CONCLUSIONS

The Memorandum of Understanding with the Arkansas Department of Environmental quality was to:

1. Monitor the fate and transport of nutrients and bacteria from land-applied swine effluent to pastures.
2. Assess the impact of farming operations (effluent holding ponds and land-application of effluent) on the quality of critical water features on and surrounding the farm.
3. Determine the effectiveness and sustainability of alternative manure management techniques, including solid separation, which may enhance transport and export of nutrients out of the watershed.

Based on data collected during the five-year project, the following overall conclusions to these three objectives can be drawn:

Objective 1:

1. Three fields (two receiving slurry and one mineral fertilizer) were sampled biannually (2014, 2016, 2018) on a 0.25-acre grid. Considering only the area of the field receiving slurry (excluding a 50 to 100 foot edge-of-field buffer), surface (0 – 4 inch) soil test P (STP) levels significantly increased from 65 to 115 mg/kg for Field 1 and from 56 to 126 mg/kg for Field 12 between 2014 and 2018. Soil test P averaged across the field receiving mineral fertilizer and prior poultry litter, showed no significant increase between 2014 and 2018 (i.e., 45 and 47 mg/kg in 2014 and 2018).

2. Complicating the interpretation of STP increases on the two fields receiving slurry is the fact that the grid-soil sampling identified specific, well-defined areas or hotspots of STP accumulation adjacent to a farm pond, field gate, and shade trees, where physical evidence of cattle grazing and loafing was apparent.

3. It is clear that several interrelated factors, including slurry, fertilizer, and cattle management have influenced the extent and magnitude of STP accumulation. To limit further accumulation in excess of optimum agronomic levels for forage production, future applications of any nutrients (i.e., as mineral fertilizer, swine slurry, or poultry litter) to fields, which received slurry from C&H Farms, should be carefully managed. This can be achieved by application of nitrogen (N) fertilizer or slurry and poultry litter at P-based rates, where P applied is equivalent to expected forage uptake of P.

Objective 2:

1. Flow-adjusted nitrate-N (and thereby total N) concentrations were greater downstream (mean of 0.29 mg/L) than upstream (mean of 0.13 mg/L) of the C&H Farm. Also, mean annual nitrate-N concentrations downstream of the C&H Farm increased slightly over the five-years of monitoring, averaging 0.275, 0.304, 0.274, 0.297, and 0.311 mg/L in 2015, 2016, 2017, 2018, and 2019, respectively (May 1 to April 30; 2014 to 2019). At the upstream site, mean annual nitrate-N averaged 0.112, 0.131, 0.118, 0.124, 0.161 mg/L in 2015, 2016, 2017, 2018, and 2019, respectively,

over the same period. No other consistent or significant trends in other monitored nutrients and E. coli were observed in Big Creek.

2. There was a statistically significant increase in nitrate-N concentrations in the well (265 to 285 feet deep) and ephemeral stream adjacent to the C&H Farm production facility over the five-year monitoring period. Mean annual nitrate-N of well water was 0.474, 0.515, 0.633, 0.657, and 0.799 mg/L for 2014, 2015, 2016, 2017, 2018, and 2019, respectively, for May 1 through April 30 of each year. For the ephemeral stream, mean annual nitrate-N was 0.760, 0.739, 1.034, 1.110, and 1.152 mg/L for 2014, 2015, 2016, 2017, 2018, and 2019, respectively, over the same period.
3. Interceptor trenches below the holding ponds showed no increasing or decreasing trends in nutrient or E. coli. Given trench flow was highly correlated with precipitation, no concomitant increase in chloride or electrical conductivity in well, ephemeral stream, and trench waters, the collected information fails to suggest the holding ponds were the major contributor to observed nitrate-N increases in well and ephemeral stream at this point in time.
4. The overall conclusions of the 2014 dye-tracer studies conducted in the Big Creek Watershed by Drs. Brahana and Kosic, demonstrate the complexity of subsurface flows can be in the karst system of in this area of the Boone formation.
5. Although on-farm nutrient management planning occurs at the field scale, there is a lack of consistent and well-maintained GIS databases of karst features and geologic mapping at this scale. In Arkansas, the AGS topographic-scale geologic mapping (which includes an inventory of karst features), usually maps 1- 3 quads a year. Thus, NMP development and risk assessment would be aided by the availability of consistent karst feature databases and geologic mapping.

<u>Objective 3:</u>

The general findings were:

1. Hydrated lime amendments tended to enhance the manure solids separation effectiveness as related to increasing the % Solids and P concentration of the separated solids. In principle, this would be beneficial for transport of P off the generating farm.
2. Hydrated lime amendments also increased the manure pH enough that N losses via ammonia volatilization seemed to be increased. If the manure were viewed as a desirable N fertilizer, the increased losses would not be desirable. If air quality were, it atmospheric ammonia emissions would not be desirable.
3. Use of granular agricultural grade lime at the rates used, had no consistent effect on the solids separation process.

Despite the potential benefits of lime treatment providing options to manage slurry in compliance with nutrient management planning requirements, all presented economic, logistical, labor, and legal constraints severely limit their viability for adoption.

Overall Conclusions:

Differences in nitrate-N concentrations between down and upstream sites were strongly influenced by stream flow, where the difference (i.e., downstream was greater than upstream) is very large at low flow and small at high flow. This suggests that at low flows, base flow nitrate-N emerges into Big Creek between upstream and downstream sites and that this base flow has a higher nitrate-N concentration than in base flow above the upstream site. However, at high flows it appears that water entering Big Creek from both the subwatershed above the upstream site and the intervening subwatershed between the downstream site, is similar.

Despite higher nitrate-N concentrations at the down than upstream site on Big Creek, the relationship between upstream and downstream concentrations is unchanged over time, suggesting that over the 5 years of monitoring, the input of nitrate-N into Big Creek between up and downstream sites did not change (i.e., no increase or decrease).

Finally, it is concluded that as long as the integrity of the holding ponds is maintained, the main long-term environmental concerns with CAFO operation lies with land use and nutrient management of the fields permitted to receive slurry.