco, K., Pollock, E., Quick, R., Thompson, B., Murdock, J., 2016, Geochemical processes and controls affecting water quality of the karst area of Big Creek near Mt. Judea, AR, Journal of the Arkansas Academy of Science. <http://buffaloriverwatershedalliance.wildapricot.org/resources/Pictures/Brahana%20Dye%20Trace%20article%20final%20draft.pdf>

Halihan, T., Fields, J., 2015, Electrical Resistivity Surveys of Applied Hog Manure Sites, Mount Judea, AR Final Report, Oklahoma State University, Stillwater, OK. Accessed at http://www.bigcreekresearch.org/related_material/2016_Fields%20and%20Halihan_ER%20Surveys%20of%20Applied%20Hog%20Manure%20Sites%20MTJ%20AR%20004....pdf

Mott, D.N., and Laurans, J., 2004, Water Resources Management Plan, United States Department of the Interior National Park Service, Buffalo National River, Harrison, AR: https://www.nature.nps.gov/water/planning/management_plans/buff_final_screen.pdf

Mott, D.N., 2016, Permitted Concentrated Animal Feeding Operation Assessment, Buffalo National River, Arkansas

Murdoch, J., Bitting, C., and Brahana, 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, Springer Berlin Heidelberg.

Watershed Conservation Resource Center, 2016, Surface-Water Quality in the Buffalo National River, 25-year (1985-2011) data: Watershed Conservation Resource Center, Fayetteville, AR.

Burkholder, J.M., 2017, Report prepared for Buffalo River Watershed Alliance, "Assessment of Environmental Data and Draft Regulatory Changes Regarding the C&H CAFO, Including the Present Draft Permit" <http://buffaloriverwatershedalliance.wildapricot.org/resources/Pictures/Burkholder%20Comments%20%20CH%20CAFO%202017%20.pdf>

Smolen, M. D., 2017, Report Prepared for Buffalo River Watershed Alliance, "Review of C&H Hog Farms Application for Arkansas Pollution Control and Ecology Commission Regulation 5, Liquid Animal Waste Management System Permit" <http://buffaloriverwatershedalliance.wildapricot.org/resources/Pictures/Smolen%20Final%20Report%20CandH%20Reg%205%20Permit.pdf>

Smolen, M.D. 2015, Report prepared for Earthjustice, "COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT ASSESSMENT OF C & H HOG FARMS, NEWTON COUNTY, ARKANSAS" <http://buffaloriverwatershedalliance.wildapricot.org/Resources/Documents/Ex%204%20-%20FINAL%20Smolen%20comments%20with%20CV.pdf>

Smolen, M.D. 2014, Report prepared for Earthjustice, "Review of C & H Hog Farm Animal Waste Management Plan" <http://buffaloriverwatershedalliance.wildapricot.org/resources/Pictures/Smolen%20Final%20Report%20to%20EJ%20on%20CH%20NOI.pdf>

Aley, T., 1982. Characterization of Groundwater Movement and Contamination Hazards on the Buffalo National River, Arkansas: Ozark Underground Laboratory, Protem, Missouri.

Aley, T. and C. Aley, 1989. Delineation and characterization of the recharge area for Mitch Hill Spring, Buffalo National River, Arkansas: Ozark Underground Laboratory, Protem, Missouri.

Aley, Thomas, 1999. Inventory and delineation of karst hydrological features, Buffalo National River, Arkansas: Ozark Underground Laboratory, Protem, Missouri.

Aley, T. and C. Aley, 2000. Inventory and delineation of karst features, Buffalo National River, Arkansas. Report on Phase 2 investigations and final project report: Ozark Underground Laboratory, Protem, MO.

Mott, D.N., Hudson, M.R., and Aley, T., 2000, Hydrogeologic Investigations Reveal Interbasin Recharge Contributes Significantly to Detrimental Nutrient Loads at Buffalo National River, Arkansas: Proc. of the Arkansas Water Resources Center Annual Research Conference on Environmental Hydrology, AWRC misc. pub. no. 284, University of Arkansas, Fayetteville, Arkansas.