EXHIBIT S

DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

Summary of Big Creek Research and Extension Team Final Report

A. **Mission:** We were engaged by the Arkansas Department of Environmental Quality (ADEQ) to evaluate the potential impact of the C&H Farm operation on the water quality of Big Creek. The Memorandum of Understanding with ADEQ 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 of alternative manure management techniques, which may enhance transport and export of nutrients out of the watershed.

Based on data collected during the five-year period, we provided 23 quarterly reports to ADEQ and Governor's Office. These reports and other details can be found at the projects' website https://bigcreekresearch.org/. Work of the Big Creek Research and Extension Team (BCRET) remained within the above objectives and resources available.

B. **Project Reviews:** An external panel of experts reviewed our initial monitoring plan and a draft final report. Comments and suggestions of the review panel were addressed or incorporated in the plan (https://bit.ly/3eJtP3B and https://bit.ly/34TARyb and the final report: https://bit.ly/BCRET_FINAL20)

The main conclusions of the external review of the Final Report are: "*The review team, based on the findings presented in the draft report, concurs with the conclusions reached by the BCRET. Namely that at present there is no evidence that the operations associated with C&H Farms has significantly impacted the quality of the ground or surface waters associated with the holding ponds or the fields where slurry has been applied. There is a potential, however, that long-term continued application of slurry to pastures in excess of nutrient requirements may contribute to degradation in water quality absence the use of techniques to reduce nutrient availability in the slurry. Acceptance of these findings by the scientific community at large is further evidenced by publication of portions of the report in peer-reviewed journals.*"

C. **Project Findings:** Between 2014 and 2018, there was a statistically significant increase soil phosphorus (measured as Mehlich-3 soil test phosphorus) on Fields 1 (from 65 to 115 ppm or 76%) and 12 (56 to 126 ppm or 125%), which received swine slurry, but not on Field 5a (from 50 to 45 ppm or -10%), which received mineral fertilizer only. Variations in P application rates, as well as evidence of cattle grazing and loafing shown by detailed soil sampling that identified specific, well-defined areas or hotspots of soil phosphorus accumulation near farm ponds, field gates, and shade trees.

D. To limit further accumulation of nutrients in soil in excess of levels optimal for forage production, future applications (as mineral fertilizer, swine slurry, or poultry litter) along with grazing, must be carefully managed.

E. The Arkansas Phosphorus Index for Pastures, which determined the risk of phosphorus runoff from application given field, is part of a more comprehensive nutrient management planning process. That planning requires implementation of setbacks (where no manure slurry can be applied and plants and soil can buffer nutrient runoff) in fields adjacent to streams, residences, and karst features, such as sinkholes and rock outcrops.

F. There was a statistically significant increase in nitrate-nitrogen concentration in the ephemeral stream (0.64 to 1.09 ppm or 70%) and well samples (0.50 to 0.66 ppm or 32%) over the monitoring period (April 2014 to June 2019). The EPA drinking-water standard for nitrate-nitrogen is 10 ppm. However, interceptor trenches below the holding ponds showed no increasing or decreasing trends in nutrients, chloride, or E. coli. We conclude that as long as the integrity of holding ponds similar to those on the C&H Farm is maintained, the main long-term environmental concerns with farm operation lie with field management and nutrient application.

G. Although phosphorus and nitrogen concentrations in Big Creek were greater downstream than upstream of the C&H Farm, this change in water quality was likely due to changes in watershed land use; the amount of pasture in the watershed increases downstream, while forest decreases. While we recognize the complexity and potentially rapid movement of ground water in the karst of the Big Creek Watershed, nutrient concentrations in Big Creek have not significantly increased over time since water quality monitoring began in September 2013.

H. Nutrient concentrations in Big Creek were comparable to other watersheds in this region with similar land use, suggesting limited impact of the CAFO on Big Creek at the present time. Nutrient concentrations and water quality in Big Creek reflect the entire watershed and land management upstream, so it is challenging to see the effects of one farm on water quality. One farm generally changes water quality at the field level, but the cumulative effects of many farms can influence water quality at the larger watershed, such as Big Creek and the Buffalo National River.

I. Despite the potential benefits of lime treatment (calcium compound additions) providing options to manage slurry, such as export outside of the watershed, all treatment options present economic, logistic, labor, and legal constraints that severely limit their viability for adoption.

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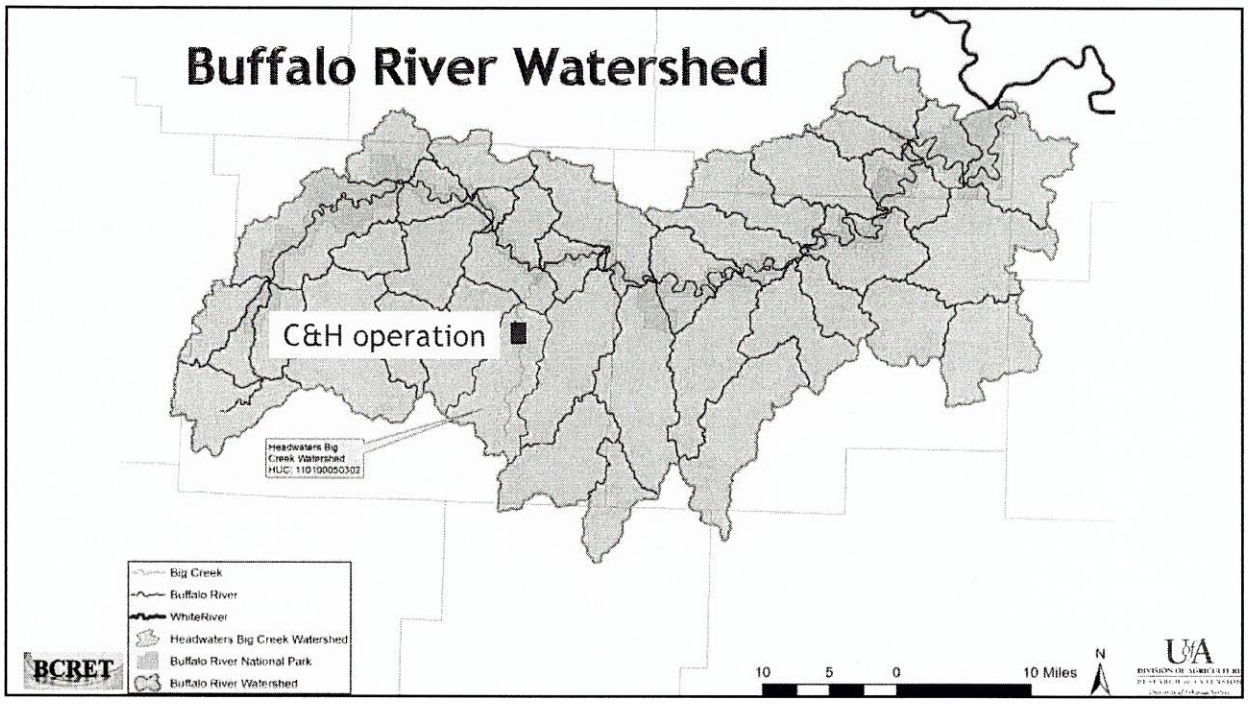
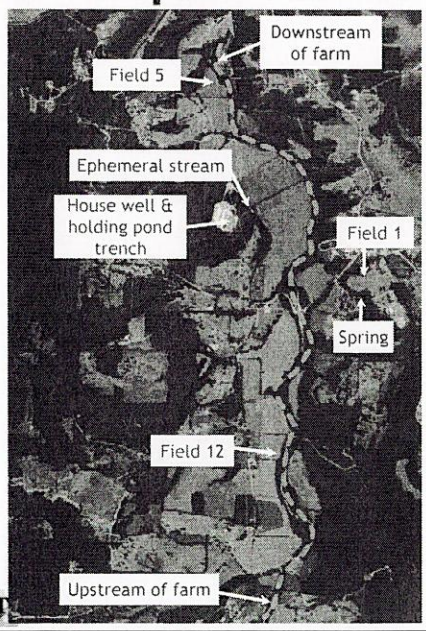
Project objectives

- ✓ Monitor fate & transport of nutrients & bacteria from land-applied swine slurry
- ✓ Assess impact of farm operations on area water quality
- ✓ Assess manure treatment options that enhance export out of the watershed
- ✓ Provide transparent & unbiased science for landowner & State to make decisions

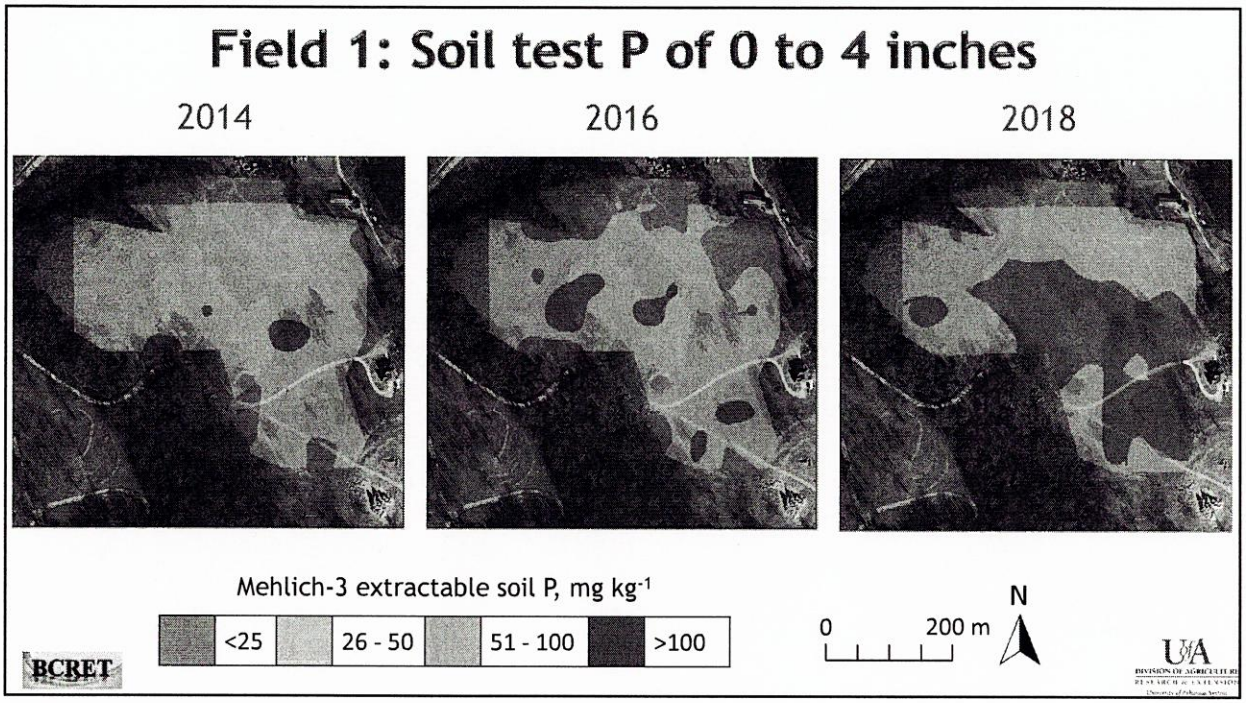


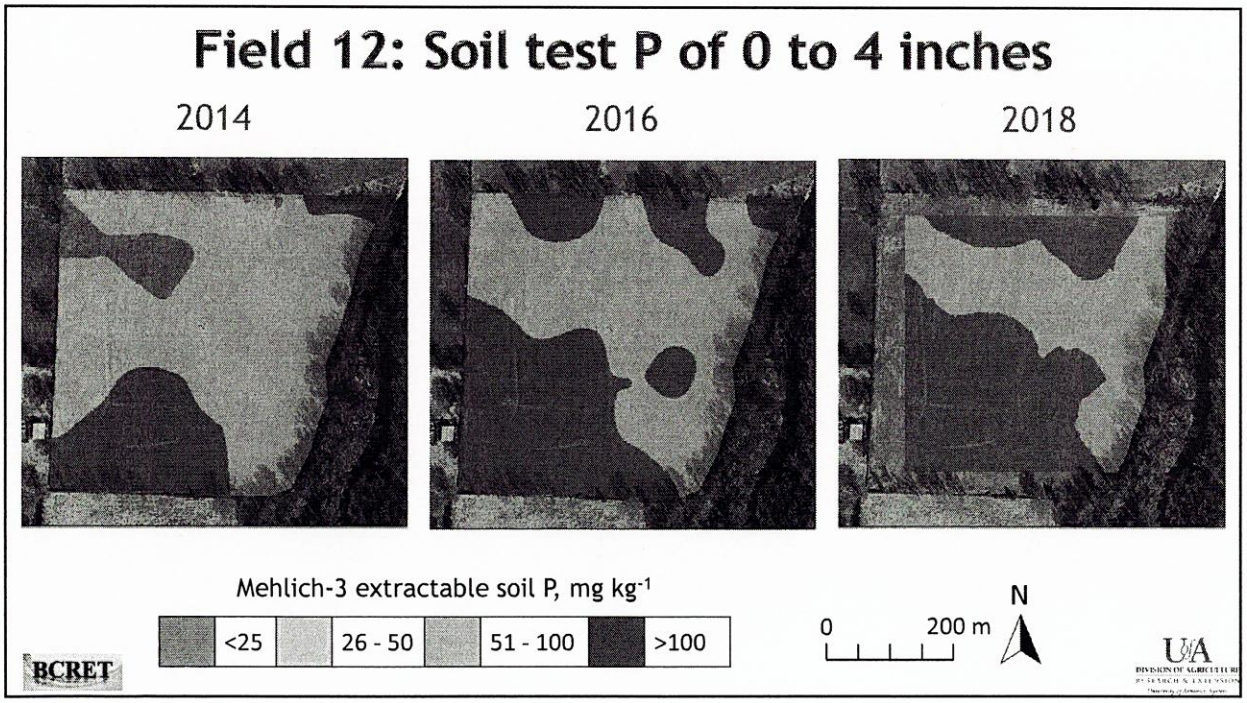
Water sample collection locations

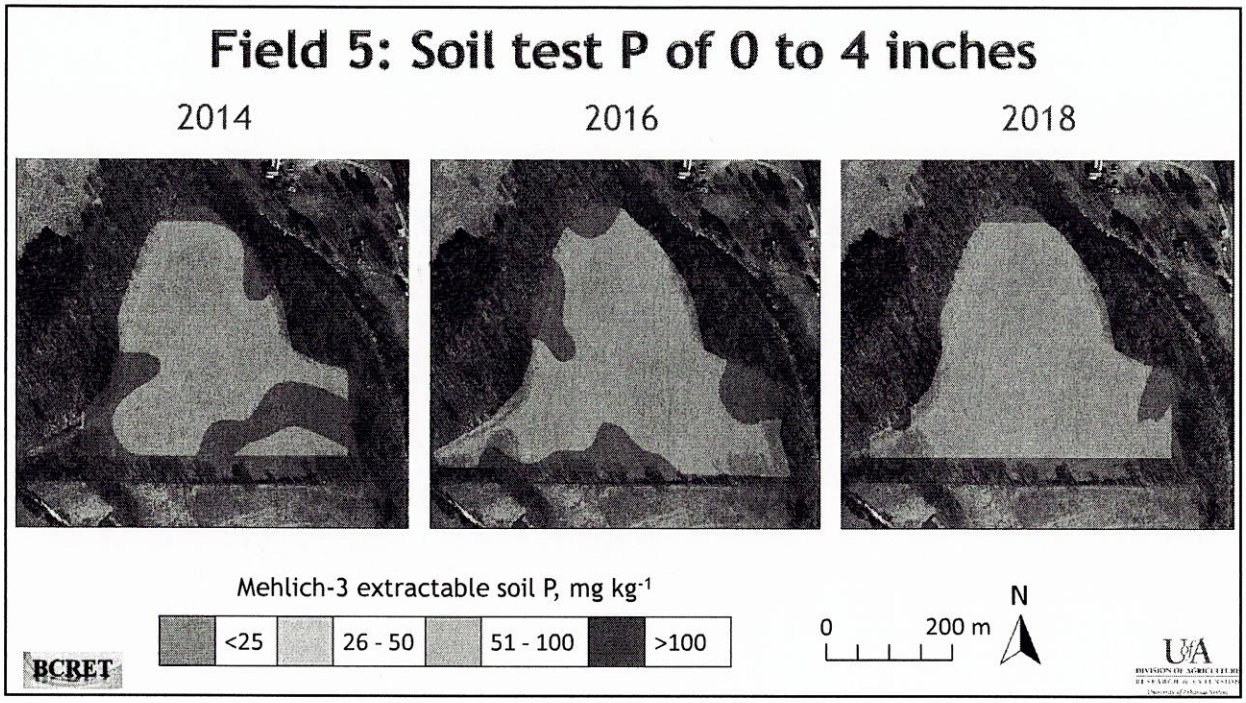


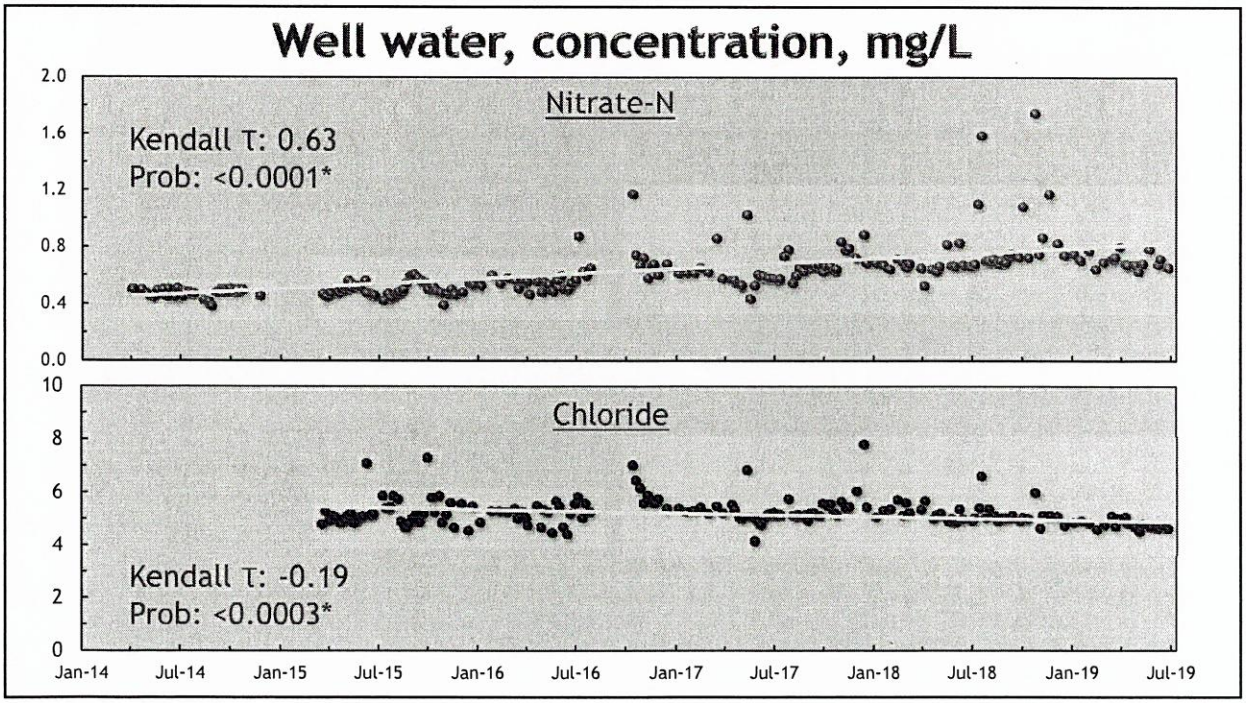
Water quality assessment

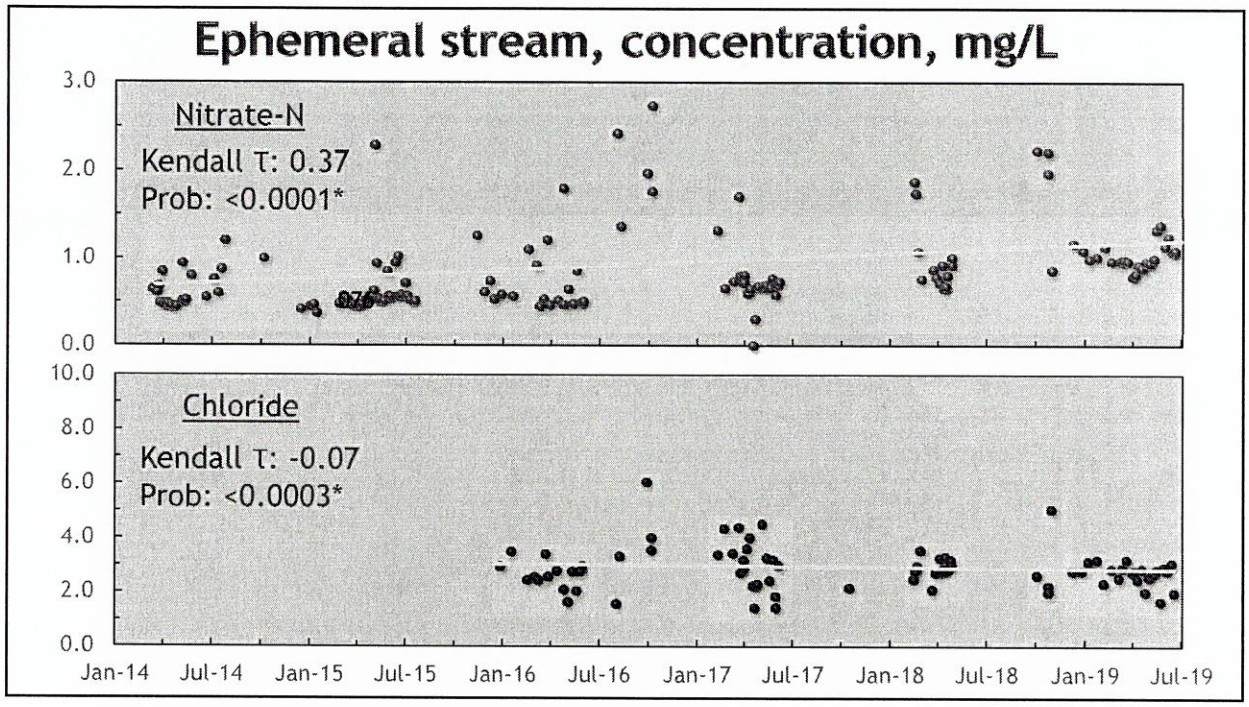
- Storm & weekly sampling of base flow for
  - N, P, sediment, bacteria
- Field runoff from 2 application fields & 1 control

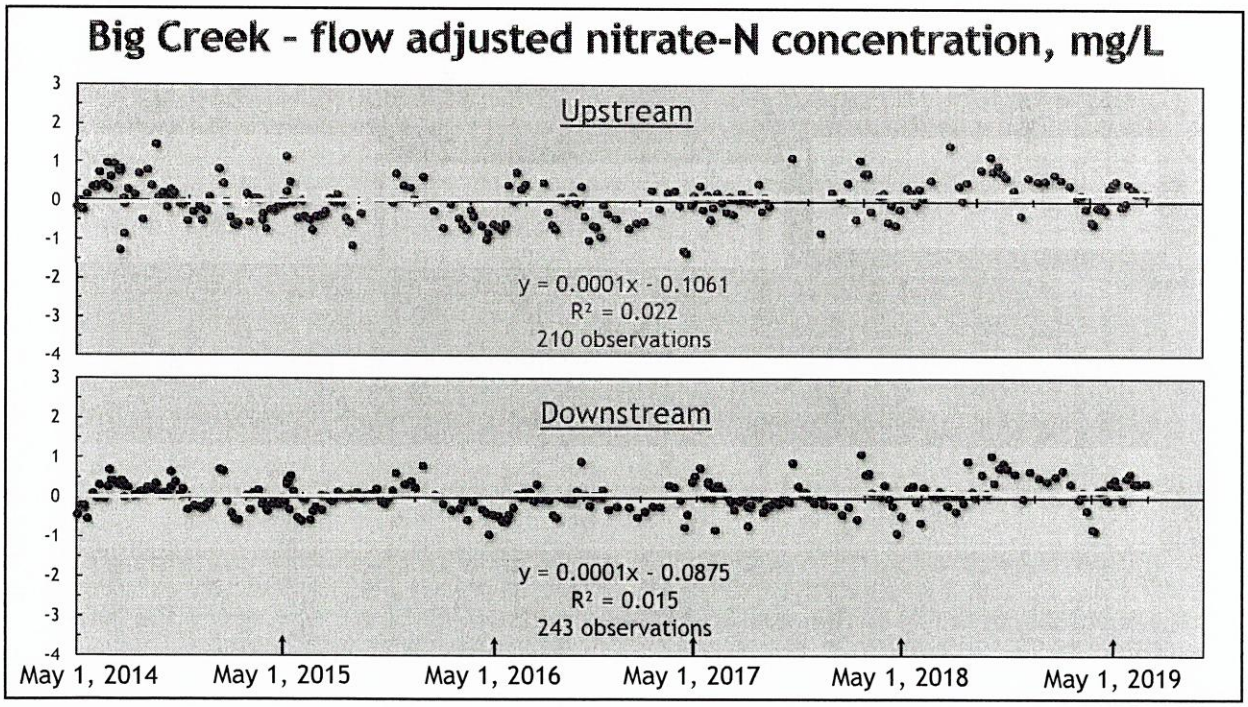

Field 1: Soil test P of 0 to 4 inches
2014
2016
2018
Mehlich-3 extractable soil P, mg kg-1
<25
26 - 50
51 - 100
>100
0
200 m
N
BCRET

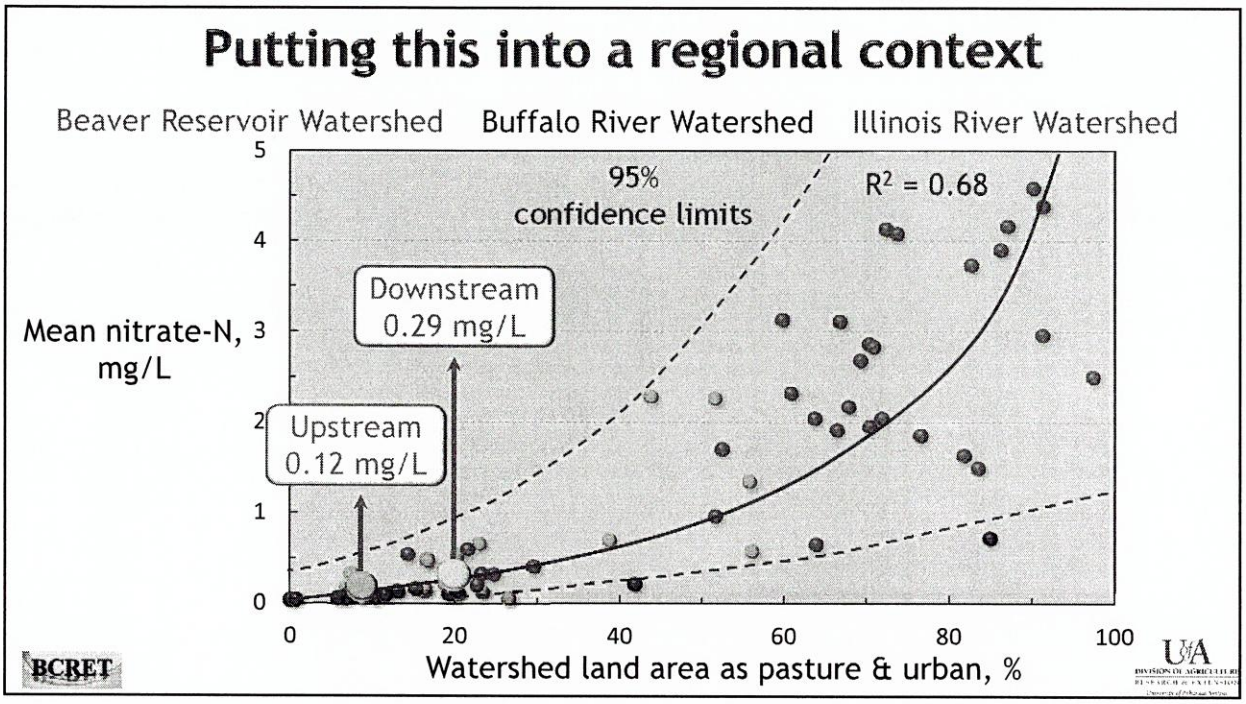

Field 12: Soil test P of 0 to 4 inches
2014
2016
2018
Mehlich-3 extractable soil P, mg kg-1
<25
26 - 50
51 - 100
>100
0
200 m
N
BCRET

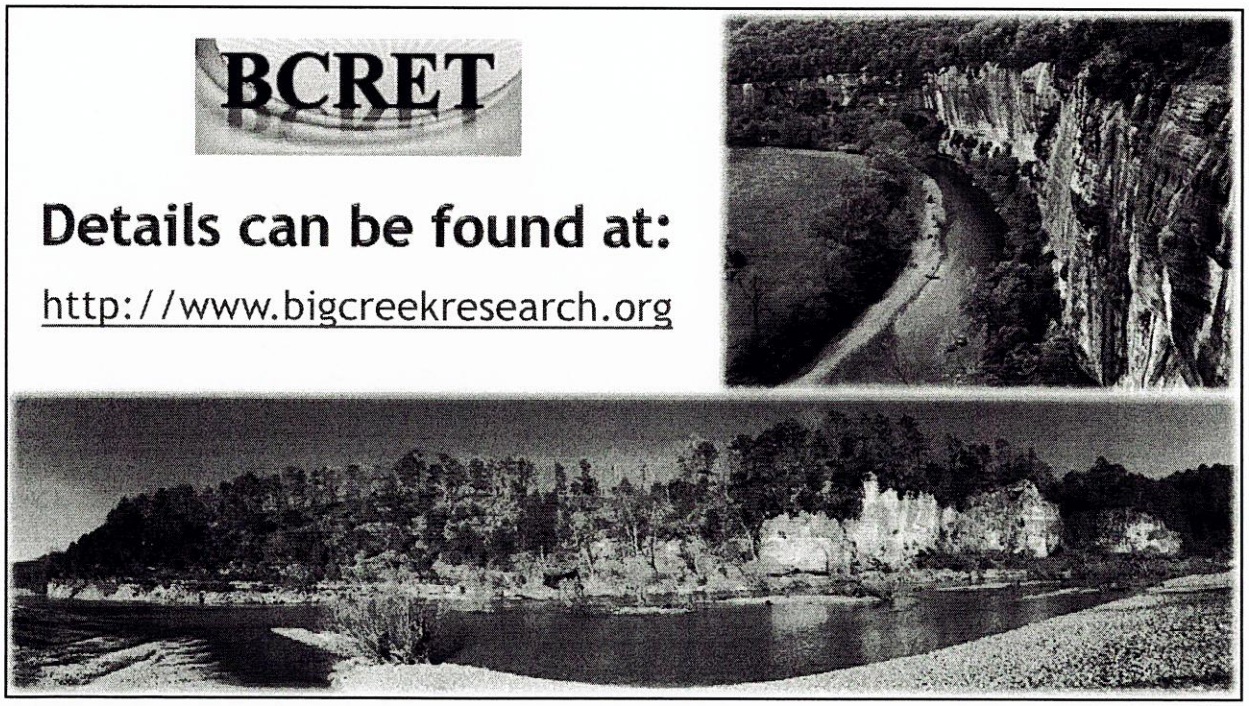

Field 5: Soil test P of 0 to 4 inches
2014
2016
2018
Mehlich-3 extractable soil P, mg kg-1
<25
26 - 50
51 - 100
>100
N
0
200 m
BCRET


Well water, concentration, mg/L
Nitrate-N
Kendall τ: 0.63
Prob: <0.0001*
Chloride
Kendall τ: -0.19
Prob: <0.0003*
2.0
1.6
1.2
0.8
0.4
0.0
10
8
6
4
2
0
Jan-14
Jul-14
Jan-15
Jul-15
Jan-16
Jul-16
Jan-17
Jul-17
Jan-18
Jul-18
Jan-19
Jul-19


Ephemeral stream, concentration, mg/L
Nitrate-N
Kendall τ: 0.37
Prob: <0.0001*
Chloride
Kendall τ: -0.07
Prob: <0.0003*
3.0
2.0
1.0
0.0
10.0
8.0
6.0
4.0
2.0
0.0
Jan-14
Jul-14
Jan-15
Jul-15
Jan-16
Jul-16
Jan-17
Jul-17
Jan-18
Jul-18
Jan-19
Jul-19


Big Creek - flow adjusted nitrate-N concentration, mg/L
Upstream
y = 0.0001x - 0.1061
R² = 0.022
210 observations
Downstream
y = 0.0001x - 0.0875
R² = 0.015
243 observations
3
2
1
0
-1
-2
-3
-4
May 1, 2014
May 1, 2015
May 1, 2016
May 1, 2017
May 1, 2018
May 1, 2019


Putting this into a regional context
Beaver Reservoir Watershed
Buffalo River Watershed
Illinois River Watershed
95%
confidence limits
R^2 = 0.68
Downstream
0.29 mg/L
Upstream
0.12 mg/L
Mean nitrate-N, mg/L
0
1
2
3
4
5
0
20
40
60
80
100
Watershed land area as pasture & urban, %
BCRET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Details can be found at:
http://www.bigcreekresearch.org