C&H HOG FARMS: AN INVESTIGATION INTO THE PERMITTING OF A CONCENTRATED ANIMAL FEEDING OPERATION IN THE BUFFALO RIVER WATERSHED

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ABSTRACT

In 2013, the first permitted concentrated animal feeding operation (CAFO) in the state of Arkansas under the National Pollutant Discharge Elimination System (NPDES) general permit program began operation. C&H Hog Farms became a controversial topic due to its location in the Buffalo River watershed, a region known for its tourism and karst geology. Due to the large CAFO's controversial nature, the permit and environmental assessment (EA) were analyzed to determine their validity. Based on the information compiled, it was found that C&H Hog Farms complies with Arkansas's general permitting program, despite the CAFO's nutrient management plan errors. It is recommended that future waste lagoons in geologically sensitive regions of the state use geosynthetic or concrete liners in order to mitigate possible water pollution and ease the public's concerns. Also, a design document should be required in order to provide engineers with uniform standards based on the latest scientific findings. In addition, it was found that the EA should only investigate the 23 acres purchased by C&H Hog Farms with federal funds. In the opinion of the researcher, the environmental assessment violated the National Environmental Protection Act due to its miscommunication with federal agencies and lack of environmental impacts investigated. Despite these findings, the overall validity of the environmental assessment will be determined in litigation. Other suggestions were provided in order to mitigate future situations with the NPDES general CAFO permitting program in the state of Arkansas.

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I. Introduction and Motivation

The first permitted concentrated animal feeding operation (CAFO) in the state of Arkansas under the National Pollutant Discharge Elimination System (NPDES) general permit program, ARG590000, is C&H Hog Farms. This family-owned farm is located in Mount Judea, Arkansas approximately five road miles and six stream miles upstream of the Buffalo River. The farm and its application fields are in the vicinity of Big Creek, a tributary of the Buffalo River. The owners of C&H Hog Farms are Jason Henson, Richard Campbell, and Phillip Campbell. The cousins argue that farming is in their blood, and their families have been producing crops in the Buffalo River watershed for decades. Also, Richard and Phillip Campbell have 15 years of hog farming experience as they owned and operated C&C Hog Barn, a small 312 sow farm located in Vendor, Arkansas. The previous facility was not covered by the NPDES general CAFO permit; instead, C&C Hog Barn was covered by an Arkansas Pollution Control and Ecology Commission (APC&EC) Regulation 5 permit. Due to the location of the new and larger hog facility, recent controversy has forced the cousins to be under intense scrutiny from politicians, experts, and concerned citizens on the operation and maintenance of their facility.

C&H Hog Farms, an antibiotic-free farrow-to-wean farm, has a 12-year commitment to their integrator, Cargill, Incorporated. The farm is designed to hold 4,000 piglets, 2,500 sows, and 3 boars at capacity, which is a large CAFO as per federal regulations. The operation focuses on impregnating sows, providing optimal gestation conditions, and weaning piglets at approximately 12 weeks of age. After this time period, the integrator transports the piglets to another facility in a different state where they will be raised and then transported again to a finishing farm to be slaughtered for food production. Due to C&H Hog Farms' classification as an antibiotic-free facility, the operators must maintain high health and safety standards for the

animals on-site. By implementing procedures such as the "shower-in" and "shower-out" policy, the operators strive to keep the animals in prime health. Through interviews with the operators, pig health has been reiterated as their number one priority.

The cousins hired the agricultural engineering consulting firm DeHaan, Grabs, & Associates, LLC, based in Mandan, North Dakota, to design and assist in the construction of C&H Hog Farms. The calculations were completed by an engineer named Nathan Pesta from the Mandan office and approved by Geoffrey H. Bates of Bates and Associates, Inc. from Fayetteville, Arkansas. The facility design deliverables completed for C&H Hog Farms included the notice of intent (NOI) and nutrient management plan (NMP), as required by ARG590000. As specified in these documents, C&H Hog Farms has two barns along with a waste storage system that is comprised of two open-air waste lagoons and two in-house shallow waste pits. The waste system is designed to hold 270 days of wastewater. Also, the waste lagoons are lined with compacted in situ clay.

With this type of storage system, a waste management plan was made which involved land application of the hog waste onto property located around the facility. Land lease agreements were obtained for 670.3 acres to be used for land application. For the acreage of land listed as application fields, soil samples were collected to determine the allowable waste application rates. The site-specific NMP details the results from soil tests, and land application rates were determined using Arkansas Natural Resources Commission (ANRC) standards and the 2010 Arkansas Phosphorus Index (API), as dictated by the general permit. In addition, the general permit outlines best management practices (BMPs) typical for this industry in order to avoid any type of agricultural storm water discharge into waters of the state. These BMPs include setbacks, buffer zones, inspection of land application equipment, precipitation

consideration, and slope requirements. With the information provided by C&H Hog Farms along with the lack of public comments during the 30-day period, ADEQ began coverage of the CAFO under ARG590001 on August 3, 2012.

In order to pay for the construction and overhead of this large CAFO, the operators received loans from the Farm Credit of Western Arkansas (FCS). In order to decrease the risk involved with this large sum of money, the operators also applied for loan guarantees from the United States Department of Agriculture (USDA) Farm Service Agency (FSA) and the Small Business Administration (SBA). Loan guarantees of $1,302,000 and $2,318,136 were provided by the FSA and SBA, respectively, in order to purchase 23.43 acres of land and construct the farrowing and gestation barns. Prior to granting these guarantees, the federal agencies had to follow the necessary procedures outlined in the National Environmental Policy Act (NEPA) to approve the proposed uses of federal funds. The NEPA requires any request for federal funding to undergo an Environmental Site Assessment (ESA) to ensure that the project funds will not be used in a way that would negatively impact the human or natural environment. Once an ESA is completed by a federal agency, such as the USDA or SBA, the process can either end with a finding of no significant impact (FONSI) or continue with an environmental site investigation (ESI) which requires further testing of the site to examine possible impacts of the project. The ESI requires the aid of various experts to determine if the funded project could harm the environment and typically takes years of investigative research to complete. If the proposed action is determined to cause environmental, social, or economic impacts, then funds are not required to be allocated by the federal government. Overall, the ESA process was enacted by NEPA in order to provide agencies input from other areas and serve as a system of "checks and balances" regarding environmental issues.

In the case of C&H Hog Farms, the ESA process was initiated by the USDA FSA, and it resulted in a FONSI. The SBA did not complete a separate ESA. With the FONSI, both federal agencies guaranteed the loan amounts requested by the farm and construction began in 2012.

In response to the complexity of these regulations and standards, stakeholders have made various interpretations. Public activist groups such as the Buffalo River Watershed Alliance (BRWA), the Ozark Society, the Arkansas Canoe Club, and the National Park Conservation Association believe that the USDA, FSA, and SBA have violated the NEPA due to weaknesses in the ESA, which led the USDA to a FONSI.

Once construction of C&H Hog Farms was almost complete, Arkansas residents began to protest the facility due to its location in the Buffalo River watershed. Concerned citizens were dissatisfied with ADEQ's authorization of this facility and surprised that they did not receive notification of the permit coverage. In addition, certain residents began to question ADEQ's approval of compacted clay-lined waste lagoons at the site due to the karst topography typical of this area of Arkansas. This type of geology is characterized by high degrees of surface water and groundwater interaction which citizens worried would impact the overall water quality of the Buffalo River watershed. In addition, various issues with the NMP, including the application rate calculations, location, and boundaries of the land application fields, have caused the public to question its validity.

The emotional outcries of the public were exacerbated by misinformation provided during public meetings. Conservation groups fear that the approval and construction of this single, large CAFO could threaten the quality of the Buffalo River as seen in waterways of North Carolina in the 1990s. National grassroots organizations, such as the Waterkeepers Alliance, have traveled to Arkansas to share the negative effects of "factory farms."

In response to these fears, the activist groups have united to sue representatives of the USDA, FSA, and SBA for violation of federal laws including the NEPA, the Endangered Species Act, and the Buffalo River Enabling Act. The government agencies have responded to their complaints by denying a majority of these allegations, but the activist groups continue to threaten with additional litigation. These citizen groups have also requested that ADEQ cease coverage of C&H Hog Farms under the general permit due to flaws in the NOI and NMP.

By witnessing meetings and conducting interviews, it has been noted that frustrations over the general permit coverage and loan guarantee approval have been caused by miscommunication and misinterpretation from all parties. In order to provide clarity, this case study will investigate the complex federal and state regulations to determine if the state of Arkansas followed the necessary requirements as outlined in the Clean Water Act (CWA) with respect to granting the CAFO coverage under the NPDES general permit. In addition, the ESA process, as outlined in the NEPA, will be analyzed to determine if the USDA FSA and SBA followed the mandated regulations when providing the CAFO with a FONSI.

Through interviews, literature analysis, and document reviews, a thorough understanding of the inner-workings of government agencies and their specific roles in environmental permitting and funding was sought. In addition, by completing a quantitative review of the land application fields using the Arkansas Phosphorus Index (API) data and the soil test results used in the waste lagoon construction, the validity of the general permit will be evaluated.

Through the analysis of current regulations, laws, and standards of federal and state agencies, issues and concerns will be addressed from an objective perspective. The topics discussed in this case study are relevant to other states and industries within the U.S. The waters of the nation must be protected from degradation by following, adding, amending, or analyzing

the current environmental laws and regulations provided by the government. By determining the validity of the general permit, NMP, and ESA associated with C&H Hog Farms, this case study will attempt to identify the errors in these documents and provide suggestions to mitigate the current and future situations involving CAFOs.

II. Research Methodology

In order to fully understand the concerns surrounding this controversial issue, interviews and public meetings have been recorded. Industry engineers, such as agriculture and permit engineers, as well as academic experts, including geologists and agronomists, have been consulted throughout the study of this hog farm. Concerns from each side of the debate have been documented and addressed, but not all are highlighted throughout this study due to their biased nature. The anxieties not addressed in this case study are still relevant to state agencies because they must keep the public's interest in mind when making decisions based on sound science, but this analysis must be free of personal and emotional opinions. As exhibited in this case study, government agencies, grassroots organizations, and individual stakeholders must remember that decisions involving regulatory and permitting decisions must be made based on scientific judgment and professional experience. Industry standards and legal requirements are created based on past experiences and lessons learned from previous projects. This case study hopes to analyze the lessons learned in this specific agricultural situation. By analyzing the current environmental regulations, standards, and guidelines along with describing the roles of federal and state agencies, the validity of the NOI, NMP, and ESA completed for C&H Hog Farms will be determined. Through detailed analysis, conclusions will be made in order to find potential ways to mitigate future issues involving CAFOs, using C&H Hog Farms as an example.

In addition, suggestions will be made based on this experience to mitigate future issues involving CAFOs. The questions and concerns discussed in this case study are not unique to the state of Arkansas. As seen throughout the country as CAFOs expand and nutrient levels continue to increase in the waters of the U.S., questions involving the future of agricultural and environmental progress must be questioned with respect to the current federal and state regulations.

III. Results and Discussion

A. Arkansas CAFO General Permit

As stated by the US EPA, the Federal Water Pollution Control Act Amendments of 1972, also known as the CWA, "establishes the basic structure for regulating discharges of pollutants into the waters of the U.S. and setting quality standards for surface waters" (EPA 2012b). Under this definition, the CWA "provides the statutory basis for the National Pollutant Discharge Elimination System (NPDES) permit program along with the basic structure for regulating the discharge of pollutants from point sources to waters of the U.S" (EPA 2012a). The NPDES permit program was established to issue, modify, revoke and reissue, terminate, monitor, and enforce permits while also imposing and enforcing pretreatment requirements (Arkansas Department of Environmental Quality 2011b). Since the 1970s, the US EPA has regulated CAFOs under this program. As defined by 40 CFR 122.23, a large CAFO is a type of animal feeding operation (AFO) where 2,500 swine each weighing 55 pounds or more are held for 45 days or more in a twelve-month period and vegetation is not sustained in normal growing seasons at the facility. There are two main types of NPDES permits for CAFOs: individual or general permits. The federal authorities can provide a state the authority to issue a single general

permit to a category of point sources located within the same geographic area whose discharges warrant similar pollution control measures (EPA 2012b). There are several critical design elements for a CAFO under the NPDES permit program, including effluent standards, monitoring, reporting and record-keeping requirements, special conditions, and standard conditions. After the state proposes a general permit, the federal agency can choose to accept or deny the state agency the authority to cover the facilities under a general permit. For instance, in the state of Arkansas, there are ten general permits including sanitary landfills and aggregate facilities. These general permits try to streamline the permitting process for not only the party being permitted, but also the agency providing the permit coverage. As stated in the definition of a general permit, it is characterized mostly by its ability to permit a standard operation. Therefore, in all CAFOs, phosphorus, nitrogen, and heavy metals typical of animal waste characterize the effluent.

On November 1, 2011, the Arkansas Department of Environmental Quality (ADEQ) was granted the authority to cover concentrated animal feeding operations (CAFOs) under the National Pollutant Discharge Elimination System (NPDES) General Permit program by the United States Environment Protection Agency (US EPA), in accordance with 40 CFR 122.28 (Arkansas Department of Environmental Quality 2011a). The US EPA has the ability to provide this authority to a state agency as long as the state agency follows 40 CFR 123, which outlines the state program requirements for general NPDES permits. After following the requirements outlined in these federal regulations, ADEQ made the general permit (ARG590000) available to the citizens of Arkansas. Six public meetings were held throughout Arkansas before the CAFO general permitting program was approved by the US EPA. At these meetings, the public was granted the opportunity to discuss the notification process associated with this type of permit.

After the comments were addressed, ADEQ was provided the authority to cover CAFO operations under ARG590000, the state of Arkansas's general NPDES permit.

ARG590000 outlined that in order to be covered, CAFO operators must submit a notice of intent (NOI), a site-specific nutrient management plan (NMP), a $200 permit fee, and an ADEQ Form 1 for proposed construction sites (Arkansas Department of Environmental Quality 2011a). Once ADEQ has reviewed these documents and deemed them to be complete, the department must provide the public with the NOI and NMP for 30 days to allow for comments. ARG590000 outlined that public notice had to be provided on the ADEQ website for 30 days before official coverage begins. Once this public comment period is complete and all comments are addressed, then ADEQ may grant the facility a notice of coverage (NOC). Operators must renew the NOI and NMP every five years, and any changes to the facilities or NMP must be approved by ADEQ. ARG590000, the CAFO general permit program, expires every five years. This renewal period provides the government and general public the opportunity to add new standards or question old standards in the general permit program.

In addition, facilities covered under the general permit program are not frequently monitored due to the uniform nature of the effluent. In the case of a discharge event, the operators must sample and analyze the effluent, with the exception of agricultural nonpoint source discharges from land application areas with an approved NMP. Samples taken after a discharge event must be analyzed for total nitrogen, nitrate nitrogen, ammonia nitrogen, total phosphorus, fecal coliform bacteria, BOD_5, total suspended solids, and pH. As seen with these parameters, the permitting authorities are concerned with the release of nutrients in the waterways of the state. The results from these tests must be submitted to ADEQ within 30 days of the discharge and oral reporting must occur with 24 hours of the discharge. These monitoring

requirements allow the permitting agency to keep tabs on the effluent characteristics at the time of discharge to determine if the waters of the state are in danger of degradation due to the event. These tests also force operators to take responsibility for permit compliance. This type of "self-monitoring" is typical for all types of NPDES permits.

After the state of Arkansas made the general permit available, C&H Hog Farms was the first CAFO to apply for coverage by submitting a notice of intent (NOI) in June of 2012. After the NOI and nutrient management plan (NMP) were reviewed by ADEQ, the application was made available for public comment on the agency's website for 30 days. Due to the lack of comments on the NOI and NMP, the state began coverage on August 3, 2012 for C&H Hog Farms, and construction quickly started at that time.

B. Arkansas Regulation 5 Permit

Before the addition of the ARG590000, animal feeding operations (AFOs) in the state of Arkansas were covered under the APC&EC Regulation 5: Liquid Animal Waste Management Systems program. This regulation was implemented in 1992 as per recommendations from Governor Bill Clinton's Animal Waste Task Force appointed in 1990 (Noble and Looney 1994). Reg. 5 permits are for no discharge agricultural facilities and cover "all confined animal operations, whereas the federal minimum requirements of the NPDES program only cover relatively large, concentrated, animal feeding operations" (Noble and Looney 1994). This permit has been provided for all AFOs in the state of Arkansas since 1992 prior to C&H Hog Farms. For instance, there are currently six similar hog-growing facilities in the Buffalo River watershed covered by a Reg. 5 permit.

Overall, the terms of the Reg. 5 permit are similar to those of the general NPDES program. Appendix A outlines the differences and similarities of the two permitting programs.

As seen in the table provided in Appendix A, some requirements of the APC&EC Reg. 5 permit are more stringent than those found in ARG590000. For instance, Section 5.404 specifically states the terms of a subsurface investigation for earthen holding ponds and treatment lagoons (Arkansas Pollution Control and Ecology Commission 2012). In addition, Section 5.102 requires the operators to "adopt a good neighbor policy and consider the use of chemical or biological additives" or other BMPs in their daily operations (Arkansas Pollution Control and Ecology Commission 2012). This section is distinctly different from the general NPDES permit requirements since residents surrounding the facility are not considered in the ARG permitting process. Due to the fundamental differences in the terms of the ARG590000 and Reg. 5, these two permits cannot be used interchangeably or directly compared, as done by ADEQ in the case of C&H Hog Farms.

C. Analysis of General Permit

In order to determine the validity of the coverage of C&H Hog Farms under the general CAFO permitting program, ARG590001, two design areas of concern will be analyzed, the compacted clay liners of the waste lagoons and the land application rates in the NMP. These two areas have received the most scrutiny from conservation groups.

1. Clay Liners

The CAFO general permit does not reference the specific guidelines necessary to design the lagoon ponds. ARG590000 requires that lagoon designers complete calculations using SPAW and AWM software tools from the NRCS incorporating projected land application rates and historical weather data. This data ensures that lagoons can handle 180 days of storage, a freeboard of one foot, and a 25-year, 24-hour storm for that area, as required by 40 CFR 412.46.

ARG590000, based on 40 CFR 412.46, requires all open storage structures to be designed using the newest version of the Animal Waste Management (AWM) software published by the USDA NRCS. Equivalent design software can be used in its place as long as the Director approves it. The AWM software provides known and accepted values for information pertinent to lagoon design, including climate data, typical values of waste based on animal type, and waste constituents for various types of animals. The AWM software is written with the latest standards provided in the USDA NRCS Agricultural Waste Management Field Handbook (AWMFH). The AWM software provides users with examples and the most up-to-date databases available from the USDA NRCS. By following the prompts in the system and denoting the location, amounts of animals, and type of structure to be constructed, it provides the volume and necessary storage dimensions for the waste (United States Department of Agriculture Natural Resource Conservation Service 2013). After performing these calculations, the AWM software then provides the designer with a set of reports that can be presented to state or federal agencies for approval based on the calculations performed by the program. These forms are not required for distribution, but the software or an equivalent must be used to size the lagoons. When using the AWM tool, the coefficient of permeability from field tests on the compacted clay liners is requested to determine the necessary depth of the liners for the seepage rate. If a coefficient of permeability of 5E-07 cm/s for in-situ clay is input into the AWM software, the program warns that the coefficient of permeability must be checked for correctness since it is greater than 3.5E-07 cm/s. This threshold value could be based on the AWMFH recommended range from Chapter 10. The coefficient of permeability for C&H Hog Farms is higher than the recommended standard according to the AWM software. It should be noted that the software used to analyze these parameters was updated in 2013, so it is unknown if the most recent

software had substantial changes from the previous version. The databases referenced by the software were last updated in 2010, according to the latest version of the software accessed in February of 2014.

Based on the calculations provided in the general permit, the design engineers did not use the AWM software or specify which program was used in the design of the open storage lagoons. Since the software was not used, the unit waste production values (cubic feet/day/1000 lbs of animal) used for C&H Hog Farms do not match those provided in the AWM software databases (Arkansas Department of Environmental Quality 2012). The AWM databases provide values from the Iowa State University MidWest Plan Service (MWPS). The unit waste production values used by the design engineers of C&H Hog Farms are not referenced, so the validity of their assumptions is questionable. The database provided in the AWM software was last revised on September 8, 2009, so these same values were available to the designers of C&H Hog Farms in 2012. These unit waste production values include information on moisture, total solids, volatile solids, sludge, flush water, nitrogen losses, phosphorus losses, and potassium losses for each type, age, and sex of animal (United States Department of Agriculture Natural Resource Conservation Service 2013). The actual unit waste production values used to design the waste lagoon system at C&H were not referenced.

Once the AWM software has been used to size the lagoons, the output then becomes the input for another USDA NRCS program, the soil, plant, air, and water (SPAW) hydrology tool. The SPAW program checks the storage capacity of the structure based on the historic rainfall values for the past 100 years. The engineers did use the SPAW model throughout the design of the waste lagoons at C&H Hog Farms. As seen in the correspondence between ADEQ and DeHaan, Grabs, and Associates, the design engineers were required to update the SPAW model

when the lagoons were constructed in order to ensure that they provided a 100 year confidence interval as required by 40 CFR 412.46. This program found that the lagoons held the required amount of waste for a 25-year, 24-hour storm along with one foot of freeboard. The lagoons sized for C&H Hog Farms have the capacity to hold 270 days of waste, which is greater than the required 180 days of design storage required by the state of Arkansas.

It was determined that design engineers followed the AWMFH as a guidance document because it was referenced in APC&EC Regulation 5. In Reg. 5, the State defines best management practices to be procedures and practices that "prevent or reduce pollution of the waters of the state as set forth in this regulation and the General Permit" (Arkansas Pollution Control and Ecology Commission 2012). Assuming that the "General Permit" refers to the CAFO General Permit, parts of Reg. 5 are used for the NPDES general CAFO program. According to Reg. 5, Arkansas requires the design and waste management ponds to follow the NRCS technical publications including the Field Office Technical Guide (FOTG) and the AWMFH. Section IV of the FOTG for Newton County references the practice standard titled "Pond Sealing or Lining Compacted Clay Treatment (No. Code 521D)" (United States Department of Agriculture Natural Resource Conservation Service 2011). This practice standard states that compacted soil liners for waste storage must be designed to lower unit seepage rates by following the AWMFH. The minimum liner thickness allowed by the AWMFH for a water depth less than or equal to 16 feet is 12 inches (United States Department of Agriculture Natural Resource Conservation Service 2009). The water depths for 270 days of storage with a freeboard of 1 foot for pond 1 and pond 2 at C&H Hog Farms are 9.7 feet and 12.2 feet, respectively, as found in the final construction documents (Pesta 2013).

In order to determine the composition of the soil, the AWMFH standards suggest employing the use of scientists or published surveys in identification. High seepage losses are associated with class IV soils, so the AWMFH recommends using soil dispersants to obtain the necessary permeability (United States Department of Agriculture Natural Resource Conservation Service 2009). The NRCS standards continue by saying that typically class IV soils have acceptable permeability values naturally, assuming that the soils do not have high calcium content or are constructed in "unfavorable geologic conditions, such as karst formations" (United States Department of Agriculture Natural Resource Conservation Service 2009). These conservative options lower or completely eliminate seepage rates from the waste ponds, which in turn protect the underground waters. These alternatives are more costly, but these measures help mitigate water quality degradation of the state's waterways.

According to the AWMFH, an initial seepage rate of 5000 gallons/acre/day is allowed for compacted clay lined waste lagoons (United States Department of Agriculture Natural Resource Conservation Service 2009). After the manure seals the compacted clay liner, the seepage rate is assumed to lower by half an order of magnitude. This is an industry-wide assumption that recently changed in order to be conservative. Previously, it was estimated that the initial seepage rate was lowered by a full order of magnitude due to manure sealing. The state of Arkansas does not have more stringent regulations on this matter or any specific regulations.

The coefficient of permeability, k, value used in the compacted clay liners was measured on June 14, 2012. The k value was found to be 5E-07 cm/s. This is higher than the recommended range for coefficient of permeability values for compacted clay liners, as given in the AWMFH. The acceptable range of k values from NRCS is between 1E-09 (high) to 1E-07 (low) cm/s (United States Department of Agriculture Natural Resource Conservation Service

2009). Despite the low coefficient of permeability value measured at C&H Hog Farms, the seepage rates were still found to be less than 5,000 gallons/acre/day due to the thickness of the clay liner, as seen in Table 1.

Specific discharge, v	Pond 1		Pond 2	
	H_i = 9.7 ft	H_f = 9 ft	H_i = 11.7 ft	H_f = 12.2 ft
ft3/ft2/d	0.0106	0.0099	0.0125	0.0129
gal/ac/day	3448.57	3233.04	4064.39	4218.35

Table 1: Seepage rates calculated for the original and final design depths at C&H Hog Farms.

The liner calculations completed by the engineering team from North Dakota followed an example provided in the AWMFH to determine the seepage rates of the lagoons. The rates were calculated by putting the coefficient of permeability, the thickness of the liner, and the maximum height of the waste in the lagoon into Darcy's Law, Q=k*i*A. When simplified, the unit seepage or specific discharge is Q/A, which yields v. By using this equation, along with conversion factors provided in Table 10D-6 of the AWMFH, the specific discharge of the waste lagoons can be calculated, as seen above in Table 1 (United States Department of Agriculture Natural Resource Conservation Service 2009). The specific discharge values calculated for the ponds at C&H Hog Farms are correct as verified in Table 1.

In addition, the AWMFH also requires geologic consideration in the design phase of a waste management system. The USDA NRCS recommends "alternatives to compacted clay liners should be considered for poor foundation conditions such as karstic bedrock" (United States Department of Agriculture Natural Resource Conservation Service 2011). For C&H Hog Farms, the bedrock was not assumed to be karstic because it was not tested. As seen in the general permit, the soil borings taken on June 25, 2012 gave three boring logs. The depths were 13.5 feet for boring 1, 18.5 feet for boring 2, and 11.5 feet for boring 3. The soil samples taken

from Boring 1 were located at the proposed location of the gestation barn. Boring 2 was sampled next to the proposed location of Pond 2, and Boring 3 was drilled at the proposed location of Pond 1. The in-situ high plasticity clay found at depths of 7-11 feet in Boring 2 was used to construct the compacted clay liners (Arkansas Department of Environmental Quality April 12, 2013). The clay samples pulled from Boring 2 did not report information on the bedrock of the area. In all of the design calculations, the bedrock under C&H Hog Farms was not addressed.

It is widely accepted that the northwest corner of Arkansas is characterized by its karstic geology. Caves and springs are found throughout the Buffalo River watershed, as seen in Figure 1 (Brahana 2014a). According to a USGS map of the Mt. Judea quadrangle, the farm is situated over the Boone Formation (Braden and Ausbrooks 2003). Karstic bedrock, a geologic formation that prevents nutrient and pathogen attenuation in soils, does not provide the necessary filter under waste lagoon systems needed to protect the ground and surface waters surrounding these ponds.

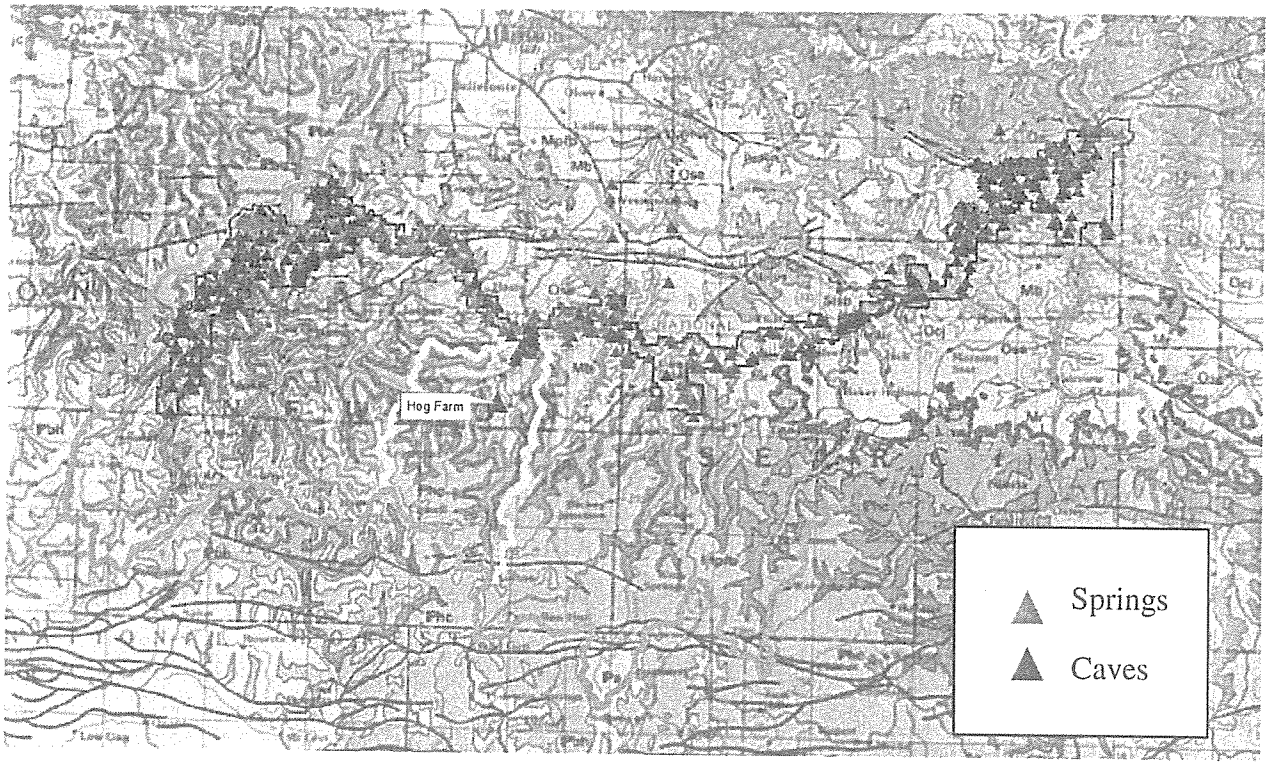

Figure 1: Caves in the Buffalo River Watershed (Brahana 2014a).

Based on the permit and its supplementary documents, the composition of the bedrock under C&H Hog Farms is not discussed. Based on geologic records and characteristics of this region of Arkansas, the geologic formations serving as the foundation of C&H Hog Farms are karstic. According to the AWFMH and USDA NRCS and ANRC standards, lagoons can be built in karstic regions as long as conservative design specifications are used. For instance, due to the interaction between ground and surface water in these formations, the AWFMH recommends facilities construct lagoons using concrete, geomembrane, or chemically-enhanced compacted clay as liners. Due to lack of consideration of karstic formations by the design engineers, C&H Hog Farms can be considered at a higher risk of contaminating the groundwater and, in turn, the surface water. The possible contamination of Big Creek and the Buffalo River is also exacerbated by the low coefficient of permeability of the compacted clay liner. If the engineering designers had implemented a conservative, yet more expensive, liner design for the

lagoons, fewer risks could be associated with this type of storage system. The design of the compacted clay lined lagoons at C&H Hog Farms complies with the quantitative standards dictated by the USDA NRCS, but they do not consider the geology which is also part of the necessary design parameters as dictated by the industry. Due to the vague description of design standards for waste management of CAFOs in ARG590000, ADEQ has the right to grant coverage to C&H Hog Farms under ARG590000. Due to the terms of a general permit, a facility is permitted based solely on its uniform effluent standards, regardless of geographic region in a state. General permits are not required to take geology into consideration for a specific site due to the broad assumption of uniform environment in a state. Due to these indistinct references, C&H Hog Farms followed the necessary requirements for the design and construction of the waste lagoons as dictated by the ARG590000. The researcher does not consider it suitable to construct compacted clay-lined waste lagoons over this type of geologic formation.

No information on the bedrock geology is known based on the permit and supplementary documents. According to the AWMFH and the Arkansas NRCS Practice Standard Code No. 521D, special consideration must be taken for karstic bedrock. Waste lagoon liners in karstic regions require special design measures when there are "highly unfavorable geologic conditions" on-site (United States Department of Agriculture Natural Resource Conservation Service 2009). The AWMFH and NRCS Code 521D explain that if the pond liner occurs in this type of area, then alternatives including soil dispersants, geomembranes, or geosynthetic clay liners should be investigated. Soil dispersants are typically used in cases where soils are from groups III or IV since these soil groups contain excessive amounts of calcium or magnesium on the clay particles. The soil reports for the lagoon liners have a soil group of IV according to AWMFH standards where limestone and gypsum weathering can occur (United States Department of Agriculture

Natural Resource Conservation Service 2009). In this case, if the engineers did not follow the recommended steps in the liner design they could be in violation of the AWM recommendations as required by ADEQ in the waste storage design.

According to Evan Teague, an environmental specialist from the Farm Bureau, the farm went "above and beyond" the general permit's requirements in the design and sizing of the waste lagoons with the use of an 18-inch compacted clay liner (Teague 2013). After utilizing Darcy's Law, the ponds would not have met the required NRCS seepage rate of 5,000 gallons/acre/day if the ponds had the minimum 12-inch thick layer of compacted clay in the design. Without assuming any manure sealing of the pond liners, Pond 1 and 2 would have initial seepage rates of 4942 and 6097 gallons/acre/day, respectively, considering the critical pressure heads on the liners. These values show that the farmers and engineers were not trying to surpass the environmental standards; instead, the design engineers were complying with the necessary required seepage rates.

C&H Hog Farms would have exceeded the general permit and agricultural standards if the coefficient of permeability was lowered using dispersants. For instance, if the coefficient of permeability were 5E-8 cm/s, which is considered the mid-range value for a natural liner according to the AWMFH, the engineers would have exceeded the requirements of the seepage rate with a liner thickness of 18 inches. With these values, the liners would have had initial seepage rates for Ponds 1 and 2 at 345 gallons/acre/day and 422 gallons/acre/day, respectively.

Waters of the state include groundwater. ARG590000 consistently states that the NMP should "identify appropriate site specific conservation practices to be implemented...to control runoff of pollutants to waters of the State" (Arkansas Department of Environmental Quality 2011a). BMPs discussed in relation to the design, operation, and maintenance of the storage

structure could include those found in NRCS AWMFH (Arkansas Department of Environmental Quality 2011a). The Director has the ability to require site-specific design standards to account for geographic properties, such as karst.

Even though the permit does not specifically list its design standards for the waste lagoons, the general permit new source performance standards dictate that the AWM software produced by the NRCS must be used in the design of these structures or an equivalent design tool (Arkansas Department of Environmental Quality 2011a). The design engineers for C&H Hog Farms did not document the use of this design tool to determine the dimensions of the storage lagoons, and the references used were not specified in the NOI. The AWM software is based on the AWMFH also created by the NRCS. This means that the design standard required by the federal regulations is the AWMFH. The state of Arkansas did not explicitly specify any other form of guidelines in ARG590000. Due to the lack of referencing by the engineers, it is difficult to decipher the guidance document used in the design of these lagoons. Clarification was provided by the state once a public comment from Dr. Robert Cross was answered in November 13, 2013. In this letter, Ryan Benefield, P.E., the Deputy Director of ADEQ, stated that the AWMFH was used as the "guidance and design manual for agricultural waste management" (Benefield 2013). From this correspondence, it is assumed that the design engineers used the AWMFH for the design of the waste lagoons for C&H Hog Farms. Benefield also stated that ADEQ "reviewed the application and believes it complies with the technical standards" of the AWM (Benefield 2013). Despite this statement, it is not clear if the approved NOI and NMP follow the entirety of the standards provided in the AWMFH. According to the AWMFH, seepage from waste lagoons should be limited to "prevent any virus or bacteria from migrating out of the storage facility to an aquifer or water source" and "to prevent the conversion

of ammonia to nitrate in the vadose zone" (United States Department of Agriculture Natural Resource Conservation Service 2009).

Based on the general permit's ambiguity, ADEQ allowed C&H Hog Farms to comply with portions of recommended technical documents. Conversely, Reg. 5 "no discharge permits" specifically list technical standards to be applied for waste management system design, including the NRCS FOTG and AWMFH. This lack of specificity allows the ADEQ to protect itself from further litigation because the suggestions published by the USDA NRCS are not legally binding in this case. In the future, it is recommended that ARG590000 be revised to include specific design parameters and guidelines dictated by ADEQ, similar to APC&EC Regulation 5 requirements. By adding these details, design and permit engineers can have clear guidelines to follow throughout the design and approval process.

It should be noted that clay-lined lagoons have been used in karstic areas of Arkansas in the past. APC&EC Regulation 5 dictated the design standard for waste lagoons to be the AWMFH. The "no-discharge" permits provided by ADEQ in the past have all been based on these standards. The difference is the amount of waste produced at C&H Hog Farms is much larger than other permitted farms in the Buffalo River watershed. With this in mind, the state of Arkansas has consistently minimized the potential implications of the geology of the northwest corner of Arkansas in permitting of farming facilities. It is recommended that the state's past approvals in this geologically sensitive area should be examined.

Even with this consideration, the ADEQ is required to protect all waters of the state, which include "all streams, lakes, 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 upon this state or any portion of this state" (Arkansas Pollution Control and Ecology Commission 2012). Based on this information, ADEQ must maintain groundwater quality around all waste lagoons. It is not guaranteed that the ground or surface water will result in contamination due to the karstic bedrock, but the USDA NRCS provided safeguards in AWMFH to avoid these possible situations. Despite these recommendations, the design and permit engineers did not appear to consider the geologic formations characteristic of Newton County in the approval of the coverage of C&H Hog Farms.

The primary concern with the lagoon liner design is the possible contamination of groundwater. Due to the karstic features of this area, the waste seeping from the lagoons will not have a chance to attenuate the contaminants, which in turn could lead to degradation of the surface water. The Boone formation is not characterized by large sinkholes; instead, this geologic formation is known for its solution channels, which may increase surface to ground water interaction. The greatest risk involving the compacted clay liners will be the contamination of the surface water, not the failure of the lagoon structures due to the dissolved bedrock. The failure of the bedrock is still a concern due to the loadings of the waste on the bedrock, but it is not as probable due to the characteristics of the Boone formation. In addition, NRCS Code 313 "Waste Storage Facility" lists four potential impact categories for liner failure, including "the site is located in an area of solutionized bedrock such as limestone or gypsum" (United States Department of Agriculture Natural Resources Conservation Service 2003). These standards do not state that waste management systems cannot exist in these areas, but additional safety measures should be put in place in order to avoid possible impacts.

a. Clay liner conclusions

Following the analysis of the AWMFH and other design standards, it is recommended that future waste lagoons in karstic regions be designed using more conservative parameters such as synthetic or concrete liners or soil dispersants, as suggested in the AWMFH. The current design for the liner does comply with portions of the USDA NRCS standards, but it does not take the overall recommendations of the agriculture agency communities. Groundwater degradation is still possible for facilities that practice waste application on adjacent fields, but following industry-recommended design standards for the design of waste lagoons could decrease environmental impacts from CAFOs. These lagoon liner alternatives would not have completely eliminated all waste seepage from the impoundments, but it would have lowered the overall risks. It is also important to note that these conservative liners or soil additives would not have protected the groundwater in a case where the karst geology had deep sinkholes. Due to the weak properties of karst bedrock, the overall geologic foundation of the lagoons still could have resulted in a structural failure. This catastrophic result would not be prevented by these conservative measures, but due to the Boone formation's overall characteristics, this type of accident would be rare.

Despite the environmental benefits of conservative lagoon liner designs, it is understood that these extra precautions can become an economic burden to operators. For example, synthetic or concrete liners are more expensive options for facility operators to implement, but in karst areas such as Newton County, Arkansas, the additional expenditures could prevent groundwater contamination. According to the AWMFH, the cost of the liners per square foot increases from \$0.17-0.28/ft^2 for traditional, 1.5-foot thick compacted clay liners to \$0.50-

1.25/ft^2 for geosynthetic liners and \$7.50-8.00/ft^2 for 5-inch, reinforced concrete liners (United States Department of Agriculture Natural Resource Conservation Service 2009). This means that the geosynthetic liner would cost approximately 3 to 4.5 times the price of the 18-inch compacted clay liner. The concrete liner cost would be 28.5 to 44 times the cost of the 18-inch compacted clay liner. These additional costs are significant, but they could prevent the eventual shut down of the entire farming facility in the case of surface or ground water degradation. This could result if the state of Arkansas determines that C&H Hog Farms is threatening the high quality ecosystems found in Big Creek and Buffalo River waterways. After evaluating the design guidelines used for C&H Hog Farms, the ADEQ had the authority to request the construction of a more conservative liner system for the waste ponds. It is of the opinion of the author that these measures provide the necessary safeguards recommended by federal design guidelines for areas of karst geology as seen in Newton County, Arkansas. The additional construction costs could have provided more confidence in the design for the facility operators, state officials, and academic advisors. This would not have completely prevented the public or academic upset over the location of the facility, but it would have strengthened the design prepared.

2. Nutrient Management Plan

When designing a nutrient management system, engineers must use engineering judgment, industry and regulatory standards, along with formulas and software in order to design these complex systems.

a. Land application calculations

The NMP does not match the information provided in the NOI. For instance, the waste from the lagoons is to be extracted and land applied every 180 or 270 days, as per the design section of

the NOI. In the NMP, the PI was calculated for the fields from March to June only. The NMP does not reflect the four seasons that the hog farm may have to apply manure to the fields. In order to avoid discharge, the farm must be able to land apply at any time throughout the year.

i. Overview of Arkansas Phosphorus Index (API)

The API is a risk assessment tool used to analyze possible phosphorus runoff from agricultural practices. It is used to "assess the risk of phosphorus runoff from pastures and hayland as part of farm nutrient management plan (NMP) development" (Sharpley et al. c). It takes into account source potential, transport potential, and the use of BMPs to determine a measured amount of risk. As seen in Table 2, the scale of risk is very high, high, medium, or low. As recommended by this index, values should remain in the low or medium API risk ranges.

P Index Value	Site Interpretations and Recommendations
Low < 33	Caution against long-term buildup of P in the soil.
Medium 33-66	Evaluate the Index and determine any field areas that could cause long-term concerns. Consider adding BMPs.
High 67-100	Reduce litter application rate and re-run PI until the P index is in the Medium range.
Very High > 100	No P application. Add BMPs to decrease this value below the Very High class in the short term and develop a conservation plan that would reduce the API value to a lower risk category, with a long-term goal of a value in the Medium class or lower.

Table 2. Interpretation and Recommendations for API (Sharpley et al. a).

Various inputs are involved in determining the API risk including soil and manure management, risk of runoff and erosion, field slope and proximity to streams and practice of

industry-approved site characteristics including diversions, ponds, filter strips, riparian forest buffers and field borders.

The API is computed using:

P Index = P Source Potential * P Transport Potential * BMPs Multiplier [Equation 1]

The P Potential characteristics include soil test P, soluble P application rate, soil erosion, soil runoff class, flooding frequency, application method, and timing of P application (Sharpley et al.).

P Source Potential is calculated using the following equation:

$$\text{P Source Potential} = \{WEP_{coef} * [WEP_{app} + MNRL_{coef} * (TP_{app} - WEP_{app})]\} + \{STP_{coef} * STP\}$$

[Equation 2]

The Soil test P (STP) is in lbs/acre and is found through sampling procedures and laboratory testing. It is found by extracting 0-4 inches of soil from the site. The Water extractable P (WEP_{app}) is also completed using standard procedures to estimate WEP. The total amount of phosphorus applied (TP_{app}) is determined by the University of Arkansas Diagnostics Lab using standard procedures. The mineralization factor ($MNRL_{coef}$), water extractable P (WEP_{coef}), and soil test P (STP_{coef}) are all factors applied to the equation in order to account for various differences. These values depend on the physical state of the waste product and whether or not it is treated chemically with alum, for instance. For C&H Hog Farms, the untreated liquid manure would have values of 0.031, 0.05, and 0.0018 for WEP_{coef}, $MNRL_{coef}$, and STP_{coef}, respectively. The liquid biosolids used on Fields 5-9 would have a different WEP_{coef} of 0.029. Typical values are not provided in the API guidance document for WEP_{app}, TP_{app}, or STP.

The P Transport Potential is calculated using the following equation:

P Transport Potential = Soil erosion + Runoff class + Flooding frequency + Application method + Application timing [Equation 3]

The loss rating values (LRV) are assigned to the components of Equation 3 based on tables, measured data, and industry standards. The LRVs are then input into Equation 3 in order to determine the total phosphorus transport potential. Soil erosion is found using the USDA NRCS tool RUSLE2, which estimates soil loss in tons/acre/year. FSA 9531 states that this value is usually near zero for well-managed fields (Sharpley et al. c). In the NMP for C&H Hog Farms, the RUSLE2 values used ranged from 0.05 to 6.6 tons/acre. In order to determine the LRV for soil runoff class, the pasture use, soil hydrologic group, runoff curve number, and slope must be determined for each field. Soil classification information is provided by the NRCS on two different websites, but the guidance documents also encourage site visits in order to "refine the estimate" (Sharpley et al. c). The runoff curve number is based on pasture management and soil hydrologic group based on a one-year, 24-hour storm event. "The soil runoff classes are Negligible (0.2-0.4 cfs/ac/in), Very Low (0.5-0.6 cfs/ac/in), Low (0.7-0.8 cfs/ac/in), Moderate (0.9-1.0 cfs/ac/in), High (1.1-1.2 cfs/ac/in), and Very High (1.3-1.4 cfs/ac/in)" (Sharpley et al. c). The flooding frequency LRV is determined using the USDA NRCS Soil Survey Tool found online (USDA NRCS 2013). By choosing a land area in the US on the maps provided in the tool, the flooding frequency of none or very rare, rare, occasional, or frequent is provided. This NMP does not consider various seasons of the year for the application timing LRV; instead, it only considers application in March-June. The LRV for this period of time is lower than the other growing seasons, excluding the dormant winter period from December to February. This coincides with the NMP which states "most land applications will be conducted in the spring, summer, and fall" (Arkansas Department of Environmental Quality 2012). Pasture management

can be listed as continuously grazed, rotationally grazed, or hayed. Fields that are continuously grazed typically have higher P runoff values caused by "compaction and additional P inputs from cattle" (Sharpley et al. c). In the original NMP, the fields are either rotationally grazed or hayed. The newer application rates completed for the winter months showed that these fields were continuously grazed with less than 0.75 animal units/acre, where an animal unit is defined as 1000 lbs. The application method listed throughout the NMP is surface applied which corresponds with a LRV of 0.2. The flooding frequency is determined by the USDA NRCS survey information database (USDA NRCS 2013). For the fields at C&H Hog Farms, they are either listed as occasional or none.

For the best management practices multiplier, nine BMPs are considered with different amounts of credit, which meet NRCS conservation practice standards. The nine BMPs include diversions, terraces, ponds, filter strips, grassed waterways, paddock fencing, riparian herbaceous buffers, and field borders. If BMPs are not used, then the BMP multiplier is equal to one.

The BMPs multiplier equation is calculated using the following equation:

$$\text{BMPs Multiplier} = \{(1 - \text{Effectiveness}_1)*(1 - \text{Effectiveness}_2)*\ldots*(1\text{-Effectiveness}_9)\} \quad \text{[Eqn 4]}$$

Once these values are calculated based on laboratory tests, typical values, and BMP credits, the API can be calculated. The risk classes range from low, medium, high, or very high based on the value determined in the equation. The P Index values relate strictly to the P application rates input into the equation. The N application rates must be considered as well. Once a field reaches a very high PI range, application must cease on the land. At the high PI risk range, the nutrient management planner must implement conservation measures in order to try to keep the land at a medium class or lower for PI.

ii. Comparison of API calculations

Through the complaints by the citizen groups, concerns over the NMP have been described. The actual land used for application is still unknown by the general public due to issues with the application maps and acreage provided by C&H Hog Farms to ADEQ. Also, certain land was noted as being available for land application in the original NMP, even though actual land owners had objected to the use of their property for waste disposal. The issues with the boundaries and buffers include only a small portion of the issues with the NMP completed in May of 2012 by Nathan Pesta and stamped by Geoffrey H. Bates, PE. For instance, Fields 5-7 and 9 contain many unknown values for parameters necessary to complete an estimate for the PI range. For these four fields, the NMP provided to ADEQ does not include information on soil name, K_f, K_f used, soil hydrologic group, RUSLE1, runoff curve number, soil runoff class, soil runoff LRV, flooding frequency LRV, total P transport value, pre BMP PI value, PI range, or post BMP PI value. This means that for 24 percent of the land application area, PI values were not calculated as required by Section 1.5.1.2 of ARG590000. The reasons behind these omissions are not known. This section of the general permit requires that all operators submit a "nutrient management plan with the NOI that meets the requirements of 40 CFR 122 and 412 and have been developed in accordance with Arkansas Natural Resource Conversation Service Practice Standard Code 590 (Nutrient Management), including the Arkansas Phosphorus Index, 2010 Revision" (Arkansas Department of Environmental Quality 2011a). Also, it is important to note that even if these fields do not require prudent application of phosphorus, the PI value should still be provided as "low". The values not added for Fields 5-7 and 9 were applied for the remaining fields, so it is possible to find these values with the information provided by the USDA NRCS surveys (USDA NRCS 2013). The application rates for these fields could be

dependent upon the nitrogen levels in the soil, but a PI value should still be assigned despite the other compound's restrictions as per ARG590000.

In the API, a majority of the information for the application fields is provided by the USDA NRCS Web Soil Survey (USDA NRCS 2013). This online tool provides information, such as flooding frequency, hydrologic soil classification, K_f values, carbonate concentration, and depth to water table, for land throughout the US. The Web Soil Survey allows designers to determine some of the necessary values to calculate the API range, but additional site investigations are useful as well.

After Pesta completed the original NMP in 2012, supplemental information was provided prior to the cool season land application for C&H Hog Farms in December of 2013 (Henson 2013b). The winter land application rates were completed by nutrient management planner, Monica Hancock. She calculated the PI range for fields 3, 9, 10, 15, and 17. These fields were proposed land application sites. Based on the inspection report completed by ADEQ in January 2014, only fields 3, 15, and 17 were used for waste application. In order to provide an analysis of the original NMP, the values provided by Monica Hancock in 2013 are compared to those determined by Nathan Pesta in 2012.

The county information provided by both nutrient management planners was the same, as seen in Table 3 below. The nutrient source type used by Hancock was strictly liquid manure, which comes from waste storage pond (WSP) #2 according to Pesta's NMP. Pesta denotes the waste as being liquid biosolids in WSP#1 and liquid manure in WSP#2, as seen in Table 4. The waste in both WSPs comes from the same source, so these types of waste should be the same. Defining the waste in WSP#1 is incorrect because liquid biosolids are defined as "sewage sludge" in API guidance documents (Sharpley et al. a). Also, the US EPA defines liquid

biosolids as being "nutrient-rich organic materials resulting from the treatment of domestic sewage in a treatment facility" (EPA 2012a). Based on these definitions, the waste in WSP#1 cannot be considered to be constituted of liquid biosolids because it is not a product of domestic waste or any form of treatment; instead, it is raw, liquid manure. Pesta's assumptions are incorrect, while Hancock remediated the original NMP by considering all waste to be liquid manure.

County Information	
Farm County	Newton
R	270
10-Yr EI	110
Kf adjusted for frost?	Yes

Table 3. Information on Newton County, Arkansas in NMP (Arkansas Department of Environmental Quality 2012).

The nutrient concentrations provided by Hancock in Table 4 were determined using laboratory tests. Originally, Pesta estimated the waste to be comprised of the nutrient concentrations listed in Table 4. For the water extractable P (WEP) concentration used in the 2012 NMP, two different values were provided by Pesta. This typographical error is highlighted in purple. For fields 1-10, the WEP concentration was given as 0.07 lb WEP/1000 gal, while it was 0.7 lb WEP/1000 gal for Fields 11-17. This assumed typographic error was overlooked by ADEQ in their review. This type of mistake is significant because the WEP concentration is important in the calculation of the PI range.

Manure Source	Source Type	Amount Available (1000 gal)	N Concentration (lb/1000 gal)	P_2O_5 Concentration (lb/1000 gal)	K_2O Concentration (lb/1000 gal)	Water Extractable P (lb/1000 gal)
WSP	Liquid Manure	848	12.61	10.06	10.54	1.15
WSP #1	Liquid Biosolids	1230	37.6	28.9	29.1	1.9
WSP #2	Liquid Manure	1531	30.2	23.2	23.4	0.07

Table 4: Nutrient Source and Description

In the next section of the NMP, shown in Table 5, Hancock assumed losses of 25% for nitrogen caused by application. This is due to the volatilization of nitrogen during application, as seen in examples provided by the UA Extension Service document titled "Soil Phosphorus: Management and Recommendations" (Sharpley et al. b). No other assumed losses were determined in the winter application rate calculations. Pesta's calculations heavily relied on nutrient losses for storage and application. As seen in Table 5, the 2012 plan assumed nitrogen losses caused by storage and application losses, which are not typical according to guidance documents. Furthermore, concentrations of P_2O_5 and K_2O were assumed to lose 80% due to storage losses. This means that overall Pesta assumed that only 20% of the concentrations of the constituents would be available for plant consumption, which is not practical. By assuming these high losses, Pesta's available concentrations are substantially less than those calculated by Hancock as seen in Table 6. For instance, Hancock's concentrations are 36.3%, 53.9%, and 55.6% higher than those determined by Pesta for N, P_2O_5, and K_2O, respectively. These values are extremely varied, and they show that Pesta's assumptions were overly conservative due to the losses.

Nutrient Source Description	N		P_2O_5		K_2O	
	Storage Losses (%)	Appl. Losses (%)	Storage Losses (%)	Appl. Losses (%)	Storage Losses (%)	Appl. Losses (%)
WSP		25%				
WSP #1	60%	50%	80%		80%	
WSP #2	60%	50%	80%		80%	

Table 5: Nutrient Loss and Mineralization Factors

Nutrient Source	N		P_2O_5		K_2O		Water Extractable P	
	Concentration (lb/1000 gal)	Total (lb)	Concentration (lb/1000 gal)	Total (lb)	Concentration (lb/1000 gal)	Total (lb)	Concentration (lb/1000 gal)	Total (lb)
WSP	9.46	8020	10.06	8531	10.54	8938	1.15	975.2
WSP #1	7.52	9250	5.78	7109	5.82	7159	1.9	2337
WSP #2	6.04	9247	4.64	7104	4.68	7165	0.07	107.17

Table 6: Estimated Plant Available Nutrients

The following section for comparison is the Field P Index Calculations, as seen in Table 7. The soil phosphorus levels are the same for each nutrient management planner because they are based on soil tests performed by University of Arkansas Division of Agriculture Cooperative Extension Service. The actual test results from February 17, 2012 are published in the original NMP (Arkansas Department of Environmental Quality 2012). The soil results show the nutrient availability indices for compounds such as P, K, Ca, Mg, SO_4-S, Zn, Fe, Mn, Cu, B, and NO_3-N. Not all of these concentrations are used in the API, but this information is collected to determine if these other compounds and heavy metals could be application rate limiting. Soil properties and recommended application rates for warm-season grasses in units of lb/acre were provided through the soil tests. The soil map units, slope gradients, and flooding frequencies for each field were listed in the field PI calculations were determined from USDA NRCS Web Soil Survey. The slope gradient is characterized by minimum, maximum, representative, and used values for each field. Usually, the representative slope gradient is used in the calculations,

except for Field 3 in the original NMP. The used slope gradient for Field 3 was 14%, even though the representative slope gradient was 2%. This appears to be another typographical error that was not identified during the review process. In December 2013, Hancock corrected this mistake by changing the used slope gradient to the same value as the representative gradient. The other slope values used by the nutrient management planners are identical, as seen in Table 7.

Fields Shown	Soil Test P		Soil Map Unit	Slope Gradient (%)				Slope Length (ft)				Flooding Frequency
	ppm	lb/ac		Min	Max	Rep	Used	Min	Max	Rep	Used	
JH 3	42	56	48	0	3	2	2	15	75	45	45	Occasional
JH 15	15	20	43	8	20	14	14	15	30	20	20	None
JH 17	50	67	1	3	8	5	5	15	75	45	45	None
H3	42	56	48	0	3	2	14	15	75	45	23	Occasional
H15	15	20	43	8	20	14	14	15	30	20	20	None
H17	50	67	1	3	8	5	5.5	15	75	45	45	None

Table 7: Field P Index Calculations

It should be noted that the maximum slope gradients of some fields listed in the NMP have values of 20%. Also, the average of the minimum and maximum slope gradients provides the representative slope of 14%. This is an issue because using this average value does not represent the overall slope gradient of the field. It is recommended that the nutrient management planners use a weighted average in the determination of the slope gradient of the fields. Also, it is recommended that the maps denote the portions of the fields that have slopes greater than 15% to show the allowable land application area. In section 4.2.1.7 of ARG590000, slopes with a gradient greater than 15% cannot receive waste (Arkansas Department of Environmental Quality 2011a). By not denoting the exact areas available for land application in the maps and using

average slope values as the representative slope gradient, the farmers are at a greater risk of violating the terms of the general permit.

In Table 8, application area in acres was determined by the nutrient management planners through the subtraction of buffer length and width from the total available field area in acres. Then, the revised universal soil loss equation (RUSLE), published by the USDA, was used to determine the soil loss in tons/acre of each field. The use of the RUSLE provides the amount of soil expected to erode from an area of land due to storms and other natural events (USDA 2010). According to Dr. Sharpley and the API guidance documents, these values should be low (close to zero) as long as the groundcover is maintained and the slopes gradients are not high (Sharpley 2014). The RUSLE2 is a more advanced and recent erosion prediction tool than the RUSLE1(USDA 2010). For C&H Hog Farms, the RUSLE1 and RUSLE2 results were provided by the nutrient management planners. Hancock's RUSLE1 and RUSLE2 outputs are identical to one another while Pesta's RUSLE1 and RUSLE2 results vary, as seen in Table 8. By comparing the RUSLE2 calculations for Field 3, Pesta's RUSLE2 value is 0.01 tons/acre while Hancock's results show erosion of 0.05 tons/acre. These two values are close to zero, which is to be expected since the field has 95-100% ground coverage and a representative slope gradient of 2%. Field 15, on the other hand, shows dramatic differences between the application rate calculations. As seen in Table 8, Hancock calculates 0.28 tons/acre while Pesta has 5.2 tons/acre for the soil erosion loss for Field 15. In comparison to Field 3, these RUSLE2 values should be higher because Field 15 has a slope gradient of 14% while also maintaining 95-100% groundcover. Despite the increased slope gradient, Pesta's RUSLE2 result can also be interpreted as a loss of 634,608 lbs of soil per year for the entire field which is very high. This amount of erosion, without considering land application, would cause incredible sediment build-up which should

already be seen in water quality degradation of Big Creek. Hancock's value of 0.28 tons/acre for the RUSLE2 value seems more realistic in comparison to Pesta's. Also, the RUSLE2 values for Field 15 were much higher than the other fields, which correlate to the high slope gradient. For Field 17, the RUSLE1 calculation values are identical for both nutrient management planners; yet, the RUSLE2 calculations differ by almost an order of magnitude. Based on this information, Pesta's RUSLE2 values are high because they should be closer to 0 due to the inputs of slope and field maintenance.

Field	Field Area (ac)	Buffer Length (ft)	Buffer Width (ft)	Appl. Area (ac)	Predominate Vegetation	Percent Ground Cover (%)	Conservation Support Practices (P)	RUSLE 1 (ton/ac)	RUSLE 2 (ton/ac)
JH 3	15.9	1437	100	12.6	Grass	95-100	None in place	0.05	0.05
JH 15	42.6	3615	100	34.3	Grass	95-100	None in place	0.28	0.28
JH 17	52.3	3703	100	43.8	Grass	95-100	None in place	0.12	0.12
H3	15.9	1000	100	13.6	Grass	95-100	None in place	0.24	0.01
H15	66.3	2300	100	61.02	Grass	95-100	None in place	0.28	5.2
H17	88.7			88.7	Grass	95-100	None in place	0.12	1.1

Table 8: Field P Index Calculations, cont.

In Table 9, a continuation of the Field PI calculations, the application timing and pasture use inputs are different for each planner. Hancock's rates were calculated for application in the winter months of November to February on lands that would be continuously grazed by less than 0.75 animal units. Pesta's original NMP only considered land application from March to June on fields that would be used strictly for hayland. The pasture use of the fields provides different values of runoff curve numbers used in the API based on soil hydrologic group (Sharpley et al. a). A continuously grazed field has higher runoff curve numbers used in the API versus fields

used for rotational grazing or hayland. These pasture use differences are problematic in terms of ARG590000 as well. In the general permit, Section 3.2.6.3 describes substantial changes to the NMP to include the "addition of any crop or other uses not included in the terms of the CAFO's nutrient management plan" (Arkansas Department of Environmental Quality 2011a). This means that the different use provided in the new calculations actually violates the terms of the original NMP, meaning that Hancock computed application rates using a different pasture use. If C&H Hog Farms wishes to continue the pasture use of "continuously grazed <0.75 animal units," then the facility should request a major modification of the NMP. This type of oversight shows that ADEQ potentially allowed the facility operators to change the terms of the original NMP without following the general permit standards.

Field	Pasture Use	Application Method	Application Timing	Nutrient Source	Application Rate (1000 gal/ac)	Pre BMP PI Value	P Index Range	Target Post BMPs PI Values
JH 3	Continuously Grazed <0.75 An. Units	Surface Applied	Nov-Feb	WSP	7	31	Low	32
JH 15	Continuously Grazed <0.75 An. Units	Surface Applied	Nov-Feb	WSP	10	32	Low	32
JH 17	Continuously Grazed <0.75 An. Units	Surface Applied	Nov-Feb	WSP	7.5	31	Low	32
H3	Hayland	Surface Applied	March-June	WSP #1	10	47	Medium	
H15	Hayland	Surface Applied	March-June	WSP #1	9.9	63	Medium	
H17	Hayland	Surface Applied	March-June	WSP #1	18	58	Medium	

Table 9: Field P Index Calculations, cont.

To continue with the comparison of Table 9 above, the nutrient sources were not the same because Hancock's surface application uses liquid manure, while Pesta's rates are based on

the nutrient information for liquid biosolids. Also, nutrient application rates can be much greater in the spring and summer than during the winter because the crops need more nutrients during those growing seasons. Application during the winter is usually discouraged because the crops are not utilizing the nutrients at sufficient rates due to the lack of growth. This does not mean that land application cannot take place during these times. Hancock's land application rates must be lower to reflect the decreased need for the nutrients during the dormant season. This is true for Hancock, except that Field 15 has a higher rate by 100 gal/ac than Pesta's calculations. This could be caused by the significantly lower erosion impacts seen in Hancock's calculations versus Pesta's. Based on the seasonal and nutrient source differences, the application rates cannot be directly compared.

Based on Hancock's inputs, the overall Pre and Target Post BMP PI values have a low P-Index range for the three fields investigated, as seen in Table 9 above. Pesta's calculations produced a medium P-Index range for Fields 3, 15, and 17. The highest PI value determined for Field 15 is close to the high P Index range which begins at a value of 67. Target Post PI Values were not provided in Pesta's NMP. Neither nutrient management planners implemented BMPs for the application fields; therefore, the BMP multiplier was equal to 1.

From the Table 10 below, each nutrient management planner used identical PI Max and Planned application rates. The nutrient loading recommendation rates shown in Table 10 relate to the nutrient composition of the harvested crop of the land application fields. In this section, Pesta describes the commodity of the land application fields to be "bermudagrass teamed with tall fescue, hay" (Arkansas Department of Environmental Quality 2012). According to the designer, the nutrient composition of the dry harvested bermudagrass is 1.88% for N, 0.19% for P, and 1.4% for K in reference to Table 6-6 of the AWMFH. It is unknown where these values

were determined because Table 6-6 does not actually provide the nutrient percentages for N, P, or K for dry harvested commodities; instead, this table lists presents average concentrations of Ca, Mg, S, Cu, Mn, and Zn in various commodities. This error presents confusion in later calculations. In addition, Section C of the original NMP also notes that the yield goal of the commodity is 6.5 tons/acre in reference to the "U of A Cooperative Extension Service" (Arkansas Department of Environmental Quality 2012). Referencing the University of Arkansas Cooperative Extension Service without any documentation of the guidance document number or author is ambiguous. In order to search for the source of this yield goal, several guidance documents and industry standards were investigated. First, Table 6-6 in the AMWFH shows that bermudagrass has a typical yield of 8 tons/acre while tall fescue typically yields 3.5 tons/acre (United States Department of Agriculture Natural Resources Conservation Service 2012). When these values are averaged, assuming that the fields are "teaming" with fescue, a value of 5.75 tons/acre is determined. According to a UA Division of Agriculture guidance document FSA2139, the estimated yield potential for common bermudagrass and tall fescue are 5.8 and 4.6 tons/ac, respectively (Jennings and West). In comparison with these two guidance documents, Pesta's yield goal assumption is high; therefore, his values are not conservative. Based on the terms of the general permit, "the realistic yield goal for each crop or use" must be identified for each field (Arkansas Department of Environmental Quality 2011a). By choosing this high value, Pesta is not choosing a realistic yield goal; instead, he is choosing a value from an unknown reference that could possibly originate in North Dakota. Also, the commodities listed in Section C are for Newton and McHenry Counties in North Dakota. The locations provided do not match the actual county that C&H Hog Farms was built. This oversight could also explain why the values do not match up with Arkansas guidance documents.

Field	Nutrient Source	Application (1000 gal/ac)		Nutrient Recommendation (lb/ac)			Nutrients Applied (lb/ac)			Surpluses/Deficits (lb/ac)		
		PI Max	Planned	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
JH 3	WSP	7	7	100	0	80	66	70	74	-34	70	-6
JH 15	WSP	10	10	100	100	80	95	101	105	-5	1	25
JH 17	WSP	7.5	7.5	100	0	120	71	75	79	-29	75	-41
H3	WSP #1	10	10	489	57	220	75	58	58	-414	1	-162
H15	WSP #1	9.9	9.9	489	57	220	74	57	58	-415	0	-162
H17	WSP #1	18	18	489	57	220	135	104	105	-354	47	-115

Table 10: Field Nutrient Application Planning Per Acre Basis

As seen in Table 10 above, Hancock's nutrient loading recommendation rates vary from Pesta's. These values are different because Hancock follows the nutrient recommendations given for each application field based on the soil test reports provided by the University of Arkansas Division of Agriculture Cooperative Extension Service. The crops assumed throughout the soil tests were for warm-season grasses, such as bermudagrass. Table 11 shows the differences between the nutrient management planner recommendations against those given in the soil analysis reports completed by the University Of Arkansas Division Of Agriculture. As seen below, Pesta's values are not close to those provided by the University. The original NMP values were calculated solely based on a numeric basis, while Hancock's recommendations reflect those of the University. For certain fields, such as Field 15, Pesta is conservative with the application of phosphorus, but for other nutrients, such as nitrogen, his recommendations are over eight times higher than those of the University.

	Recommended Nutrient Loading (lb/acre)								
	Field 3			*Field 15*			*Field 17*		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
UA Agri	60	0	110	60	100	110	60	0	160
Hancock	100	0	80	100	100	80	100	0	120
Pesta	489	57	220	489	57	220	489	57	220

Table 11: Comparison of all recommendations

These differences in the surpluses and deficits for the fields, as seen in Table 12 below, can be attributed to the large difference of nutrient recommendation rates between the two nutrient management planners.

Field	Nutrient Source	Application (1000 gal)		Nutrient Recommendation (lb/ac)			Nutrients Applied (lb/ac)			Surpluses/Deficits (lb/ac)		
		PI Max	Planned	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
JH 3	WSP	88.2	88.2	1260	0	1008	834	887	930	-426	887	-78
JH 15	WSP	343.01	343.01	3430	3430	2744	3244	3451	3615	-186	21	871
JH 17	WSP	328.49	328.49	4380	0	5256	3107	3305	3462	-1273	3305	-1794
H3	WSP #1	136.04	136.04	6653	775	2993	1023	786	792	-5629	11	-2201
H15	WSP #1	604.1	604.1	29839	3478	13424	4543	3492	3516	-25296	14	-9909
H17	WSP #1	1596.6	1596.6	43374	5056	19514	12006	9228	9292	-31368	4172	-10222

Table 12: Field Nutrient Application Planning Per Field Basis

As seen in the comparison between these two land application rate calculations, the original assumptions of the nutrient composition of the manure (liquid biosolids or liquid manure) and the land application rate recommendations caused the final land application rate variations. The nutrient recommendations provided by Pesta relate to the nutrient uptake characteristics of the bermudagrass, while Hancock's nutrient recommendations are based on the soil properties provided by the test results from the University of Arkansas Extension Service. Recall that the recommendations provided in the soil tests reports consider the crop properties along with the necessary regulations, so Hancock accounts for both factors in determination of the recommended nutrient rates. The recommendations provided by Hancock are more conservative by taking soil and plant properties into account, unlike Pesta's NMP. Pesta had the results for the soil tests reports when completing the API calculations, so this information should have been considered in the recommendations.

It should also be noted that the soil analysis reports provided by the University of Arkansas Extension Service state in the notes that nitrogen should not be applied after September 1. This is due to the crop being characterized as "warm-season grasses" (Arkansas Department of Environmental Quality 2012). Also, the recommended values provided by the U of A should be applied "in spring when night temperatures are > 60 degrees F for 1 week" (Arkansas Department of Environmental Quality 2012). Neither nutrient management planner followed the recommendations or notes provided by the Extension Service. This oversight is not a question of validity with the land application rates, but it shows discrepancies in both sets of calculations. Overall, by comparing the two planners, Hancock's application rates are based on more practical and scientifically-sound values, but hog manure was available for analysis in the beginning.

It is recommended that the land application rates use the actual nutrient concentrations, as provided in lab testing, the true RUSLE1 and RUSLE2 values, and the correct crop and pasture use for the fields. Typographical errors should be removed, as well, in order to remove any doubt associated with the land application rate calculations. In addition, an investigation into the allowable land application rates based on the seasons is recommended.

b. Land application maps

According to the Director's response on February 20, 2014, ADEQ believes that the NMP for ARG590001follows the terms of ARG590000 (Marks 2014). The discrepancies in the land application fields and land lease agreements were addressed by the state agency's correspondence with C&H Hog Farms following two inspections. The ADEQ inspector, Jason Bolenbaugh, recognized the errors in the land application maps found in the NMP and informed C&H that they had to address these issues (Bolenbaugh 2013). Following the second inspection, the maps had not been adjusted to match the actual fields instead of the proposed fields. The

inspection completed on January 23, 2014 was prompted by a complaint from an individual regarding the boundaries of Application Field 12. According to the detailed description of the complaint published in the inspection report, after discussing the matter with C&H Hog Farms, the facility "acknowledged they were aware of the error and they were going to submit a new map with the revised NMP" (Bolenbaugh 2014). In the inspection report sent to C&H Hog Farms on January 28, 2014, Bolenbaugh requested a response to each violation by February 11, 2014. In this section, it was noted that "the maps in the NMP do not correctly identify the land application areas" for Fields 12 and 16 because land use contracts are not available for sections of these fields. In addition, Bolenbaugh requested that the actual acreage used for land application must match the value stated in the NMP. In the NOI attached to the Public Notice of Public Hearing published on February 19, 2014, the NMP did not change the area of land application; instead, it reported the same value of 630.7 acres (Arkansas Department of Environmental Quality 2014b). Also, this notice of public hearing stated that the NOI and revised NMP were received on February 11, 2014. As seen by these dates, C&H Hog Farms had the opportunity to change these minor modifications in the time allotted, but they did not revise the maps or acreage denoting the land application areas. Instead, the permittee chose to only provide the major modification to the permit in the revised NMP. According to the ADEQ database, there are not any amended maps of land application areas that take the loss of portions of Fields 5, 12, and 16 into consideration (Arkansas Department of Environmental Quality 2014a); therefore, despite the department's request for these changes, the maps have not been revised by the date requested. It should be noted that the loss of land application areas are not considered substantial modifications to the NMP, according to the terms of ARG590000 (Arkansas Department of Environmental Quality 2011a). As identified by Director Marks,

"adequate property exists for land application of all generated wastes, even without Field 5 and the questioned portions of Field 12 and 16" (Marks 2014). In a letter from Jason Henson to Jason Bolenbaugh dated September 20, 2013, he stated that "C&H Hog Farms is working with an engineer to revise the maps as requested" for Field 5 (Henson 2013a). As noted in the latest inspection report, the map for Field 5 still had an action item that was not completed within four months. These action items have not been completed; instead, they have simply been acknowledged by C&H Hog Farms.

In January of 2014, C&H Hog Farms requested a major revision to the NMP in order to change the application method for Fields 7-9 (Henson 2014b). Under these proposed changes, Fields 1-4 and 7-17 would use the VacTanker method to land apply (Arkansas Department of Environmental Quality 2014b). The revised NMP did not include changes to the land application field maps. This means that, despite the opportunity to make these minor revisions to the NMP, C&H Hog Farms has opted to further delay the correction of the land application area. As of publication of this case study, ADEQ has not published modified maps. This means that the facility has operated with erroneous land application maps for approximately one year.

According to C&H Hog Farms' response to the second inspection, the facility "has a certified nutrient management planner working on the revisions to the maps for Fields 12 and 16" and these changes will be sent to ADEQ "no later than March 30, 2014" (Henson 2014a). In addition, the letter states that the nutrient management planner is also working on revisions "related to the number of acres available for land application" which will also be submitted by March 30, 2014 (Henson 2014a). Although a date was provided for Fields 12 and 16, a timeline for Field 5 was still not addressed in this letter. As of January 28, 2014, C&H Hog Farms had

only land applied to Fields 3, 15, and 17, as shown in Figure 2. Currently, these fields do not have identified issues involving the land lease agreements or boundaries.

DATE	FIELD	TEMP	WIND/DIR	HOUR'S	GAL	CROP	METHOD	TOTAL ACRES	CONDITION OF FIELD	EQUIPMENT CON	POND LINER
12/27/2013	15	45	E AT 4	1	3,000	MIXED	HONEYWAGON	1	DRY	GOOD	GOOD
12/30/2013	15	40	SW AT 7	2	6,000	MIXED	HONEYWAGON	2	DRY	GOOD	GOOD
12/31/2013	15	52	S AT 4	6	24,000	MIXED	HONEYWAGON	9	DRY	GOOD	GOOD
1/16/2014	15	51	NW 16	5	18,000	MIXED	HONEYWAGON	7	DRY	GOOD	GOOD
1/16/2014	17	51	NW 16	2	6,000	MIXED	HONEYWAGON	2	Fair	GOOD	GOOD
1/19/2014	3	59	SSW 8	4	18,000	MIXED	HONEYWAGON	6	DRY	GOOD	GOOD
1/20/2014	15	66	NNW 6	6	36,000	MIXED	HONEYWAGON	13	DRY	GOOD	GOOD

Figure 2. Land application details (Bolenbaugh 2014).

c. Lease agreements

Part F of the original NMP land application field maps with incorrect property boundaries. The topographic maps are listed to have an approximate area of 685 acres, which is different from the areas of 630.7 acres provided in previous maps and calculations in the NMP and NOI. Due to these incorrect maps, surrounding landowners that did not provide consent for land application wrote letters to the ADEQ describing their concerns. They did not want their property rights infringed upon by the farm or the research completed on the land application fields.

There are also issues within the NMP that were not addressed in the comparison of the P Index calculations. For example, the "Local Zoning Ordinances" page found in Section A of the NMP is not completed, signed, or dated (Arkansas Department of Environmental Quality 2012). The land use contracts provided in Section G have misspelled landowner names, which causes the validity of the documents to be questioned (Arkansas Department of Environmental Quality 2012).

d. Karst terrain

The major concern related to land application on these karstic areas is the loss of nutrient and pathogen attenuation in the soil. The ground and surface waters are connected in karstic areas by

solution channels (Brahana 2014a). By losing the natural filtering process provided by typical soils, the nutrients are not diluted before entering the ground water and, subsequently, the surface water. This puts Big Creek at possible risk for water quality degradation; this does not mean that land application will assuredly occur in the future, but it could be a contributing factor if water quality is lost over time.

In the first inspection report, land application sites were identified that had limestone rock outcrops. For instance, Fields 1, 15, and 17 are located next to or have limestone rock outcrops (Bolenbaugh 2013). The aerial photos provided are the first acknowledgements by the ADEQ and C&H Hog Farms of possible karst terrain. These areas of questionable geology were not noted in the NOI, NMP, or EA. The actual area of land application for these fields is unknown; therefore, actual compliance with the setbacks required for karst features is unknown. This report is not assuming that the facility violated these BMPs during land application, but it is unknown if these boundaries were respected. The evidence provided in these maps questions the knowledge ADEQ and C&H Hog Farms had on the geology of the construction and land application areas.

A general permit is not required to include any special cases caused, for instance, by geology. ARG590000 assumes that the state's entire geographic area has the same pollution control measures, which may not be the case for this hog farm. As seen in the inspection report from July of 2013, the Department is aware of the karst features surrounding the hog farm in the land application fields. Karst topography is varied throughout an area, as seen in the corrected maps provided by Bolenbaugh's inspections (Bolenbaugh 2014).

The geology of the land application fields is also of concern throughout the NMP. The Soil Survey Tool provided by the USDA NRCS does not denote concentrations of $CaCO_3$ in the

soil, but information from the USGS shows that the bedrock of the land application fields is karstic (USDA NRCS 2013). These two references contradict one another. According to Figure 3, the geologic formations of the land application fields and facility are Bloyd (Qat), Batesville (Mbv), Boone (Mb), Fayetteville Shale (Mf), and Pitkin Limestone (Mp) (Braden and Ausbrooks 2003). A majority of the application fields are located on the Qat or Mb formations. The Bloyd formation is made up of alluvium and terrace deposits that are composed of "unconsolidated clay, silt, sand, and gravel" deposits with shaly or sandy limestone units (Braden and Ausbrooks 2003). Fields 3, 5-10, 12, and 16 are made up of the Bloyd alluvial formation that abuts Big Creek and its tributaries.

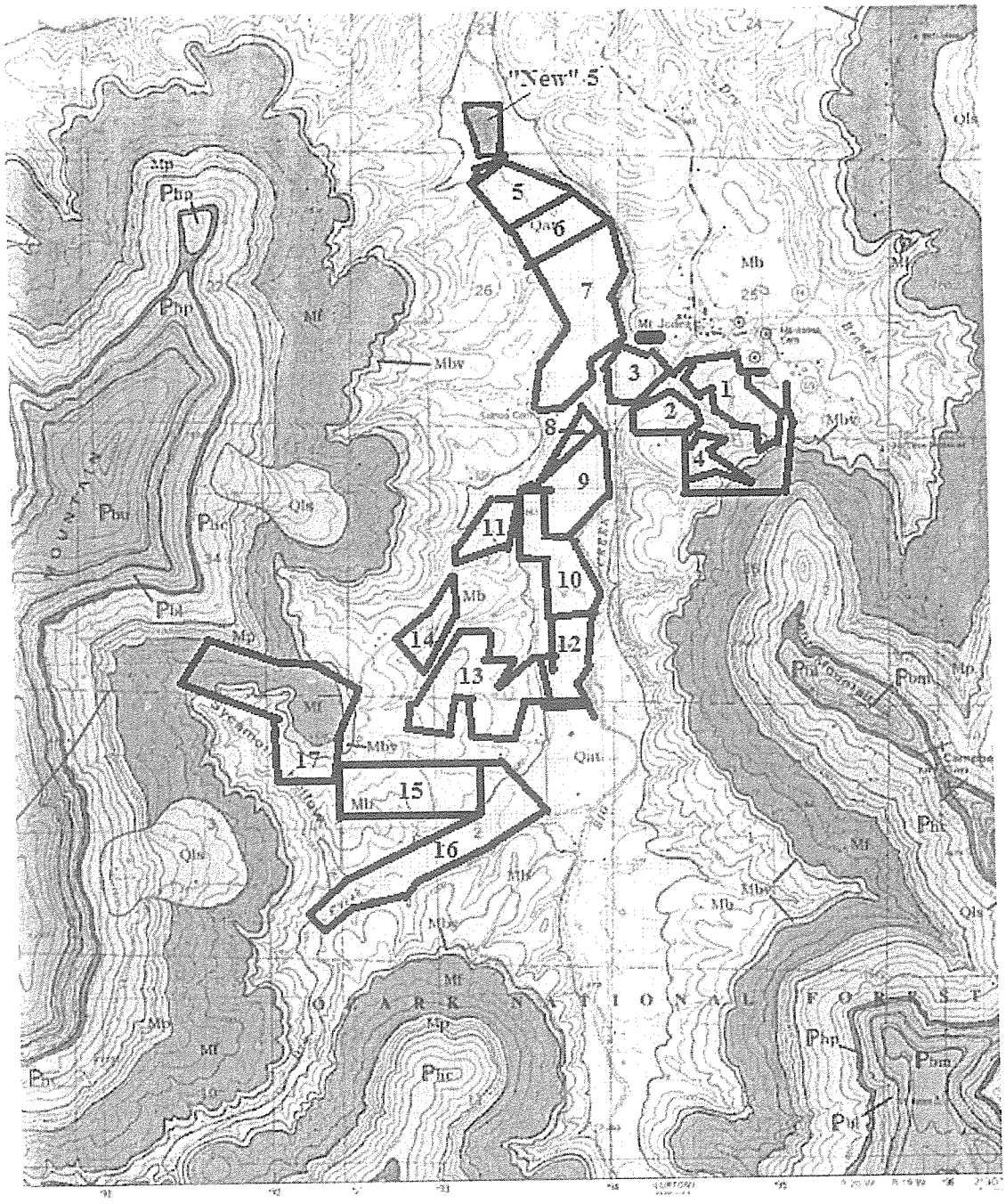

Figure 3: Geologic formations under land application fields (Braden and Ausbrooks 2003; as modified by Hovis 2014).

The other fields are predominantly composed of the Boone formation. This geologic formation is characterized by its "coarse-grained fossiliferous and fine-grained limestones interbedded with anastomosing and bedded chert" and is known for having abundant springs and

sinkholes (Braden and Ausbrooks 2003). The St. Joe Limestone Member of the Boone Formation is found "along the Buffalo River and Big Creek and their drainages south to Vendor in the central portion of the quadrangle," which is near Mt. Judea. The geologic formations of the karst terrain are made up, from shallowest to deepest, of Boone formation, cherty Boone, and finally St. Joe Limestone (Brahana 2014b). The limestone layer underlies all of the formations, so when the landscape has been eroded over time, the St. Joe Limestone is exposed.

BMPs are established by the general permit and other guidance documents in order to prevent agricultural storm water discharges. At C&H, BMPs were not included in the PI calculations for the land application fields, but setbacks are required by ADEQ in the general permit. These setbacks do not guarantee that the nutrients will not enter the waterways, but they act as methods of prevention. These setbacks, as given in the general permit, must be observed along waterways, property boundaries, residential areas, and sinkholes, for instance. Physical sinkholes or other conduits to surface waters must be seen at the soil surface in order to require a setback of 100 feet (Arkansas Department of Environmental Quality 2011a). Due to the properties of the Boone formation, sinkholes are not as abundant on the surface as the underground conduits to surface waters. In order to investigation the prevalence of karstic features at these land application fields, the Big Creek Research and Extension Team are conducting ground penetration radar tests (Cochran 2014).

3. Conclusion

When designing a nutrient management system, engineers must use engineering judgment, industry and regulatory standards, along with formulas and software in order to design these complex systems. These perceived errors expose the deficiencies in the original NMP. These issues highlight ADEQ's apparent non-discriminating approval during the original review

of the NOI and NMP. C&H Hog Farms has not land applied on questionable fields, so the facility has not violated the terms of the NMP by infringing on the property rights of the owners.

Ultimately, the original NMP for C&H Hog Farms has come under scrutiny from critics of the farm. As identified in this case study, the NMP has typographical mistakes, arbitrary assumptions, and erroneous maps. The land application rates for the hog facility depend on the manure composition and season, so these values can change for each application. The application rate values from calculations in December of 2013 were not constant, as required by the general permit (Henson 2013b). With the change of the pasture use, the land application rates calculated violated the terms of the general permit. In order to use the pasture for continuous grazing, the facility operators must submit the major modification to ADEQ and go through a public commenting period in order to use the pasture for this according to section 3.2.6.3(c) (Arkansas Department of Environmental Quality 2011a).

The extensive errors found in the NMP have concerned many citizens. It is recommended that corrected maps be provided to ADEQ. Also, calculations and assumptions should be reviewed once the permit is reopened to the public for comment. Currently, P-Index inputs for Fields 5-7 and 9 are blank. Due to this error, baseline land application rates are being used despite the incomplete information. This is problematic because future land application rates must follow the PI Max land application rates provided by Pesta, even though they were incorrectly calculated without the required inputs.

All in all, this NMP appears to violate the terms of the general permit. The API is supposed to be used as a risk management tool in order to "determine maximum application rates of P on pastures, as a function of source potential, transport potential, presence of best management practices and an acceptable level of risk" (Sharpley et al. c). Since the inputs and

calculations computed in the API are not used properly, then the maximum application rates of P are incorrect. The use of faulty assumptions and incorrect calculations negate the purpose of implementation of the API.

D. Environmental Assessment

In addition to the concerns with ADEQ, activist groups have also questioned other government agencies over the environmental assessment (EA) completed for C&H Hog Farms. Due to the high costs of construction and purchase of land, the CAFO operators applied for loan guarantees from the federal government. The FSA and SBA provided loan guarantees of $1,302,000 and $2,318,136, respectively, in order to purchase 23.43 acres of land and construct the farrowing and gestation barns. The loan guarantees were provided to Farm Credit Services in order to remove the risk from the bank for this large sum of money.

Prior to granting these guarantees, the federal agencies had to follow the necessary procedures outlined in the National Environmental Policy Act (NEPA) to approve the proposed uses of federal funds. NEPA requires any request for federal funding to undergo an Environmental Site Assessment (ESA) to ensure that the project funds will not be used in a way that would negatively impact the human or natural environment. Each federal agency must follow the terms of the NEPA while additionally following their own policies specific to their agencies. Once an ESA is completed by a federal agency, such as the USDA or SBA, the process can either end with a finding of no significant impact (FONSI) or continue with a formal environmental site investigation (ESI) which requires further analysis of the site to examine possible impacts of the project. The ESI entails the expertise of various professionals to determine the extent of possible harm to the environment. If the proposed project is determined to cause environmental issues then conditional mitigation measures must be put in place. The

regulations to be considered in the EA process using the USDA FSA guidelines can be seen in Figure 4 below. These regulations serve as the constraints of the proposed action.

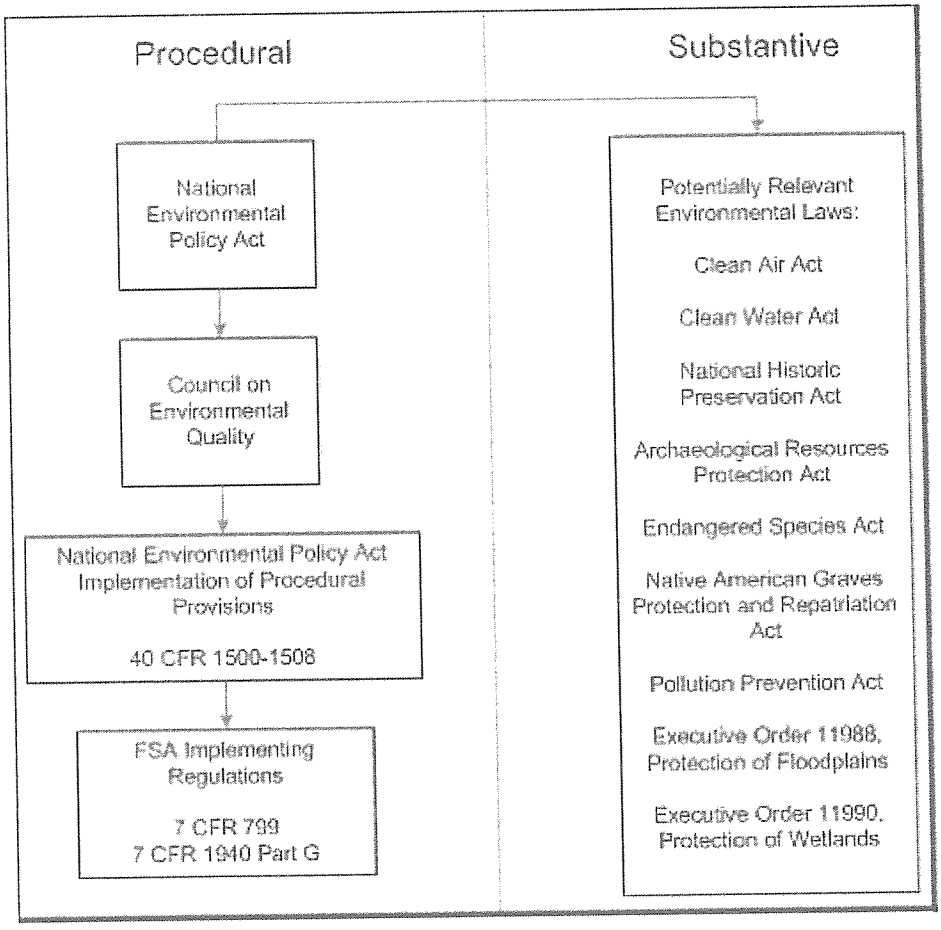

Figure 4: Regulations considered in USDA FSA ESAs (USDA Farm Service Agency 2009).

In the case of C&H Hog Farms, the CAFO operators applied for loan guarantees from both the FSA and SBA in order to purchase 23.43 acres of land and construct the farrowing and gestation barns on the land purchased with the federal funds. While following USDA standards, the FSA completed a Class II Environmental Assessment (EA), which resulted in a finding of no significant impact (FONSI). The SBA did not complete a separate EA due to its own guidelines. According to the SBA standard operating procedures (SOP 90 57), "the SBA should participate

in the evaluation of environmental impact" if "SBA's involvement begins only after environmental assessments are completed and accepted, then SBA will not require any additional environmental evaluation" (U.S. Small Business Administration 1980).

It is difficult to find documentation on SBA's input or comments on the EA. According to a letter requested by Kevin Cassidy, an Earthrise attorney, there is no available communication at the SBA on the loan guarantee to C&H Hog Farms because "loan files are not generated for electronic loan" according to a paralegal for the SBA (Lado et al. 2013). The only information determined was that the loan guarantee was approved on November 16, 2012. Based on this letter, it is assumed that the SBA became involved with the hog farm after the USDA FSA processed the EA and FONSI.

The earliest signed document between the USDA FSA and C&H Hog Farms was an Environmental Inspection Report signed and appraised by Jim Wiedeman on January 30, 2012 for the C&H Farms file (USDA FSA 2012). Assuming that the FCS had communicated originally with the USDA FSA to start the documentation involved with an EA, the SBA relied on SOP 90 57 in order to avoid the additional NEPA process for the same proposed land and construction project. By completing one EA for C&H Hog Farms, the federal agencies avoided redundant procedures. Due to the FONSI determined from the single EA, the SBA and FSA guaranteed the loan amounts requested by the farm. The land application fields were not included in the EA because federal money was not used to purchase or construct anything on these lands.

Since the loan guarantees were provided by the federal agencies, the public has questioned the legitimacy of the EA completed for C&H Hog Farms. Opponents of the hog farm have banded together to sue the federal agencies for violating the NEPA, Endangered Species

Act, Buffalo National River Enabling Act, and Administrative Procedure Act (Bates et al. 2013). In order to determine the legitimacy of the EA completed for C&H Hog Farms, an analysis will be provided in this case study.

The EA was completed by the FSA on September 26, 2012. According to a template provided in the FSA Handbook, an EA should have a title page, a cover sheet, and a table of contents listing the organization of the entire document (USDA Farm Service Agency 2009). The EA for C&H Hog Farms includes a majority of the recommended information as dictated in this template. It does not include the SBA as a sponsoring or cooperative agency; instead, it includes cooperating agencies to be the State Historic Preservation Office (SHPO), US Fish and Wildlife Service (US FWS), US Forestry Service (USFS), ADEQ, NRCS, Federal Emergency Management Agency (FEMA), and National Park Service (NPS). The executive summary includes an introduction, description of proposed action and alternatives, affected environment and environmental consequences, cumulative impacts, mitigation measures, list of preparers, list of persons and agencies contacted, references, and followed by Appendices A, B, and C. According to the template, the sections affected environment and environmental consequences should be considered separately to address each of the ten resources discussed in the affected environment required by the USDA FSA as seen in Figure 5 below. The resources and necessary forms used in the EA for C&H Hog Farms are those found for the Farm Ownership loan guarantee for "Farmland purchased, new ground disturbance planned," as seen in the highlighted portion of Figure 5.

Proposed Action/Activity	No NEPA	CATEX	EIL	EA	Wetlands/Floodplains	Surface Water	Sole Source Aquifers	Coastal Zone Management	Coastal Barrier Resources	Wildlife (including Threatened & Endangered)	Vegetation	Cultural Resources	Soils Not in 41-58	Air	Noise	Important Land Resources (including Wild and Scenic Rivers & National Natural Landmarks)	Social and Economic	Environmental Justice	FSA-850 (EIL for EP)	RD 1940-22 (EE for EIAP)	AD-1026	NRCS CPA-026	ESA, Section 7 Consultation	NHPA, Section 106 Consultation
LMD																								
Direct and Guaranteed Loans																								
Farm Ownership																								
Closing costs	X																							
Construction, addition to existing structure		X	X							X		X		X	X		X			X				
Construction, disturbed areas 1/				X	X	X	X	X	X	X		X		X	X			X						
Construction, nondisturbed areas				X	X	X	X	X	X	X	X	X	X	X	X	X		X					X	X
Conservation Easements	X																							
Develop farmland				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X
Enlarge existing farm		X	X		X	X	X			X	X	X	X	X	X	X	X	X					X	X
Farmland purchase, new ground disturbance planned				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X			X	X
Farmland purchase, no new ground disturbance planned		X	X													X	X	X		X				
Irrigation/wells		X	X			X	X			X	X	X	X											
Improve/repair, structures 50 years old or older		X	X									X		X		X				X				X
Improve/repair, structures under 50 years old		X	X											X		X				X				

Figure 5: Farm Ownership Loan Consideration Requirements (USDA Farm Service Agency 2009).

The introduction section lists the acreage of the farm to be 478.93 acres. This does not correlate with the value provided throughout the general permit and NMP completed for C&H Hog Farms, which gave a value of 670.4 total acres. It is assumed that the 478.93 acres comprise the land owned by the operators of the farming facility. The purpose and need provided in the introduction states that "it is FSA's position that it is common knowledge that the local integrator, Cargill, has a need for hogs such as those that will be produced at this facility" (USDA FSA 2012). This statement shows the possible bias associated with the approval of this hog farm in Newton County prior to listing the alternatives in the NEPA process. The sections titled "regulatory compliance" and "organization of EA" are left blank, even though they should have been completed (USDA FSA 2012).

The overall organization of the EA is erratic and difficult to interpret, as explained in later detail. The USDA FSA explains "alternative designs and alternative projects were not considered" because "the location is in close proximity to the integrator's feed mill and process plant" and "the applicant wishes to produce hogs for Cargill, while living in a rural area" (USDA FSA 2012). The "no action alternative" was not considered by the federal agency because "the community will lose the potential financial benefits of this project" and the land is located near the integrator (USDA FSA 2012). Also, "alternative projects were not considered due to this being the most favorable location" (USDA FSA 2012). The agency disregarded the analysis of other alternatives. In the subsequent section of the EA, impacts to water or air quality resources could be avoided by following the CNMP provided by the hog farm. Biological resources would not be affected by the facility due to a "clearance determination by Arkansas Fish and Wildlife" (USDA FSA 2012). It should be noted that this agency does not exist. Also, the SHPO provided a "blanket clearance letter" to the FSA showing that cultural resources would not be impacted. Also, according to the EA, socioeconomic impacts would not be experienced because the facility does not alter the income of the surrounding citizens (USDA FSA 2012).

Overall, mitigation measures were not provided because the agencies assumed that operators would follow the NMP submitted to ADEQ. No appendices were listed even though approximately 600 pages of documents are attached to the EA. The attached documents are not organized in a logical method or explained as to why they are included in the EA. In addition, indecipherable maps without legends are scattered throughout the EA attachments. The researcher attempted to understand the information provided in the numerous pages, but only vague assumptions can be made as to why this information was included. It was determined that information on C&H Hog Farms and C&C Farm, the previous facility owned by the Campbell

brothers, was comingled throughout the EA appendix. Random forms such as Environmental Risk Survey Forms from the USDA FSA are included on undetermined land. The land is postulated to be owned by the farming families, and part of C&C Hog Farm later becomes included as land application fields for C&H Hog Farms. In the researcher's judgment, the only land that needs to have an Environmental Risk Survey Form should be the 23.43 acres possibly purchased using the federal funds. Following pages of appraisals of the 490 acres of land, driving directions to C&H Hog Farms are included. Next, FEMA Standard Flood Hazard Determination forms are provided for the approximately 490 acres of land owned by the operators. Once again, the researcher finds that the only land included in these forms for the EA is the 23.43 acres to be purchased with federal money. A USDA NRCS form on highly erodible land and wetland conservation determination is provided only for the proposed action land of 23.43 acres. An illegible map provided by the USDA FSA is included for an unknown reason followed by USDA Soil Conservation Service maps that show mostly soils around Jasper and Parthenon. These maps are not focused on showing the details of Mount Judea since this information is cut off due to the problematic printing or copying practice. A general soil map for Newton County is included as published by the USDA SCS Forest Service. These maps are followed by Highly Erodible Land Conservation and Wetland Conservation Certification forms for all operators of C&H Hog Farms for different pieces of land.

After additional unclear maps, a letter from the US FWS to the FCS is provided along with the original letter from the FCS to the US FWS. In addition, Farm Credit provided a letter sent to the Arkansas Historic Preservation Program (AHPP) that was stamped and sent back to the author on July 17, 2012 (USDA FSA 2012). These letters and forms are followed by the entire CNMP for C&C Hog Barn from February 2011 (USDA FSA 2012). Email

correspondence between the FSA and FCS was included followed by the ADEQ stormwater general NPDES permit approved for C&H Hog Farms. Subsequently, the NOC, NOI, and NMP for C&H Hog Farms were included in the EA. Duplicate copies of the stormwater permit and Stormwater Pollution Prevention Plan (SWPPP) were provided. The SWPPP showed that only 8.2 acres would be disturbed during construction of C&H Hog Farms. Democrat Gazette ad copy showing the dates of publication of the draft EA and FONSI were included to complete the EA.

As seen in this previous listing, various documents for C&C Hog Farm and C&H Hog Farms are intermingled throughout the assessment. Documents and notes on the permit and NMP for C&C Hog Farm are listed prior to those of C&H Hog Farms. Also, letters and other important permitting information are sandwiched in between land lease agreements for C&C Hog Farm.

The overall assessment is considered to be a Class II Environmental Assessment for livestock operations. The details listed in the introduction of the executive summary are not clear. The application states that it is to purchase 23.43 acres of land and construct two swine barns, but it lists the farm to consist of 478.93 acres. It is unknown as to how this land area was calculated because in previous documents to the ADEQ, C&H Hog Farms has a total of 670.3 acres when total land application fields are summed. The introduction also states that the farm "presently has a Cargill Hog operation that will shut down when the new barns are in production" (USDA FSA 2012). This is confusing because C&C is located in a different part of Newton County, Arkansas, not adjacent to C&H Hog Farms. The two farms are considered together in this EA, which should not happen for these loan guarantees. It is understood that the Campbells had to provide collateral for the loans given by the Farm Credit Service, but C&C

should be listed as a separate entity from C&H Hog Farms, which is done in the NOI and NOC provided by ADEQ under ARG590000.

According to the FSA guidelines, a "Class II EA will be prepared if there is the potential to impact" resources (USDA Farm Service Agency 2009). According to this statement, it is known that CAFOs can cause potential impacts if the proper agencies and actions are not taken in order to mitigate these problems. In order to determine that the impacts of the proposed actions will not negatively impact the human or natural environment, the EA process is followed. Consultations are required in order to ensure that a potentially impacted resource including "threatened and endangered species or their critical habitat, cultural resources, wetlands, or floodplains" will be protected (USDA Farm Service Agency 2009). According to the letter provided by the US FWS to the USDA FSA, an effects determination was not provided and the agency did not provide concurrence with the proposed action. The only thing listed included endangered, threatened, and candidate species in the general area along with BMPs for this operation. This was considered to be informal communication, as listed in the EA, which provided the necessary approval to determine that "there will be no impact to wildlife and/or any threatened or endangered species based on a clearance determination by Arkansas Fish and Wildlife" (USDA FSA 2012). The actual decision from the USDA FSA was not provided to the US FWS. Since this was not provided, the cooperative agency could not formally approve the proposed action. The USDA FSA potentially overstepped their jurisdiction in this sense. Later, in 2013, the US FWS stated that "the Service 1) never received a copy of the draft EA, 2) never provided any comments on the draft EA, 3) never received an effects determination from FSA, and 4) never concurred with an effects determination" for C&H Hog Farms. In addition, the cooperative agency concluded that "pursuant to section 7 of the ESA, it is the responsibility of

the federal action agency to make effect determinations and for projects that 'may affect' federally listed species request concurrence form the Service" (Chang et al. 2013). In addition, similar communication issues were identified in letters between The Department of Arkansas Heritage, part of the State Historic Preservation Office (SHPO), and the FSA. On June 26, 2012, Dan Benton of the Farm Credit Service informed the SHPO of the proposed action that requested a loan guarantee from the FSA for the construction of a 2500 head swine farm on 23.43 acres (USDA FSA 2012). The SHPO found that the construction would not impact the surrounding cultural resources, as denoted by a stamp dated and signed by the AHPP on July 16, 2012 (USDA FSA 2012). These statements expose the lack of interagency communication throughout the process. Farm Credit contacted the federal agencies instead of the USDA FSA officials.

Correspondence between the US Fish and Wildlife Service (US FWS) and FSA are provided. According to a letter from the US FWS to the FSA, the farm is to hold 2,500 hogs and be located near Ponca, Arkansas. In addition, the US FWS lists two endangered or threatened species and one candidate species found in this area. It provides BMPs and other standard practices that should be considered in the construction of facilities in "karst landscapes." The letter concludes by stating, "The comments herein are for the sole purpose of providing technical assistance to the action agency or for individual pre-project planning assistant. These comments and opinions should not be misconstrued as an 'effect determination' or considered as concurrence with any proceeding determination(s) by the action agency in accordance with Section 7 of the ESA" (USDA FSA 2012). This letter provides ways for the hog farm to mitigate impacts to endangered, threatened, and candidate species, but these considerations were not discussed in the executive summary of the EA. The NMP provided by C&H Hog Farms does not consider the land to be karstic, while the letter provided by the US FWS does. Also, the

executive summary of the EA, Section 3.1.2, states that Arkansas Fish and Wildlife provided clearance when in fact that agency does not exist. The federal agency is the US FWS and the state of Arkansas has an agency titled the Arkansas Game and Fish Commission. This information provided is not properly documented.

The no action alternative section should have included discourse on the continued operation of C&C Hog Farm. If C&H Hog Farms was not approved, the older hog farm would have continued operation in order to continue creating revenue for the families involved.

Also, the EA is supposed to be a decision tool used by federal agencies to make a decision on how to allocate funds for proposed projects. Ultimately, "the NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment" (Eccleston 2000). The decision making process needs to be "public, unbiased, and rigorous" involving a "systematic, interdisciplinary approach" (Eccleston 2000). After reviewing the EA for C&H Hog Farms, the federal agencies interacted in a multidisciplinary manner instead of interdisciplinary. According to Eccleston, a multidisciplinary process is one "in which specialists representing pertinent disciplines perform their assigned task with little or no interaction" (Eccleston 2000). Contrarily, an interdisciplinary approach "ensures integrated use of the natural and social sciences and the environmental design arts" (Eccleston 2000). Due to the correspondence between the agencies, it is alleged that the lead agency did not inform the other cooperating agencies of the actual boundaries of the farm and actions to be taken at the large CAFO.

Also when reviewing the EA, the general stormwater permit was examined. It was determined that more information should have been included on the listing of waterways where

the pollutants will run off in cases of discharge. In the permit, it is detailed that the sediments from construction would be discharged into "a unnamed tributary of the Big Creek" and then finally end in the White River (USDA FSA 2012). As seen in Figure 6, the Buffalo River discharges into the White River. This section should describe all waterways affected, as shown in the example included with this input. The correct list of waterways should include discharge from the unnamed tributary of Big Creek to Big Creek then into the Buffalo River ultimately discharging into the White River. The permit does not mention the Buffalo River as a transmitter of the possible construction discharge. It is unknown as to why this waterway was removed from the list. This detail should not be interpreted as a complete oversight by ADEQ, but it is important to notice. The sediment from eight acres of disturbed land would not be enough to cause irreparable harm to the ecosystem of the Buffalo River, but the national river should be listed as a waterway that would transport the construction runoff. In order for ADEQ to remain conservative and protect the uses of waterways in the state of Arkansas, it is recommended that all affected rivers be included.

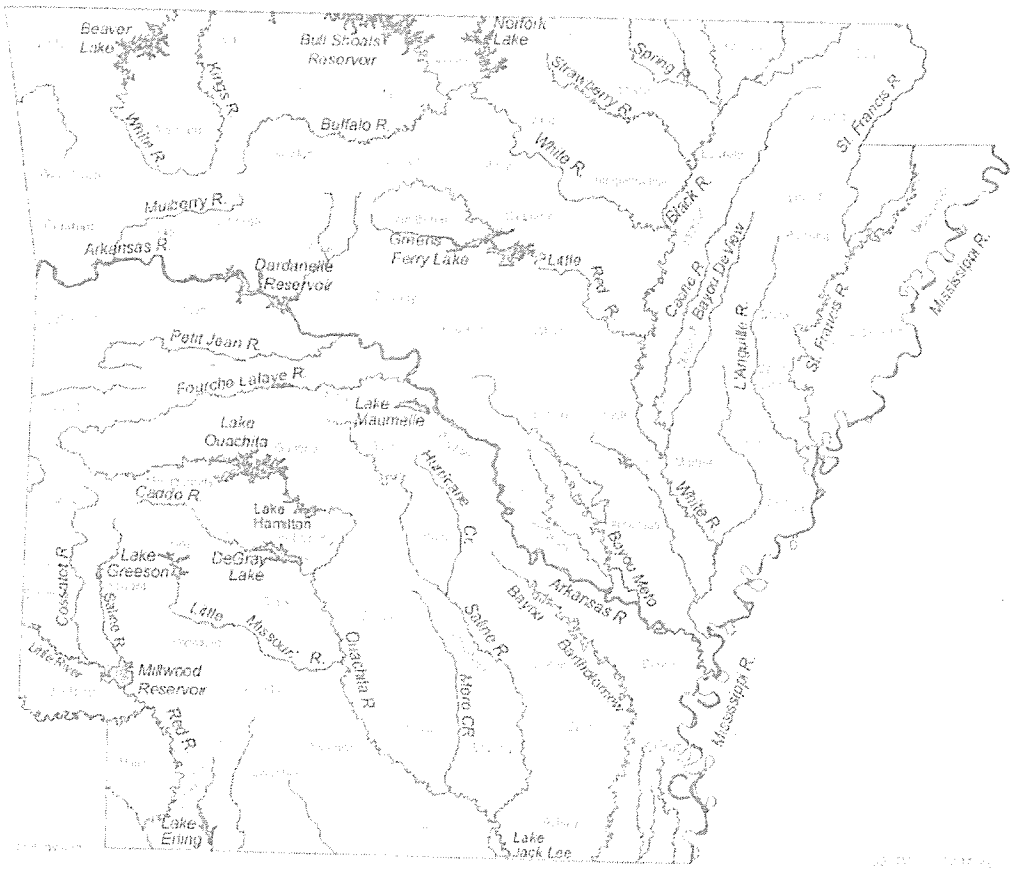

Figure 6: Map of Rivers in Arkansas (Anonymous 2014a).

IV. Response

A. Public Response

On February 27, 2013, Kevin Cheri, the Superintendent of the Buffalo National River (BNR), wrote a letter to the Farm Service Agency (FSA) outlining 45 flaws in the hog farm's NOI, NMP, and the environmental assessment (EA) (Cheri 2013). The letter was also forwarded to other politicians, federal agencies, state agencies, local tribes, and environmental activist groups. After his comments were published and the hog farm was publicized, locals realized that this hog farm was being built. Previously, many individuals did not know about the proposal or construction of C&H Hog Farms. In response, long-standing environmental groups such as the

Ozark Society and Arkansas Canoe Club started to spread the news of the hog farm. Also, concerned citizens united to form the Buffalo River Watershed Alliance (BRWA) to save the Buffalo River from this farm in the watershed and "help secure the future of our national treasure" (Buffalo River Watershed Alliance 2014). Quickly, the activist groups organized public meetings, letter-writing campaigns, and picketing events to show their disdain for the proposal of this "factory farm." At the beginning of their efforts, the groups did not understand that the farm was almost completely constructed. Misinformation about C&H Hog Farms spread throughout the state, and public meetings did not clear up questions that the public had regarding the farm. Outlandish statements at meetings evoked fear in attendees. Panelists at various meetings informed people that inhaling hog waste odors could cause damaging health effects to both children and adults, including cancer and asthma. Due to the proximity of the farm to the Mount Judea School, the children were projected to have issues with focus and concentration in the classroom due to the stench of the hog farm (Buffalo River Watershed Alliance 2013). These exclamatory statements, frightened citizens and increased public outcry.

In October of 2013, representatives from the Waterkeepers Alliance of North Carolina were showcased at seven locations around the state of Arkansas in a "whistle-stop tour" to inform Arkansans of the environmental, economic, and health impacts that CAFOs have on areas (Baldwin and Dove 2013). The graphic photos of dead and beaten hogs frightened citizens into believing that these images would become reality by allowing this CAFO to be built and permitted in the state of Arkansas.

Currently, researchers are working independently on a project to determine the benchmark conditions of the Big Creek Basin. Dr. Brahana believes that without preliminary data showing

the state of the watershed before the land application of waste around Mt Judea, future studies will not have values in which to compare their results.

B. Political Response

C&H Hog Farms became a political issue throughout the entire state of Arkansas due to the public outcry. After the NPS had published their disdain for the farming facility, the Fayetteville City Council passed an ordinance to show their discord with the permitting and construction of C&H Hog Farms. The document, originally authored by Fayetteville City Attorney Kit Williams, was titled "A Resolution to Oppose The Permitting and Operation of the Concentrated Hog Farm Along a Major Tributary to the Buffalo National River." The document signed on behalf of the City of Fayetteville proclaimed that the hog farm's "adverse impact on regional tourism and the quality of life of our citizens who have decades enjoyed the opportunity to canoe or hike along the pristine and wild Buffalo River certainly affects out City" (Marsh et al. 2013). In addition, the waste storage lagoons "will be like massive pollution bombs, armed and aimed at the Buffalo National Wild and Scenic River only a few miles away." Sentiments were countered when Newton County Quorum Court passed a resolution that "opposes the interference in the livelihood of these families by the City of Fayetteville and other entities" (Reed and Bergan 2013). The public tension seen between these two areas of Arkansas illustrates the strong tensions between citizens over this controversial topic.

In addition, the hog farm became politicized when Representative Greg Leding drafted a bill that attempted to create a moratorium on CAFO construction in the Buffalo River Watershed along with other measures posed to hinder the operation of C&H Hog Farms and other possible CAFOs in the sensitive watershed (Leding et al. 2013). The moratorium section and emergency clause of the bill failed in the state legislature, but Act 1511 passed. The legislation mandated

that a NOC cannot be granted to a CAFO without the publication of the NOI in statewide and county newspapers. In addition, Act 1511 established a five member committee that would review the public notification policy for CAFOs applying for coverage under a general permit and provide these recommendations to the state legislature by December 31, 2013. This act was approved on April 23, 2013, and the first meeting of the Committee for the Study of Concentrated Animal Feeding Operation Procedures (further noted as the committee) took place on November 13, 2013.

As mandated by Act 1511, members were chosen from ADEQ, the Arkansas Agricultural Department, the Arkansas Farm Bureau, and appointed by Governor Mike Beebe. Members of the committee included: Ryan Benefield, the acting Chief of the Water Division for ADEQ, Jeff Marley, a livestock operator and member of the Farm Bureau, Gene Pharr, an agricultural grower from Lincoln, Arkansas and member of the Farm Bureau, Dr. Eric Wailes, an agricultural professor from the University of Arkansas, and Ross Noland, an attorney from a law firm in Little Rock. The recommendations published by the committee were published on January 17, 2014.

The members analyzed the current CAFO general permit public notification process, input from stakeholders, and existing public notification processes from other states. The requirements of Oklahoma, New Mexico, Missouri, and Georgia were included in the final report. The final determinations published by the committee, stated that the general permit applicant had to "provide written notice by letter" to "property owners adjacent to the CAFO production site and property owners adjacent to manure spreading sites, the County Judge of the County where the CAFO production site and any manure spreading site is located, Mayors of incorporated municipalities within ten miles of the CAFO production site, and the superintendent

of the school district that serves the CAFO production site" (Benefield et al. 2014). In addition, "the applicant shall publish notice one time of the proposed CAFO in the paper of the largest circulation in the county of the CAFO production site" and "post a 2 x 3 foot sign on a public road nearest the entrance to the CAFO production site" for 30 days (Benefield et al. 2014). It was also noted that the committee did not approve providing the Buffalo National River Superintendent notice of possible CAFOs in the Buffalo River watershed. The recommendations provided by the committee will be considered by the APC&EC or a legislative committee for future legislation considerations. This committee shows the state of Arkansas's attempts to appease the public outcry over the public notification process used in the approval of coverage under ARG590000 for C&H Hog Farms.

In addition to Act 1511, other political responses took place after construction was completed and operation began at C&H Hog Farms. These actions were motivated by the negative public opinion sponsored by the conservation groups. In order to combat misinformation provided by the conservation groups, public meetings were held by ADEQ. These meetings were a venue for the agency to explain the approval of coverage for C&H Hog Farms and interpret the permitting process associated with the general permit. The public was also granted an additional question and answer session by ADEQ, even though the comments were not allowed to modify the terms of C&H Hog Farms' permit coverage.

Despite these meetings, public opinion remained negative towards C&H Hog Farms, ADEQ, the state government, and any entity that possibly promoted the facility. After being the target for this negative impact, the owners of C&H Hog Farms requested aid from the Arkansas Newton County Cooperative Extension. The operators asked the Extension office to help them conduct a study on the farm in order to see if the CAFO would impact the environment of the

facility and land application fields and surrounding areas. The farmers wanted to show that they too wanted to be stewards of the environment while also providing them with a living wage. In mid-2013, the Governor of Arkansas, Mike Beebe, along with state legislators and other experts decided to propose a monitoring program for C&H Hog Farms to the state legislature for funding. The hope was that this program would "address public concerns over possible pollution of ground and surface water in the area through study" (McGeeney 2013). Originally, Jason Henson had contacted agents at the Newton County Extension Office to ask for help with implementing the NMP for C&H Hog Farms. Later on, as public opinion began to sour, he proposed the idea of the monitoring program. Beebe openly endorsed the need for a monitoring program in his weekly blog on August 16, 2013. In his address, Governor Beebe stated that "based on legal interpretations, neither I nor my ADEQ Director has the legal authority to unilaterally halt a properly permitted farming operation, or to declare an executive moratorium on such farms near certain bodies of water" (Beebe 2013). He continued by stating that ADEQ had examined the permit for flaws and found that C&H Hog Farms had followed the proper regulatory process in their NOI and NMP. He continued by stating "while the State may not have the authority to stop the operation of a legally permitted farm, we do have the authority to go above and beyond the required diligence for environmental monitoring" (Beebe 2013). He concluded that the research team from the University of Arkansas was going to request funding for this project from the Arkansas Legislative Council. This funding would be directly taken from the Arkansas Rainy Day Fund to kick-start the project (McGeeney 2013). On September 5, 2013, the Arkansas Legislative Council approved the use of $340,510 for the monitoring program (Beherec 2013). The purpose of the study is the "development and implementation of best practices so our farms can operate in compliance with state and federal laws" according to

Mark Cochran, the vice president of the University of Arkansas Division of Agriculture (Beherec 2013). After the funding was granted, Director Marks stated "the department may tweak the guidelines of the permit during the course of the study if needed. But Marks said the farm would not face penalties if it is operating under the terms in the permit" (Beherec 2013). Since the approval of these funds, the University of Arkansas research team has been conducting tests on C&H Hog Farms. Impacts of the facility are being researched with the permission of the facility operators and the owners of three land application fields. This political and, in turn, academic response to the CAFO has tested the terms of the permit.

It should be noted that Director Marks did not put together the proposal for the monitoring program. As stated in a letter to Earthjustice, Director Marks said ADEQ "agreed to have neither authority over, nor direct knowledge of, the day-to-day activities of the research team in order to ensure that the research is being performed as an independent review of the permitted facility" (Marks 2014). Despite Director Marks' lack of power with the permit, 40 CFR 122.28(b)(3) states that the issuance of an individual permit can be considered if "circumstances have changed since the time of the request to be covered so that the discharger is no longer appropriately controlled under the general permit" or "the discharge(s) is a significant contributor of pollutants" based on the "the location of the discharge with respect to Waters of the State" or "other relevant factors" (Arkansas Department of Environmental Quality 2011b). With this consideration, Director Marks could find that C&H Hog Farms should be covered under an individual NPDES permit instead of a general NPDES permit.

The terms of the permit include that "ADEQ may issue a single general permit to a category of point sources located within the same geographic area whose discharges warrant similar pollution control measures" (Arkansas Department of Environmental Quality 2011b). 40

CFR 122.28 continues by stating that a general NPDES permit may be issued if there are point sources in a geographic area that "require the same effluent limitations or operating conditions," "require the same or similar monitoring requirements," and other requirements. This hog farm complies with sections stating that general permits can be authorized for operations that "involve the same or substantially similar types of operations; discharge the same types of wastes," and "in the opinion of the Director, are more appropriately controlled under a general permit than under individual permits" (Arkansas Department of Environmental Quality 2011a). Unfortunately, C&H Hog Farms violates the first two of the five terms listed because additional monitoring and operating conditions have been identified by the state of Arkansas. As seen in these specific terms, ADEQ should not provide coverage for an operation where additional monitoring programs are found to be necessary, such as the Big Creek Research and Extension Team.

According to statements made by Marks and Beebe, the general permit regulations may be revised if scientific evidence is found to defend environmental concerns. Federal and state laws allow these changes, but they appear to violate the basis of the general NPDES permit. The fact sheet for ARG590000 states that a general permit is appropriate for "a category of point sources located within the same geographic area whose discharges warrant similar pollution control measures" (Arkansas Department of Environmental Quality 2011b). If a monitoring program is put in place, it shows that the facility may require special operating conditions or monitoring requirements. The research is scientific, but the actual idea of conducting research violates the terms of the general permit. It should also be noted that the results from the research requested originally by the farm owners could ultimately close the facility if environmental impacts are found.

V. Final Conclusions

A. Validity of General Permit

In the opinion of the researcher, the general permit coverage and NMP associated with C&H Hog Farms are invalid. The CAFO should be covered under the NPDES individual permit program because its location requires site-specific standards. Contrarily, according to the general permit program, operators have a "duty to apply" for an NPDES permit if the operation could possibly discharge (EPA 2012b). Also, the terms of the general NPDES CAFO program are vague for construction in a sensitive watershed. C&H Hog Farms was provided coverage based on unclear assumptions allowed by ADEQ. Based on the analysis provided in this case study, the researcher is of the opinion that Director Marks was incorrect when she stated that there is no possibility of error in the calculations for C&H Hog Farms because "there are six layers of review in this process" and no one at ADEQ found an error (Arkansas Department of Environmental Quality 2013). As identified by the researcher, there are questionable assumptions and procedures followed throughout the design of the facility and NMP.

After the analysis of C&H Hog Farms and the terms of ARG590000, the CAFO is covered under the wrong permit program. This is perceived since the Big Creek Research and Extension Team was established to monitor the impact of the facility on the surrounding environment. This research project should not be allowed by the state of Arkansas because it provides continual monitoring of the CAFO, which violates the terms of ARG590000.

Also, the incomplete NMP for C&H Hog Farms was used as the safeguard for possible environmental impacts listed in the EA completed by the USDA FSA. This erroneous document should not have been approved by ADEQ due to its questionable inputs. As of the publication of this case study, the land application field maps are still not corrected and published for the hog

facility despite its operation for approximately one year. In addition, the researcher has asked ADEQ for additional information regarding the NMP and terms of the general permit for C&H Hog Farms, but the state agency has not responded to these questions as of publication of this case study. As seen in the reasons and documentation provided through the case study, C&H Hog Farms should not be covered under the NPDES general CAFO permitting program. It is reiterated that, despite the deficiencies in the design and permitting of this facility, the operators of C&H Hog Farms provided due diligence to ADEQ throughout the process.

B. Validity of EA/FONSI

After analyzing the EA and determination of a FONSI for C&H Hog Farms by the USDA FSA and SBA, the researcher is unsure of the validity of these documents. The overall format of the EA is disorganized and confusing. The public was given the necessary notification and commenting time as specified in the terms of the federal regulations, so these conclusions from the federal agencies could have been clarified at that time. Even the SHPO showed concern in 2013 despite their stamp of approval on the original correspondence between the Farm Credit officer and the AHPP director. This shows that the federal agencies are not thoroughly considering the documents that they sign. It should be noted that the information provided to other federal agencies such as the US FWS and AHPP lacked details on the area of land and its location to be used for the construction of C&H Hog Farms.

The validity of the EA will be determined by District Judge Marshall and Magistrate Judge Young in the US District Court for the Eastern District of Arkansas Western Division. This case study has identified the deficiencies in the EA and speculated violations of several federal acts, but these gentlemen will hear the case and decide the ultimate validity of the documents.

C. Lawsuits: frivolous or substantive?

In the opinion of the researcher, the lawsuit filed by Earthjustice on behalf of the activist groups is necessary due to the poor organization and decision making completed in the EA. The officials that pieced this document together did not follow a logical process in preparing this federal document. The USDA FSA ignored the formalities necessary to complete a thorough EA, which now puts the farming families in a difficult situation in this controversial issue. The responsibility of environmental regulatory compliance was placed on the NMP, which is acceptable, but other agencies should have been formally consulted in order to provide the most environmentally sensitive plan. The USDA FSA did not provide the federal agencies with effects determination or a copy of the draft EA, which are standard practices for EAs. In the opinion of the researcher, the purchase of 23.43 acres and construction of the gestation and farrowing barns would have resulted in a FONSI even if the USDA FSA had provided clear and formal communication throughout the EA process. Hog farms and lagoons have been in the Buffalo River watershed for decades, and the larger size of these lagoons does not guarantee the harm or disappearance of endangered, threatened, or candidate species. In addition, the approval of the loan guarantees to purchase the land and construct the barns is not contingent upon the location of the land application fields since those can change over time as dictated by the permit or ADEQ. Nonetheless, the USDA FSA officials did not follow the formal steps of the NEPA process as outlined in the USDA FSA guidelines, and the public has the right to question these federal agencies in the court system.

In fact, the hearing for the complaint is being held at the time of the completion of this case study, so the decision from the judicial system is unknown. The desired outcome of the lawsuit for the plaintiffs would involve the revocation of the loan guarantees forcing FCS to call the

loans. This would ultimately result in the closure of C&H Hog Farms (Cross 2013). In reality, the actual loans have already been exhausted since the farm is completely constructed and in operation. Also, the outcome of this lawsuit would not necessarily shut down C&H Hog Farms; instead, it would simply put the FCS at more of a risk if the hog facility defaulted on its loans. As seen in this complaint, the plaintiffs are attempting to find a way to close the doors of this facility, but this is outcome is not guaranteed.

A frivolous aspect of the lawsuit is the inclusion of the violation of the Buffalo Enabling Act by the activist groups. Public Law 92-237 was passed in 1972 by Congress to establish the Buffalo National River in Arkansas. After threats from the US Corps of Engineers to dam the waterway, citizens rallied to pass this legislation to save the river. As mentioned in the act, the river was protected in order to preserve "as a free-flowing stream an important segment of the Buffalo River in Arkansas for the benefit and enjoyment of present and future generations" (Anonymous 1972). This act gave the Secretary of the Interior the power to maintain the river's "unique and scientific features" within the boundaries of the national river. The point of this act was to ensure that a dam or other power-oriented project could not take place within these boundaries. Fishing, hunting, farming, and other nonresidential purposes could continue on the property as long as the Secretary of the Interior approved these actions. Section 4 of the Enabling Act provides a discussion on projects built or financed by other government agencies:

> *The Federal Energy Regulatory Commission shall not license the construction of any dam, water conduit, reservoir, powerhouse, transmission line, or other project works under the Federal Power Act (41 Stat. 1063), as amended (16 U.S.C. 791a et seq.), on or directly affecting the Buffalo National River and* ***no department or agency of the United States shall assist by loan, grant, license, or otherwise in the construction of any water resources project that would have a direct and adverse effect on the values for which such river is established, as determined by the Secretary.*** *Nothing contained in the foregoing sentence, however, shall preclude licensing of, or assistance to, developments below or above the Buffalo National River or on any stream tributary thereto which will not invade the area or unreasonably diminish the scenic, recreational, and fish and*

wildlife values present in the area on March 1, 1972. No department or agency of the United States shall recommend authorization of any water resources project that would have a direct and adverse effect on the values for which such river is established, as determined by the Secretary, nor shall such department or agency request appropriations to begin construction on any such project, whether heretofore or hereafter authorized, without, at least sixty days in advance, (i) advising the Secretary, in writing, of its intention so to do and (ii) reporting to the Committee on Natural Resources of the House of Representatives and the Committee on Energy and Natural Resources of the Senate, respectively, the nature of the project involved and the manner in which such project would conflict with the purposes of this subchapter or would affect the national river and the values to be protected by it under this subchapter.

This section of the Enabling Act can be interpreted in many ways. First of all, it should be noted that the original intent of this Act was to protect the Buffalo River from being dammed by the Corps of Engineers. In later years, a tributary had also been threatened by a damming project, but these types of projects were thrown out due to this Public Law. In order to interpret the emphasized portion of this law, the definition of a water resource project must be determined. According to 7 CFR 1940.302(j), a water resource project "includes any type of construction which would result in either impacts on water quality and the beneficial uses that water quality criteria are designed to protect or any change in the free-flowing characteristics of a particular river or stream to include physical, chemical, and biological characteristics of the waterway. This definition encompasses construction projects within and along the banks of rivers or streams, as well as projects involving withdrawals from, and discharges into such rivers or streams. Projects which require Corps of Engineers dredge and fill permits are also water resource projects," according to 7 CFR 1940.302(j). This hog farm is not constructed within or along the banks of the river; instead, it is built on a hill overlooking Big Creek. The land application fields abut Big Creek, but these are not considered constructed areas, and the federal funds do not contribute to the leasing of the property against the waterway. Technically, the federal money was used to construct the gestation and farrowing barns along with the purchase of the acreage where the farm is located. This money may not have been attributed to the

construction of the waste lagoons. Big Creek is at risk of being contaminated due to the waste lagoons, but this is not a certain effect of these waste lagoons. Also, the land purchased for the facilities is considered private property, and it is located approximately 5 miles from the Buffalo River. It does not lie in the boundaries of the Buffalo National River, as seen in Figure 7. If this facility is considered a water resource project, it is not guaranteed that it would affect the water quality of the river or change the free flowing characteristics of the waterway. It does involve a discharge into waterways, but only under certain precipitation events according to the terms of the general permit. This discharge is discouraged by designing the waste management system to a 100-year confidence interval. In the opinion of the researcher, C&H Hog Farms is not a water resources project; instead, it is viewed as an agricultural project. The intent of the Enabling Act was to prevent dams, not private industry. Overall, this lawsuit exposes the deficiencies in the EA process completed for C&H Hog Farms.

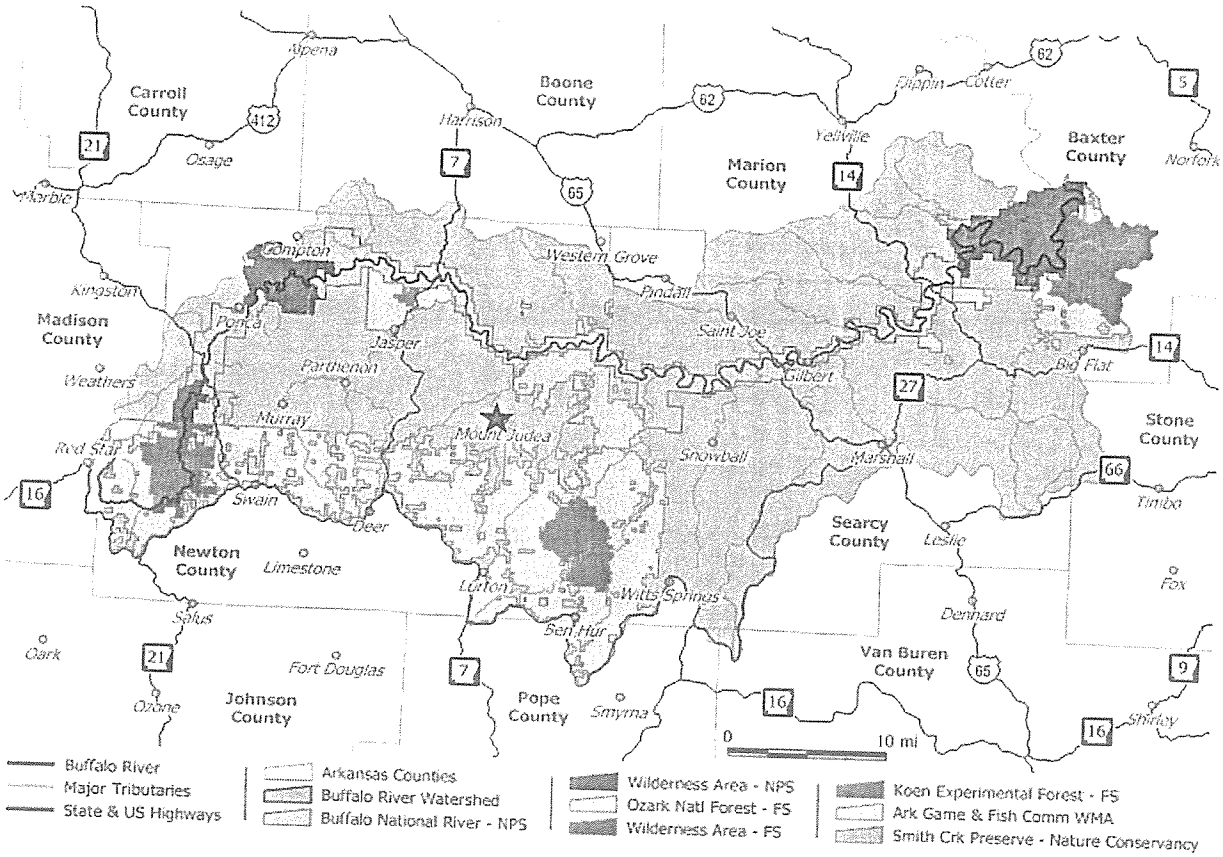

Figure 7. Buffalo River Watershed (Anonymous 2014b; as modified by Hovis 2014).

D. Suggestions to mitigate the situation

The state should list the AWMFH as a design guidance document in order to establish explicit design standards. The design engineers can still be allowed to use other references in the design of these waste management systems under the general permit, but the Director must first approve them. These clarifications help prevent seepage of waste into the Waters of the State in karstic terrain. Risk-based options are provided in the AWMFH, which can be implemented at this time for additional construction and design costs.

Currently, it is unknown if C&H Hog Farms is a definite contributor of pollutants. One concern includes the karst features under the waste lagoon storage system. The fact of the matter is that, despite standards and suggestions from the agriculture community, ADEQ approved the waste lagoon system for C&H Hog Farms without considering the karst formations. Due to the

location of these storage systems, the location of the discharge could be a substantial issue for the Waters of the State if a catastrophic failure took place. This scenario is speculative, but the point is that ADEQ should be protecting the Waters of the State by taking into consideration these worst-case scenarios. ADEQ and Director Marks had and, currently, have the authority to require an individual permit as per 40 CFR 122.28(b)(3). This does not force C&H Hog Farms to close its doors, but it does require some possible adjustments to the terms of their permit. Finally, it should be restated that the point of the general permit is to avoid having to create monitoring programs and base decisions on specific geographic information. The terms of the general permit are supposed to be relative to all areas of the state. If one area of the state is substantially different than another and requires special consideration, then it does not meet the general NPDES permit requirements.

In addition, C&H Hog Farms could prevent the possible contamination of ground and surface waters by replacing the compacted clay liners with geosynthetic liners, as suggested by the USDA NRCS guidelines. Also, removing the waste and applying it to fields outside of the Buffalo River watershed could mitigate the possible contamination. The Big Creek Research and Extension Team are investigating these mitigation measures (Sharpley 2014).

ADEQ and the public will formally reconsider the overall terms of ARG590000 and C&H Hog Farms once these permits expire in 2016 and 2017, respectively. In addition, the conservation groups are trying to create special protection of sensitive watersheds through third party rulemaking procedures through the APC&EC.

Appendix A: A comparison between Regulation 5 and Arkansas general permit requirements

	ARG590000	Reg. 5
Types of animals covered:		
Hog	X	X
Poultry	X	X
Dairy	X	X
Horse	X	
Sheep	X	
Veal Calve	X	
General requirements		
Adopt a good neighbor policy		X
Public notification	Place notification on ADEQ website	Provide copy of public notice to the county quorum court or the city zoning authority. Notify all adjacent land owners
Point source discharge with rainfall events	X	
Agricultural stormwater runoff	X	X
Subsurface investigation required		X
Must log waste/wastewater applied	X	X
Sample of wastewater must be collected at least once a year	X	X
Soil sampled once every 3 years	X	
Soils sampled at least 1 time every 5 years		X
Annual report sent to ADEQ	X	X

	ARG590000	Reg. 5
Major modifications		
Volume increase by over 10% of animal waste		X
Addition of land application sites	X	X
Addition of other crop/use of land application field	X	
Changes to field-specific maximum annual rates	X	
Change in Waste Management Plan including waste treatment, type,		X
Minor modifications		
Correcting typographical errors	X	X
Change in ownership of facility	X	X
Transfer or land application sites to another permit	X	X
Addition of land application sites to protect environment		X
Remove land application sites	X	X
Removal of educational requirements		X
Technical guidelines		
ANRC Practice Standard Code 590	X	
Arkansas Phosphorus Index, 2010 Revision	X	
Field Office Technical Guide		X
Agricultural Waste Management Field Handbook		X
NRCS Animal Waste Management software	X	
Soil Plan Air Water (SPAW) Hydrology Tool	X	
Not constructed within 1,320 feet of the nearest occupied dwelling		X

	ARG590000	Reg. 5
Waste Management Plan		
Land apply with respect to nutrient uptake cycle of vegetation on land application sites		X
Minimize odors		X
Land use agreements	X	X
NMP reviewed annually by operator		X
No land application when soil is saturated, frozen, covered in ice or snow, or when significant precipitation is anticipated within 24 hours	X	X
No application on slopes with a grade >15%	X	X
Setbacks		
100 feet of waterways measured from ordinary high water mark		X
100 feet from open tile line intake structures, sinkholes, agricultural well heads, or other conduits to surface waters	X	
300 feet from Extraordinary Resource Waters	X	
50 feet of property lines	X	X
500 feet to other facilities		X
500 feet of occupied buildings	X	X
Areas prohibited by ADH regs for protection of public water supplies	X	X

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