December 28, 2017

TO: Engineering Supervisor of the Permits Branch of the Office of Water Quality
Arkansas Department of Environmental Quality
5301 Northshore Drive
North Little Rock, AR 72118-5317

FROM: C & H Hog Farms, Inc.
HC 72 Box 2
Vendor, AR 72683

Re: AFIN: 51-00164; No-Discharge Permit No.: 5264-W
Response to Supplemental Information Request Letter

Dear Engineering Supervisor:

On December 27, 2017, Michael McAlister, Managing Attorney, notified C & H Hog Farms, Inc. of the Department's request for additional supplemental information to the Regulation 5 Permit Application submitted by C & H Hog Farms on April 6, 2016.

C & H Hog Farms submits the following in response to the additional information requested, corresponding to the numbering in Mr. McAlister's December 27, 2017 letter:

1. The buffers for Field 22 have been reviewed and updated. The pond located on the adjacent property to the south and west of Field 22 has been buffered. The Nutrient Management Plan (NMP) has been updated accordingly and is included with this submission.

2. In addition to the documents hand delivered to the Department on December 6, 2017, C & H Hog Farms is also submitting the construction plan and technical design for the optional pond liner modification. C & H Hog Farms is not immediately aware of any other construction plans or testing relevant to the construction and design of the ponds; however, if there are specific documents the Department is aware of which it is seeking, please notify me.

3. Sheet 15 – Waste Storage Pond 2 Stage Storage Table is included with this submission.

4. The Operation and Maintenance Plan for the storage pond levees has been updated with the specific verbiage provided in Mr. McAlister's December 27, 2017 letter. The Nutrient Management Plan (NMP) has been updated accordingly and is included with this submission.

5. Although C & H Hog Farms feels the Department has no authority to justify a 500-foot buffer from what it has mischaracterized as the "Mount Judea sport complex", this buffer has been updated in the Nutrient Management Plan (NMP) and is included with this submission.

6. As the Department is already aware, the University of Arkansas has been engaged in a 5-year study relative to the sustainability of the management of nutrients on C & H Hog

Farms. While this study is ongoing, C & H Hog Farms is including with this submission the annual reports from the Big Creek Research and Extension Team (BCRET) for 2013 through 2017. Additionally, C & H Hog Farms is submitting a copy of the Drilling Study Report commissioned by the Department. Also, the drilling logs for the two (2) agricultural-use water wells onsite are included with this submission.

7. C & H Hog Farms is not aware that it was asked during the initial technical review or in the September 19, 2017 supplemental information request to update this statement; however, the statement has now been updated in the Nutrient Management Plan (NMP) and is included with this submission.

Respectfully,

Jason Henson

Jason Henson
C & H Hog Farms, Inc.

From:	William A. Waddell, Jr.
To:	Water Permit Application; McAlister, Michael
Cc:	chhogfarmsinc@outlook.com
Subject:	RE: Another Document
Date:	Thursday, December 28, 2017 4:26:57 PM

Jason sent the e-mail and document referenced below after speaking with Michael McAlister and understands that nothing else is needed or requested. Is that correct?

From: C H Hog Farms Inc [mailto:chhogfarmsinc@outlook.com]
Sent: Thursday, December 28, 2017 4:01 PM
To: Water-permit-application@adeq.state.ar.us
Cc: William A. Waddell, Jr.
Subject: Another Document

Here's another document you might need.

Thanks,
Jason Henson
C & H Hog Farms, Inc.

Nutrient Management Plan

for

C & H Hog Farms, Inc.

Owners/Operators: Jason Henson
Richard Campbell
Philip Campbell

Address: HC 72 Box 2

City: Vendor, AR **Zip:** 72683

Telephone: (870) 434-5004

Location(s): Section 26, Township 15 North, Range 20 West

Latitude: 35º 55’ 30.47”N **Longitude:** 93º 4’ 18.42”W

Newton County, Arkansas

Nutrient Management Plan
C & H HOG FARMS, INC.
Newton County, Arkansas

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Farm Overview

Title Page

Signature Page

Location and Contact Information

Operation and Maintenance

Section 1

Nutrient Management Plan

For:

C & H Hog Farms, Inc.
HC 72 Box 2
Vendor, AR 72683
Phone: (870) 434-5004

Purpose of Plan – The goal of nutrient management is to effectively and efficiently use the nutrient resources to adequately supply soils and plants with the proper amount of nutrients to produce food, forage, fiber, and cover while minimizing the transport of nutrients to ground and surface water and environmental degradation. This plan will comply with Arkansas ADEQ Regulation 5.

The owners of C&H Hog Farms, Inc. are respectfully making an application for a Regulation 5 permit.

Section 1

NMP Signature Page

The following individuals have assisted in the development of this Nutrient Management Plan and certify their elements meet the nutrient management planning requirements for the State of Arkansas.

Nutrient Management Planner:

Name: Monica Hancock Certification No.: 10591004-0056

Title: Water Quality Technician- Land Resource Specialist

Signature: Monica Hancock Date: 3-2-16

Engineering Plans and Review:

Name: Pat Bass Certification No: 4185

Title: [signature]

Signature: [signature] Date: 4-3-2016

STATE OF ARKANSAS REGISTERED PROFESSIONAL ENGINEER P. T. BASS

Name: Dennis Carman Certification No: 7670

Title: [signature] PROFESSIONAL ENGINEER

Signature: [signature] PE Date: 4-3-2016

Decision Maker:

As the decision maker for the operation associated with this Nutrient Management Plan, I certify that I have been involved in the planning process and agree with the practices herein. I understand that I am responsible for keeping all necessary records associated with this Nutrient Management Plan.

Signature: Jason Henson Date: 4-6-16

Jason Henson

Section 1

Farm Location and Contact Information

For:

C & H Hog Farms, Inc.
Owners/Managers: Jason Henson
Richard Campbell
Philip Campbell
HC 72 Box 2
Vendor, AR 72683
Phone: (870) 434-5004

Directions to Farm: Facility is located approximately 1.6 miles west of Mt. Judea, Arkansas on County Road 41.

Entrance into the Farm: Entrance is located at: Latitude 35° 55' 30.47" N; Longitude 93° 4' 18.42" W; in the center of Section 26, Township 15 North, Range 20 West, in the Mt. Judea Quad.

Field Locations: Fields contained within this plan are located in: Sections 22, 23, 25, 26, 34, 35 and 36, Township 15 North, Range 20 West and Sections 2 and 3, Township 14 North, Range 20 West.

Watershed: All fields are contained within the Headwaters Big Creek – Buffalo River Watershed (110100050302) and the Left Fork Creek Watershed (110100050301). These watersheds are not in a designated nutrient surplus area.

Operation and Maintenance

Animal Mortality

Normal animal mortality is managed daily by collection of the dead animals and disposal of the carcasses in an incinerator. Other acceptable options for disposal of mortality include composting, freezing, and hauling to a rendering plant.

In case of catastrophic loss, the Arkansas Livestock and Poultry Commission may authorize hauling the carcasses to a rendering plant unless the mortality was caused by disease. When hauling is not feasible, or if disease caused the loss, the Livestock and Poultry Commission may require burial in designated locations with specific guidelines. In such situations, C & H Hog Farms, Inc will contact the Livestock and Poultry Commission by phone **(501-907-2400)** to determine the proper disposal plan.

Land Application

C & H Hog Farms, Inc. is requesting that manure and wastewater from either storage pond (Pond 1 or Pond 2) be transported via liquid tanker trucks or an irrigation system and applied to all fields included in this plan. Regardless of conveyance method, all application rates will be the same. Recognizing that Pond 1 will have a higher fertilizer content than Pond 2, field application recommendations are given from both sources for each field.

Spreader Calibration

Proper calibration of spreader equipment is essential to ensure the amount of swine fertilizer applied is within the required guidelines to protect water quality. The two methods of calibration that are generally used are 1) calibration based on equipment settings and operational conditions and 2) calibration based on gallons per load and number of loads applied.

Soil and Swine Fertilizer Sampling

Several soil cores have been taken from each field and composited into one sub-sample for each individual field. Soils samples are to be taken once every five years or when the nutrient management plan is revised, whichever occurs first. It is required that a manure sample be analyzed each year and the results sent to ADEQ with the farm's annual report.

Operation and Maintenance

Nutrient Utilization

- Swine fertilizer/wash water shall be evenly distributed over application sites at the rates specified in this nutrient management plan by means of liquid tanker trucks and/or irrigation system. Application rates will be the same, regardless of conveyance method.
- Land application of swine fertilizer/wash water shall not be undertaken when soil is saturated, frozen, covered with ice or snow, or when significant precipitation is reasonably anticipated in the next twenty-four hours (greater than 50% chance).
- Swine fertilizer/wash water shall not be applied on slopes with a grade of more than fifteen percent (15%) or in any manner that will allow nutrients to enter the waters of the state. These non-application buffer areas are marked on the field maps.
- Application of swine fertilizer/wash water shall not be made within 100 feet of streams including intermittent streams, ponds, lakes, springs, sinkholes, rock outcrops, wells and water supplies; or 300 feet of extraordinary resource waters as defined by the Arkansas Pollution Control and Ecology Commission Regulation No. 2. Buffer distances from streams, ponds and lakes shall be measured from the ordinary high water mark. These non-application buffer areas are marked on the field maps.
- Application of swine fertilizer/wash water shall not be made within 50 feet of property lines or 500 feet of neighboring occupied buildings existing as of the date of the permit. The restrictions regarding property lines or neighboring occupied buildings shall not apply if the adjoining property is also approved as a land application site under a permit issued by the department or if the adjoining property owner consents in writing (see setback waivers in Section 3). These non-application buffer areas are marked on the field maps.
- Application of swine fertilizer/wash water shall not be made in areas where the land application of swine fertilizer/wash water is prohibited by Arkansas Department of Health regulations for the protection of public water supplies.
- ADEQ has developed a standard form entitled “Animal Waste Application Records” for use in logging nutrient applications. This form is located in Section 7 under “Recordkeeping”.

Odor Management

Although it may not be practical or feasible to eliminate all odor emissions from the operation, it is possible to manage or mitigate the odor. The odor reduction practices listed below may be utilized by the operation in an effort to reduce odor emissions:

- Animal Cleanliness – Clean, dry, and healthy animals are less odorous.
- Minimize Dust – Dust particles may absorb and concentrate odorous compounds. Proper cleaning techniques within the facility can minimize dust and, therefore, reduce odor.
- Waste Storage Facility Maintenance – Proper maintenance of pits and waste storage ponds can reduce odor. Frequently flushing manure is an effective method to reduce odor emissions from the pits.

- Proper Disposal of Mortality – Normal mortality for the animal feeding operation must be properly handled for both odor control and biological security purposes. Composting, freezing, incineration, and rendering are acceptable methods for mortality disposal.
- Natural Barriers – Trees and shrubs planted around the facility can act as biofilters for odorous compounds.
- Land Application Practices – To the extent possible, consider weather conditions when making land applications. Sunny, low humidity days reduce odors; turbulent breezes will dilute and dissipate odors.

Pond Levees

- Pond levees will be inspected weekly and after major storm events.
- Pond levees will be inspected for signs of seepage, damage (including but not limited to damage from burrowing animals and woody vegetative growth), and erosion, and repaired as needed.

Section 2

C & H Hog Farms, Inc.

Application for Regulation 5 Permit

Engineering Plans and Review

September 1, 2015

Prepared by: T. P. Bass, P.E.

Reviewed by: Dennis K. Carman, P.E.

Manure Storage Volume Availability and Minimal Requirements

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BACKGROUND

The C & H HOG Farm is located near Mount Judea in Newton County, Arkansas. This facility has an existing Permit for operation issued by the Arkansas Department of Environmental Quality and Ecology and approved August 03, 2012. Details of this permit can be viewed at adeq.state.ar.us for Permit Number ARG590001.

Facility Location: Near Mount Judea, Newton County, Arkansas

Latitude Deg/Min/Sec:	35° 55' 30.47"
Longitude Deg/Min/Sec:	-93° 4' 18.42"

Permitting History

Original Permitting - ADEQ Letter dated August 03, 2012. Re: Concentrated Animal Feeding Operations General Permit (Tracking Number ARG590001 - AFIN 51-00164)

"The Notice of Intent (NOI) package for coverage under the General Permit No. ARG590000, for a concentrated animal feeding operation, was received on 6/25/2012. In accordance with Department policy, the NOI has been reviewed and has been determined to be complete. Coverage under this

general permit will be effective the date of this letter. A copy of the General Permit ARG590000 is available from the Department".

Permit Modification to allow Tanker Methods for field application. ADEQ Letter dated June 5, 2014. Re: Concentrated Animal Feeding Operations General Permit (Tracking Number ARG590001- AFIN 51-00164)

"The Notice of Intent (NOI) package for a substantial change of coverage under the General Permit No. ARG590000, for a concentrated animal feeding operation, was received on 2/11/2014. In accordance with Department policy, the NOI has been reviewed and has been determined to be complete. The substantial change will be effective the date of this letter. A copy of the General Permit ARG590000 is available from the Department".

Engineering Plans and Reports: Engineering plans and reports dated June 1, 2012 have been prepared, submitted and approved by ADEQ. Engineering plans were prepared by DeHaan, Grabs & Associates LLC, consulting engineers in accordance with ADEQ rules and regulations and can be viewed at the website listed below.

Engineering Plan Sheets
http://www.adeq.state.ar.us/downloads/WebDatabases/PermitsOnline/NPDES/PermitInformation/ARG590001_Maps_20120613.pdf

As Built Engineering Plan Sheets
http://www.adeq.state.ar.us/downloads/WebDatabases/PermitsOnline/NPDES/PermitInformation/ARG590001_As%20Built%20Engineering%20Plan%20Sheets_20130412.pdf

Existing Facility Field Review

Field Applications Areas: Areas viewed were pasture and hayland that were either not subject to flooding or only subject to occasional flooding. Slopes, after buffering, are within specified limits of 15% or less. The Owner clearly understood buffers and was following those buffer limitations to the letter. Vegetative cover was excellent with superior vegetative cover in those areas receiving nutrients from manure application.

Permit Application – Liner Addition: A permit change application is currently being processed with the intent to permit the owner to add a liner to the bottom of ponds 1 and 2 and a cover on pond 1 to flame the methane generated. Although this addition is not required, the owner continues to demonstrate willingness to add features above and beyond the regulatory requirements for operating this facility in an environmentally safe and acceptable manner.

Existing Facility Design Review

This facility has been previously reviewed by and approved by ADEQ and a permit for operation has been issued. The facility has been in operation since 2012. Several follow-up visits have been made, by

ADEQ, EPA, Big Creek Research & Extension Team (BCRET) and others, as the facility operations and permit application changes have been challenged by groups and individuals with environmental concerns. The Design and As-Built plans, prepared by DeHaan, Grabs & Associates LLC, were reviewed as a part of this permit application.

Key components of this review are as follows:

The facility was constructed as planned and designed. No exceptions, issues or concerns were identified. This facility was clearly well designed and constructed and continues to be operated and maintained in a safe manner. Specific key details are noted as follows:

Side slopes: All side slopes for pond 1 and 2 meet or exceed the Regulation 5 referenced requirements as shown on the Engineering Plans.

Top width: Top widths of pond 1 and 2 meet or exceed the Regulation 5 referenced requirements as shown on the Engineering Plans. The levees have a gravelly top for stability and accessibility during wet periods as required by the reference standards and normal operation procedures. The referenced standard requires that the facility be acces**s**ible under all climatic conditions for inspections and normal operations.

Liner: This facility has an 18" constructed clay liner that exceeds the Regulation 5 referenced requirements and shown in the Engineering Plans, checked during construction and certified for operation by the department. As previously noted, the owner is proposing to add a synthetic liner to the ponds 1 and 2, that while not technically required, will further reduce potential seepage. In my professional opinion, this liner is not necessary but will provide added security that concerns others. (*Dennis K. Carman, P.E. AR, P.E. 7670*)

Vegetative cover: The vegetative cover on the back slopes of pond 1 and 2 were in excellent condition and has been well maintained. No signs of erosion or other embankment issues were observed. A specific review of the back slopes of the embankment was made during the field visit to identify any signs of seepage that could be coming from the facility. None were present as would be expected from a facility designed with this level of environmental protection by the embankment construction methods and liner requirements.

Manure transfer appurtenances: Adequate and operating properly

Staff Gage: In place and functioning

Sizing of the Facility and Manure Volume Calculations

Animal Population Description

The farm is a farrowing farm. Currently pigs are weaned each day with the weaned pigs being placed and maintained in nursery pens. On a weekly basis the weaned pigs are shipped off farm. While the

number and size of the shipped pigs vary, the weekly shipment should average 1500 pigs or less with an average weight of about 14 lbs. As the population of the nursery pens will vary from zero after shipment to 1500 or less prior to shipment the average nursery pig population is estimated as 750 animals.

Due to pen space and herd movement constrains the maximum number adult breeding and replacement animals are classified into the following groups: 6, 450 lb. Boars; 2252, 425 lb. Gestating Sows; and 420, 400 lb. Lactating Sows and 750, 14 lb. nursery pigs. In practice the normal operation populations will vary below these maximums resulting in actual manure production and volume requirements likely to be less than calculated.

Barn and Water Information

The animals are maintained in pens within the barns. The pen's slatted floors allow manure to be deposited in the pull plug pits located below the pens. The pits are pre-charged with water from an exterior manure storage pond. Periodically the pits are drained to transfer the pre-charged water with additional accumulated manure to the external manure storage ponds.

The farm uses "wet/dry" feeders extensively so that any animal drinking water spillage will fall into the feed troughs and be consumed with the feed. As a result, there will be effectively little spilled drinking water adding to the manure volume in the pits.

In addition to the manure deposited directly into the pits, the pressure washer system used to clean the pens, add approximately 929 gallons of wash water to the pits on a daily basis. See the Appendix Section *Barn Wash-Water Volume Determination* for details.

Precipitation Additions to Manure

The Barn pits drain into Pond 1, the first (southernmost) holding pond. There is an open concrete spillway that allows manure to flow from the first holding pond 1 into the second holding pond. Normally the barn pits are recharged from the second pond. However, at times water management needs may necessitate recharging the barn pits from the first pond.

As the ponds are exposed to the weather, precipitation will be added to the manure in the ponds. The amount of precipitation is determined by the area that drains into the ponds and the amount of precipitation minus evaporation. A topographic survey confirms that the top inside of the ponds and spillway embankments serve as the boundary for precipitation drainage into the ponds. Precipitation outside this boundary drains away from the ponds and does not become added to the manure. To simplify calculations, it is assumed that all the precipitation that falls within this 59,457 ft^2 area is added to the manure. This likely provides a slight over estimate of added volume since a portion of the precipitation will fall on soil and be absorbed and or evaporated without being added to the manure volume in the ponds.

Figure 1. Yellow outer boundary denotes the drainage area (59,457 ft^2) into the holding ponds. The red inner boundary denotes area of the top of the free board for holding Pond 1 (16,999 ft^2) and Pond 2 (34,618 ft^2).

Storage Volume Availability

In-Barn Pull Plug Pit Volumes

The pits provide a maximum of 768,145 gallons of in barn manure storage. Of this total, the Gestation Barn Pits have a maximum capacity of 563,710 gallons. The remaining capacity of 204,436 gallons is in the Farrowing Barn Pits. Refer to the Appendix Section *Barn Pull Plug Pit Volume Calculation* for determination of these volumes. Normally this maximum capacity is not fully utilized as the pits function primarily for manure collection and short term storage.

Topographic Elevation Survey of Existing Holding Ponds

To quantify potential precipitation additions to the manure volume, a topographic elevation survey of the catchments for the holding ponds was conducted utilizing total station survey equipment. This survey measured the elevation at various locations around the holding ponds, as well as points on the interior slopes and bottoms of the ponds. The survey was followed by a second survey utilizing a traditional transit and "Philadelphia Rod," which measured elevation at various points on the outside of the ponds to document drainage patterns away from the ponds. In addition, visual inspections and photographs were made to provide additional inputs. All this information was provided by BCRET and utilized to build a Graphical Information System (GIS) surface model that provides both precipitation

capture area of the holding ponds and storage volumes of holding ponds (Table 1 and Figures 1&2). This pond information and historical rainfall information are being used to estimate potential precipitation additions to manure slurry volume.

Table 1. Summary information for the topographic survey surface modeling area and volume.

Pond	Area	Total volume [3]	Available storage [4]
	ft^2	gallon	gallon
Pond 1	16,999 [1]	743,352	615,946
Pond 2	34,618 [1]	1,978,743	1,721,128
Sum of Pond 1 & 2	51,617[1]	2,722,095	2,337,074
Drainage area into ponds [4]	59,457[2]	Not applicable	Not applicable

[1] Area of the top of the pond's 1 ft. deep freeboard zone.

[2] Area in which water would drain into the ponds during a precipitation event.

[3] Total volume from the bottom of the pond to the top of the freeboard.

[4] Available storage is the total volume minus a 6 inch bottom layer, assumed as unpumpable, and the top 1 ft. freeboard layer.

Figure2. Holding Pond Contours (Survey by Big Creek Research & Extension Team)

Storage Volume Required

Design Requirements for 180 days of storage during wettest consecutive months which for Arkansas tend to be October to March. (Average precipitation less evaporation)

Manure Production

NRCS AWFH Production Estimates

Animal type		Boar	Gestating Sow	Lactating Sow	Nursery Pig	Grow-Finish (Replacement Gilts)
Weight range	lb				10 to 50	50 to 265
Design Weight	lb	440	440	423	27.5	154
Cycle Length	d	365	365	365	36	120
Weight	lb/d/au	19	25	59	88	65
Volume	ft^3/d/au	0.30	0.41	0.97	1.40	1.10
Moisture	%	90%	90%	90%	90%	90%
N	lb/d/au	0.14	0.16	0.45	0.92	0.54
P	lb/d/au	0.05	0.05	0.13	0.15	0.09
P205	lb/d/au	0.11	0.11	0.30	0.34	0.21
K	lb/d/au	0.09	0.11	0.28	0.35	0.24
K2O	lb/d/au	0.11	0.13	0.34	0.42	0.29

Farm Animal Population Information

Animal type		Boar	Gestating Sow	Lactating Sow	Nursery Pig	Grow-Finish (Replacement Gilts)	Totals
Number Animals		6	2252	420	750		3,428
Animal weight	lb	450	425	400	14		1,289
AU	1000 lb	2.70	957.10	168.00	10.50		1,138
Time Period	days	180	180	180	180		180

As Excreted Farm Totals Prior to Losses and Water Additions

Weight	lb	9,234	4,306,950	1,784,160	166,320		6,266,664
	ft^3	146	70,634	29,333	2,646		102,759
Volume	gal	1,091	528,342	219,409	19,792		768,634
Moisture	%	0.90	0.90	0.90	0.90		0.90
N	lb	68	27,564	13,608	1,739		42,979
P	lb	24	8,614	3,931	284		12,853
P2O5	lb	56	19,726	9,002	649		29,433
K	lb	44	18,951	8,467	662		28,123
K2O	lb	52	22,741	10,161	794		33,748

Wash Water

Additional Non-Precipitation Water to Manure

Type of Addition	Daily (gal)	Total for time (gal)	Per Animal gal/hd/day	% of Manure Vol %
Add'l Flush Water	0	0	0.00	0.0%
Wash Water	929	167,220	0.27	21.8%
Total from barn	929	167,220	0.27	21.8%

Climatic Data for Newton County Arkansas

Precipitation Information (in)

Month	Precipitation	Evaporation	P-E	P-E >=0	P-E used	
Jan	2.06	0.72	1.34	1.34	1.34	
Feb	2.75	1.08	1.67	1.67	1.67	
Mar	4.58	2.52	2.06	2.06	2.06	
Apr	3.97	3.60	0.37	0.37		
May	5.06	4.68	0.38	0.38		
Jun	3.27	4.68	-1.41	0.00		
Jul	2.94	5.40	-2.46	0.00		
Aug	2.74	5.04	-2.30	0.00		
Sep	4.15	3.24	0.91	0.91		
Oct	3.47	2.88	0.59	0.59	0.59	
Nov	3.88	1.44	2.44	2.44	2.44	
Dec	3.55	0.72	2.83	2.83	2.83	
Totals	42.42	36.00	6.42	12.59	10.93	in
					0.91	ft

25-yr, 24-Hr Storm	7	in
	0.58	ft
Rain Catch Area	59,457	ft^2
	1.36	ac

Precipitation Accumulation for Time Period
Accumulation (in/12) X Rain Catch Area (ft^2)

	ft^3	gal
Precipitation	54,155	405,083
25-yr, 24-Hr Storm	34,683	259,431
Total	88,839	664,513

Summary of Required Storage for 180 day cycle (wet months)

Storm Storage = 259,431 gals. (To remain empty and available at all times for Storm Events)
Manure Production = 768,634 gals. (4,270 gals/day)
Wash Water = 167,220 gals. (929 gals/day)
Precipitation= 405,083 gals. (2,250 gals/day)
Total Required Storage = 1,600,368 gals.

Sum of Pond 1 and 2 available storage = 2,337,074 gals.

Conclusion: Total available storage in ponds 1 and 2 exceeds requirements by 736,706 gals.

System Evaluation of Ponds 1 & 2

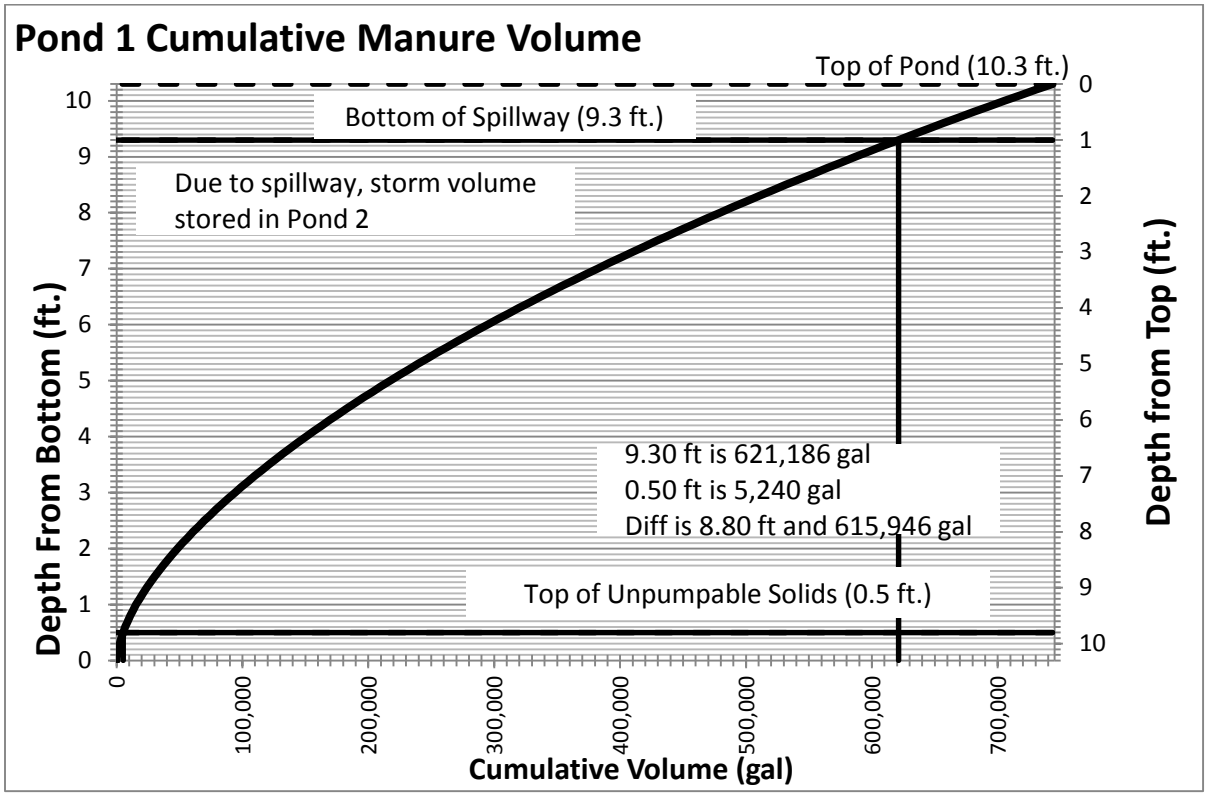
The manure and wash water collection operation consist of an intermittent flow through system from the housing structures to pond 1 then into pond 2. Each pond will maintain a 1.0 foot freeboard. All outside runoff from the surrounding area plus direct rainfall into the ponds along with a volume equal to a 24 hour 25 year storm event will be stored in pond 2. Staff gage located in pond 2 will be used to indicate the maximum accumulation of effluent before removal by pumping is required. The under house collection pits are periodically recharged by recycling water from pond 2. Occasionally due to pond 2 water management needs pond 1 may supply recycle water to the pits.

Water level management and nutrient application pumping may occur from either Pond 1 or Pond 2 to manage water levels and properly utilize available nutrients and maximize environmental protection provided by matching available storage with the Nutrient Management Plan. Both ponds will be pumped directly into land application equipment such as tankers, irrigation equipment, or other commonly accepted manure transfer and application equipment. As needed, to maintain available volumes, both ponds will be agitated during pumping to remove settled solids.

As built drawings and final designs of both ponds were completed in April 2013 by DeHaan; Grabs & Associates. The only change since the initial construction has been the addition of a junction box at the intersection of the discharge pipes from each of the housing facilities for cleanout purposes. An additional well has also been added to furnish potable water for the showers and is not a part of the swine production and manure management facility.

Pond 1

Based on the pond configuration shown in Figure 1 the stage-storage curve for Pond 1 is as follows



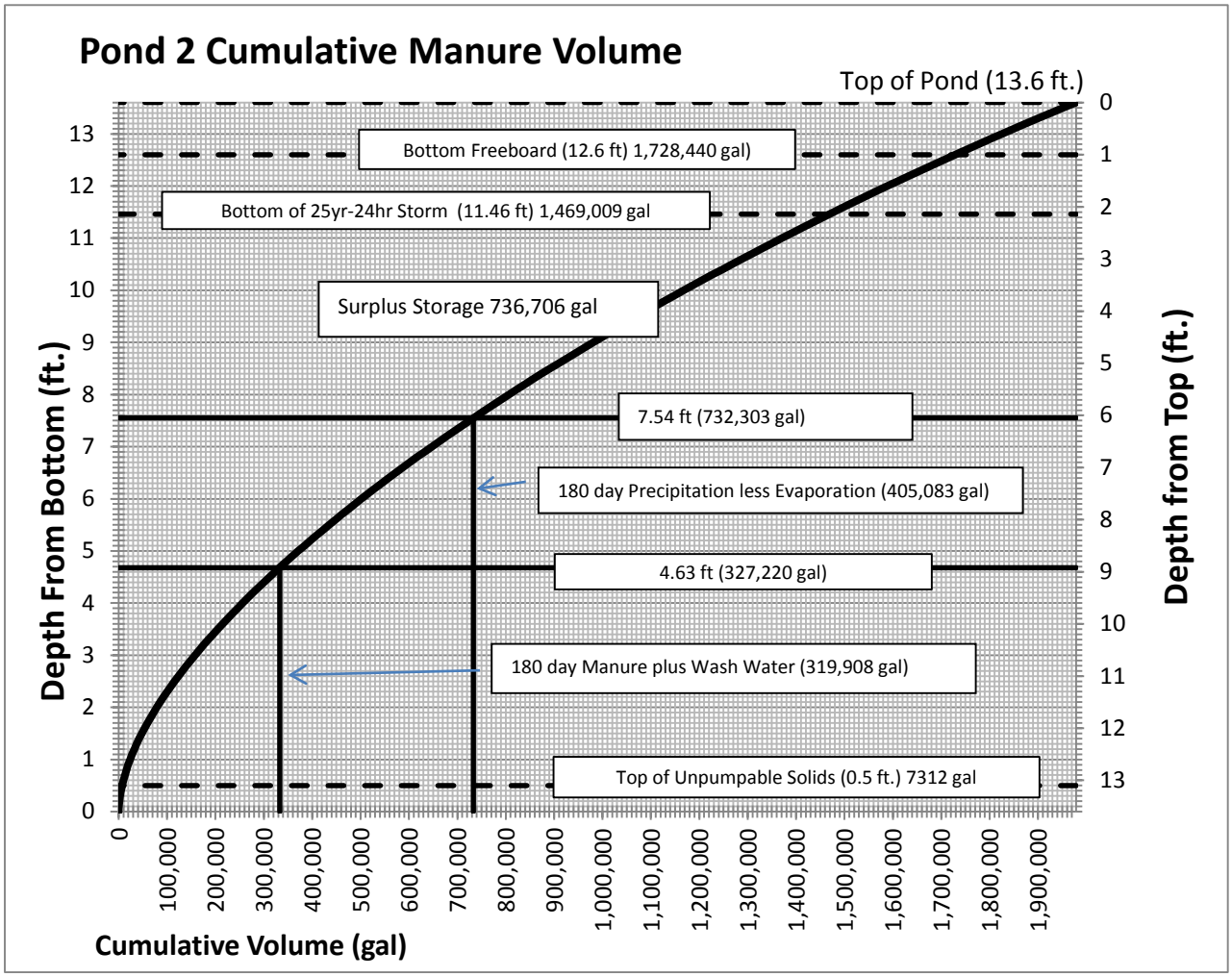
Pond 1 serves as the primary receiving area for all discharges of manure slurry which will allow most of the solids to settle before effluent flows into Pond 2. The concrete spillway from Pond 1 to Pond 2 ensures the 1 foot freeboard of Pond 1 will be maintained.

Pond 2

Pond 2 will store the remaining manure slurry produced plus all of the runoff volume that can be expected for the wettest 180 day period. The one foot freeboard and one half foot of unpumpable liquid will be deducted as unavailable from the pond's available storage. Calculations are as follows:

Manure = 768,634 gals (180 days) = 4,270 gal/day.
Wash water = 167,220 gals (180 days) = 929 gal/day
Subtotal Manure Slurry = 935,854 gals (180 days) = 5,199 gal/day
Manure Slurry flow into pond 2 = Total Manure Slurry - Pond 1 Available Storage = 935,854 - 615,946 = 319,908 gals (180 days) = 1,777 gal/day
Total Runoff for 180 wet months precipitation less evaporation = 405,083 gals = 2,250 gal/day
Storm Storage = 259,431 gals. (To maintain empty and available at all times for storm events)
Total Available Volume Required for Pond 2= 319,908 + 405,083 + 259,431 = 984,422 gals
Total Available in Pond 2 as modeled = 1,721,128 gals
Conclusion: Available Storage Volume in ponds 2 exceeds requirements by 736,706 gals.

Based on the pond configuration shown in Figure 1 the stage-storage curve for Pond 2 is as follows:



A staff gage will be used as a management tool as well as a means to indicate the maximum liquid level permissible before pumping.

The level of liquid accumulation in pond 2 should be monitored and maintained so that the storm volume is only encroached during a 25 year 24 hour storm event. The freeboard volume should never be encroached. The additional storage capacity will facilitate proper water level management. In addition it also helps with providing flexibility in matching nutrients and nutrient application timing more easily with the nutrient management plan. It also provides house pit recycle water reserve to help manage in house and ventilation discharge odors.

Number of Days Storage

The actual maximum days of storage of manure slurry is based on pond storage capacity and normal runoff and storm water accumulations.

Total Pond Storage Available = 2,337,074 gals (Total Volume in both ponds less the volumes occupied by freeboard, 25 yr. storm runoff and an unpumpable 0.5 ft bottom layer)

Average manure production= 4,270 gals/day

Wash water = 929 gals/day

Runoff of 9 months (270 days) precipitation less evaporation (where rainfall exceeds evaporation [September through May]) = 12.59 ins. = 1.05 ft.

Drainage Area = 59,457 ft^2

The 270 day daily runoff= 59,457 ft^2 x 1.05 ft. x7.48 gal/ft^3. / 270 days = 1728 gal/day

Volume Accumulation for Sept through May = (4270+929+1728) x 270 = 1,870,290 gals.

Remaining Volume in Ponds 1 & 2 after 9 months accumulation (September - May) = 2,337,074 gals available storage – 1,870,290 gals accumulation – 259,431 gals storm water = 207,353 gals.

Remaining 3 months (June – August) where evaporation exceeds rainfall, the only accumulation is manure slurry = 4,270 + 929 = 5,199 gals/day.

Additional days of storage above the 270 days = 207,353 gals / 5199 gals / day = 40 days

Maximum Days of Storage = 270 + 40 = 310 days

Appendix

Barn Wash-Water Volume Determination

Discussions with C&H management revealed that the farm used "wet/dry" feeders so that any animal drinking water spillage would fall into the feed troughs and consumed with the feed. As a result, there will be effectively no spilled drinking water adding to manure slurry volume. Estimates for pen wash down water were provided in the form of the number of pressure washers, the flow rates in gallons per minute, and the average time spent washing each day. As a more direct determination of pen wash water additions to the manure was desired, two standard water meters were purchased and installed to measure all the water used by two pressure washers used in the barns (Figure 9).

Figure 1. Standard water meter with hose adapters and mounting base installed to measure water use during pressure washing to clean animal pens.

Periodically, pictures of the meters were submitted providing readings and the date of the readings to document cumulative and daily wash-water volumes added to the manure slurry volume. From March 20, 2014 to September 9, 2014 a total of 161,722 gallons of water was used to wash the pens with the water then draining into the manure pits. The average daily water use over these 174 days was 929 gallons/day. (Table 8 and Figures 10 and 11).

Table 1. Pen wash-water meter readings and water volumes in gallons.

Date	Days	Meter 1			Meter 2			Total	
		Reading	Cumulative	Daily average	Reading	Cumulative	Daily average	Cumulative	Daily average
		---------- Gallons ----------							
3/20/2014		126.5			80.2				
9/10/2014	174	96,610	96,483	554	65,319	65,239	375	161,722	929

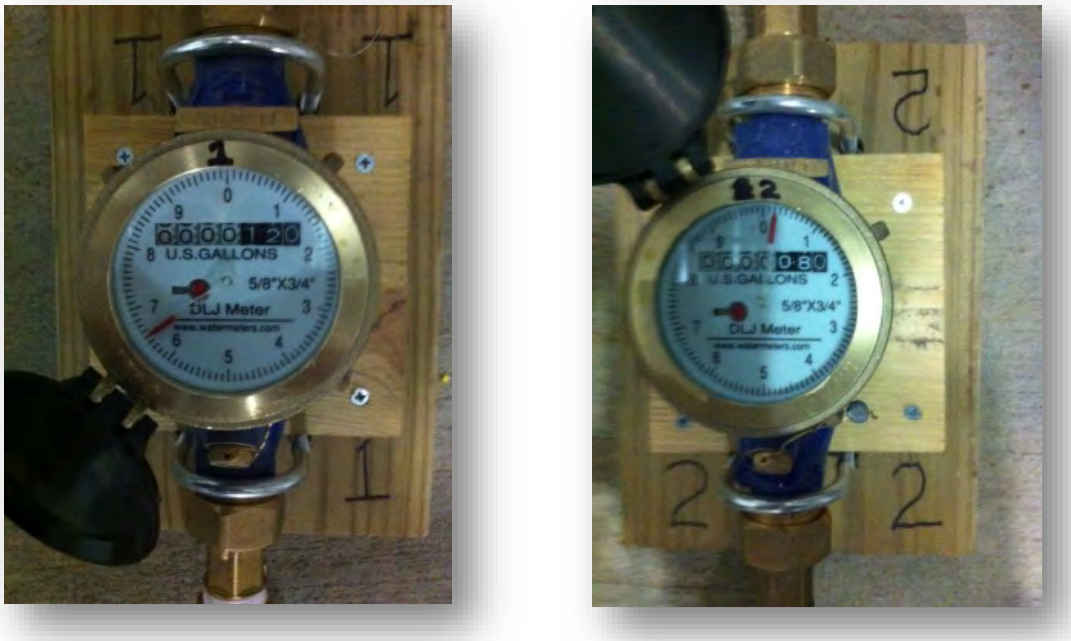


Figure 2. Two water meters purchased and installed on March 20th, 2014 to measure pen wash down water additions to manure volume. Initial meters readings were 126.6 and 80.2 gallons for meter 1 and 2.

Figure 3. Two water meters purchased and installed on March 20th, 2014 to measure pen wash down water additions to manure volume. Meters readings were 96,609.6 and 65,319.3 gallons for meter 1 and 2 on September 10th, 2014.

Miscellaneous

Barn Pull Plug Pit Volume Calculations
Based on Spread Sheet File Pull Pit Volumes 5_28_15.xlsx (Separate Document) by: Big Creek Research & Extension Team (BCRET)

Pond Volume Calculations
Based on Spread Sheet File Calc Chart Ponds Elev Model As built Volumes 5-19-2015.xlsx (Separate Document) by: Big Creek Research & Extension Team (BCRET)

Section 3

Land Application Site Information

Land Application Site Table including Latitude and Longitude for each field

Setback Distance Table (BMP Buffers)

Land Use Contracts

Letters of Consent with Neighboring Landowners

Land Application Sites								
Field	Landowner	New/Existing	Section	Township	Range	Spreadable Acreage	Longitude	Latitude
1	Jason Henson	Existing	25	15N	20W	8.2	93°3'32.372"W	35°55'1.349"N
2	Jason Henson	Existing	25	15N	20W	6.0	93°3'43.637"W	35°54'55.793"N
3	Charles Campbell	Existing	25/26	15N	20W	13.2	93°3'53.07"W	35°54'59.383"N
4	Jason Henson	Existing	36	15N	20W	7.2	93°3'39.78"W	35°54'49.65"N
*5	Louetta/Glen Ricketts	New	23	15N	20W	9.7	93°4'30.114"W	35°55'53.941"N
*6	Louetta/Glen Ricketts	New	26	15N	20W	5.6	93°4'49.381"W	35°55'48.19"N
*6A	Shawn Ricketts	New	26	15N	20W	7.3	93°4'27.597"W	35°55'42.631"N
7	E.G. Campbell	Existing	26	15N	20W	62.5	93°4'12.854"W	35°55'24.9"N
*7A	E.G. Campbell	New	26	15N	20W	28.3	93°4'14.499"W	35°55'27.002"N
8	Charles Campbell	Existing	26/35	15N	20W	7.2	93°4'7.519"W	35°54'56.821"N
8A	Charles Campbell	Existing	35	15N	20W	1.4	93°4'17.42"W	35°54'45.295"N
9	Charles Campbell	Existing	35	15N	20W	24.6	93°4'18.724"W	35°54'43.111"N
9A	Charles Campbell	Existing	26/35	15N	20W	10.3	93°4'2.05"W	35°54'56.223"N
10	Fayma Dickey	Existing	35	15N	20W	13.6	93°4'18.767"W	35°54'42.431"N
10A	Billy F. Cheatham	Existing	35	15N	20W	16.4	93°4'10.843"W	35°54'30.331"N
11	Fayma Dickey	Existing	35	15N	20W	13.3	93°4'22.582"W	35°54'33.004"N
12	Robert Flud	Existing	35	15N	20W	11.2	93°4'15.143"W	35°54'13.541"N
13	Charles Campbell	Existing	2	14N	20W	11.6	93°4'21.856"W	35°53'56.972"N
13A	Charles Campbell	Existing	35/2	15N/14N	20W	29.8	93°4'35.599"W	35°53'59.62"N
13B	Charles Campbell	Existing	35	15N	20W	8.1	93°4'20.307"W	35°54'3.407"N
14	Charles Campbell	Existing	35	15N	20W	7.6	93°4'38.516"W	35°54'22.791"N
15	Clayel Criner	Existing	2	14N	20W	21.5	93°4'46.334"W	35°53'47.015"N
*15A	Clayel Criner	New	2	14N	20W	10.4	93°4'54.416"W	35°53'52.182"N
15B	Clayel Criner	Existing	2	14N	20W	13.7	93°5'2.42"W	35°53'43.458"N
16	Barbara Hefley	Existing	2	14N	20W	15.2	93°4'38.587"W	35°53'35.201"N

Land Application Sites (Continued)								
Field	Landowner	New/Existing	Section	Township	Range	Spreadable Acreage	Longitude	Latitude
17	Jason Criner	Existing	34/35 2/3	15N 14N	20W 20W	30.9	93°5'3.665"W	35°53'55.374"N
*18	Murl Bryant	New	25	15N	20W	21.7	93°3'27.778"W	35°55'32.715"N
*19	Murl Bryant	New	25	15N	20W	10.1	93°3'34.212"W	35°55'37.349"N
*20	Rondal Campbell	New	35	15N	20W	20.7	93°4'17.971"W	35°54'45.772"N
*21	Rondal Campbell	New	35	15N	20W	18.6	93°4'59.439"W	35°54'35.005"N
*21A	Rondal Campbell	New	34	15N	20W	15.6	93°5'10.85"W	35°54'44.478"N
*21B	Rondal Campbell	New	35	15N	20W	6.0	93°4'54.343"W	35°54'48.234"N
*22	Kelis Campbell	New	26	15N	20W	35.2	93°4'50.239"W	35°55'9.687"N
*23	Greg Grice	New	22	15N	20W	28.1	93°5'43.327"W	35°56'27.709"N
*24	Donald Haddock	New	23	15N	20W	8.0	93°4'35.322"W	35°55'59.004"N
*32	Howard Criner	New	22	15N	20W	10.0	93°5'22.606"W	35°56'26.454"N
*33	Howard Criner	New	22	15N	20W	3.4	93°5'16.715"W	35°56'32.636"N
*34	Rondal Campbell	New	26	15N	20W	12.8	93°4'42.775"W	35°55'2.033"N
*35	C & H Hog Farms, Inc.	New	25	15N	20W	18.4	93°3'14.369"W	35°55'10.6"N
*36	C & H Hog Farms, Inc.	New	25	15N	20W	8.4	93°3'1.819"W	35°55'19.23"N

***Indicates new land that has not been previously permitted.** All other land was included in the original NPDES permit. To better reflect land management, some fields were further divided into subsets (A or A & B) due to cross fencing or natural field barriers. ArcGIS software utilized to calculate longitude, latitude, PLSS and acreage.

Manure Application Setback Distance Table (BMP's)

Field	Land Owner	Open Acres	50 ft. Buffer	100 ft. Buffer	500 ft. Buffer	Steep Slope Buffer	Spreadable Acres	Land Use	Grass Type
1	Jason Henson	17.7	0	0.7+0.1	6.5	2.2	8.2	Rotational	Mixed
2	Jason Henson	8.8	0	0	0	0.3+1.7+0.1+0.7	6.0	Rotational	Mixed
3	Charles Campbell	16.7	0.9	0.6	2.0	0	13.2	Rotational	Mixed
4	Jason Henson	10.9	0	0.6+0.3+0.6+0.7	0	1.5	7.2	Rotational	Mixed
5*	Louetta/Glen Ricketts	13.3	0.6	2.3+0.7	0	0	9.7	Rotational	Mixed
6*	Louetta/Glen Ricketts	9.1	0	0	0	1.4+0.6+1.5	5.6	Rotational	Mixed
6A*	Shawn Ricketts	17.5	0.8	0.2+1.0	0	8.2	7.3	Rotational	Mixed
7	E.G. Campbell	72.9	2.2	0.7+3.9+0.5+0.6+0.5	2.0	0	62.5	Rotational	Mixed
7A*	E.G. Campbell	35.1	2.7	3.8+0.1+0.2	0	0	28.3	Rotational	Mixed
8	Charles Campbell	10.7	0.4+0.7+0.1	1.5+0.8	0	0	7.2	Rotational	Mixed
8A	Charles Campbell	2.9	0.5	0.5+0.5	0	0	1.4	Rotational	Mixed
9	Charles Campbell	29.6	0.1	1.8+0.4+2.1+0.6	0	0	24.6	Rotational	Mixed
9A	Charles Campbell	11.6	0	0.9+0.3+0.1	0	0	10.3	Rotational	Mixed
10	Fayma Dickey	14.7	0.1	0.1+0.9	0	0	13.6	Rotational	Mixed
10A	Billy F. Cheatham	17.7	0	0.6+0.4+0.3	0	0	16.4	Rotational	Mixed
11	Fayma Dickey	19.2	0.3	1.3	0	1.1+2.3+0.7+0.1+0.1	13.3	Rotational	Mixed
12	Robert Flud	13.1	0.6 + 0.4	0.5 + 0.4	0	0	11.2	Rotational	Mixed
13	Charles Campbell	13.0	0.3	0.3	0	0.8	11.6	Rotational	Mixed
13A	Charles Campbell	36.9	1.0	1.4	0	1.7+2.4+0.6	29.8	Rotational	Mixed
13B	Charles Campbell	15.5	0.9	0.4+0.9	0	2.0+3.2	8.1	Rotational	Mixed
14	Charles Campbell	15.1	1.3	0.9	0	5.3	7.6	Rotational	Mixed
15	Clayel Criner	28.2	0.1+0.4	1.3	0	4.7+0.2	21.5	Rotational	Mixed
15A	Clayel Criner	14.2	0.7	0	0	3.1	10.4	Rotational	Mixed
15B	Clayel Criner	21.0	0	1.2+0.4	0	4.1+1.6	13.7	Rotational	Mixed
16	Barbara Hefley	21.3	0.5	2.0+0.8+2.8	0	0	15.2	Rotational	Mixed
17	Jason Criner	36.1	0.9+1.3	1.6+1.4	0	0	30.9	Rotational	Mixed
18*	Murl Bryant	29.6	1.3+0.1+0.7	1.4	4.4	0	21.7	Rotational	Mixed
19*	Murl Bryant	13.3	1.0	2.2	0	0	10.1	Rotational	Mixed

Manure Application Setback Distance Table (BMP's) continued

Field	Land Owner	Open Acres	50 ft. Buffer	100 ft. Buffer	500 ft. Buffer	Steep Slope Buffer	Spreadable Acres	Land Use	Grass Type
20*	Rondal Campbell	24.8	0.1	2.1+1.1+1.7	0	0.2	20.7	Rotational	Mixed
21*	Rondal Campbell	49.8	0	2.9+1.7+1.4+0.5+1.1+1.8	0	10.1+11.4+0.3	18.6	Rotational	Mixed
21A*	Rondal Campbell	19.8	0	0.2	0	4.0	15.6	Rotational	Mixed
21B*	Rondal Campbell	7.1	0	0	0	0.7+0.4	6.0	Rotational	Mixed
22*	Kelis Campbell	46.4	0	0.4+0.2+0.1	0	1.6+0.2+8.7	35.2	Rotational	Mixed
23*	Greg Grice	33.8	1.0+2.0	0.6+0.4+0.5+0.4+0.6+0.2	0	0	28.1	Rotational	Mixed
24*	Donald Haddock	11.6	0	3.1+0.5	0	0	8.0	Rotational	Mixed
32*	Howard Criner	11.9	0.8	1.1	0	0	10.0	Rotational	Mixed
33*	Howard Criner	5.9	0.4	1.3+0.8	0	0	3.4	Rotational	Mixed
34*	Rondal Campbell	16.5	0.4	1.2	0	1.1+0.1+0.6+0.3	12.8	Rotational	Mixed
35*	C & H Hog Farms Inc	26.3	1.7+0.5	0.5	0	5.2	18.4	Rotational	Mixed
36*	C & H Hog Farms Inc	12.1	0	1.4+0.3	0	0.8+0.5+0.7	8.4	Rotational	Mixed
	Total Open Acres:	**831.2**				**Total Spreadable Acres:**	**611.8**		

***Indicates new land that has not been previously permitted.** All other land was included in the original NPDES permit. To better reflect land management, some fields were further divided into subsets (A or A & B) due to cross fencing or natural field barriers. ArcGIS software utilized to calculate all acreage and buffers.

LAND USE CONTRACT

I, Jason Henson (Name of Landowner), agree to allow C&H Hog Farms, Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 21.4 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
1	SW	25	15N	20W	8.2
2	SW	25	15N	20W	6.0
4	NW	36	15N	20W	7.2

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.

Philip Campbell — Permittee's Signature
2-19-16 — Date

Jason Henson — Landowner Signature
2-19-16 — Date

LAND USE CONTRACT

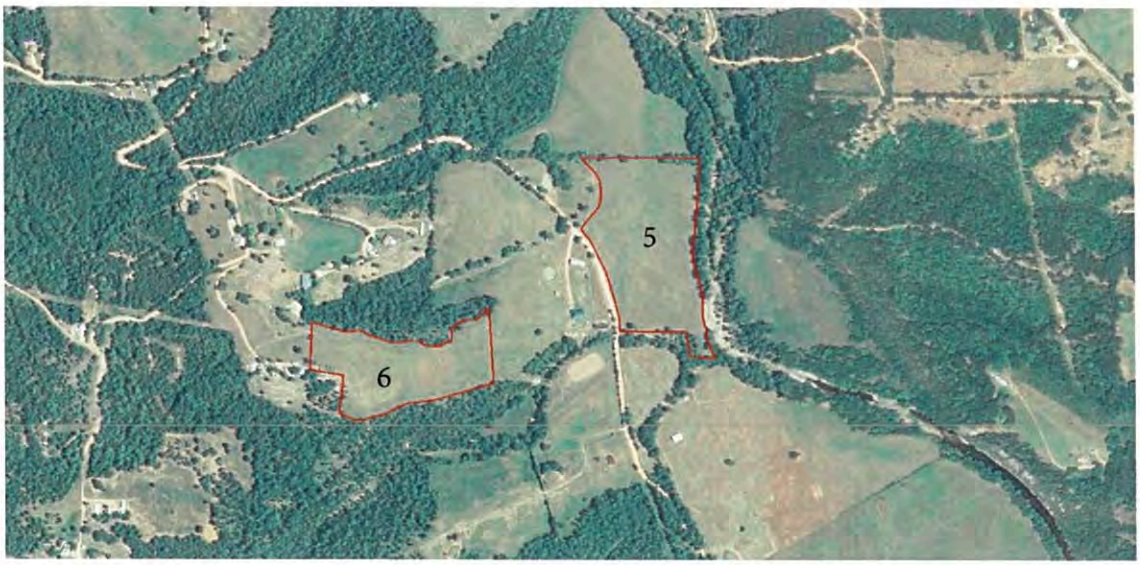
I, Lovetta Ricketts (Name of Landowner), agree to allow C+H Hog farms Inc. (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 15.3 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
5	SW/SE	23	15N	20W	9.7
6	NW	26	15N	20W	5.6

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.



Jason Henson — Permittee's Signature — 11-18-15 — Date

Lovetta Ricketts — Landowner Signature — 10-25-15 — Date

LAND USE CONTRACT

I, Shawn Ricketts (Name of Landowner), agree to allow C+H Hog farms Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 7.3 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
6A	NW	26	15N	20W	7.3

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.

Jason Hixson — Permittee's Signature — 11-16-15 — Date

Shawn Ricketts — Landowner Signature — 10-25-15 — Date

LAND USE CONTRACT

I, E.G. Campbell (Name of Landowner), agree to allow C+H Hog farms Inc (Name of Permittee) to land apply swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 90.8 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
7	NE/SE	26	15 N	20 W	62.5
7A	NE	26	15N	20 W	28.3

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.

Jason Henson — Permittee's Signature — 11-10-15 — Date

E.G. Campbell — Landowner Signature — 11-10-15 — Date

LAND USE CONTRACT

I, Charles Campbell (Name of Landowner), agree to allow C+H Hog farms Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 56.7 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
3	SW SE	25 26	15N	20W	13.2
8+8A	SE NE	26 35	15N	20W	8.6
9+9A	NE	26 35	15N	20W	34.9

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.

Permittee's Signature — Date — Landowner Signature — Date

LAND USE CONTRACT

I, Fayma Dickey (Name of Landowner), agree to allow C & H Hog Farms Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 26.9 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
10	NE	35	15N	20W	13.6
11	NW/NE	35	15N	20W	13.3

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.

Jason Henson — Permittee's Signature — 11-10-15 — Date

Fayma Dickey — Landowner Signature — 10-28-15 — Date

LAND USE CONTRACT

I, Billy F. Cheatham (Name of Landowner), agree to allow C+H Hog farms Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 16.4 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
10A	NE/SE	35	15N	20W	16.4

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.

Jason Henson — Permittee's Signature — 11-10-15 — Date

Billy F. Cheatham — Landowner Signature — 10-27-15 — Date

LAND USE CONTRACT

I, Robert Flud (Name of Landowner), agree to allow C+H Hog farms Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 11.2 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
12	SE	35	15N	20W	11.2

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.

Jason Henson — Permittee's Signature
11-10-15 — Date
Robert Flud — Landowner Signature
10-27-15 — Date

LAND USE CONTRACT

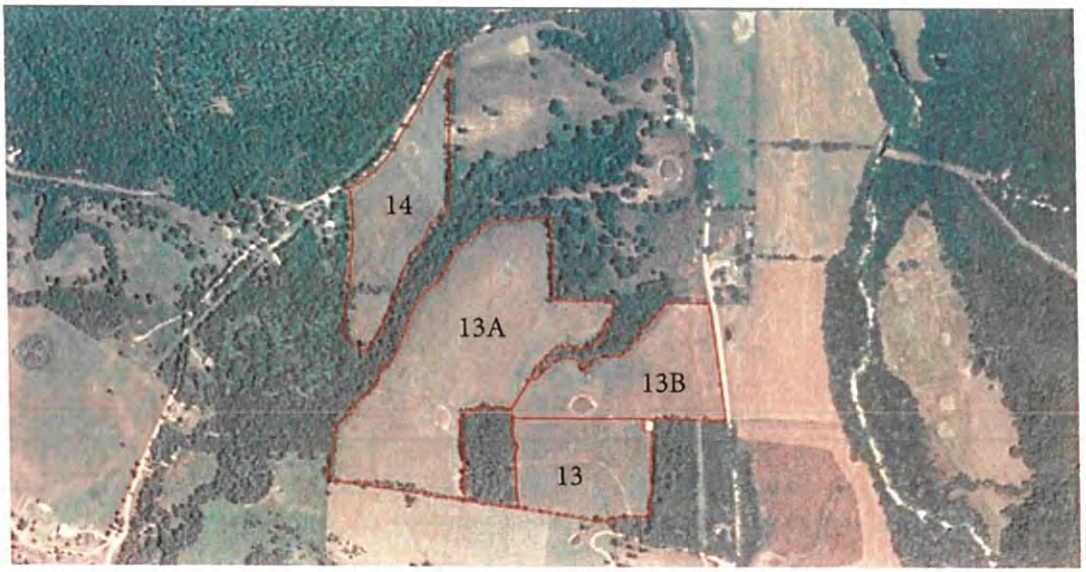
I, Charles Campbell (Name of Landowner), agree to allow C + H Hog Farms Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 57.1 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
13	NE	2	14N	20W	11.6
13A	SW NW	35 2	15N 14N	20W	29.8
13B	SE	35	15N	20W	8.1
14	SW	35	15N	20W	7.6

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.



Jason Henson — Permittee's Signature — 11-10-15 — Date

Charles Campbell — Landowner Signature — 10-23-15 — Date

LAND USE CONTRACT

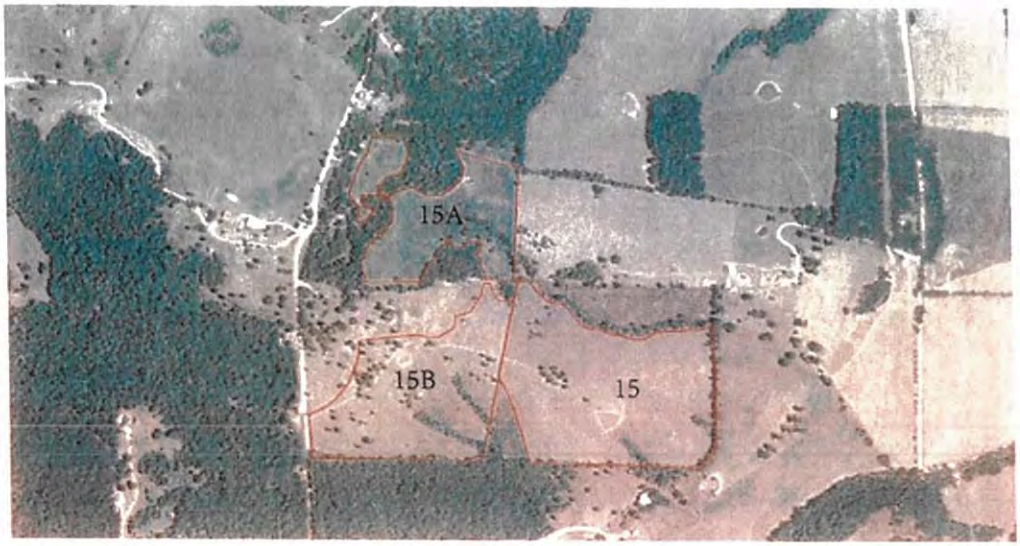
I, Clayel Criner (Name of Landowner), agree to allow C+H Hog farms Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 45.6 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
15	NW	2	14N	20W	21.5
15A	NW	2	14N	20W	10.4
15B	NW	2	14N	20W	13.7

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.



Jason Hemjer — Permittee's Signature
11-10-15 — Date
C Clayel Criner — Landowner Signature
11-10-15 — Date

LAND USE CONTRACT

I, Barbara Hefley (Name of Landowner), agree to allow C+H Hog farms Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 15.2 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
16	SW	2	14N	20W	15.2

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.

Jason Henson — Permittee's Signature
11-10-15 — Date
Barbara Hefley — Landowner Signature
11/9/15 — Date

LAND USE CONTRACT

I, Jason Criner (Name of Landowner), agree to allow C+H Hog farms Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 30.9 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
17	SE/SW	34/35	15N	20W	30.9
	NW/NE	2/3	14N	20W	

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.

Jason Henson — Permittee's Signature
11-10-15 — Date
Jason Criner — Landowner Signature
11-10-15 — Date

LAND USE CONTRACT

I, Murl Bryant (Name of Landowner), agree to allow C+H Hog Farms Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 31.8 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
18	NW/NE	25	15N	20W	21.7
19	NW	25	15N	20W	10.1

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.

Jason Henson — Permittee's Signature
11-10-15 — Date
Murl Bryant — Landowner Signature
10-23-15 — Date

LAND USE CONTRACT

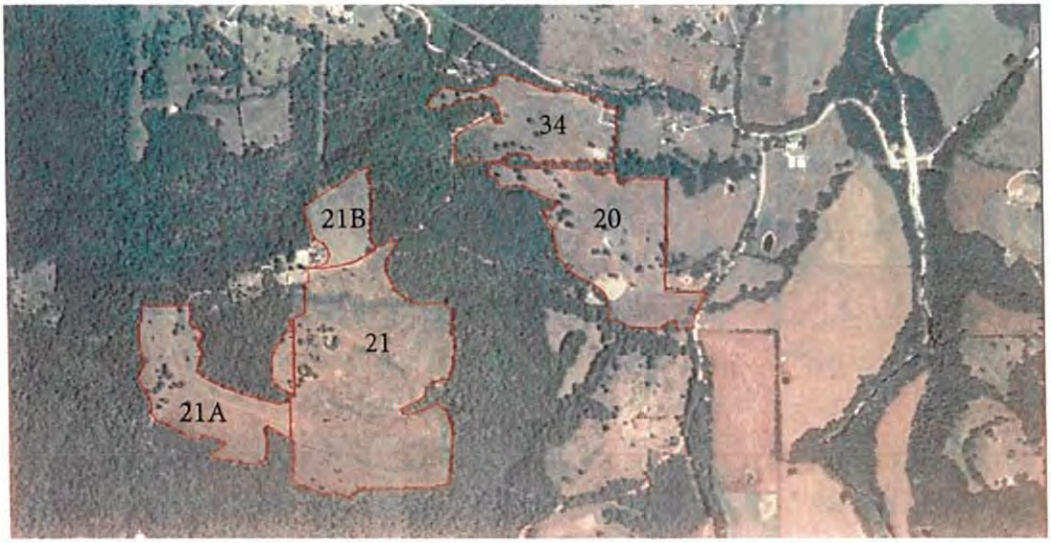
I, Rondal Campbell (Name of Landowner), agree to allow C+H Hog Farms Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 73.7 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
20	NW/NE	35	15N	20W	20.7
21	NW	35	15N	20W	18.6
21A+B	NE NW	34 35	15N	20W	21.6
34	SW	26	15N	20W	12.8

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.



Jason Henson — Permittee's Signature
11/10/15 — Date
Rondal Campbell — Landowner Signature
11-12-15 — Date

LAND USE CONTRACT

I, Kelis Campbell (Name of Landowner), agree to allow C+H Hog farms Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 35.2 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
22	NW/SW	26	15N	20W	35.2

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.

Jason Henson — Permittee's Signature — 11-10-15 — Date

Kelis Campbell — Landowner Signature — 11-10-15 — Date

LAND USE CONTRACT

I, Greg Grice (Name of Landowner), agree to allow C+H Hog farms Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 28.1 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
23	NW	22	15N	20W	28.1

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.

Jason Henson — Permittee's Signature — 10-10-15 — Date

Landowner Signature — 11-10-15 — Date

LAND USE CONTRACT

I, Donald Haddock (Name of Landowner), agree to allow C+H Hog Farms Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 8.0 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
24	SW	23	15N	20W	8.0

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.

Jason Henson — Permittee's Signature — 10-10-15 — Date

Donald G Haddock — Landowner Signature — 11-10-15 — Date

LAND USE CONTRACT

I, Howard Criner (Name of Landowner), agree to allow C & H Hog Farms Inc (Name of Permittee) to land apply Swine (Type of Waste) waste from his/her operation located in the Newton (County of Operation) County to 13.4 (Total Acreage Available) acres of my property located in Newton (County of Application Site) County.

A description of the areas to be used as waste application sites are as follows:

Site No.	¼ Section	Section	Township	Range	Available Acreage*
32	NE	22	15N	20W	10.0
33	NE	22	15N	20W	3.4

*Available acreage is the total acreage minus buffer zone areas.

I am also aware that the land applicator or the owner of the operation is to apply waste according to the management plan developed and submitted by the Natural Resource Conservation Service or a registered professional engineer or an Arkansas Natural Resources District Water Quality Technician and as per guidelines and conditions set forth by the Arkansas Department of Environmental Quality.

Jason Henson — Permittee's Signature — 11-10-15 — Date

Howard Criner — Landowner Signature — 10-23-15 — Date

Setback Requirement Waiver

I, Zelmer Campbell, do hereby give consent to C & H Hog Farms, Inc. to apply wastewater and manure adjacent to my property line and neighboring occupied buildings. I understand this allows C & H Hog Farms to apply wastewater and manure within 50 feet of my property line and within 500 feet of neighboring occupied buildings.

Zelmer Campbell — 2-18-16

Landowner Signature — Date

Jason Henson — 2-18-16

C & H Hog Farms, Inc. Representative — Date

Setback Requirement Waiver

I, Darlene Kent, do hereby give consent to C & H Hog Farms, Inc. to apply wastewater and manure adjacent to my property line and neighboring occupied buildings. I understand this allows C & H Hog Farms to apply wastewater and manure within 50 feet of my property line and within 500 feet of neighboring occupied buildings.

Darlene Kent — 2/18/16

Landowner Signature — Date

Jason Henson — 2-18-16

C & H Hog Farms, Inc. Representative — Date

Setback Requirement Waiver

I, James C. Campbell, do hereby give consent to C & H Hog Farms, Inc. to apply wastewater next to my property line.

James C. Campbell
Landowner Signature

7-21-14
Date

Jason Henson
C & H Hog Farms, Inc. Representative

7-21-14
Date

012261

Field 14

Setback Requirement Waiver

I, Bob Freeman, do hereby give consent to C & H Hog Farms, Inc. to apply wastewater and manure adjacent to my property line and neighboring occupied buildings. I understand this allows C & H Hog Farms to apply wastewater and manure within 50 feet of my property line and within 500 feet of neighboring occupied buildings.

Bob Freeman
Landowner Signature

3-22-14
Date

Jason Henson
C & H Hog Farms, Inc. Representative

3-22-14
Date

Setback Requirement Waiver

I, Jason Baethke, do hereby give consent to C & H Hog Farms, Inc. to apply wastewater and manure adjacent to my property line and neighboring occupied buildings. I understand this allows C & H Hog Farms to apply wastewater and manure within 50 feet of my property line and within 500 feet of neighboring occupied buildings.

Landowner Signature — Date: 5-4-15

Jason Henson — Date: 5-4-15

C & H Hog Farms, Inc. Representative

Setback Requirement Waiver

I, Don T. Rockwell, do hereby give consent to C & H Hog Farms, Inc. to apply wastewater and manure adjacent to my property line and neighboring occupied buildings. I understand this allows C & H Hog Farms to apply wastewater and manure within 50 feet of my property line and within 500 feet of neighboring occupied buildings.

Landowner Signature

3-26-14
Date

Jason Henson
C & H Hog Farms, Inc. Representative

3-26-14
Date

Setback Requirement Waiver

I, Brad Anderson, do hereby give consent to C & H Hog Farms, Inc. to apply wastewater next to my property line.

Brad Anderson
Landowner Signature

1-24-15
Date

Richard Tenpenny
C & H Hog Farms, Inc. Representative

1-24-15
Date

Setback Requirement Waiver

I, J.C. Freeman, do hereby give consent to C & H Hog Farms, Inc. to apply wastewater and manure adjacent to my property line and neighboring occupied buildings. I understand this allows C & H Hog Farms to apply wastewater and manure within 50 feet of my property line and within 500 feet of neighboring occupied buildings.

J.C. Freeman — 2-18-16

Landowner Signature — Date

Jason Henson — 2-18-16

C & H Hog Farms, Inc. Representative — Date

Section 4

Collected Information:

County Road Map Overview

Aerial Overview Map of Land Application Sites

Aerial Maps of Individual Fields with BMP Buffers

Soils Maps

Topographical Map

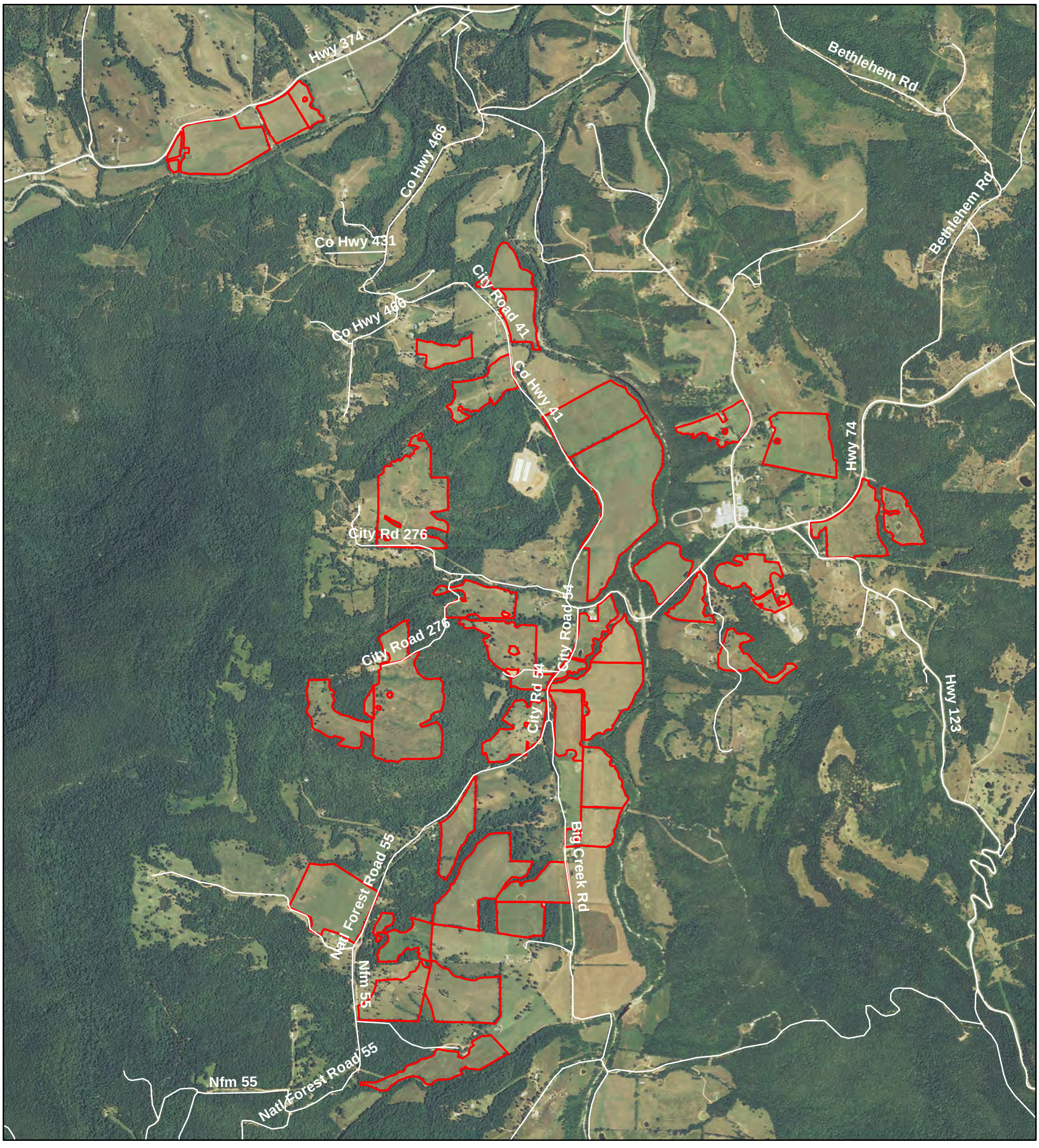
Section, Township, Range Overview Map

Watershed Overview Map (12 digit HUC)

Soil Test Results

Manure Analysis

County Road Map Overview



Legend

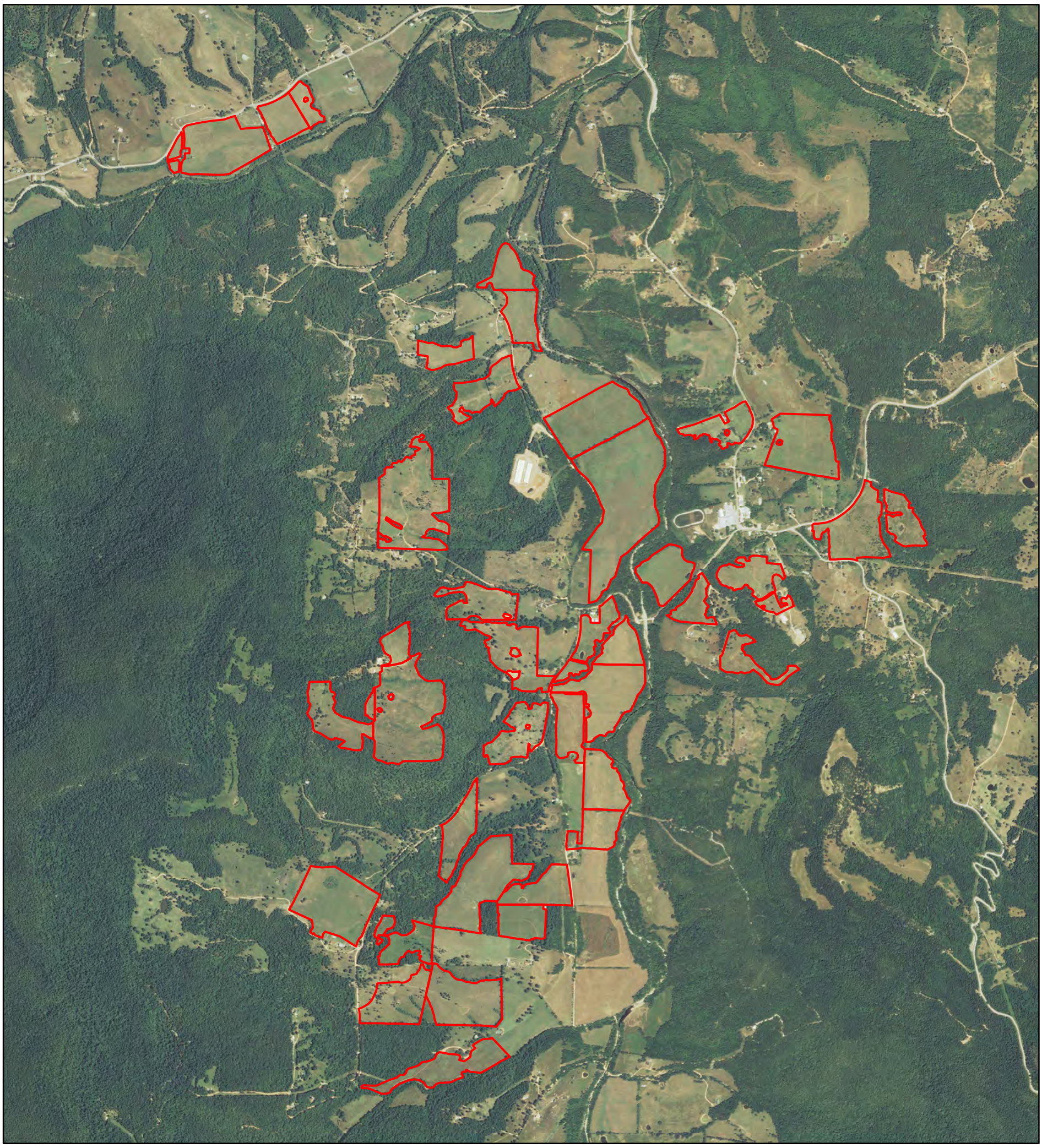
road_tanw_l_ar101

Correct Field Boundaries

1,800 0 1,800 3,600 5,400 7,200 Feet

N

Correct Field Boundaries



Legend

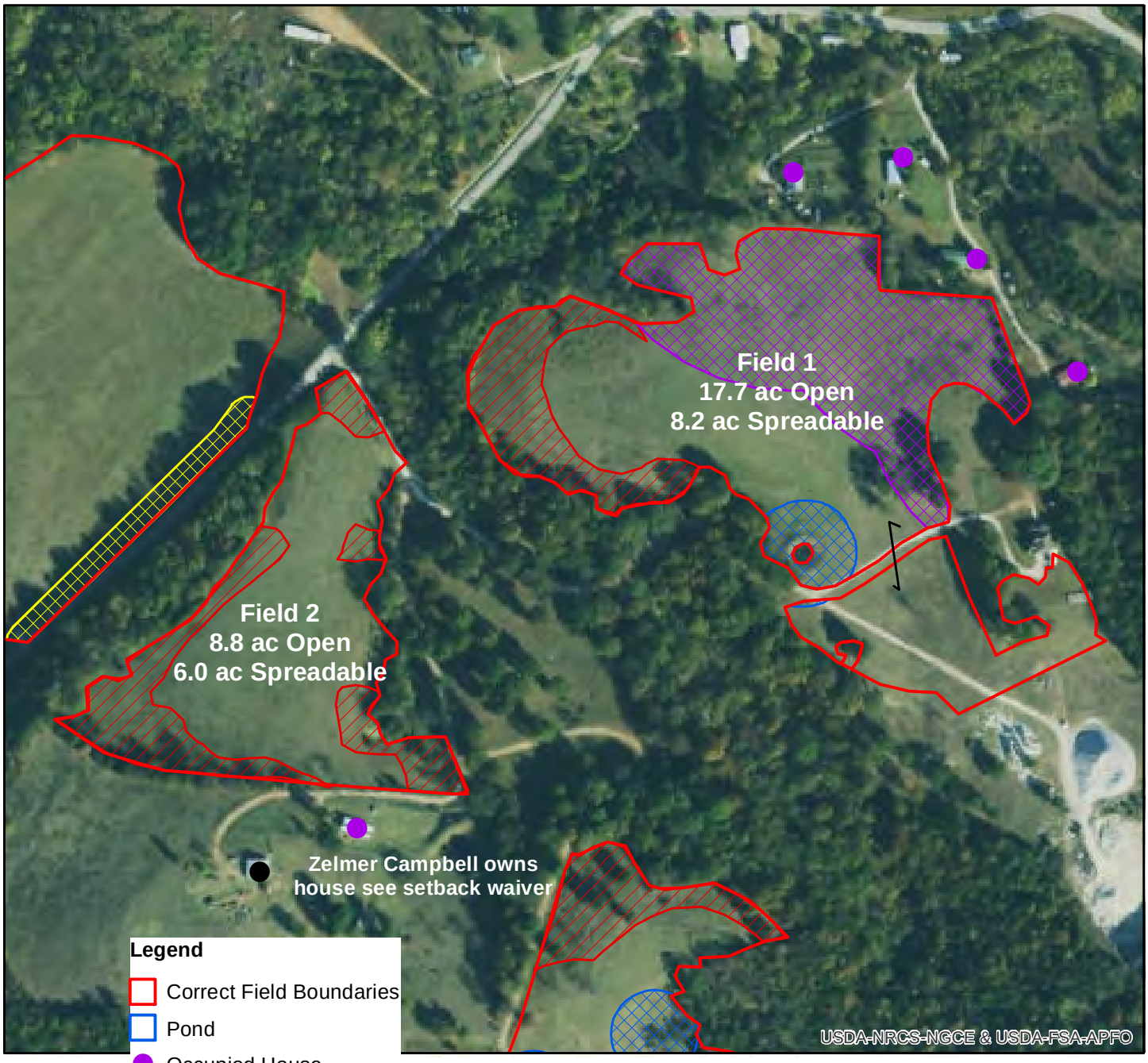
Correct Field Boundaries

1,800 0 1,800 3,600 5,400 7,200

Feet

N

Buffered Field Map
Field 1 and 2
Jason Henson
T15N, R20W, S25
Mt. Judea Quad



Legend

- Correct Field Boundaries
- Pond
- Occupied House
- Unoccupied House
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- Steep Slope Buffer
- NAIP

200 0 200 400 600 800 Feet

N

Buffered Field Map
Field 4
Jason Henson
T15N, R20W, S36
Mt. Judea Quad

Legend

- Correct Field Boundaries
- Pond
- Occupied House
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- Steep Slope Buffer

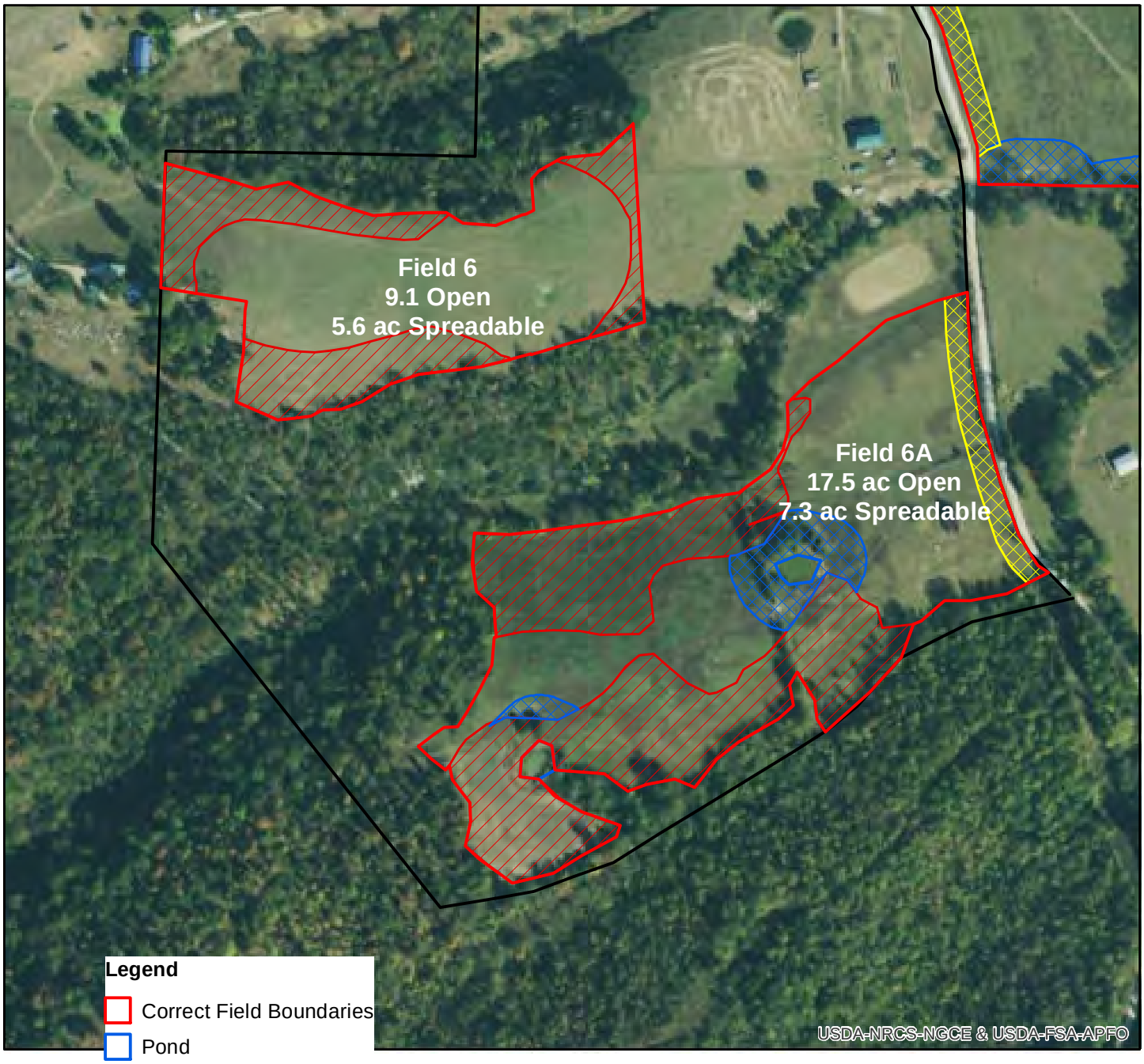
140 0 140 280 420 560 Feet

5

N

Buffered Field Map
Field 5
Louetta/Glen Ricketts
T15N, R20W, S23
Mt. Judea Quad

Buffered Field Map
Field 6 Louetta/Glen Ricketts
Field 6A Shawn Ricketts
T15N, R20W, S26
Mt. Judea Quad



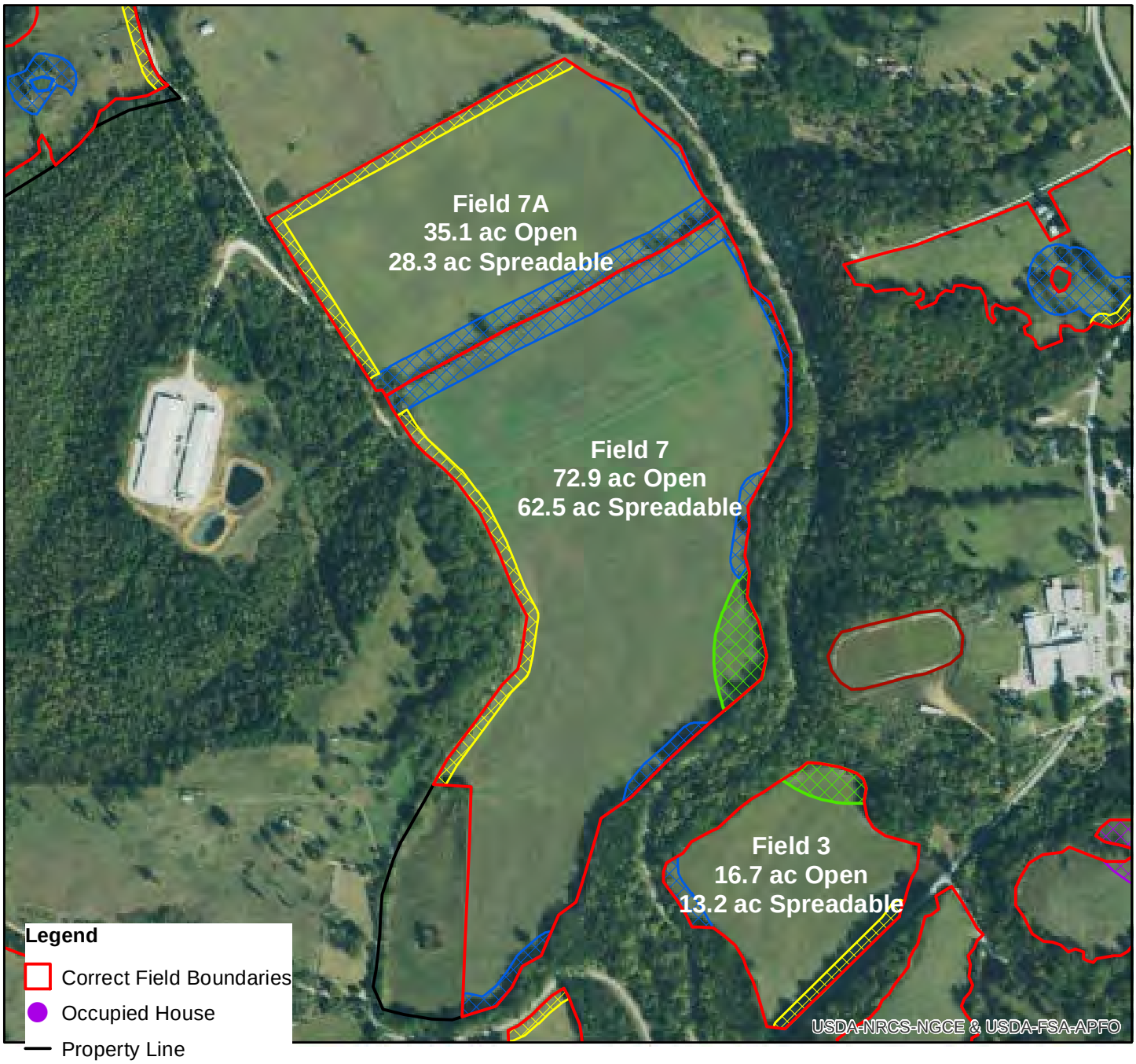
Legend

- Correct Field Boundaries
- Pond
- Unoccupied House
- Property Line
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- Steep Slope Buffer
- NAIP

190 0 190 380 570 760 Feet

N

Buffered Field Map
Field 7 and 7A
E.G. Campbell
Field 3 Charles Campbell
T15N, R20W, S25 and S26
Mt. Judea Quad



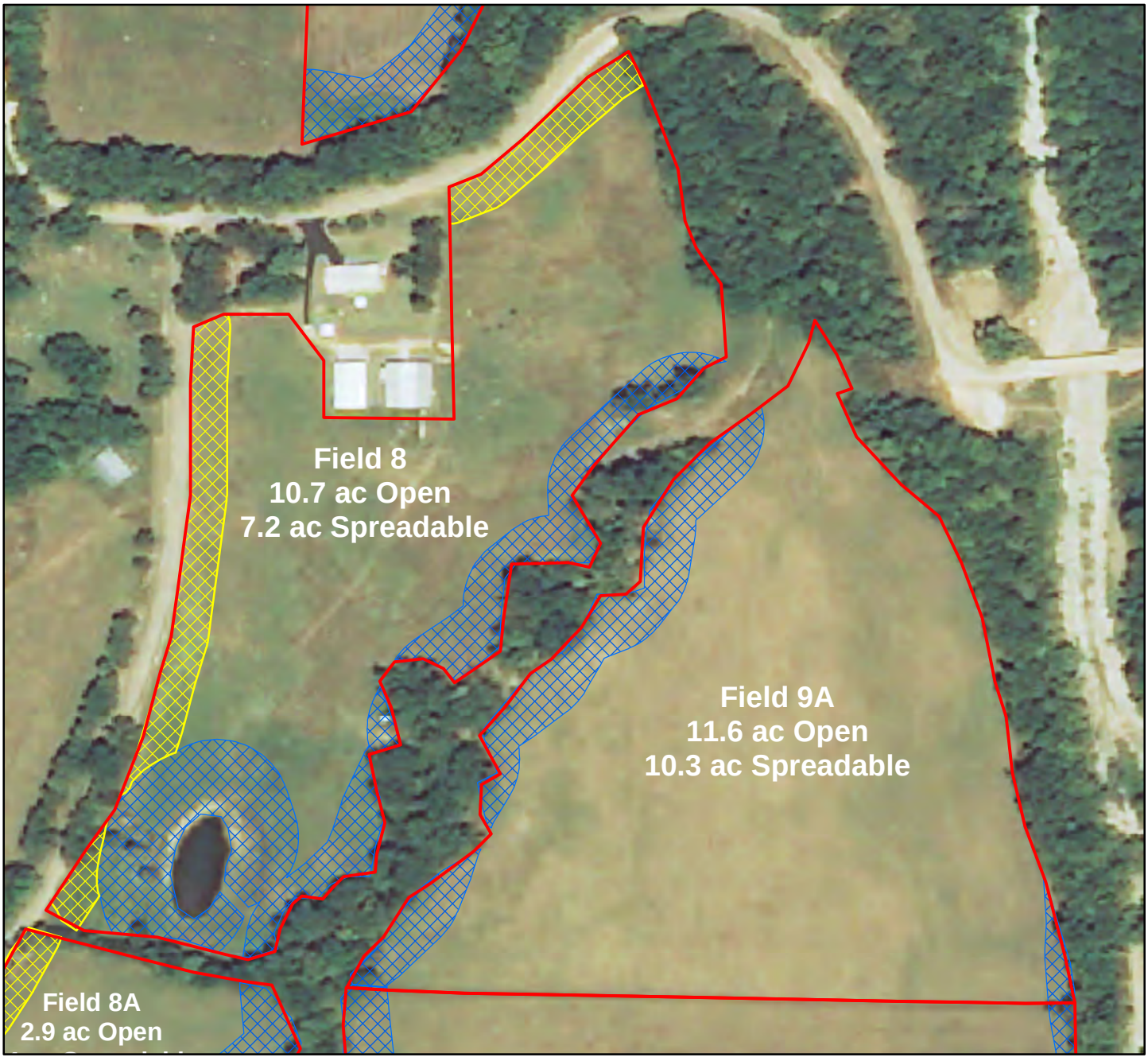
Legend

- Correct Field Boundaries
- Occupied House
- Property Line
- Pond
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- Track Line
- Track Line 500 Ft Buffer
- NAIP

380 0 380 760 1,140 1,520
Feet

N

Buffered Field Map
Charles Campbell
Fields 8 and 9A
T15N, R20W, S26 & S35
Mt. Judea Quad



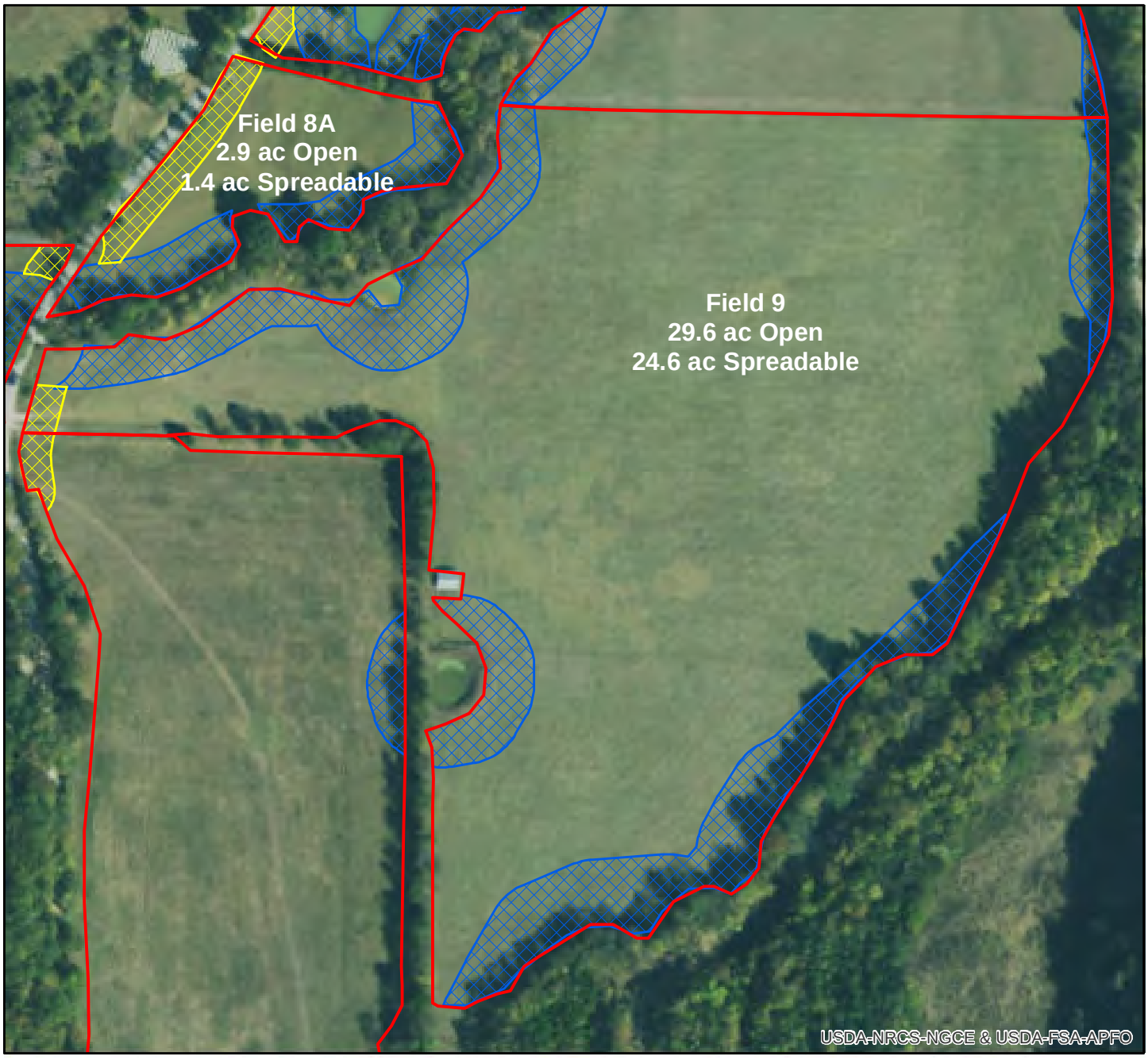
Legend

- Correct Field Boundaries
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- Steep Slope buffer

120 0 120 240 360 480 Feet

N

Buffered Field Map
Charles Campbell
Fields 8A and 9
T15N, R20W, S35
Mt. Judea Quad



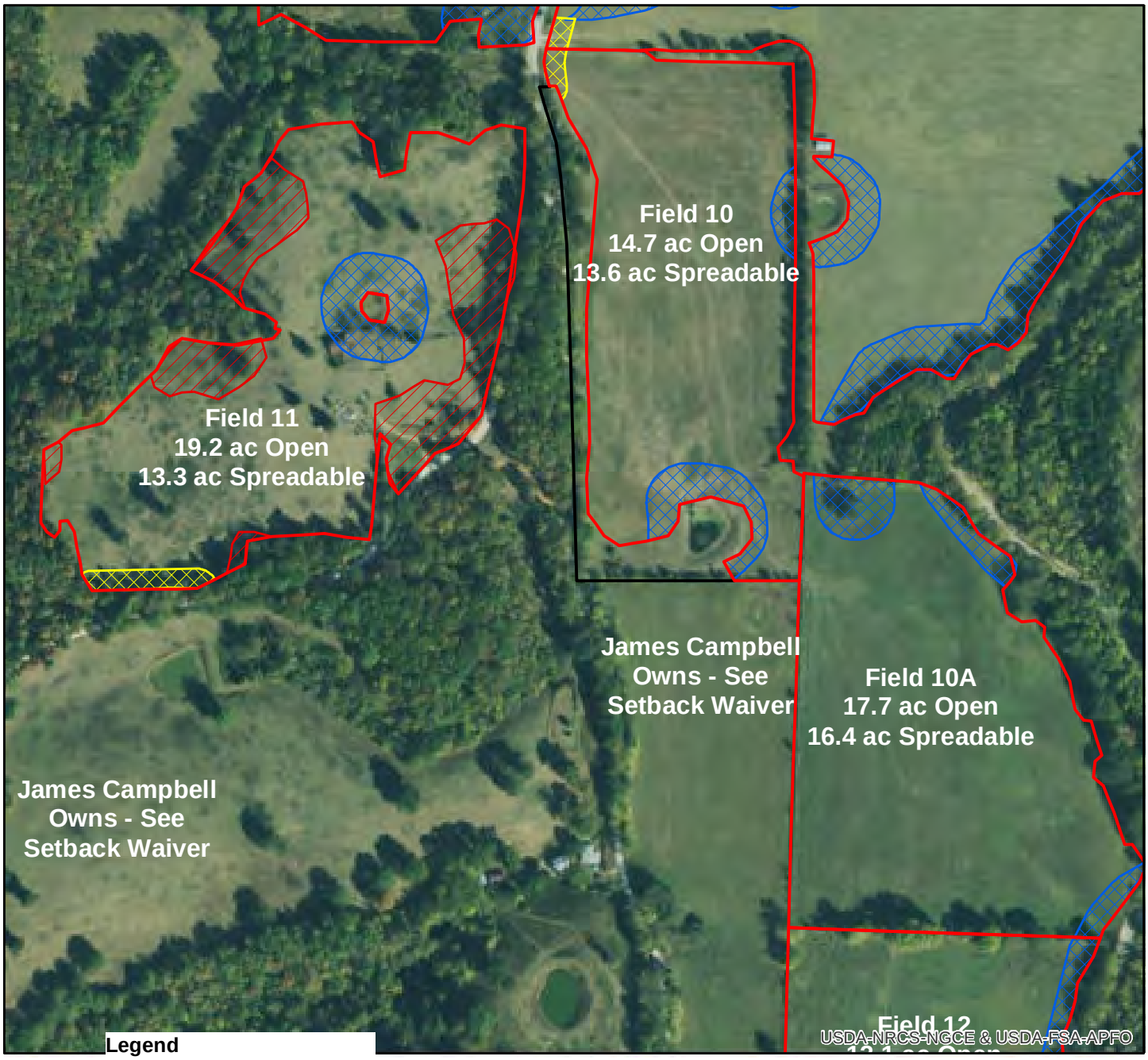
Legend

- Correct Field Boundaries
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- Steep Slope Buffer
- NAIP

140 0 140 280 420 560 Feet
10

N

Buffered Field Map
Fields 10 and 11 Fayma Dickey
Field 10A Billy F. Cheatham
T15N, R20W, S35
Mt. Judea Quad



Buffered Field Map
Robert Flud
Field 12
T15N, R20W, S35
Mt. Judea Quad

Legend

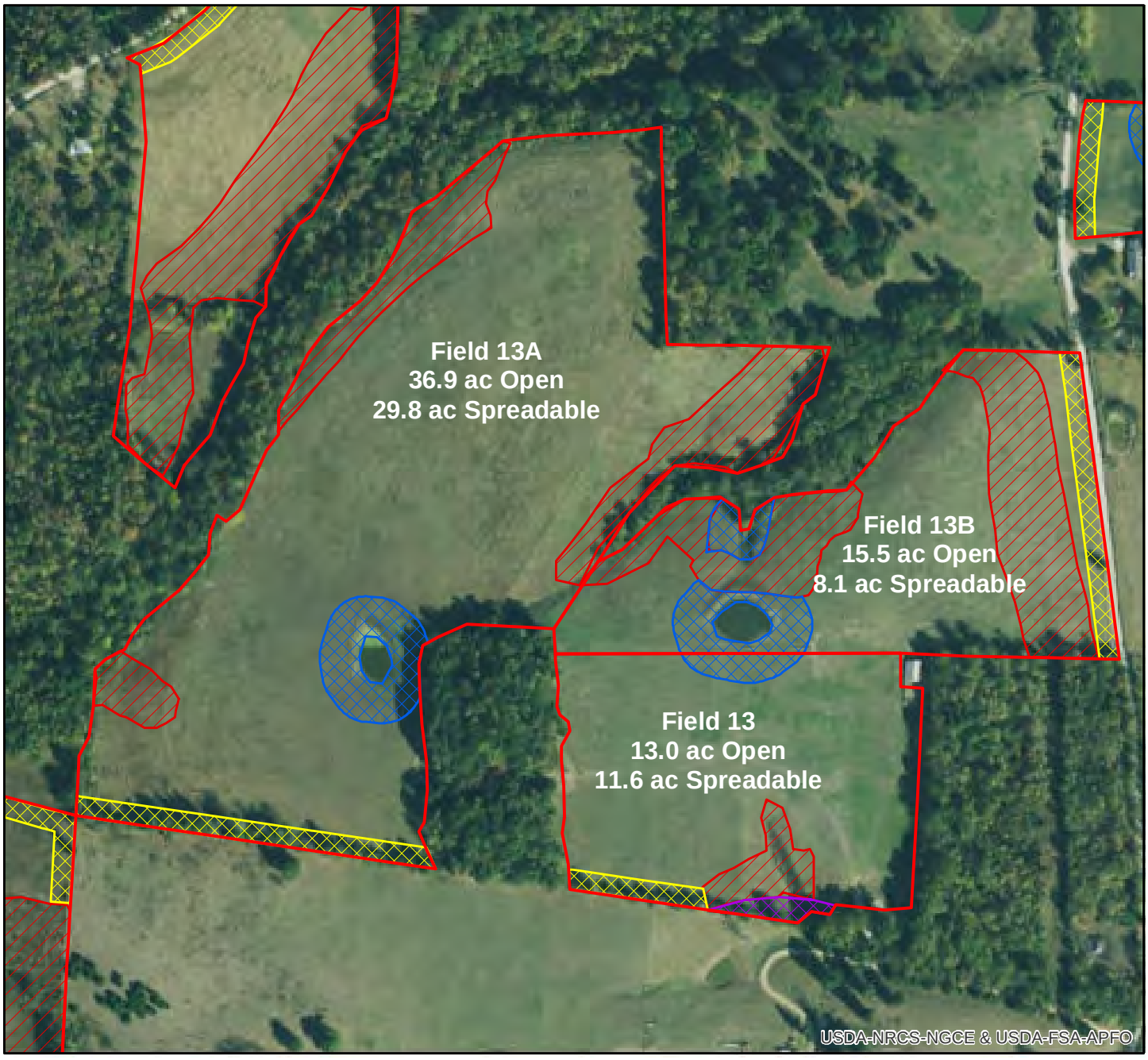
- Correct Field Boundaries
- Pond
- Occupied House
- Property Line
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- Steep Slope Buffer
- NAIP

120 0 120 240 360 480 Feet

12

N

Buffered Field Map
Fields 13, 13A, 13B
Charles Campbell
T15N, R20W, S35
T14N, R20W, S2
Mt. Judea Quad



Legend

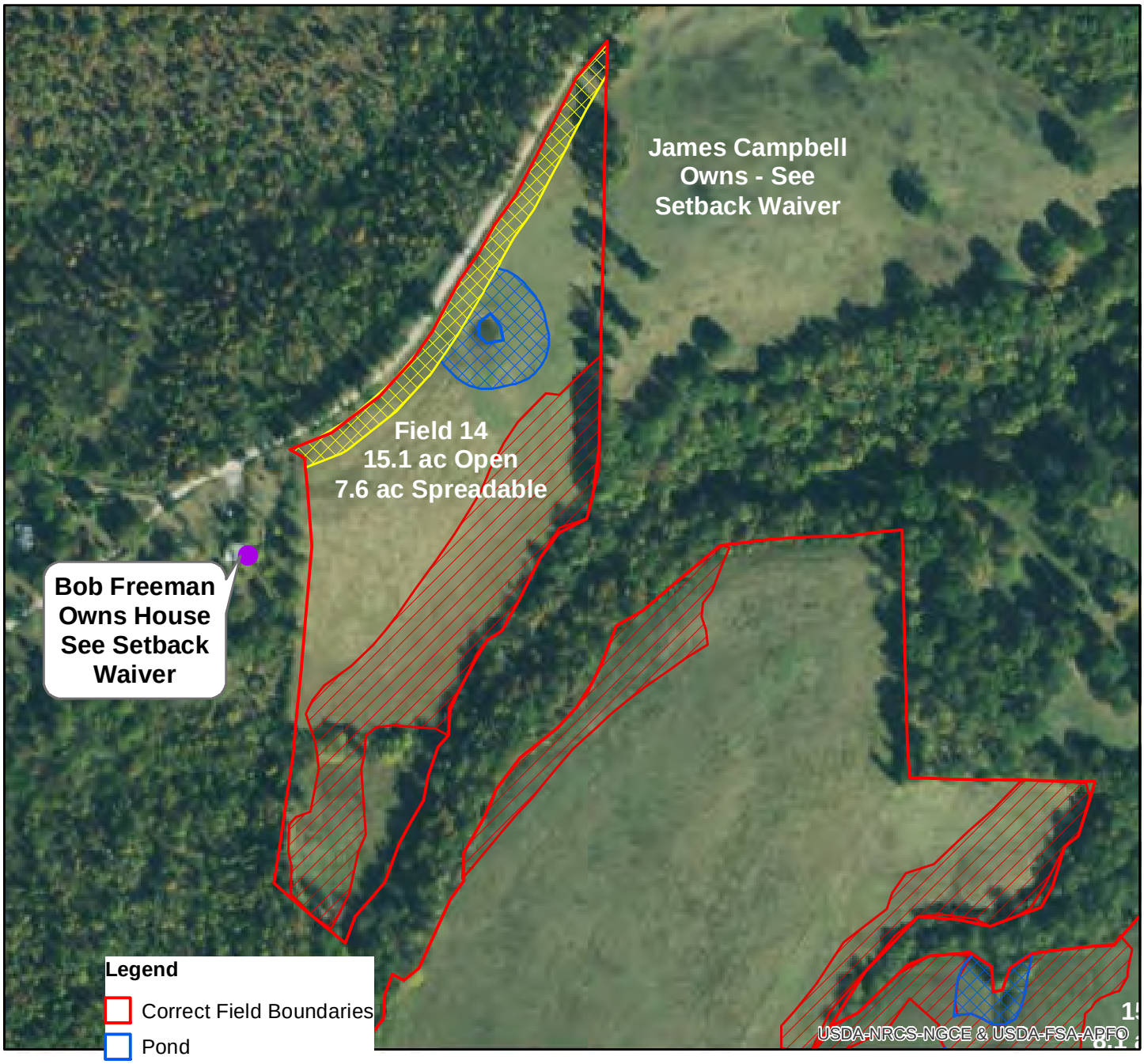
- Correct Field Boundaries
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- Steep Slope Buffer
- NAIP

220 0 220 440 660 880 Feet

13

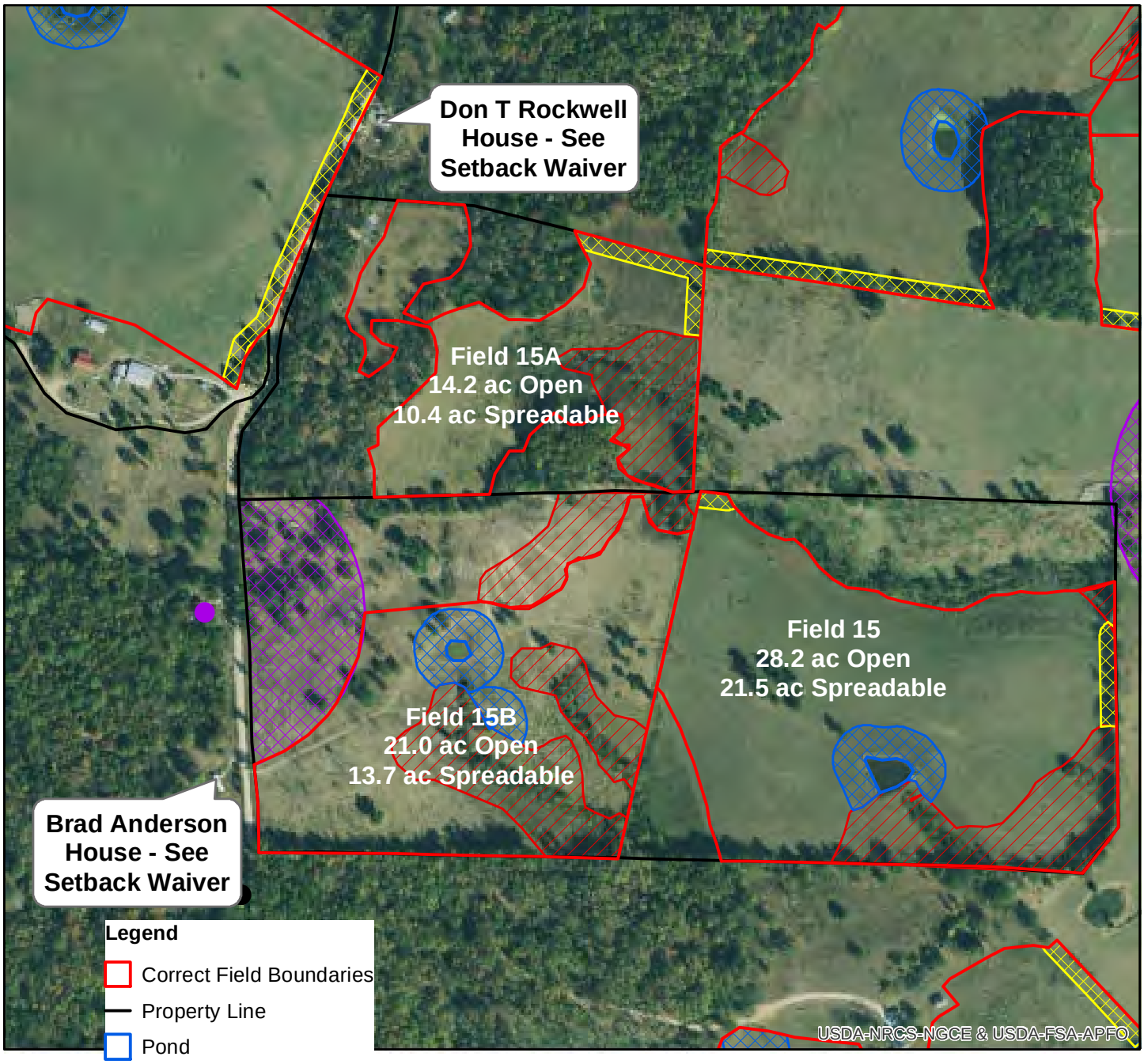
N

Buffered Field Map
Field 14
Charles Campbell
T15N, R20W, S35
Mt. Judea Quad



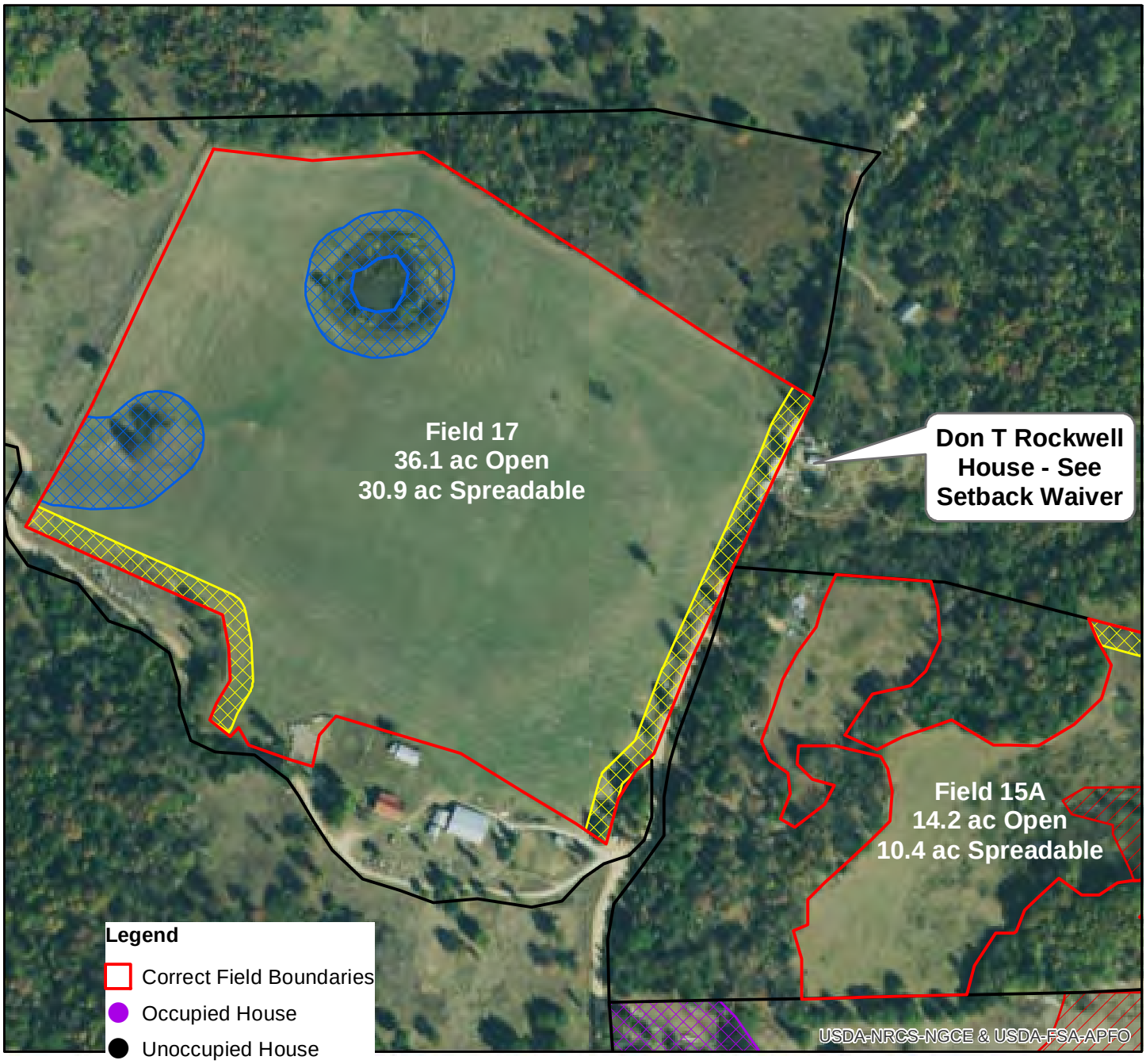
14

Buffered Field Map
Fields 15, 15A, 15B
Clayel Criner
T14N, R20W, S2
Mt. Judea Quad



Buffered Field Map
Field 16
Barbara Hefley
T14N, R20W, S2
Mt. Judea Quad

Buffered Field Map
Field 17
Jason Criner
T15N, R20W, S34 & 35
T14N, R20W, S2 & 3
Mt. Judea Quad



Legend

- Correct Field Boundaries
- Occupied House
- Unoccupied House
- Pond
- Property Line
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- Steep Slope Buffer
- NAIP

190 0 190 380 570 760 Feet

17

N

Buffered Field Map
Field 18
Murl Bryant
T15N, R20W, S25
Mt. Judea Quad

Buffered Field Map
Field 19
Murl Bryant
T15N, R20W, S25
Mt. Judea Quad

Legend

- Pond
- Correct Field Boundaries
- Occupied House
- Unoccupied House
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- Steep Slope Buffer
- NAIP

140 0 140 280 420 560 Feet

19

N

Buffered Field Map
Field 20
Rondal Campbell
T15N, R20W, S35
Mt. Judea Quad

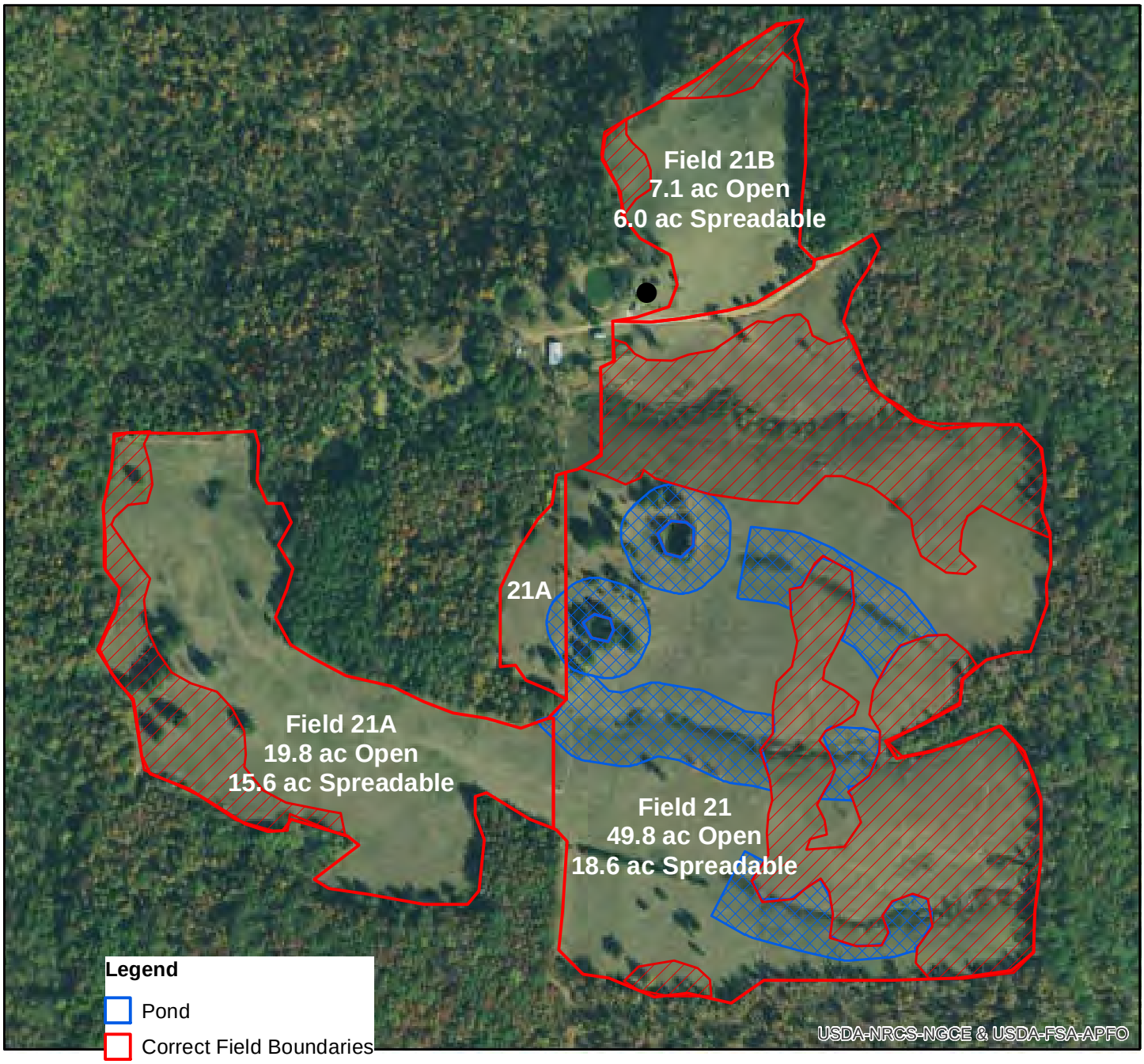
Legend

- Pond
- Correct Field Boundaries
- Occupied House
- Unoccupied House
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- Steep Slope Buffer
- NAIP

140 0 140 280 420 560 Feet
20

N

Buffered Field Map
Fields 21, 21A, 21B
Rondal Campbell
T15N, R20W, S34 and S35
Mt. Judea Quad



Legend

- Pond
- Correct Field Boundaries
- Occupied House
- Unoccupied House
- Steep Slope Buffer
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- NAIP

240 0 240 480 720 960
Feet

21

N

Buffered Field Map
Field 22
Kelis Campbell
T15N, R20W, S26
Mt. Judea Quad

Legend

- Pond
- Correct Field Boundaries
- Occupied House
- Unoccupied House
- Steep Slope Buffer
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- NAIP

200 0 200 400 600 800 Feet

N

Buffered Field Map
Greg Grice
Field 23
T15N, R20W, S22
Mt. Judea Quad

Buffered Field Map
Field 24
Donald Haddock
T15N, R20W, S23
Mt. Judea Quad

Legend

- Correct Field Boundaries
- Unoccupied House
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- Steep Slope Buffer

90 0 90 180 270 360 Feet

24

N

Buffered Field Map
Field 32 & 33
Howard Criner
T15N, R20W, S22
Mt. Judea Quad

Legend

- Pond
- Correct Field Boundaries
- Occupied House
- Unoccupied House
- Steep Slope Buffer
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- NAIP

120 0 120 240 360 480 Feet
25

N

Buffered Field Map
Rondal Campbell
Field 34
T15N, R20W, S26
Mt. Judea Quad

Legend

- Pond
- Correct Field Boundaries
- Occupied House
- Unoccupied House
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- Steep Slope Buffer
- NAIP

140 0 140 280 420 560 Feet

N

Buffered Field Map
Fields 35 and 36
C & H Hog Farms, Inc.
T15N, R20W, S25
Mt. Judea Quad

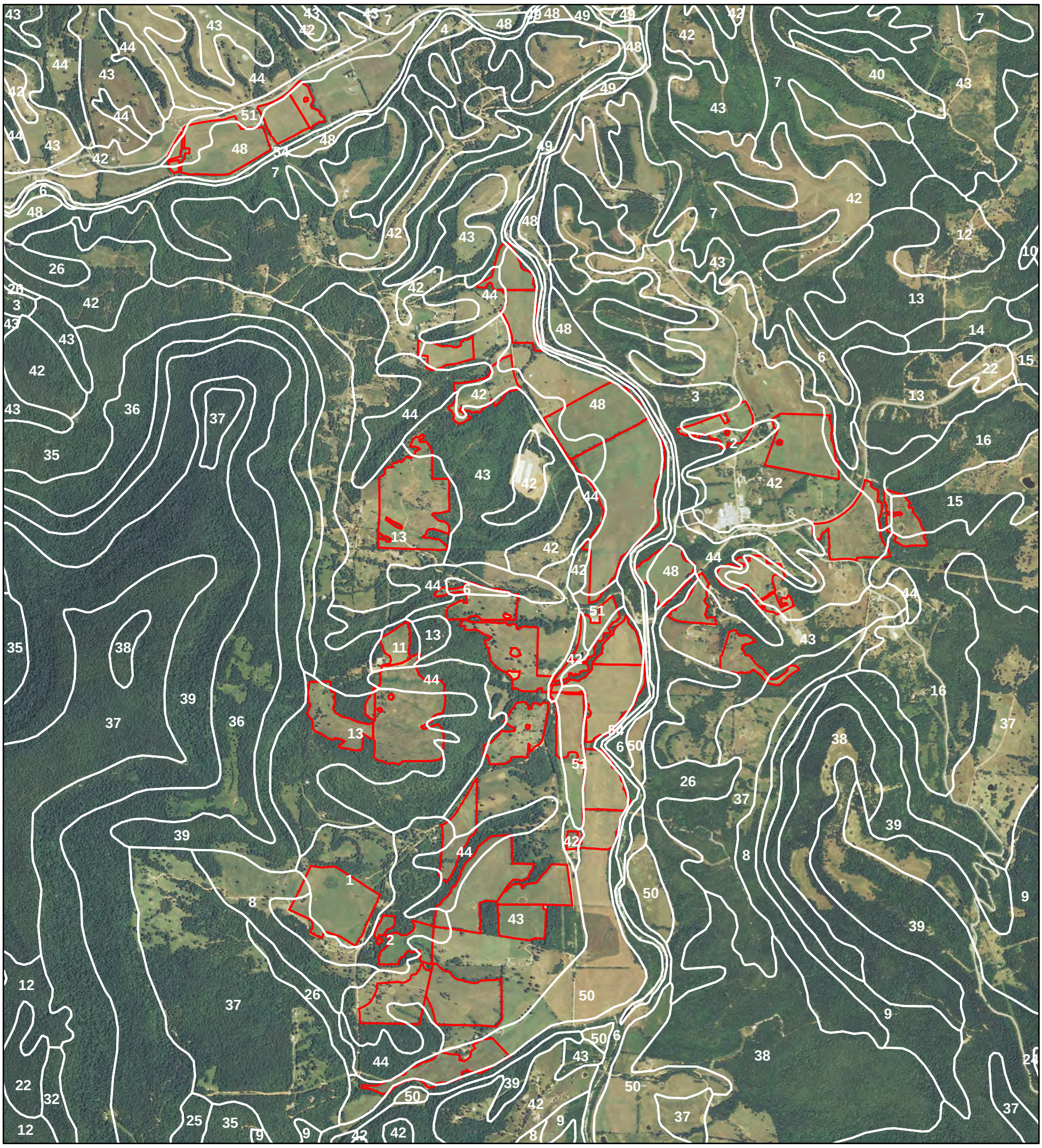
Legend

- Correct Field Boundaries
- Pond
- Occupied House
- Unoccupied House
- 50 Ft Buffer
- 100 Ft Buffer
- 500 Ft Buffer
- Steep Slope Buffer
- NAIP

190 0 190 380 570 760 Feet

N

Soils Map Overview



Legend

Team_1_soils

Correct Field Boundaries

1,800 0 1,800 3,600 5,400 7,200 Feet

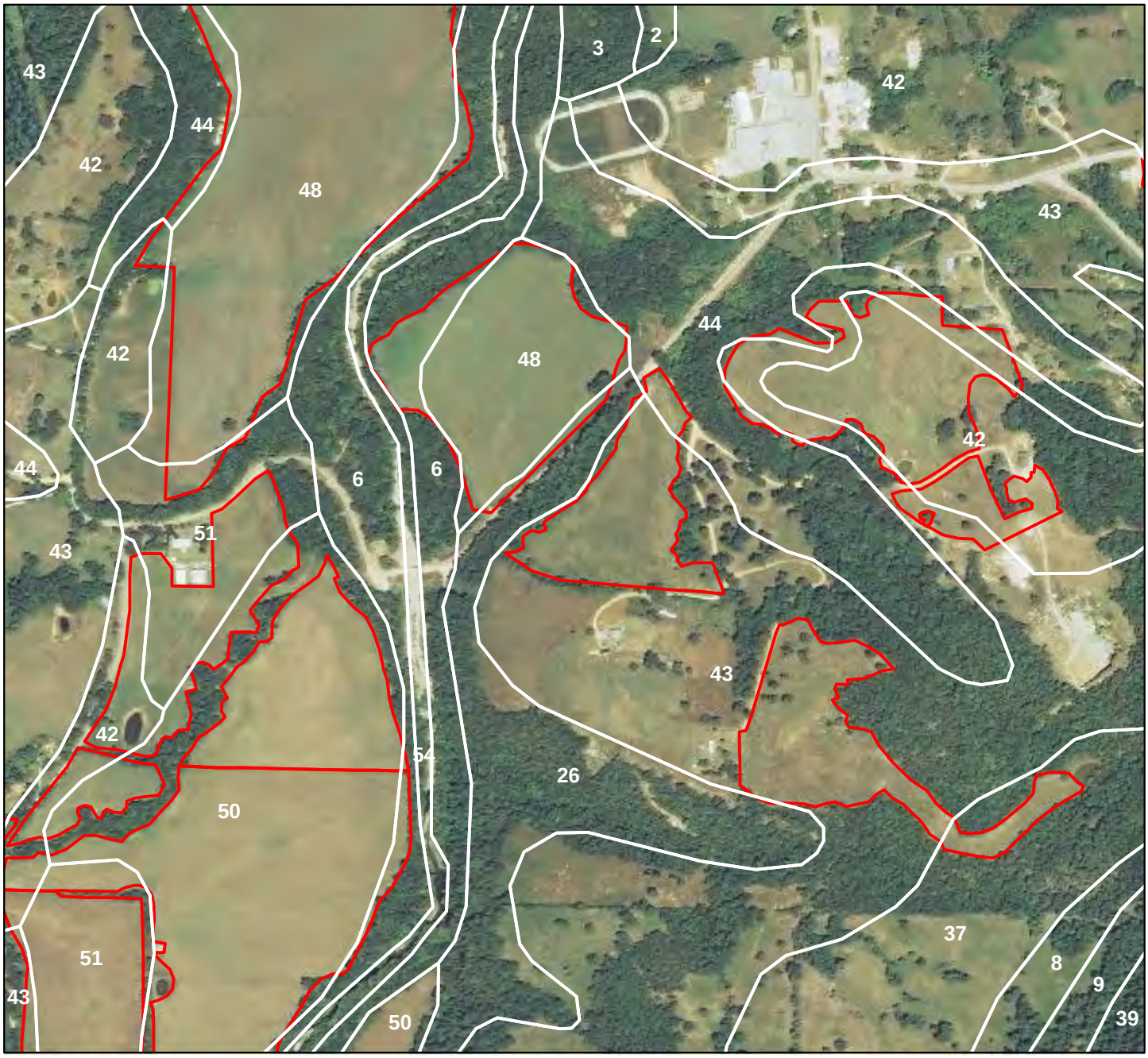
N

SOIL LEGEND

The legend is numeric. Soils without a slope designation in the name are those on level to nearly level landscapes of occasionally or frequently flooded bottomlands. The soil name followed by the superscript 1/ is a mapping unit that was designed primarily for woodland management. Fewer soil examinations were made in these units and included areas are generally larger.

SYMBOL	NAME
1	Arkana very cherty silt loam, 3 to 8 percent slopes
2	Arkana-Moko complex, 8 to 20 percent slopes 1/
3	Arkana-Moko complex, 20 to 40 percent slopes 1/
4	Britwater gravelly silt loam, 3 to 8 percent slopes
5	Ceda cobbly loam, frequently flooded
6	Ceda-Kenn complex, frequently flooded
7	Clarksville very cherty silt loam, 20 to 50 percent slopes
8	Eden-Newnata complex, 8 to 20 percent slopes 1/
9	Eden-Newnata complex, 20 to 40 percent slopes 1/
10	Eden-Newnata-Rock outcrop complex, 40 to 60 percent slopes 1/
11	Enders gravelly loam, 3 to 8 percent slopes
12	Enders gravelly loam, 8 to 20 percent slopes
13	Enders stony loam, 3 to 20 percent slopes
14	Enders stony loam, 20 to 40 percent slopes
15	Enders-Leesburg stony loams, 8 to 20 percent slopes 1/
16	Enders-Leesburg stony loams, 20 to 40 percent slopes 1/
17	Estate-Lily-Portia complex, 8 to 20 percent slopes 1/
18	Estate-Lily-Portia complex, 20 to 40 percent slopes 1/
19	Leadvale silt loam, 3 to 8 percent slopes
20	Lily-Udorthents-Rock outcrop complex, 8 to 20 percent slopes 1/
21	Lily-Udorthents-Rock outcrop complex, 20 to 40 percent slopes 1/
22	Linker loam, 3 to 8 percent slopes
23	Linker gravelly loam, 3 to 8 percent slopes
24	Linker-Mountainburg complex, 3 to 8 percent slopes
25	Linker-Mountainburg complex, 8 to 20 percent slopes
26	Moko-Rock outcrop complex, 15 to 50 percent slopes 1/
27	Mountainburg gravelly fine sandy loam, 3 to 8 percent slopes
28	Mountainburg very stony fine sandy loam, 3 to 8 percent slopes
29	Mountainburg very stony fine sandy loam, 8 to 20 percent slopes
30	Mountainburg very stony fine sandy loam, 20 to 40 percent slopes
31	Nella gravelly loam, 3 to 12 percent slopes
32	Nella gravelly loam, 12 to 20 percent slopes
33	Nella stony loam, 8 to 20 percent slopes
34	Nella stony loam, 20 to 40 percent slopes
35	Nella-Enders stony loams, 8 to 20 percent slopes 1/
36	Nella-Enders stony loams, 20 to 40 percent slopes 1/
37	Nella-Steprock complex, 8 to 20 percent slopes 1/
38	Nella-Steprock-Mountainburg very stony loams, 20 to 40 percent slopes 1/
39	Nella-Steprock-Mountainburg very stony loams, 40 to 60 percent slopes 1/
40	Nixa very cherty silt loam, 3 to 8 percent slopes
41	Nixa very cherty silt loam, 8 to 12 percent slopes
42	Noark very cherty silt loam, 3 to 8 percent slopes
43	Noark very cherty silt loam, 8 to 20 percent slopes
44	Noark very cherty silt loam, 20 to 40 percent slopes
45	Peridge silt loam, 3 to 8 percent slopes
46	Portia sandy loam, 3 to 8 percent slopes
47	Portia sandy loam, 8 to 12 percent slopes
48	Razort loam, occasionally flooded
49	Riverwash, frequently flooded
50	Spadra loam, occasionally flooded
51	Spadra loam, 2 to 5 percent slopes
52	Steprock gravelly loam, 3 to 8 percent slopes
53	Wideman loamy fine sand, frequently flooded

Soils Map



Legend

Team_1_soils

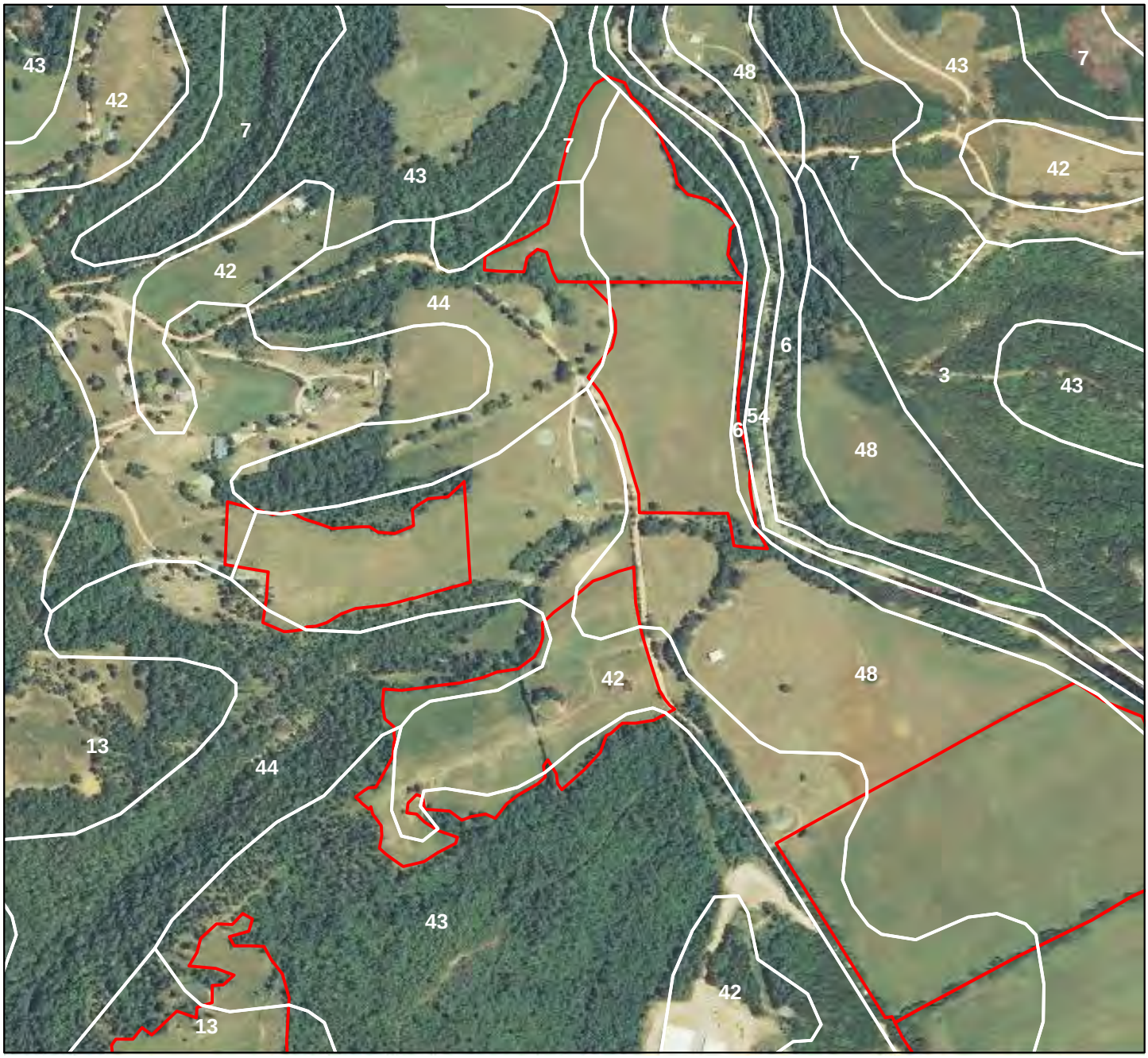
Correct Field Boundaries

380 0 380 760 1,140 1,520 Feet

30

N

Soils Map



Legend

Team_1_soils

Correct Field Boundaries

380 0 380 760 1,140 1,520 Feet

N

Soils Map

Legend

Team_1_soils

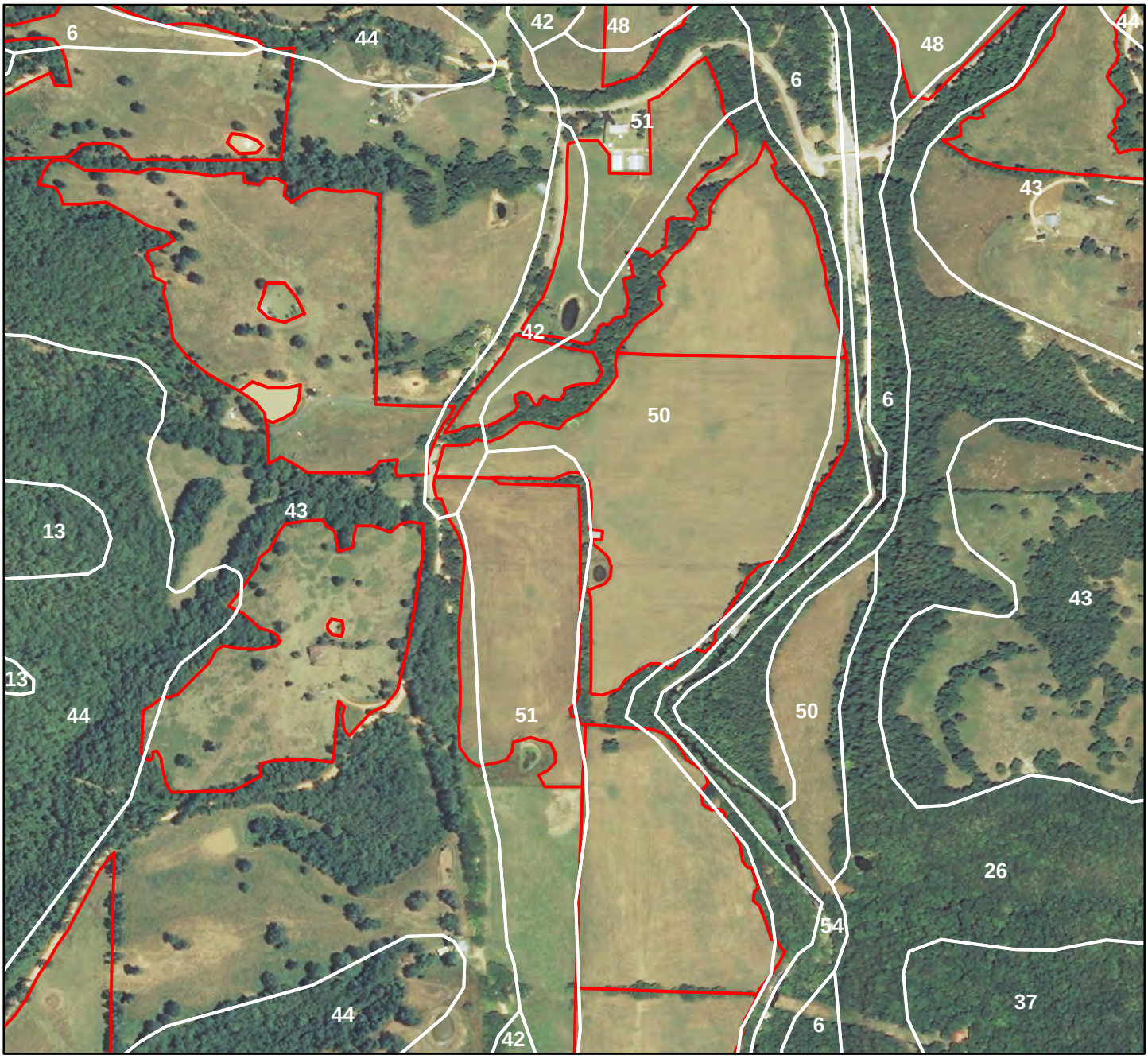
Correct Field Boundaries

380 0 380 760 1,140 1,520 Feet

32

N

Soils Map



Legend

Team_1_soils

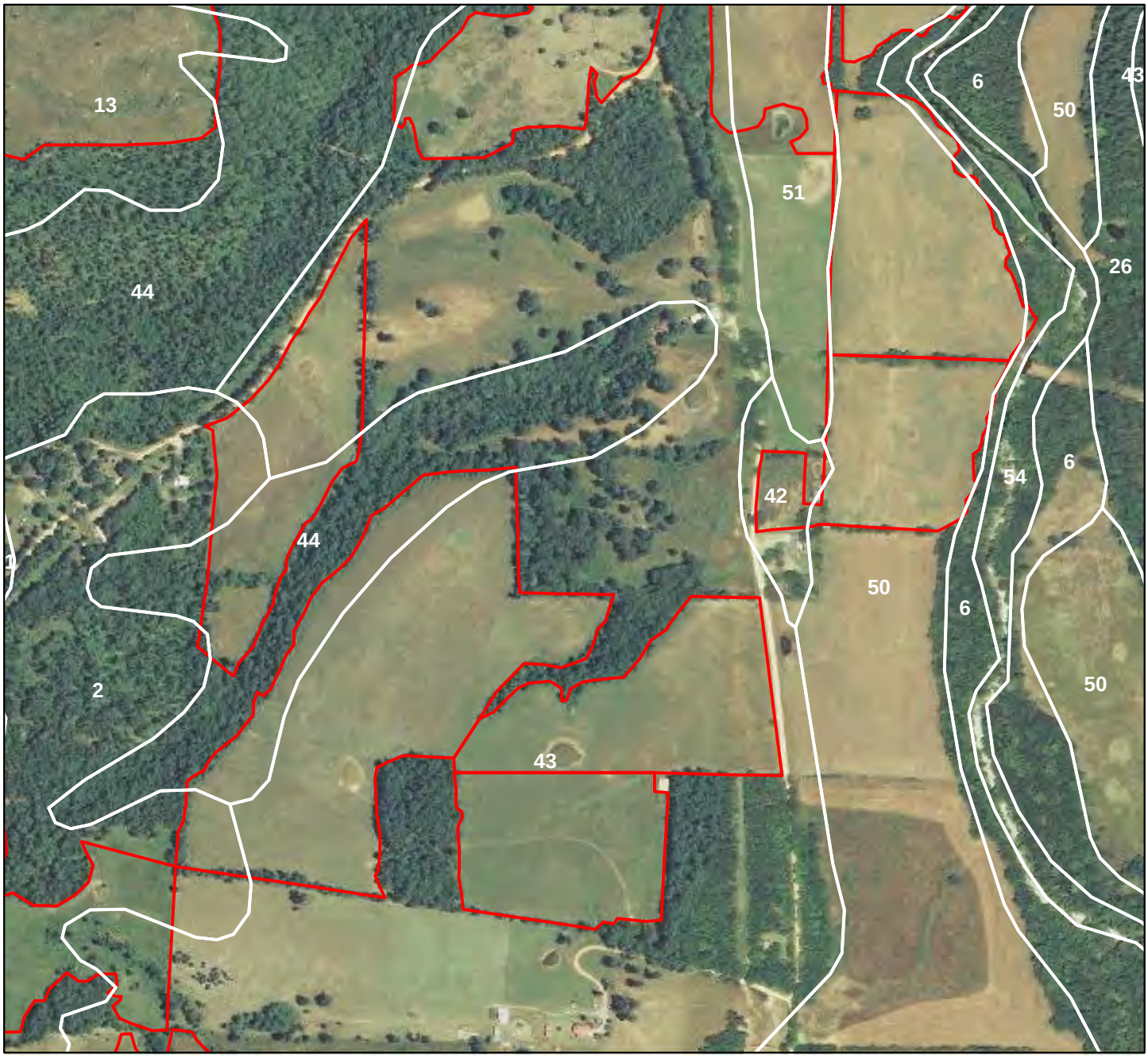
Correct Field Boundaries

380 0 380 760 1,140 1,520 Feet

33

N

Soils Map



Legend

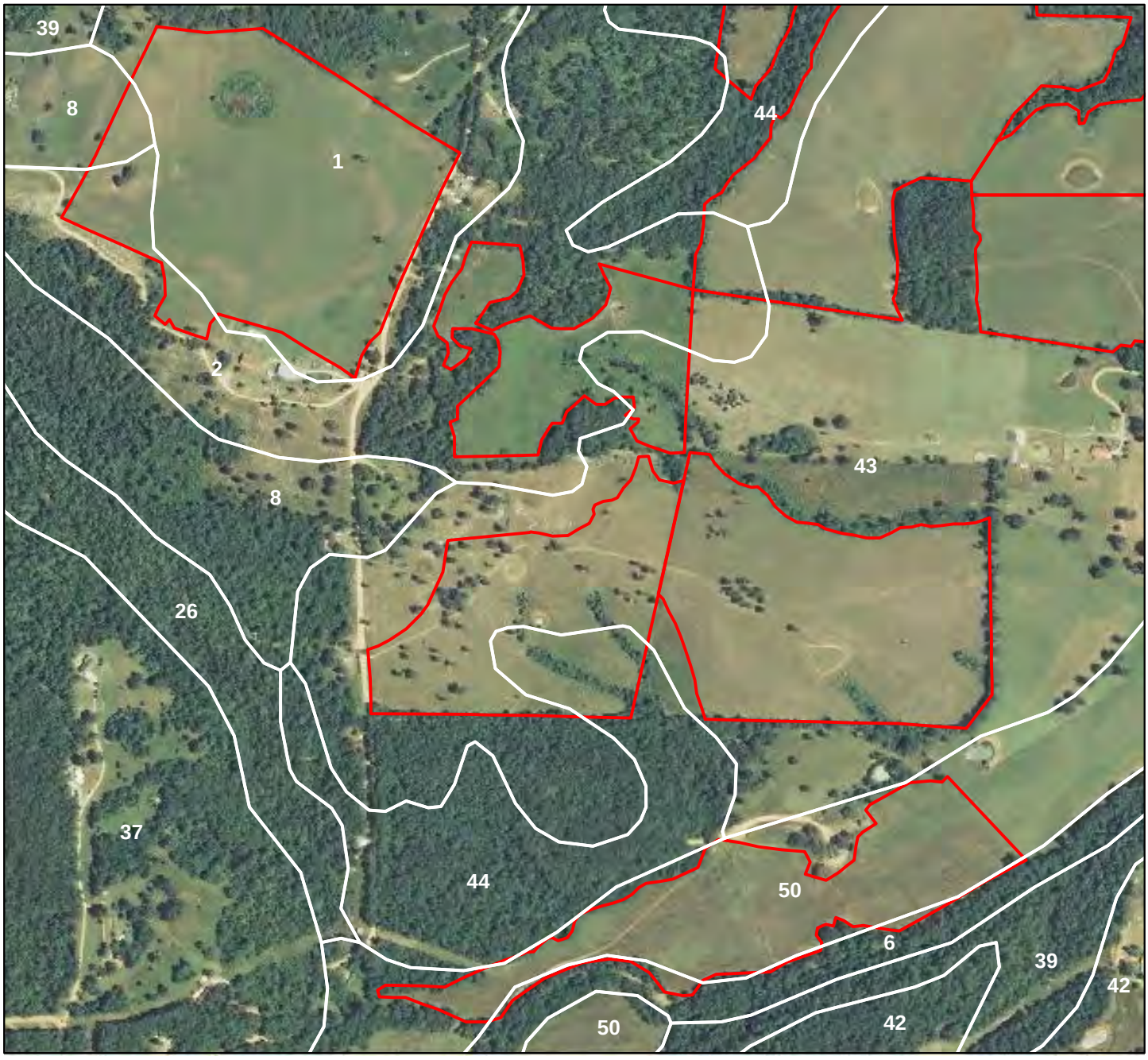
Team_1_soils

Correct Field Boundaries

380 0 380 760 1,140 1,520 Feet

N

Soils Map



Legend

Team_1_soils

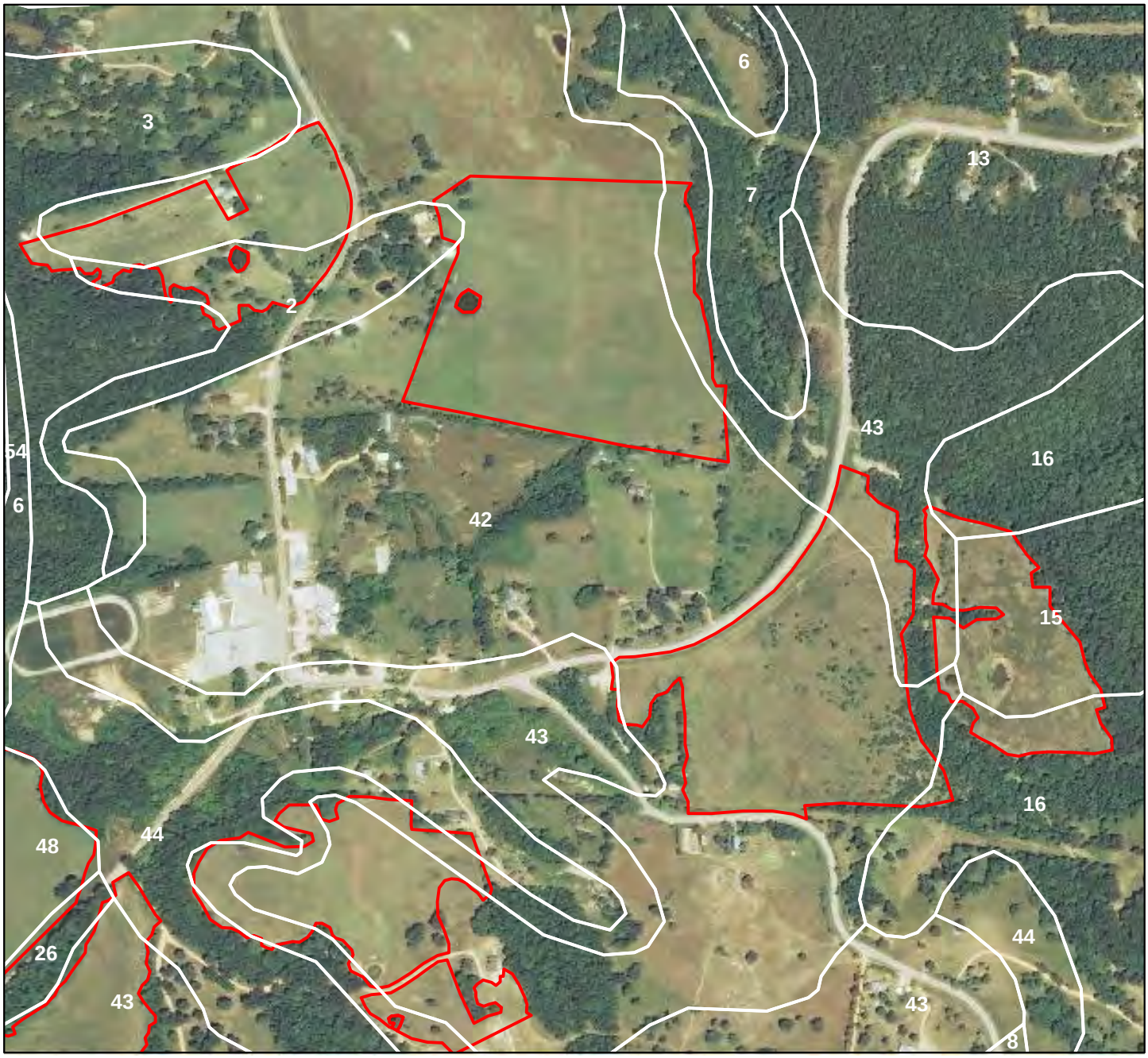
Correct Field Boundaries

380 0 380 760 1,140 1,520 Feet

35

N

Soils Map



Legend

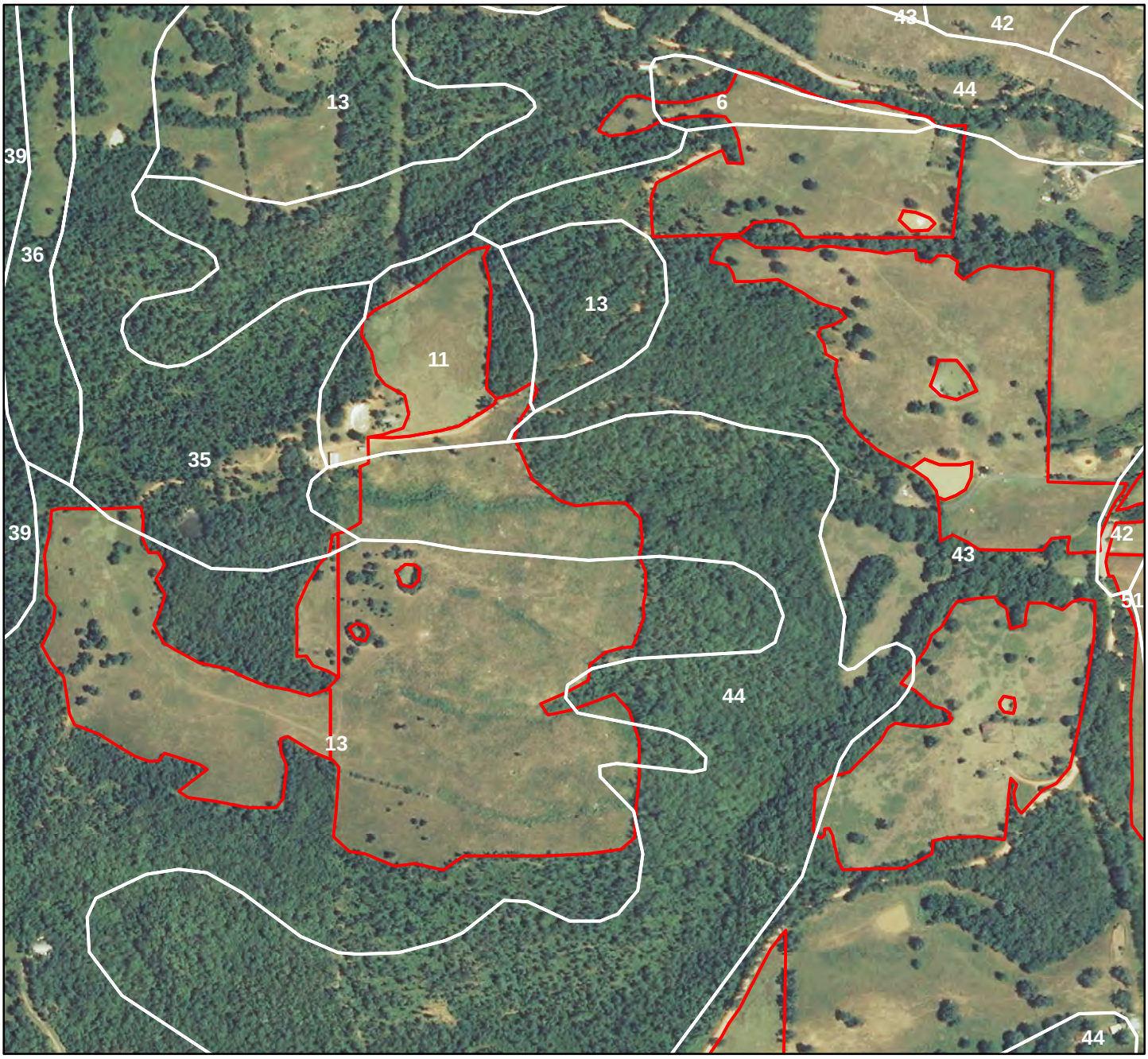
Team_1_soils

Correct Field Boundaries

380 0 380 760 1,140 1,520 Feet

N

Soils Map



Legend

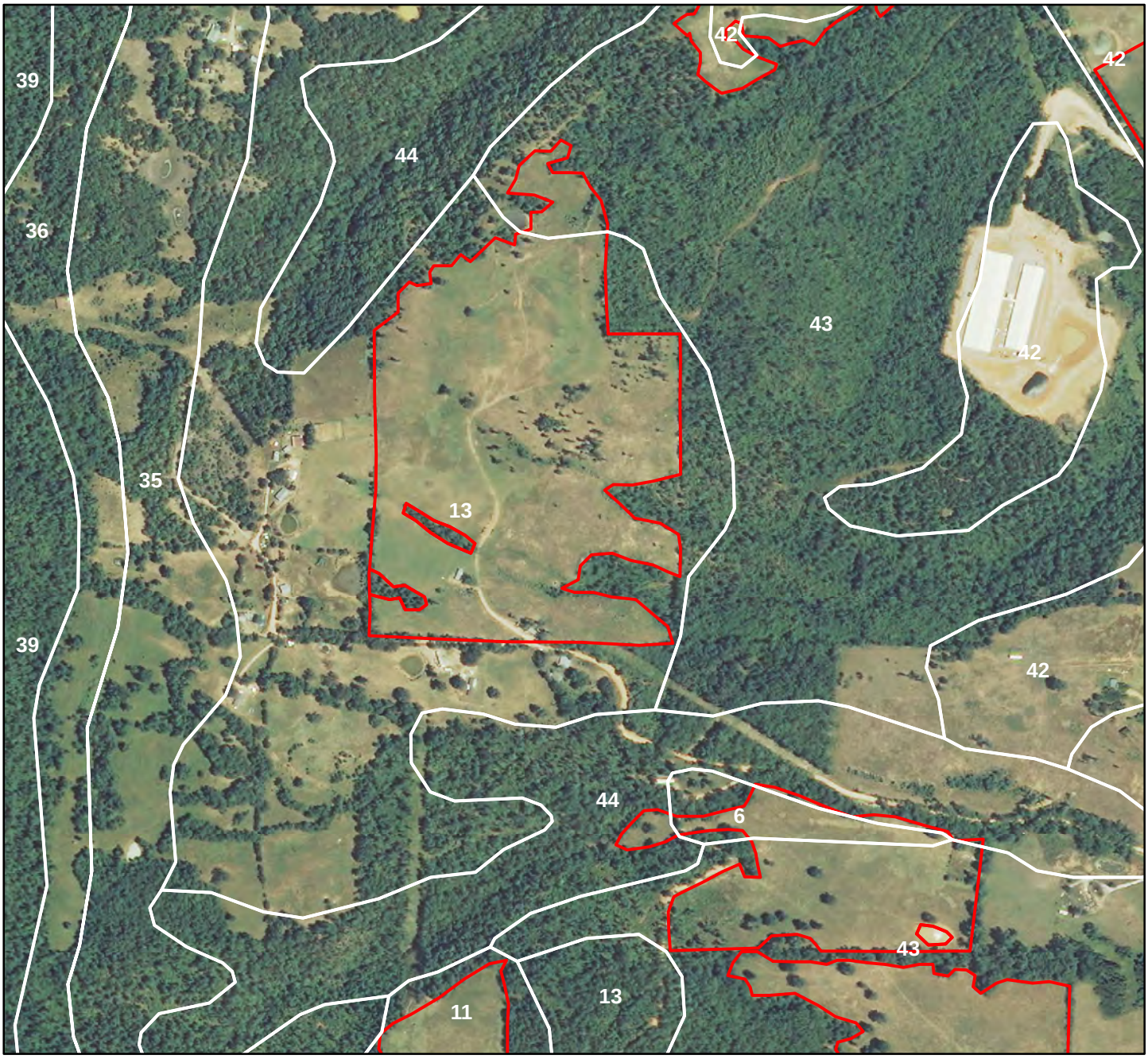
Team_1_soils

Correct Field Boundaries

380 0 380 760 1,140 1,520 Feet

N

Soils Map



Legend

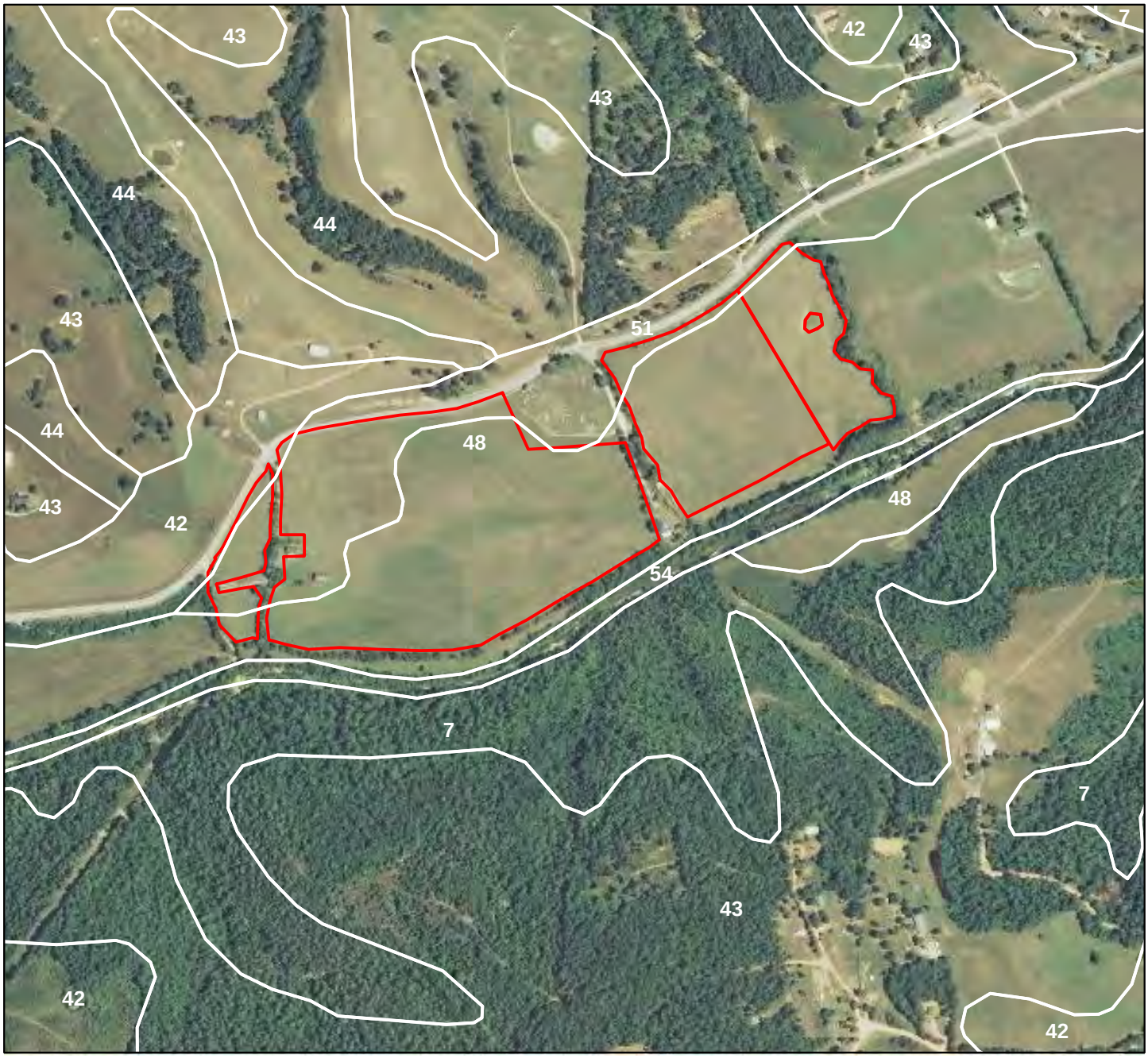
Team_1_soils

Correct Field Boundaries

380 0 380 760 1,140 1,520 Feet

N

Soils Map



Legend

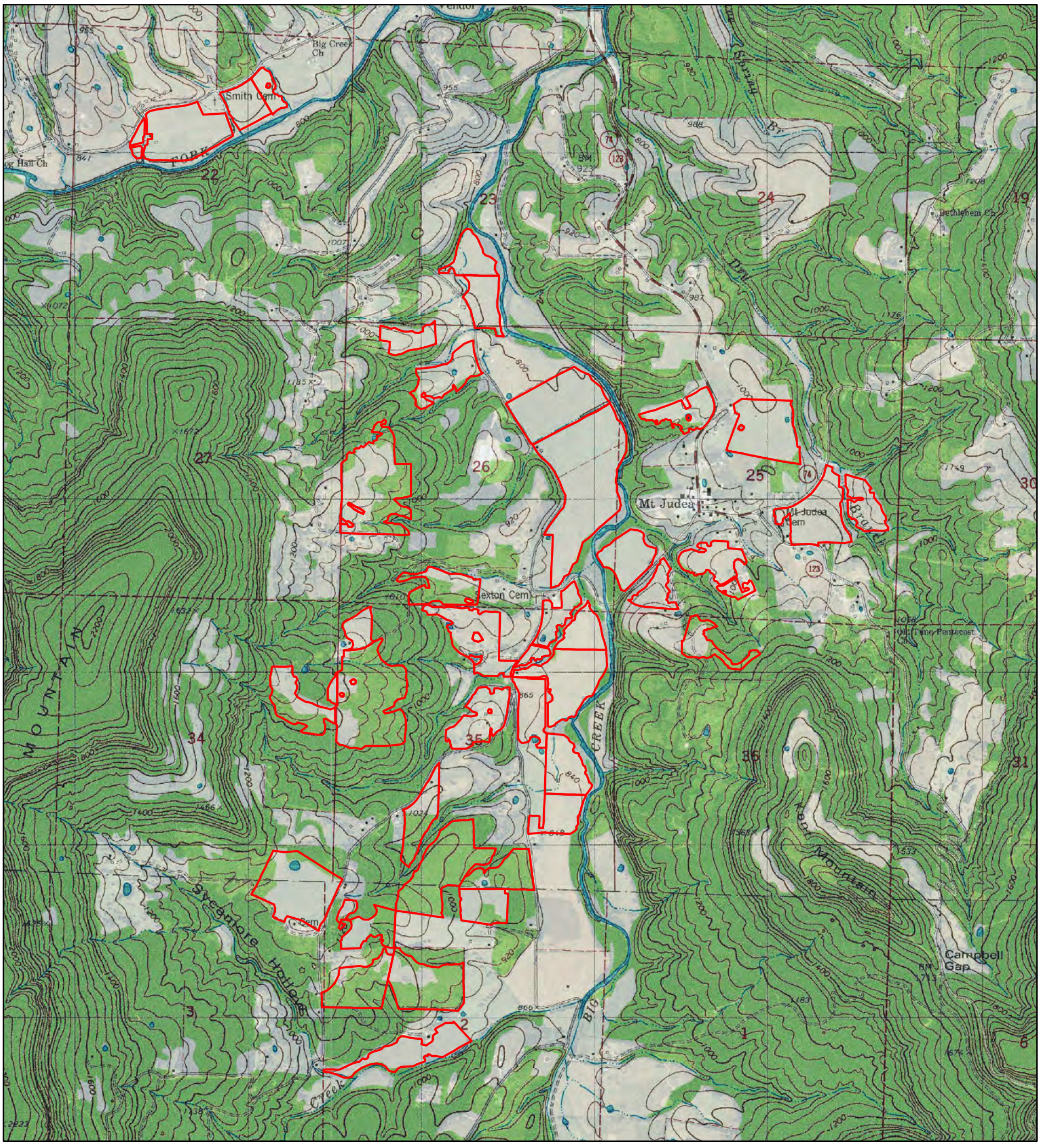
Team_1_soils

Correct Field Boundaries

380 0 380 760 1,140 1,520 Feet

N

Topo



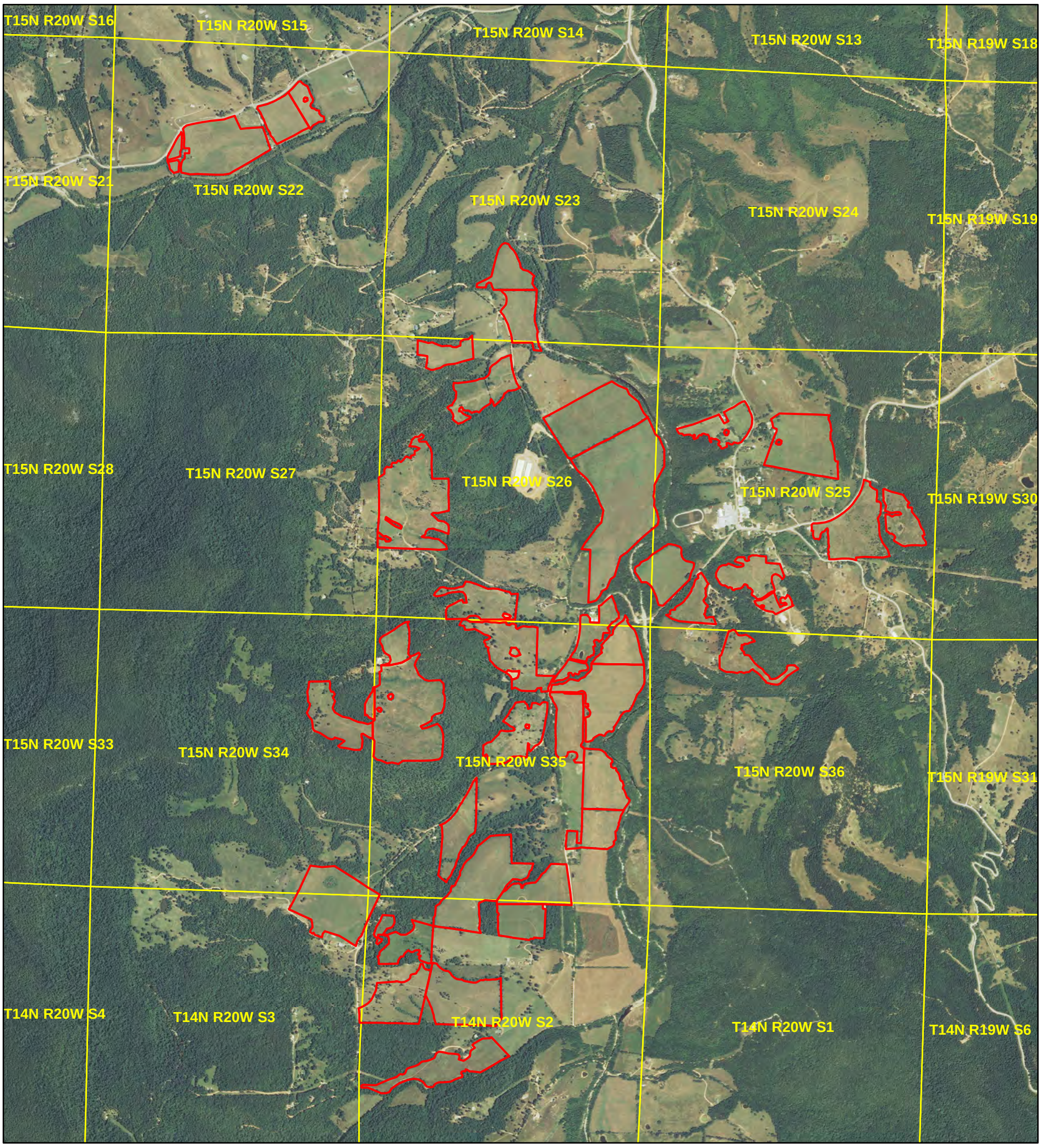
Legend

Correct Field Boundaries

1,800 0 1,800 3,600 5,400 7,200 Feet

N

Section, Township, Range Overview Map



Legend

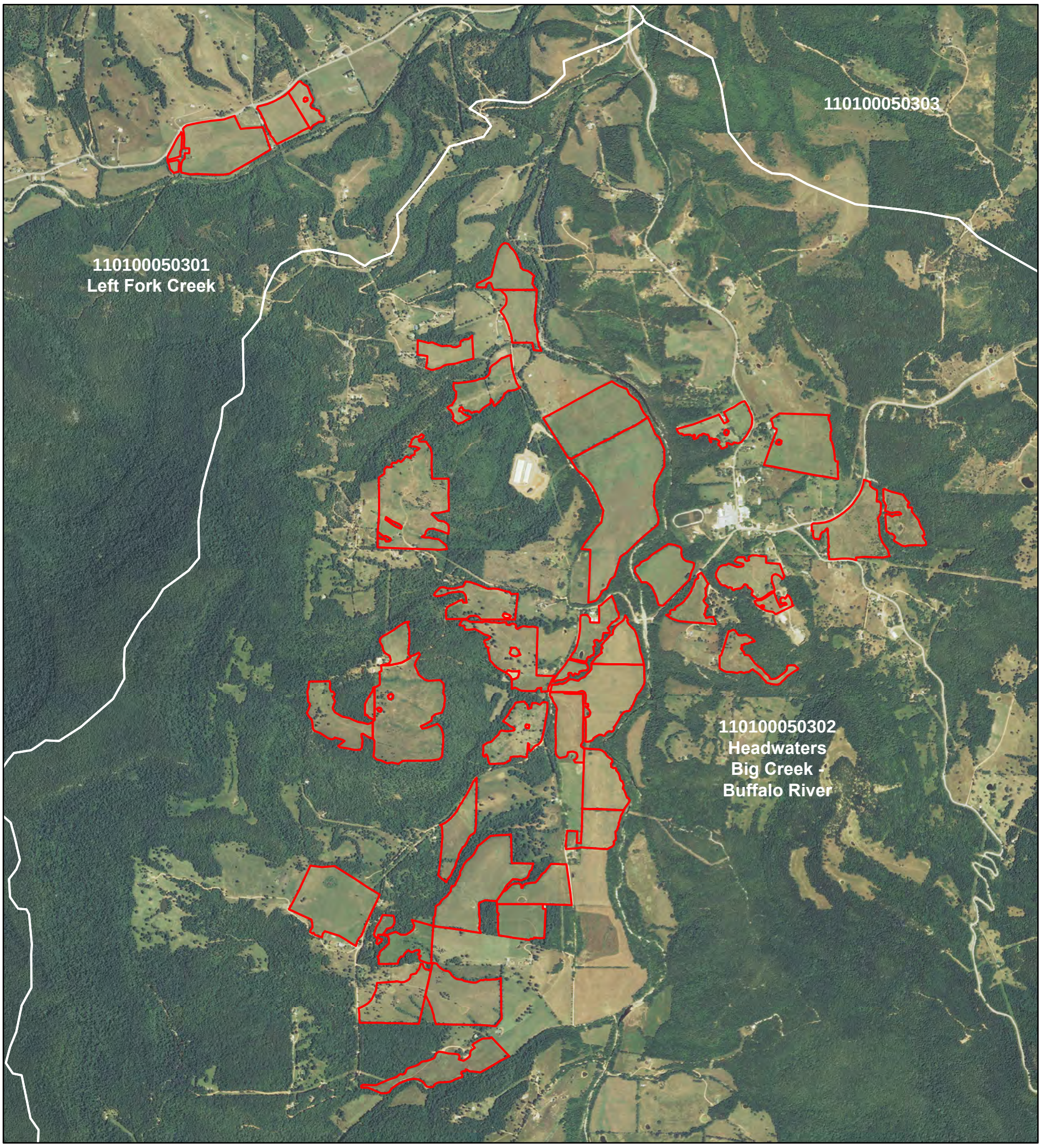
Correct Field Boundaries

plss_a_ar_utm15

1,800 0 1,800 3,600 5,400 7,200 Feet

N

Watershed Overview Map



Legend

Correct Field Boundaries

wbdhu12_a_ar

1,800 0 1,800 3,600 5,400 7,200 Feet

N

DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

Cooperative Extension Service
Soil Testing And Research Laboratory
Marianna, AR 72360
http://soiltest.uark.edu

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JASON HENSON	**Client ID:** 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655
Date Processed:	12/4/2015
Field ID:	JH 1
Acres:	18
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154610
Sample Number:	3466528

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	95	190	Above Optimum
K	443	886	Above Optimum
Ca	4722	9444	--
Mg	169	338	--
SO4-S	19	38	--
Zn	7.9	15.8	--
Fe	106	212	--
Mn	261	522	--
Cu	1	2	--
B	0.6	1.2	--
NO3-N	85	170	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	7.1	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	28.25	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Clay	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
92.92	83.58	4.99	4.02	0.34

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	0	0	0	0	0
Crop 2	Pasture - Cool-Season Grasses (MNT) (203)	60	0	0	0	0	0	0
Crop 3	Warm-Season Grasses (MNT) (207)	60	0	0	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

5. Crop 2 Notes:

Apply the recommended rate of N, P, and K in late winter. For higher production apply an additional 50 lb N/Acre after every 4 to 6 weeks of grazing. For fall/winter grazing, apply 50 lbs N/Acre in late summer.

6. Crop 3 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.

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Marianna, AR 72360
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JASON HENSON		**Client ID:**	8706881318
HC 72 BOX 10			
MT JUDEA	AR	72655	

Date Processed:	12/4/2015
Field ID:	JH 2
Acres:	9
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154611
Sample Number:	3466529

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	108	216	Above Optimum
K	283	566	Above Optimum
Ca	1621	3242	--
Mg	124	248	--
SO4-S	19	38	--
Zn	5.3	10.6	--
Fe	137	274	--
Mn	326	652	--
Cu	0.8	1.6	--
B	0.4	0.8	--
NO3-N	52	104	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.2	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	13.42	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam - Silty Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
73.91	60.41	7.70	5.41	0.39

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	0	0	0	0	0
Crop 2	Pasture - Cool-Season Grasses (MNT) (203)	60	0	0	0	0	0	0
Crop 3	Warm-Season Grasses (MNT) (207)	60	0	0	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

5. Crop 2 Notes:

Apply the recommended rate of N, P, and K in late winter. For higher production apply an additional 50 lb N/Acre after every 4 to 6 weeks of grazing. For fall/winter grazing, apply 50 lbs N/Acre in late summer.

6. Crop 3 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.

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RESEARCH & EXTENSION
University of Arkansas System

Cooperative Extension Service
Soil Testing And Research Laboratory
Marianna, AR 72360
http://soiltest.uark.edu

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JASON HENSON	**Client ID:** 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655
Date Processed:	12/4/2015
Field ID:	CC 3
Acres:	17
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154612
Sample Number:	3466530

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	89	178	Above Optimum
K	89	178	Low
Ca	1994	3988	--
Mg	71	142	--
SO4-S	11	22	--
Zn	3.8	7.6	--
Fe	186	372	--
Mn	253	506	--
Cu	1.6	3.2	--
B	0.4	0.8	--
NO3-N	26	52	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.7	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	13.86	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam - Silty Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
78.35	71.96	4.27	1.65	0.47

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	lb/acre						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	220	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	300	0	0	0	0
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	100	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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University of Arkansas System

Cooperative Extension Service
Soil Testing And Research Laboratory
Marianna, AR 72360
http://soiltest.uark.edu

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MT JUDEA	AR	72655	

Date Processed:	12/4/2015
Field ID:	JH 4
Acres:	11
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154613
Sample Number:	3466531

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	75	150	Above Optimum
K	220	440	Above Optimum
Ca	1718	3436	--
Mg	166	332	--
SO4-S	19	38	--
Zn	7.5	15	--
Fe	255	510	--
Mn	96	192	--
Cu	0.9	1.8	--
B	0.4	0.8	--
NO3-N	32	64	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.6	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	15.64	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silty Clay Loam - Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
68.03	54.92	8.84	3.61	0.67

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	lb/acre						
Crop 1	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	0	0	0	0	5000
Crop 2	Pasture - Cool-Season Grasses (MNT) (203)	60	0	0	0	0	0	5000
Crop 3	Warm-Season Grasses (MNT) (207)	60	0	0	0	0	0	5000

4. Crop 1 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

5. Crop 2 Notes:

Apply the recommended rate of N, P, and K in late winter. For higher production apply an additional 50 lb N/Acre after every 4 to 6 weeks of grazing. For fall/winter grazing, apply 50 lbs N/Acre in late summer.

6. Crop 3 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.

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Cooperative Extension Service
Soil Analysis Report
Soil Testing And Research Laboratory
Marianna, AR 72360
http://www.uark.edu/depts/soiltest

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MTN JUDEA	AR		72655

Date Processed:	4/1/2014
Field ID:	GR 5
Acres	24
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	38459
Sample Number:	2045423

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	63	126	Above Optimum
K	123	246	Medium
Ca	2331	4662	--
Mg	104	208	--
SO4-S	9	18	--
Zn	5.4	10.8	--
Fe	141	282	--
Mn	86	172	--
Cu	1.6	3.2	--
B	0.5	1.0	--
NO3-N	16	32	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.5	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	16	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silty Clay Loam - Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
81.1	73.4	5.5	2.0	0.3

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Pasture (207)	---------- lb/acre ----------						
Crop 1	Warm-Season Grasses (MNT) (207)	60	0	60	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	250	0	0	0	0
Crop 3	Winter Annuals (EST/MNT) (210)	90	0	40	0	0	0	0

4. Crop 1 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

6. Crop 3 Notes:

Apply the recommended P and K fertilizer rates and one-third of the total N rate immediately before or after stand is successfully established. Apply the remaining N(60 lb N/Acre/application) during mid February. For higher production, apply an additional 50 lb N/Acre in mid March.

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Cooperative Extension Service
Soil Analysis Report
Soil Testing And Research Laboratory
Marianna, AR 72360
http://www.uark.edu/depts/soiltest

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MTN JUDEA	AR		72655

Date Processed:	4/1/2014
Field ID:	SR 6
Acres	5
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	38460
Sample Number:	2045424

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	116	232	Above Optimum
K	216	432	Above Optimum
Ca	698	1396	--
Mg	70	140	--
SO4-S	12	24	--
Zn	3.4	6.8	--
Fe	120	240	--
Mn	181	362	--
Cu	0.4	0.8	--
B	0.3	0.6	--
NO3-N	13	26	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.9	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	8	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
60.8	45.5	7.6	7.2	0.5

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Pasture (207)	---------- lb/acre ----------						
Crop 1	Warm-Season Grasses (MNT) (207)	60	0	0	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	0	0	0	0	0
Crop 3	Winter Annuals (EST/MNT) (210)	90	0	0	0	0	0	0

4. Crop 1 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

6. Crop 3 Notes:

Apply the recommended P and K fertilizer rates and one-third of the total N rate immediately before or after stand is successfully established. Apply the remaining N(60 lb N/Acre/application) during mid February. For higher production, apply an additional 50 lb N/Acre in mid March.

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MTN JUDEA	AR		72655

Date Processed:	4/1/2014
Field ID:	GR 6A
Acres	9
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	38461
Sample Number:	2045425

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	111	222	Above Optimum
K	238	476	Above Optimum
Ca	1133	2266	--
Mg	117	234	--
SO4-S	16	32	--
Zn	4.8	9.6	--
Fe	130	260	--
Mn	244	488	--
Cu	0.9	1.8	--
B	0.4	0.8	--
NO3-N	29	58	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.8	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	12	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam - Silty Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
61.9	48.0	8.3	5.2	0.5

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	0	0	0	0	0
Crop 2	Pasture - Cool-Season Grasses (MNT) (203)	60	0	0	0	0	0	0
Crop 3	Warm-Season Grasses (MNT) (207)	60	0	0	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

5. Crop 2 Notes:

Apply the recommended rate of N, P, and K in late winter. For higher production apply an additional 50 lb N/Acre after every 4 to 6 weeks of grazing. For fall/winter grazing, apply 50 lbs N/Acre in late summer.

6. Crop 3 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.

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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655
Date Processed:	12/4/2015
Field ID:	EGC 7
Acres:	73
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154614
Sample Number:	3466532

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	89	178	Above Optimum
K	88	176	Low
Ca	889	1778	--
Mg	116	232	--
SO4-S	15	30	--
Zn	6.4	12.8	--
Fe	182	364	--
Mn	205	410	--
Cu	1.6	3.2	--
B	0.2	0.4	--
NO3-N	20	40	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.4	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	10.24	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
56.04	43.42	9.44	2.20	0.98

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Hay (144)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	220	0	0	0	5000
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	300	0	0	0	5000
Crop 3								

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

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JASON HENSON	Client ID:	8706881318
HC 72 BOX 10		
MTN JUDEA	AR	72655
Date Processed:	4/1/2014	
Field ID:	EGC 7A	
Acres	34	
Lime Applied in the last 4 years:	No	
Leveled in past 4 years:	No	
Irrigation:	Unknown	
County:	Pope	
Lab Number:	38463	
Sample Number:	2045427	

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	38	76	Optimum
K	55	110	Very Low
Ca	751	1502	--
Mg	75	150	--
SO4-S	12	24	--
Zn	3.5	7.0	--
Fe	131	262	--
Mn	172	344	--
Cu	1.5	3.0	--
B	0.3	0.6	--
NO3-N	13	26	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.5	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	9	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
50.5	41.3	6.9	1.6	0.7

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Hay (134)	---------- lb/acre ----------						
Crop 1	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	45	350	0	0	0	4000
Crop 2	Warm-Season Grasses (MNT) (207)	60	0	160	0	0	0	4000
Crop 3	Winter Annuals (EST/MNT) (210)	90	0	120	0	0	0	4000

4. Crop 1 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

5. Crop 2 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

6. Crop 3 Notes:

Apply the recommended P and K fertilizer rates and one-third of the total N rate immediately before or after stand is successfully established. Apply the remaining N(60 lb N/Acre/application) during mid February. For higher production, apply an additional 50 lb N/Acre in mid March.

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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655
Date Processed:	12/4/2015
Field ID:	CC 8
Acres:	11
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154615
Sample Number:	3466533

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	82	164	Above Optimum
K	111	222	Medium
Ca	2083	4166	--
Mg	95	190	--
SO4-S	12	24	--
Zn	4.4	8.8	--
Fe	155	310	--
Mn	224	448	--
Cu	0.9	1.8	--
B	0.4	0.8	--
NO3-N	30	60	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.5	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	14.57	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silty Clay Loam - Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
79.41	71.48	5.43	1.95	0.54

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	180	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	250	0	0	0	0
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	60	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655
Date Processed:	12/4/2015
Field ID:	CC 8A
Acres:	3
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154616
Sample Number:	3466534

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	72	144	Above Optimum
K	79	158	Low
Ca	1606	3212	--
Mg	80	160	--
SO4-S	13	26	--
Zn	3	6	--
Fe	168	336	--
Mn	194	388	--
Cu	0.8	1.6	--
B	0.3	0.6	--
NO3-N	20	40	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.2	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	12.45	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam - Silty Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
71.89	64.49	5.35	1.63	0.42

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	lb/acre						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	220	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	300	0	0	0	0
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	100	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655
Date Processed:	12/4/2015
Field ID:	CC 9
Acres:	30
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154617
Sample Number:	3466535

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	82	164	Above Optimum
K	87	174	Low
Ca	3027	6054	--
Mg	96	192	--
SO4-S	11	22	--
Zn	5.2	10.4	--
Fe	198	396	--
Mn	140	280	--
Cu	2	4	--
B	0.5	1	--
NO3-N	32	64	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.9	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	18.75	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Clay	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
86.66	80.74	4.27	1.19	0.46

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	220	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	300	0	0	0	0
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	100	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655

Date Processed:	12/4/2015
Field ID:	CC 9A
Acres:	12
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154618
Sample Number:	3466536

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	67	134	Above Optimum
K	93	186	Medium
Ca	2433	4866	--
Mg	77	154	--
SO4-S	11	22	--
Zn	2.5	5	--
Fe	156	312	--
Mn	169	338	--
Cu	1.5	3	--
B	0.3	0.6	--
NO3-N	23	46	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.6	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	16.13	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silty Clay Loam - Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
81.40	75.41	3.98	1.48	0.54

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	180	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	250	0	0	0	0
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	60	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655

Date Processed:	12/4/2015
Field ID:	FD 10
Acres:	15
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154619
Sample Number:	3466537

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	72	144	Above Optimum
K	109	218	Medium
Ca	1462	2924	--
Mg	144	288	--
SO4-S	17	34	--
Zn	5.5	11	--
Fe	294	588	--
Mn	199	398	--
Cu	2	4	--
B	0.3	0.6	--
NO3-N	72	144	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.3	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	14.45	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam - Silty Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
61.93	50.60	8.31	1.93	1.08

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	180	0	0	0	5000
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	250	0	0	0	5000
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	60	0	0	0	5000

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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University of Arkansas System

Cooperative Extension Service
Soil Testing And Research Laboratory
Marianna, AR 72360
http://soiltest.uark.edu

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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655
Date Processed:	12/4/2015
Field ID:	BC 10A
Acres:	18
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154620
Sample Number:	3466538

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	100	200	Above Optimum
K	125	250	Medium
Ca	1380	2760	--
Mg	127	254	--
SO4-S	15	30	--
Zn	6.4	12.8	--
Fe	204	408	--
Mn	206	412	--
Cu	1.8	3.6	--
B	0.4	0.8	--
NO3-N	32	64	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.7	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	12.91	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam - Silty Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
65.14	53.45	8.20	2.48	1.01

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	180	0	0	0	4000
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	250	0	0	0	4000
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	60	0	0	0	4000

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MT JUDEA	AR	72655	

Date Processed:	12/4/2015
Field ID:	FD 11
Acres:	19
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154622
Sample Number:	3466539

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	62	124	Above Optimum
K	150	300	Optimum
Ca	875	1750	--
Mg	157	314	--
SO4-S	20	40	--
Zn	4.7	9.4	--
Fe	157	314	--
Mn	281	562	--
Cu	0.9	1.8	--
B	0.3	0.6	--
NO3-N	23	46	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.4	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	10.64	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
57.70	41.13	12.30	3.62	0.65

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	40	0	0	0	5000
Crop 2	Pasture - Cool-Season Grasses (MNT) (203)	60	0	0	0	0	0	5000
Crop 3	Warm-Season Grasses (MNT) (207)	60	0	0	0	0	0	5000

4. Crop 1 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

5. Crop 2 Notes:

Apply the recommended rate of N, P, and K in late winter. For higher production apply an additional 50 lb N/Acre after every 4 to 6 weeks of grazing. For fall/winter grazing, apply 50 lbs N/Acre in late summer.

6. Crop 3 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.

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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655
Date Processed:	12/4/2015
Field ID:	RF 12
Acres:	13
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154623
Sample Number:	3466540

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	88	176	Above Optimum
K	128	256	Medium
Ca	1247	2494	--
Mg	101	202	--
SO4-S	14	28	--
Zn	3.9	7.8	--
Fe	185	370	--
Mn	206	412	--
Cu	1.5	3	--
B	0.4	0.8	--
NO3-N	21	42	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.8	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	12.00	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam - Silty Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
62.50	51.96	7.01	2.73	0.80

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	180	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	250	0	0	0	0
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	60	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655

Date Processed:	12/4/2015
Field ID:	CC 13
Acres:	13
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154624
Sample Number:	3466541

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	86	172	Above Optimum
K	176	352	Above Optimum
Ca	1670	3340	--
Mg	131	262	--
SO4-S	18	36	--
Zn	7.6	15.2	--
Fe	122	244	--
Mn	510	1020	--
Cu	1.2	2.4	--
B	0.5	1	--
NO3-N	45	90	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.4	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	13.49	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam - Silty Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
74.06	61.88	8.09	3.34	0.74

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	0	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	0	0	0	0	0
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	0	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655
Date Processed:	12/4/2015
Field ID:	CC 13A
Acres:	37
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154625
Sample Number:	3466542

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	75	150	Above Optimum
K	233	466	Above Optimum
Ca	1805	3610	--
Mg	144	288	--
SO4-S	18	36	--
Zn	7.9	15.8	--
Fe	110	220	--
Mn	483	966	--
Cu	1.1	2.2	--
B	0.6	1.2	--
NO3-N	46	92	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.3	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	14.41	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam - Silty Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
75.70	62.65	8.33	4.15	0.57

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	lb/acre						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	0	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	0	0	0	0	0
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	0	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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Marianna, AR 72360
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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MT JUDEA	AR	72655	

Date Processed:	12/4/2015
Field ID:	CC 13B
Acres:	16
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154626
Sample Number:	3466543

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	61	122	Above Optimum
K	227	454	Above Optimum
Ca	1730	3460	--
Mg	121	242	--
SO4-S	15	30	--
Zn	4.8	9.6	--
Fe	93	186	--
Mn	477	954	--
Cu	1	2	--
B	0.5	1	--
NO3-N	40	80	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.6	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	13.31	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam - Silty Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
77.46	64.99	7.58	4.37	0.52

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	0	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	0	0	0	0	0
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	0	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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Soil Testing And Research Laboratory
Marianna, AR 72360
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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655
Date Processed:	12/4/2015
Field ID:	CC 14
Acres:	15
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154627
Sample Number:	3466544

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	75	150	Above Optimum
K	149	298	Optimum
Ca	894	1788	--
Mg	145	290	--
SO4-S	19	38	--
Zn	8.3	16.6	--
Fe	141	282	--
Mn	446	892	--
Cu	1.1	2.2	--
B	0.3	0.6	--
NO3-N	48	96	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.8	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	10.14	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
60.55	44.09	11.92	3.77	0.77

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	150	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	200	0	0	0	0
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	40	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655
Date Processed:	12/4/2015
Field ID:	C1C 15
Acres:	28
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154628
Sample Number:	3466545

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	72	144	Above Optimum
K	144	288	Optimum
Ca	908	1816	--
Mg	155	310	--
SO4-S	18	36	--
Zn	6.9	13.8	--
Fe	131	262	--
Mn	498	996	--
Cu	1.5	3	--
B	0.4	0.8	--
NO3-N	45	90	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.7	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	10.28	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
61.10	44.15	12.56	3.59	0.80

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	lb/acre						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	150	0	0	0	4000
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	200	0	0	0	4000
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	40	0	0	0	4000

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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Cooperative Extension Service
Soil Analysis Report
Soil Testing And Research Laboratory
Marianna, AR 72360
http://www.uark.edu/depts/soiltest

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MTN JUDEA	AR		72655

Date Processed:	4/1/2014
Field ID:	C1C 15A
Acres	10
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	38485
Sample Number:	2045502

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	18	36	Low
K	98	196	Medium
Ca	1165	2330	--
Mg	81	162	--
SO4-S	11	22	--
Zn	2.5	5.0	--
Fe	91	182	--
Mn	133	266	--
Cu	0.6	1.2	--
B	0.3	0.6	--
NO3-N	27	54	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.6	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	11	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam - Silty Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
60.2	51.5	6.0	2.2	0.5

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	80	60	0	0	0	4000
Crop 2	Pasture - Cool-Season Grasses (MNT) (203)	60	70	50	0	0	0	4000
Crop 3	Warm-Season Grasses (MNT) (207)	60	70	60	0	0	0	4000

4. Crop 1 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

5. Crop 2 Notes:

Apply the recommended rate of N, P, and K in late winter. For higher production apply an additional 50 lb N/Acre after every 4 to 6 weeks of grazing. For fall/winter grazing, apply 50 lbs N/Acre in late summer.

6. Crop 3 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

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RESEARCH & EXTENSION
University of Arkansas System

Cooperative Extension Service
Soil Testing And Research Laboratory
Marianna, AR 72360
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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655
Date Processed:	12/4/2015
Field ID:	C1C 15B
Acres:	21
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154630
Sample Number:	3466547

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	66	132	Above Optimum
K	238	476	Above Optimum
Ca	1600	3200	--
Mg	201	402	--
SO4-S	25	50	--
Zn	9.1	18.2	--
Fe	139	278	--
Mn	699	1398	--
Cu	1.7	3.4	--
B	0.5	1	--
NO3-N	64	128	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.9	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	13.86	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silty Clay Loam - Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
74.75	57.71	12.08	4.40	0.56

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	0	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	0	0	0	0	0
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	0	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655

Date Processed:	12/4/2015
Field ID:	BH 16
Acres:	21
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154631
Sample Number:	3466548

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	68	136	Above Optimum
K	183	366	Above Optimum
Ca	1145	2290	--
Mg	138	276	--
SO4-S	17	34	--
Zn	4.9	9.8	--
Fe	190	380	--
Mn	236	472	--
Cu	1.4	2.8	--
B	0.3	0.6	--
NO3-N	47	94	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.5	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	12.91	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam - Silty Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
57.41	44.33	8.91	3.63	0.54

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	0	0	0	0	4000
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	0	0	0	0	4000
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	0	0	0	0	4000

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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JASON HENSON HC 72 BOX 10	Client ID: 8706881318
MT JUDEA	AR 72655

Date Processed:	12/4/2015
Field ID:	JC 17
Acres:	36
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154632
Sample Number:	3466549

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	86	172	Above Optimum
K	93	186	Medium
Ca	2539	5078	--
Mg	106	212	--
SO4-S	17	34	--
Zn	7.1	14.2	--
Fe	158	316	--
Mn	207	414	--
Cu	1.9	3.8	--
B	0.4	0.8	--
NO3-N	38	76	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.5	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	17.00	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silty Clay Loam - Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
82.35	74.68	5.20	1.40	1.07

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	0	180	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	250	0	0	0	0
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	0	60	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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JASON HENSON	Client ID:	8706881318
HC 72 BOX 10		
MTN JUDEA	AR	72655
Date Processed:	4/1/2014	
Field ID:	MB 18	
Acres	37	
Lime Applied in the last 4 years:	No	
Leveled in past 4 years:	No	
Irrigation:	Unknown	
County:	Pope	
Lab Number:	38472	
Sample Number:	2045507	

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	42	84	Optimum
K	54	108	Very Low
Ca	1683	3366	--
Mg	71	142	--
SO4-S	13	26	--
Zn	3.7	7.4	--
Fe	86	172	--
Mn	339	678	--
Cu	1.0	2.0	--
B	0.4	0.8	--
NO3-N	29	58	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.5	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	12	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam - Silty Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
75.4	68.9	4.8	1.1	0.6

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Pasture (207)	---------- lb/acre ----------						
Crop 1	Warm-Season Grasses (MNT) (207)	60	0	160	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	45	350	0	0	0	0
Crop 3	Winter Annuals (EST/MNT) (210)	90	0	120	0	0	0	0

4. Crop 1 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

Apply the recommended P and K fertilizer rates and one-third of the total N rate immediately before or after stand is successfully established. Apply the remaining N(60 lb N/Acre/application) during mid February. For higher production, apply an additional 50 lb N/Acre in mid March.

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MTN JUDEA	AR		72655

Date Processed:	4/1/2014
Field ID:	MB 19
Acres	10
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	38473
Sample Number:	2045508

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	66	132	Above Optimum
K	221	442	Above Optimum
Ca	1982	3964	--
Mg	100	200	--
SO4-S	13	26	--
Zn	5.0	10.0	--
Fe	92	184	--
Mn	352	704	--
Cu	1.1	2.2	--
B	0.6	1.2	--
NO3-N	35	70	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.8	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	14	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam - Silty Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
82.0	71.5	6.0	4.1	0.4

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Pasture (207)	---------- lb/acre ----------						
Crop 1	Warm-Season Grasses (MNT) (207)	60	0	0	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	0	0	0	0	0
Crop 3	Winter Annuals (EST/MNT) (210)	90	0	0	0	0	0	0

4. Crop 1 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

Apply the recommended P and K fertilizer rates and one-third of the total N rate immediately before or after stand is successfully established. Apply the remaining N(60 lb N/Acre/application) during mid February. For higher production, apply an additional 50 lb N/Acre in mid March.

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JASON HENSON	Client ID:	8706881318
HC 72 BOX 10		
MTN JUDEA	AR	72655
Date Processed:	4/1/2014	
Field ID:	RC 20	
Acres	30	
Lime Applied in the last 4 years:	No	
Leveled in past 4 years:	No	
Irrigation:	Unknown	
County:	Pope	
Lab Number:	38474	
Sample Number:	2045509	

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	63	126	Above Optimum
K	168	336	Optimum
Ca	1612	3224	--
Mg	103	206	--
SO4-S	11	22	--
Zn	3.6	7.2	--
Fe	104	208	--
Mn	234	468	--
Cu	0.9	1.8	--
B	0.6	1.2	--
NO3-N	21	42	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.5	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	12	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam - Silty Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
75.8	65.0	6.9	3.5	0.4

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Pasture (207)	---------- lb/acre ----------						
Crop 1	Warm-Season Grasses (MNT) (207)	60	0	0	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	200	0	0	0	0
Crop 3	Winter Annuals (EST/MNT) (210)	90	0	0	0	0	0	0

4. Crop 1 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

6. Crop 3 Notes:

Apply the recommended P and K fertilizer rates and one-third of the total N rate immediately before or after stand is successfully established. Apply the remaining N(60 lb N/Acre/application) during mid February. For higher production, apply an additional 50 lb N/Acre in mid March.

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MTN JUDEA	AR		72655

Date Processed:	4/1/2014
Field ID:	RC 21
Acres	7
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	38475
Sample Number:	2045510

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	12	24	Very Low
K	142	284	Optimum
Ca	635	1270	--
Mg	72	144	--
SO4-S	9	18	--
Zn	1.5	3.0	--
Fe	85	170	--
Mn	174	348	--
Cu	0.3	0.6	--
B	0.3	0.6	--
NO3-N	13	26	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.2	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	7	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
62.6	47.5	9.0	5.4	0.7

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	120	40	0	0	0	0
Crop 2	Pasture - Cool-Season Grasses (MNT) (203)	60	100	0	0	0	0	0
Crop 3	Warm-Season Grasses (MNT) (207)	60	100	0	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

5. Crop 2 Notes:

Apply the recommended rate of N, P, and K in late winter. For higher production apply an additional 50 lb N/Acre after every 4 to 6 weeks of grazing. For fall/winter grazing, apply 50 lbs N/Acre in late summer.

6. Crop 3 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MTN JUDEA	AR		72655

Date Processed:	4/1/2014
Field ID:	RC21A
Acres	24
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	38505
Sample Number:	2045465

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	21	42	Low
K	181	362	Above Optimum
Ca	865	1730	--
Mg	78	156	--
SO4-S	11	22	--
Zn	2.4	4.8	--
Fe	72	144	--
Mn	280	560	--
Cu	0.7	1.4	--
B	0.3	0.6	--
NO3-N	27	54	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.3	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	8	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
68.7	54.1	8.1	5.8	0.7

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	80	0	0	0	0	0
Crop 2	Pasture - Cool-Season Grasses (MNT) (203)	60	70	0	0	0	0	0
Crop 3	Warm-Season Grasses (MNT) (207)	60	70	0	0	0	0	0

4. Crop 1 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

5. Crop 2 Notes:

Apply the recommended rate of N, P, and K in late winter. For higher production apply an additional 50 lb N/Acre after every 4 to 6 weeks of grazing. For fall/winter grazing, apply 50 lbs N/Acre in late summer.

6. Crop 3 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MTN JUDEA	AR		72655

Date Processed:	4/1/2014
Field ID:	RC 21B
Acres	5
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	38490
Sample Number:	2045451

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	38	76	Optimum
K	162	324	Optimum
Ca	910	1820	--
Mg	66	132	--
SO4-S	12	24	--
Zn	2.3	4.6	--
Fe	117	234	--
Mn	119	238	--
Cu	0.5	1.0	--
B	0.4	0.8	--
NO3-N	18	36	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.3	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	8	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
69.0	56.4	6.8	5.1	0.7

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Pasture (207)	---------- lb/acre ----------						
Crop 1	Warm-Season Grasses (MNT) (207)	60	0	0	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	45	200	0	0	0	0
Crop 3	Winter Annuals (EST/MNT) (210)	90	0	0	0	0	0	0

4. Crop 1 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

6. Crop 3 Notes:

Apply the recommended P and K fertilizer rates and one-third of the total N rate immediately before or after stand is successfully established. Apply the remaining N(60 lb N/Acre/application) during mid February. For higher production, apply an additional 50 lb N/Acre in mid March.

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MTN JUDEA	AR		72655

Date Processed:	4/1/2014
Field ID:	KC 22
Acres	49
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	38491
Sample Number:	2045452

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	38	76	Optimum
K	126	252	Medium
Ca	405	810	--
Mg	60	120	--
SO4-S	13	26	--
Zn	1.4	2.8	--
Fe	109	218	--
Mn	156	312	--
Cu	0.3	0.6	--
B	0.2	0.4	--
NO3-N	15	30	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.6	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	7	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Sandy Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
42.0	29.3	7.2	4.7	0.8

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	30	60	0	0	0	3000
Crop 2	Pasture - Cool-Season Grasses (MNT) (203)	60	0	50	0	0	0	3000
Crop 3	Warm-Season Grasses (MNT) (207)	60	0	60	0	0	0	3000

4. Crop 1 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

5. Crop 2 Notes:

Apply the recommended rate of N, P, and K in late winter. For higher production apply an additional 50 lb N/Acre after every 4 to 6 weeks of grazing. For fall/winter grazing, apply 50 lbs N/Acre in late summer.

6. Crop 3 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MTN JUDEA	AR		72655

Date Processed:	4/1/2014
Field ID:	GN 23
Acres	32
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	38492
Sample Number:	2045453

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	56	112	Above Optimum
K	35	70	Very Low
Ca	734	1468	--
Mg	25	50	--
SO4-S	11	22	--
Zn	1.5	3.0	--
Fe	95	190	--
Mn	189	378	--
Cu	0.5	1.0	--
B	0.2	0.4	--
NO3-N	8	16	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.8	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	8	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
50.2	45.7	2.6	1.1	0.8

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Hay (134)	---------- lb/acre ----------						
Crop 1	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	350	0	0	0	0
Crop 2	Warm-Season Grasses (MNT) (207)	60	0	160	0	0	0	0
Crop 3								

4. Crop 1 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

5. Crop 2 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

6. Crop 3 Notes:

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MTN JUDEA	AR		72655

Date Processed:	4/1/2014
Field ID:	DH 24
Acres	12
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	38493
Sample Number:	2045454

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	45	90	Optimum
K	68	136	Low
Ca	922	1844	--
Mg	58	116	--
SO4-S	14	28	--
Zn	1.9	3.8	--
Fe	126	252	--
Mn	162	324	--
Cu	1.0	2.0	--
B	0.2	0.4	--
NO3-N	11	22	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.4	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	10	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
54.2	46.9	4.9	1.8	0.6

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Pasture (207)	---------- lb/acre ----------						
Crop 1	Warm-Season Grasses (MNT) (207)	60	0	110	0	0	0	5000
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	45	300	0	0	0	5000
Crop 3	Winter Annuals (EST/MNT) (210)	90	0	80	0	0	0	5000

4. Crop 1 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

Apply the recommended P and K fertilizer rates and one-third of the total N rate immediately before or after stand is successfully established. Apply the remaining N(60 lb N/Acre/application) during mid February. For higher production, apply an additional 50 lb N/Acre in mid March.

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MTN JUDEA	AR		72655

Date Processed:	4/1/2014
Field ID:	HC 32
Acres	15
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	38503
Sample Number:	2045463

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	57	114	Above Optimum
K	101	202	Medium
Ca	707	1414	--
Mg	48	96	--
SO4-S	12	24	--
Zn	1.9	3.8	--
Fe	99	198	--
Mn	260	520	--
Cu	0.6	1.2	--
B	0.2	0.4	--
NO3-N	15	30	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.9	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	7	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
58.6	48.7	5.5	3.6	0.8

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Pasture (207)	---------- lb/acre ----------						
Crop 1	Warm-Season Grasses (MNT) (207)	60	0	60	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	250	0	0	0	0
Crop 3	Winter Annuals (EST/MNT) (210)	90	0	40	0	0	0	0

4. Crop 1 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.
If S deficiency has occurred previously on this field apply 20 lb SO4-S/Acre.

6. Crop 3 Notes:

Apply the recommended P and K fertilizer rates and one-third of the total N rate immediately before or after stand is successfully established. Apply the remaining N(60 lb N/Acre/application) during mid February. For higher production, apply an additional 50 lb N/Acre in mid March.

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MTN JUDEA	AR		72655

Date Processed:	4/1/2014
Field ID:	HC 33
Acres	5
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	38504
Sample Number:	2045464

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	52	104	Above Optimum
K	165	330	Optimum
Ca	1766	3532	--
Mg	88	176	--
SO4-S	14	28	--
Zn	3.6	7.2	--
Fe	115	230	--
Mn	156	312	--
Cu	1.1	2.2	--
B	0.3	0.6	--
NO3-N	12	24	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	6.0	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	14	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silty Clay Loam - Clay Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
74.1	65.2	5.4	3.1	0.4

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Pasture (207)	---------- lb/acre ----------						
Crop 1	Warm-Season Grasses (MNT) (207)	60	0	0	0	0	0	0
Crop 2	Winter Annuals (EST/MNT) (210)	90	0	0	0	0	0	0
Crop 3								

4. Crop 1 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.

5. Crop 2 Notes:

Apply the recommended P and K fertilizer rates and one-third of the total N rate immediately before or after stand is successfully established. Apply the remaining N(60 lb N/Acre/application) during mid February. For higher production, apply an additional 50 lb N/Acre in mid March.

6. Crop 3 Notes:

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JASON HENSON		Client ID:	8706881318
HC 72 BOX 10			
MTN JUDEA	AR		72655

Date Processed:	4/1/2014
Field ID:	RC 34
Acres	10
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	38506
Sample Number:	2045466

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	56	112	Above Optimum
K	134	268	Optimum
Ca	638	1276	--
Mg	93	186	--
SO4-S	13	26	--
Zn	2.8	5.6	--
Fe	108	216	--
Mn	195	390	--
Cu	1.1	2.2	--
B	0.5	1.0	--
NO3-N	18	36	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.9	---
Soil EC (1:2 soil-water)		umhos/cm
Soil ECEC	7	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
59.3	43.3	10.5	4.7	0.9

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4S	Zn	B	Lime
Last Crop	Pasture (207)	---------- lb/acre ----------						
Crop 1	Warm-Season Grasses (MNT) (207)	60	0	0	0	0	0	0
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	0	200	0	0	0	0
Crop 3	Winter Annuals (EST/MNT) (210)	90	0	0	0	0	0	0

4. Crop 1 Notes:

Apply the recommended rates of N, P, and K, in spring when night temperatures are > 60 degrees F for 1 week. For higher production, topdress an additional 60 lb N/Acre after every 4 to 6 weeks of grazing. For fall grazing apply 50 lb N/Acre in early August. Do not apply N after September 1.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

Apply the recommended P and K fertilizer rates and one-third of the total N rate immediately before or after stand is successfully established. Apply the remaining N(60 lb N/Acre/application) during mid February. For higher production, apply an additional 50 lb N/Acre in mid March.

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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655
Date Processed:	12/4/2015
Field ID:	CH 35
Acres:	26
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154664
Sample Number:	3466550

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	40	80	Optimum
K	92	184	Medium
Ca	681	1362	--
Mg	89	178	--
SO4-S	19	38	--
Zn	2.6	5.2	--
Fe	111	222	--
Mn	506	1012	--
Cu	0.7	1.4	--
B	0.2	0.4	--
NO3-N	36	72	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.6	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	8.43	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Silt Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
52.55	40.39	8.80	2.80	0.57

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	40	180	0	0	0	4000
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	45	250	0	0	0	4000
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	30	60	0	0	0	4000

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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JASON HENSON	Client ID: 8706881318
HC 72 BOX 10	
MT JUDEA	AR 72655
Date Processed:	12/4/2015
Field ID:	CH 36
Acres:	12
Lime Applied in the last 4 years:	No
Leveled in past 4 years:	No
Irrigation:	Unknown
County:	Pope
Lab Number:	154665
Sample Number:	3466551

1. Nutrient Availability Index

Nutrient	Concentration		Soil Test Level (Mehlich 3)
	ppm	lb/acre	
P	20	40	Low
K	183	366	Above Optimum
Ca	427	854	--
Mg	77	154	--
SO4-S	16	32	--
Zn	1.2	2.4	--
Fe	105	210	--
Mn	420	840	--
Cu	0.3	0.6	--
B	0.1	0.2	--
NO3-N	41	82	--

2. Soil Properties

Property	Value	Units
Soil pH (1:2 soil-water)	5.4	--
Soil EC (1:2 soil-water)		umhos/cm
Soil Estimated CEC	7.78	cmolc/kg
Organic Matter (Loss on Ignition)		%
Estimated Soil Texture	Sandy Loam	

Estimated Base Saturation (%)				
Total	Ca	Mg	K	Na
42.13	27.46	8.25	6.03	0.39

3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

Crop		N	P2O5	K2O	SO4-S	Zn	B	Lime
Last Crop	Pasture (212)	---------- lb/acre ----------						
Crop 1	Mixed Cool and Warm Season Grasses 4 ton (144)	160	100	0	0	0	0	4000
Crop 2	Hay - Warm-Season Grasses (MNT) - 6 ton/acre (134)	300	110	0	0	0	0	4000
Crop 3	Mixed Cool and Warm-Season Grasses for Pasture (212)	60	80	0	0	0	0	4000

4. Crop 1 Notes:

To favor cool-season grasses, apply fertilizer in split applications in late winter and after spring hay harvest. To favor warm-season grasses, do not apply N until May 1. Split apply the recommended fertilizer rates after each subsequent hay harvest.

5. Crop 2 Notes:

For optimum fertilizer efficiency, divide the recommended N, P, and K rates by the estimated number of harvests/year. Make the first fertilizer application in spring when night temperatures are > 60 degrees F for one week. Make subsequent applications following each harvest. Do not apply N after Sept. 1.

6. Crop 3 Notes:

To favor cool-season grasses, apply N in late winter. To favor warm-season grasses, do not apply N until May 1. For higher production, topdress 50 lb N/Acre after every 4-6 weeks of grazing or as needed.

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1366 W. Altheimer Dr., Fayetteville, AR 72704
(479)575-3908 agrilab@uark.edu
University of Arkansas, Dept. of Crops, Soils, and Environmental Science
LIQUID MANURE FOR FERTILIZER ANALYSIS (report for AGRI-429)

Name:	KARL VanDEVENDER / ANDREW SHARPLE	***Received in lab:***	***4/17/2015***
Address:		***Mailed:***	***4/24/2015***
City:		State,Zip:	AR
County:		Phone #:	
E-Mail:	kvan@uaex.edu, sharpley@uark.edu	Check #:	Big Creek Research Project

Lab. No.	M50518	M50519				
Sample I.D.	C&HP1P	C&HP2P				
Animal type	swine	swine				
age / lbs	no info	no info				
Bedding type	none	none				
Manure type	pond liquid	pond liquid				
Sample date	4/16/2015	4/16/2015				
Age of manure	no info	no info				
pH	7.6	8.0				
EC(µmhos/cm)	13580	8710				
% Solids	3.37	2.42				
		-mg/l on as-is basis-				
Total N	2410	1820				
Total P	253	417				
Total K	1358	1044				
Total Ca	102	378				
NH4-N	1291	636				
Water Extractable P	169	89				
		-lbs/1000 gal on as-is basis-				
Total N	20.1	15.2				
TOTAL P AS "P2O5"	4.8	7.9				
TOTAL K AS "K20"	13.6	10.4				
Total Ca	0.9	3.1				
NH4-N	10.8	5.3				
Water Extractable P	1.4	0.7				

*lbs/1000gal P2O5 = mg/l Total P on "as-is" basis multiplied by 2.29*0.00833
*lbs/1000gal K2O = mg/l Total K on "as-is" basis multiplied by 1.2*0.00833
*Water Extractable P: **1:100 solids to H2O ratio**, I hr shake, centrifuged, filtered, acidified, analysis by ICP

Section 5

Nutrient Management

Determining Acceptable Manure Application Rates
Example Phosphorous Index Calculations

Methodology for Determining Acceptable Manure Application Rates

Determination of acceptable manure application rates will be done using the Arkansas Phosphorous Index. This index classifies evaluated potential field phosphorous runoff risk as Low, Medium, High, or Very High. Only conditions and management decisions that result in risk values in the Low or Medium ranges will allow for manure applications. The most variable inputs to the evaluation process are: manure application rate; manure total and soluble phosphorous concentrations; application timing; application method; soil test phosphorous concentrations and land use. Section 5 of this plan shows an example of typical initial conditions for each field of this operation. As these conditions change, the phosphorous runoff risk should be re-evaluated as necessary to insure manure applications are made only when the associated risk is in the Low or Medium range. As a result, inputs such as application rates will vary over time, however the phosphorous runoff risk will remain in the low to medium range. In addition, no manure application should be made that exceeds nitrogen recommendations. As demonstrated by the example calculations, this farm has sufficient land to manage pond volume levels.

Interpreting P Index Values with the ARNMP Phosphorous Index:

Range Class	Interpretation
Low (<33)	Low potential for P movement from site. Apply nutrients based on crop needs, normally nitrogen. However, if P is applied above crop needs, P build up will take place over time.
Medium (33 to 66)	Medium potential for P movement from site. Evaluate the index and determine any areas that could cause long-term concerns. Consider adding conservation practices or reduced P application to maintain the risk at 66 or less. Apply nutrients based on crop needs, normally nitrogen. If P is applied above crop requirements, soil P levels will accumulate over time.
High (67 to 100)	High potential for P movement from site. Evaluate the index and determine elevation cause. Add appropriate conservation practices and/or reduce soluble P application. The immediate planning target is a PI value of 66 or less. If this cannot be achieved with realistic conservation practices and/or reduced P rates in the short term, then a progressive plan needs to be developed with a long term goal of a PI less than 66. Apply nutrients to meet crop phosphorus needs according to NRCS Nutrient Management Standard (590).
Very High (>100)	Very high potential for P movement from site. Add conservation practices to decrease this value below 100 in the short term and develop a progressive conservation plan that would reduce the PI to a lower risk category, with a long term goal of a PI of less than 66.

Arkansas Nutrient Managemnt Planner with 2009 PI (Beta draft ver 09162015)

Planner:	Monica Hancock
Plan Description:	C & H Hog Farms, Inc

Date:	1/14/2016

Beta Test Version for Use by Select Planners working with Author. This worksheet is intended to assist in the writing of Nutrient Management Plans for the application of manure to pasture and hay land. To do this, the worksheet estimates the litter production for the farm, estimates the P Index risk value for the defined conditions of each field, assists with the allocation of nutrients to the various receiving fields, and estimates the amount of litter available for off farm use. This worksheet is the result of an effort to develop a reliable training/planning tool faithful to the 2009 Arkansas P Index developed by a multi-agency effort. However, no guarantees are made, and any observed problems or suggestions for improvement should be directed to Karl VanDevender at kvan@uaex.edu.

Nutrient Source and Description Information

Manure Source	Source Type	Amount Available		N Concentration		P2O5 Concentration		K2O Concentration		Water Extractable P		Alum
Pond 1 M50518	Liquid Manure	2,624	1000 gal	20.1	lb/1000 gal	4.8	lb/1000 gal	13.6	lb/1000 gal	1.4	lb/1000 gal	No
Pond 2 M50519	Liquid Manure	2,624	1000 gal	15.2	lb/1000 gal	7.9	lb/1000 gal	10.4	lb/1000 gal	0.7	lb/1000 gal	No

Nutrient Loss and Mineralization Factors

Manure Source	N		P2O5		K2O	
	Storage Losses (%)	Appl. Losses (%)	Storage Losses (%)	Appl. Losses (%)	Storage Losses (%)	Appl. Losses (%)
Pond 1 M50518		25%				
Pond 2 M50519		25%				
0						
0						
0						

2,624 is the 365 day amount available and was calculated from the engineering section.

Estimated Plant Available Nutrients

Manure Source	N			P2O5			K2O			Water Extractable P		
	Concentration		Total (lb)	Concentration		Total (lb)	Concentration		Total (lb)	Concentration		Total (lb)
Pond 1 M50518	15.08	lb/1000 gal	39,557	4.80	lb/1000 gal	12,595	13.60	lb/1000 gal	35,686	1.40	lb/1000 gal	3673.6
Pond 2 M50519	11.40	lb/1000 gal	29,914	7.90	lb/1000 gal	20,730	10.40	lb/1000 gal	27,290	0.70	lb/1000 gal	1836.8
0												
0												
0												
			69,470			33,325			62,976			5,510

Arkansas Nutrient Managemnt Planner with 2009 PI (Beta draft ver 02252106)

Planner:	Monica Hancock
Plan Description:	C & H Hog Farms, Inc

Beta Test Version for Use by Select Planners working with Author. This worksheet is intended to assist in the writing of Nutrient Management Plans for the application of manure to pasture and hay land. To do this, the worksheet estimates the litter production for the farm, estimates the P Index risk value for the defined conditions of each field, assists with the allocation of nutrients to the various receiving fields, and estimates the amount of litter available for off farm use. This

Fields Shown	Total Annual Summary				- - - General Field Information - - -- - - General Field Information - - -- - - General Field Information - - -- - - General Field Information - - -- - - General Field Information - - -- - - General Field Information - - -- - - General Field																			
											Slope Gradient (%)				Slope Length (ft)				Flooding Frequency				
50	PI	Nutrient Balance (+/-)			County	Field Area (ac)	Buffer Length (ft)	Buffer Width (ft)	Appl Area (ac)	Soil Map Unit	Min	Max	Rep	Used	Min	Max	Rep	Used	**D**ata **B**ase **D**efault	Used	Predominate Vegetation	Percent Ground Cover	Conservation Support Practices (P)
Field	Value	N	P2O5	K2O																				
Field 1	20	-5	+79	+141	Newton	8.40			8.40	42	3	8	5	5	15	75	45	45	None	None	Grass	95-100	None
Field 2	22	-5	+79	+141	Newton	6.00			6.00	43	8	20	14	14	15	30	20	20	None	None	Grass	95-100	None
Field 3	57	-3	+152	-30	Newton	13.20			13.20	48	0	3	2	2	15	75	45	45	Occasional	Occasional	Grass	95-100	None
Field 4	20	-5	+79	+141	Newton	7.20			7.20	43	8	20	14	14	15	30	20	20	None	None	Grass	95-100	None
Field 5	54	-3	+152	+20	Newton	9.70			9.70	48	0	3	2	2	15	75	45	45	Occasional	Occasional	Grass	95-100	None
Field 6	21	-5	+79	+141	Newton	5.60			5.60	42	3	8	5	5	15	75	45	45	None	None	Grass	95-100	None
Field 6A	21	-5	+79	+141	Newton	7.90			7.90	42	3	8	5	5	15	75	45	45	None	None	Grass	95-100	None
Field 7	57	-3	+152	-30	Newton	62.50			62.50	48	0	3	2	2	15	75	45	45	Occasional	Occasional	Grass	95-100	None
Field 7A	50	-3	+107	-80	Newton	28.30			28.30	48	0	3	2	2	15	75	45	45	Occasional	Occasional	Grass	95-100	None
Field 8	29	-3	+152	+20	Newton	7.20			7.20	51	2	5	2.5	2.5	15	75	45	45	None	None	Grass	95-100	None
Field 8A	55	-3	+152	-30	Newton	1.40			1.40	50	0	3	2	2	15	75	45	45	Occasional	Occasional	Grass	95-100	None
Field 9	56	-3	+152	-30	Newton	25.20			25.20	50	0	3	2	2	15	75	45	45	Occasional	Occasional	Grass	95-100	None
Field 9A	54	-3	+152	+20	Newton	10.30			10.30	50	0	3	2	2	15	75	45	45	Occasional	Occasional	Grass	95-100	None
Field 10	29	-3	+152	+20	Newton	14.10			14.10	51	2	5	2.5	2.5	15	75	45	45	None	None	Grass	95-100	None
Field 10A	59	-3	+152	+20	Newton	16.40			16.40	50	0	3	2	2	15	75	45	45	Occasional	Occasional	Grass	95-100	None
Field 11	18	-5	+79	+101	Newton	14.20			14.20	43	8	20	14	14	15	30	20	20	None	None	Grass	95-100	None
Field12	57	-3	+152	+20	Newton	11.40			11.40	50	0	3	2	2	15	75	45	45	Occasional	Occasional	Grass	95-100	None
Field13	32	-3	+152	+270	Newton	11.60			11.60	43	8	20	14	14	15	30	20	20	None	None	Grass	95-100	None
Field 13A	31	-3	+152	+270	Newton	30.70			30.70	43	8	20	14	14	15	30	20	20	None	None	Grass	95-100	None
Field 13B	30	-3	+152	+270	Newton	8.60			8.60	43	8	20	14	14	15	30	20	20	None	None	Grass	95-100	None
Field 14	31	-3	+152	+70	Newton	8.10			8.10	43	8	20	14	14	15	30	20	20	None	None	Grass	95-100	None
Field 15	31	-3	+152	+70	Newton	22.50			22.50	43	8	20	14	14	15	30	20	20	None	None	Grass	95-100	None
Field 15A	35	-5	-1	+81	Newton	10.40			10.40	2	8	20	14	14	15	30	20	20	None	None	Grass	95-100	None
Field 15B	31	-3	+152	+270	Newton	15.00			15.00	43	8	20	14	14	15	30	20	20	None	None	Grass	95-100	None
Field 16	54	-3	+152	+270	Newton	15.20			15.20	50	0	3	2	2	15	75	45	45	Occasional	Occasional	Grass	95-100	None
Field 17	32	-3	+152	+20	Newton	31.90			31.90	1	3	8	5	5	15	75	45	45	None	None	Grass	95-100	None
Field 18	26	-3	+107	-80	Newton	22.60			22.60	42	3	8	5	5	15	75	45	45	None	None	Grass	95-100	None
Field 19	28	-3	+152	+270	Newton	10.30			10.30	42	3	8	5	5	15	75	45	45	None	None	Grass	95-100	None
Field 20	30	-3	+152	+70	Newton	21.60			21.60	43	8	20	14	14	15	30	20	20	None	None	Grass	95-100	None
Field 21	21	-5	-41	+101	Newton	20.30			20.30	13	3	20	12	12	15	30	20	20	None	None	Grass	95-100	None
Field 21A	22	-5	-1	+141	Newton	15.60			15.60	13	3	20	12	12	15	30	20	20	None	None	Grass	95-100	None
Field 21B	28	-3	+107	+70	Newton	6.00			6.00	11	3	8	5	5	15	75	45	45	None	None	Grass	95-100	None
Field 22	25	-5	+49	+81	Newton	35.20			35.20	13	3	20	12	12	15	30	20	20	None	None	Grass	95-100	None
Field 23	53	-3	+152	-80	Newton	28.10			28.10	48	0	3	2	2	15	75	45	45	Occasional	Occasional	Grass	95-100	None
Field 24	51	-3	+107	-30	Newton	8.00			8.00	48	0	3	2	2	15	75	45	45	Occasional	Occasional	Grass	95-100	None
Field 32	53	-3	+152	+20	Newton	10.00			10.00	48	0	3	2	2	15	75	45	45	Occasional	Occasional	Grass	95-100	None
Field 33	31	-5	+79	+141	Newton	4.00			4.00	48	0	3	2	2	15	75	45	45	Occasional	Occasional	Grass	95-100	None
Field 34	30	-3	+152	+70	Newton	13.50			13.50	43	8	20	14	14	15	30	20	20	None	None	Grass	95-100	None
Field 35	26	-3	+107	+20	Newton	18.40			18.40	42	3	8	5	5	15	75	45	45	None	None	Grass	95-100	None
Field 36	63	-3	+42	+270	Newton	9.30			9.30	15	8	20	14	14	15	30	20	20	None	None	Grass	95-100	None
Farm Totals						625.90			625.90														
Available																							
Surpluses/Deficits (+/-)																							

Arkansas Nutrient Managemnt Plann

Planner:	Monica Hancock
Plan Description:	C & H Hog Farms, Inc

Beta Test Version for Use by Select Planners working wit

Nutrient Management Plans for the application of manure to
litter production for the farm, estimates the P Index risk value
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Fields Shown	Total Annual Summary				Information - - -- - - General Field Information - - -			- - - Nutrient Application Information - - -- - - Nutrient Application Information - - -- - - Nutrient Application Information - - -- - - Nutrient Application Information - - -- - -													
								- - - Application Group 1 - - -	- - - Application Group 1 - - -	- - - Application Group 1 - - -								- - - Application Group 2 - - -	- - - Application Grou		
50	PI	Nutrient Balance (+/-)			Pasture Use	RUSLE 1 (ton/ac)	RUSLE 2 (ton/ac)	Timing	Appl Method	Nutrient Source	Bulk Rate	Units	N	P2O5	K2O	Group Sub PI	Group Sub PI Range	Timing	Appl Method	Nutrient Source	Bulk Rate
Field	Value	N	P2O5	K2O									(lb/ac)	(lb/ac)	(lb/ac)						
Field 1	20	-5	+79	+141	Rotational Grazing	0.12	0.12	March-June	Surface	Pond 1 M50518	5.00	1000 gal/ac	75	24	68	7	Low	July-Oct	Surface	Pond 2 M50519	7.00
Field 2	22	-5	+79	+141	Rotational Grazing	0.28	0.28	March-June	Surface	Pond 1 M50518	5.00	1000 gal/ac	75	24	68	8	Low	July-Oct	Surface	Pond 2 M50519	7.00
Field 3	57	-3	+152	-30	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	26	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 4	20	-5	+79	+141	Rotational Grazing	0.28	0.28	March-June	Surface	Pond 1 M50518	5.00	1000 gal/ac	75	24	68	8	Low	July-Oct	Surface	Pond 2 M50519	7.00
Field 5	54	-3	+152	+20	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	26	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 6	21	-5	+79	+141	Rotational Grazing	0.12	0.12	March-June	Surface	Pond 1 M50518	5.00	1000 gal/ac	75	24	68	7	Low	July-Oct	Surface	Pond 2 M50519	7.00
Field 6A	21	-5	+79	+141	Rotational Grazing	0.12	0.12	March-June	Surface	Pond 1 M50518	5.00	1000 gal/ac	75	24	68	7	Low	July-Oct	Surface	Pond 2 M50519	7.00
Field 7	57	-3	+152	-30	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	26	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 7A	50	-3	+107	-80	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	26	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 8	29	-3	+152	+20	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	14	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 8A	55	-3	+152	-30	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	26	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 9	56	-3	+152	-30	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	26	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 9A	54	-3	+152	+20	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	26	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 10	29	-3	+152	+20	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	14	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 10A	59	-3	+152	+20	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	26	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 11	18	-5	+79	+101	Rotational Grazing	0.28	0.28	March-June	Surface	Pond 1 M50518	5.00	1000 gal/ac	75	24	68	8	Low	July-Oct	Surface	Pond 2 M50519	7.00
Field12	57	-3	+152	+20	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	26	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field13	32	-3	+152	+270	Rotational Grazing	0.28	0.28	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	15	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 13A	31	-3	+152	+270	Rotational Grazing	0.28	0.28	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	15	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 13B	30	-3	+152	+270	Rotational Grazing	0.28	0.28	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	15	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 14	31	-3	+152	+70	Rotational Grazing	0.28	0.28	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	15	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 15	31	-3	+152	+70	Rotational Grazing	0.28	0.28	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	15	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 15A	35	-5	-1	+81	Rotational Grazing	0.28	0.28	March-June	Surface	Pond 1 M50518	5.00	1000 gal/ac	75	24	68	18	Low	July-Oct	Surface	Pond 2 M50519	7.00
Field 15B	31	-3	+152	+270	Rotational Grazing	0.28	0.28	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	15	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 16	54	-3	+152	+270	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	26	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 17	32	-3	+152	+20	Rotational Grazing	0.12	0.12	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	15	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 18	26	-3	+107	-80	Rotational Grazing	0.12	0.12	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	14	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 19	28	-3	+152	+270	Rotational Grazing	0.12	0.12	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	14	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 20	30	-3	+152	+70	Rotational Grazing	0.28	0.28	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	15	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 21	21	-5	-41	+101	Rotational Grazing	0.17	0.17	March-June	Surface	Pond 1 M50518	5.00	1000 gal/ac	75	24	68	12	Low	July-Oct	Surface	Pond 2 M50519	7.00
Field 21A	22	-5	-1	+141	Rotational Grazing	0.17	0.17	March-June	Surface	Pond 1 M50518	5.00	1000 gal/ac	75	24	68	12	Low	July-Oct	Surface	Pond 2 M50519	7.00
Field 21B	28	-3	+107	+70	Rotational Grazing	0.09	0.09	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	15	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 22	25	-5	+49	+81	Rotational Grazing	0.17	0.17	March-June	Surface	Pond 1 M50518	5.00	1000 gal/ac	75	24	68	12	Low	July-Oct	Surface	Pond 2 M50519	7.00
Field 23	53	-3	+152	-80	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	26	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 24	51	-3	+107	-30	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	26	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 32	53	-3	+152	+20	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	26	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 33	31	-5	+79	+141	Rotational Grazing	0.05	0.05	March-June	Surface	Pond 1 M50518	5.00	1000 gal/ac	75	24	68	14	Low	July-Oct	Surface	Pond 2 M50519	7.00
Field 34	30	-3	+152	+70	Rotational Grazing	0.28	0.28	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	15	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 35	26	-3	+107	+20	Rotational Grazing	0.12	0.12	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	14	Low	July-Oct	Surface	Pond 2 M50519	13.50
Field 36	63	-3	+42	+270	Rotational Grazing	0.21	0.21	March-June	Surface	Pond 1 M50518	9.50	1000 gal/ac	143	46	129	34	Medium	July-Oct	Surface	Pond 2 M50519	13.50

Farm Totals

Available

Surpluses/Deficits (+/-)

Arkansas Nutrient Managemnt Plann

Planner:	Monica Hancock
Plan Description:	C & H Hog Farms, Inc

Beta Test Version for Use by Select Planners working wit

Nutrient Management Plans for the application of manure to
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Fields Shown	Total Annual Summary				Nutrient Application Information - - -- - - Nutrient Application Information - - -- - - Nutrient Application Information - - -- - - Nutrient Application Information - - -																Soil Test P and Soil Sub PI				
					2 - - - - - - Application Group 2 - - -						- - - Application Group 3 - - - - - - Application Group 3 - - - - - - Application Group 3 - - -														
50	PI	Nutrient Balance (+/-)			Units	N	P2O5	K2O	Group Sub PI	Group Sub PI Range	Timing	Appl Method	Nutrient Source	Bulk Rate	Units	N	P2O5	K2O	Group Sub PI	Group Sub PI Range	Highest Risk Timing	ppm	lb/ac	Soil Sub PI	Soil Sub Range
Field	Value	N	P2O5	K2O		(lb/ac)	(lb/ac)	(lb/ac)								(lb/ac)	(lb/ac)	(lb/ac)							
Field 1	20	-5	+79	+141	1000 gal/ac	80	55	73	5	Low											March-June	95	126	8	Low
Field 2	22	-5	+79	+141	1000 gal/ac	80	55	73	5	Low											March-June	108	144	9	Low
Field 3	57	-3	+152	-30	1000 gal/ac	154	107	140	18	Low											March-June	89	118	13	Low
Field 4	20	-5	+79	+141	1000 gal/ac	80	55	73	5	Low											March-June	75	100	6	Low
Field 5	54	-3	+152	+20	1000 gal/ac	154	107	140	18	Low											March-June	63	84	9	Low
Field 6	21	-5	+79	+141	1000 gal/ac	80	55	73	5	Low											March-June	116	154	9	Low
Field 6A	21	-5	+79	+141	1000 gal/ac	80	55	73	5	Low											March-June	111	148	9	Low
Field 7	57	-3	+152	-30	1000 gal/ac	154	107	140	18	Low											March-June	89	118	13	Low
Field 7A	50	-3	+107	-80	1000 gal/ac	154	107	140	18	Low											March-June	38	51	6	Low
Field 8	29	-3	+152	+20	1000 gal/ac	154	107	140	9	Low											March-June	82	109	7	Low
Field 8A	55	-3	+152	-30	1000 gal/ac	154	107	140	18	Low											March-June	72	96	11	Low
Field 9	56	-3	+152	-30	1000 gal/ac	154	107	140	18	Low											March-June	82	109	12	Low
Field 9A	54	-3	+152	+20	1000 gal/ac	154	107	140	18	Low											March-June	67	89	10	Low
Field 10	29	-3	+152	+20	1000 gal/ac	154	107	140	9	Low											March-June	72	96	6	Low
Field 10A	59	-3	+152	+20	1000 gal/ac	154	107	140	18	Low											March-June	100	133	15	Low
Field 11	18	-5	+79	+101	1000 gal/ac	80	55	73	5	Low											March-June	62	82	5	Low
Field12	57	-3	+152	+20	1000 gal/ac	154	107	140	18	Low											March-June	88	117	13	Low
Field13	32	-3	+152	+270	1000 gal/ac	154	107	140	10	Low											March-June	86	114	7	Low
Field 13A	31	-3	+152	+270	1000 gal/ac	154	107	140	10	Low											March-June	75	100	6	Low
Field 13B	30	-3	+152	+270	1000 gal/ac	154	107	140	10	Low											March-June	61	81	5	Low
Field 14	31	-3	+152	+70	1000 gal/ac	154	107	140	10	Low											March-June	75	100	6	Low
Field 15	31	-3	+152	+70	1000 gal/ac	154	107	140	10	Low											March-June	72	96	6	Low
Field 15A	35	-5	-1	+81	1000 gal/ac	80	55	73	13	Low											March-June	18	24	3	Low
Field 15B	31	-3	+152	+270	1000 gal/ac	154	107	140	10	Low											March-June	66	88	6	Low
Field 16	54	-3	+152	+270	1000 gal/ac	154	107	140	18	Low											March-June	68	90	10	Low
Field 17	32	-3	+152	+20	1000 gal/ac	154	107	140	10	Low											March-June	86	114	7	Low
Field 18	26	-3	+107	-80	1000 gal/ac	154	107	140	9	Low											March-June	42	56	3	Low
Field 19	28	-3	+152	+270	1000 gal/ac	154	107	140	9	Low											March-June	66	88	5	Low
Field 20	30	-3	+152	+70	1000 gal/ac	154	107	140	10	Low											March-June	63	84	5	Low
Field 21	21	-5	-41	+101	1000 gal/ac	80	55	73	8	Low											March-June	12	16	2	Low
Field 21A	22	-5	-1	+141	1000 gal/ac	80	55	73	8	Low											March-June	21	28	3	Low
Field 21B	28	-3	+107	+70	1000 gal/ac	154	107	140	10	Low											March-June	38	51	3	Low
Field 22	25	-5	+49	+81	1000 gal/ac	80	55	73	8	Low											March-June	38	51	5	Low
Field 23	53	-3	+152	-80	1000 gal/ac	154	107	140	18	Low											March-June	56	74	8	Low
Field 24	51	-3	+107	-30	1000 gal/ac	154	107	140	18	Low											March-June	45	60	7	Low
Field 32	53	-3	+152	+20	1000 gal/ac	154	107	140	18	Low											March-June	57	76	8	Low
Field 33	31	-5	+79	+141	1000 gal/ac	80	55	73	10	Low											March-June	52	69	8	Low
Field 34	30	-3	+152	+70	1000 gal/ac	154	107	140	10	Low											March-June	56	74	5	Low
Field 35	26	-3	+107	+20	1000 gal/ac	154	107	140	9	Low											March-June	40	53	3	Low
Field 36	63	-3	+42	+270	1000 gal/ac	154	107	140	25	Low											March-June	20	27	4	Low

Farm Totals
Available
Surpluses/Deficits (+/-)

Arkansas Nutrient Managemnt Plann

Planner:	Monica Hancock
Plan Description:	C & H Hog Farms, Inc

Beta Test Version for Use by Select Planners working wit

Nutrient Management Plans for the application of manure to
litter production for the farm, estimates the P Index risk value
allocation of nutrients to the various receiving fields, and esti

Fields Shown	Total Annual Summary				Application Totals				Total = Soil + Applications		Per Acre Nutrient Budget Application Rate Totals			Per Acre Nutrient Budget Nutrient Recommendation			Per Acre Nutrient Budget Surpluses / Deficits (+/-)			- - - Per Field N Appl
50	PI	Nutrient Balance (+/-)			WEP rate (lb/ac)	TP rate (lb/ac)	App Sub PIs Sum	App Sub PIs Range	Total PI Value	PI Range	N (lb/ac)	P2O5 (lb/ac)	K2O (lb/ac)	N (lb/ac)	P2O5 (lb/ac)	K2O (lb/ac)	N (lb/ac)	P2O5 (lb/ac)	K2O (lb/ac)	N (lb/field)
Field	Value	N	P2O5	K2O																
Field 1	20	-5	+79	+141	12	35	12	Low	20	Low	155	79	141	160	0	0	-5	79	141	1,303
Field 2	22	-5	+79	+141	12	35	13	Low	22	Low	155	79	141	160	0	0	-5	79	141	931
Field 3	57	-3	+152	-30	23	66	44	Medium	57	Medium	297	152	270	300	0	300	-3	152	-30	3,922
Field 4	20	-5	+79	+141	12	35	13	Low	20	Low	155	79	141	160	0	0	-5	79	141	1,117
Field 5	54	-3	+152	+20	23	66	44	Medium	54	Medium	297	152	270	300	0	250	-3	152	20	2,882
Field 6	21	-5	+79	+141	12	35	12	Low	21	Low	155	79	141	160	0	0	-5	79	141	869
Field 6A	21	-5	+79	+141	12	35	12	Low	21	Low	155	79	141	160	0	0	-5	79	141	1,226
Field 7	57	-3	+152	-30	23	66	44	Medium	57	Medium	297	152	270	300	0	300	-3	152	-30	18,570
Field 7A	50	-3	+107	-80	23	66	44	Medium	50	Medium	297	152	270	300	45	350	-3	107	-80	8,408
Field 8	29	-3	+152	+20	23	66	23	Low	29	Low	297	152	270	300	0	250	-3	152	20	2,139
Field 8A	55	-3	+152	-30	23	66	44	Medium	55	Medium	297	152	270	300	0	300	-3	152	-30	416
Field 9	56	-3	+152	-30	23	66	44	Medium	56	Medium	297	152	270	300	0	300	-3	152	-30	7,487
Field 9A	54	-3	+152	+20	23	66	44	Medium	54	Medium	297	152	270	300	0	250	-3	152	20	3,060
Field 10	29	-3	+152	+20	23	66	23	Low	29	Low	297	152	270	300	0	250	-3	152	20	4,189
Field 10A	59	-3	+152	+20	23	66	44	Medium	59	Medium	297	152	270	300	0	250	-3	152	20	4,873
Field 11	18	-5	+79	+101	12	35	13	Low	18	Low	155	79	141	160	0	40	-5	79	101	2,203
Field12	57	-3	+152	+20	23	66	44	Medium	57	Medium	297	152	270	300	0	250	-3	152	20	3,387
Field13	32	-3	+152	+270	23	66	25	Low	32	Low	297	152	270	300	0	0	-3	152	270	3,447
Field 13A	31	-3	+152	+270	23	66	25	Low	31	Low	297	152	270	300	0	0	-3	152	270	9,121
Field 13B	30	-3	+152	+270	23	66	25	Low	30	Low	297	152	270	300	0	0	-3	152	270	2,555
Field 14	31	-3	+152	+70	23	66	25	Low	31	Low	297	152	270	300	0	200	-3	152	70	2,407
Field 15	31	-3	+152	+70	23	66	25	Low	31	Low	297	152	270	300	0	200	-3	152	70	6,685
Field 15A	35	-5	-1	+81	12	35	31	Low	35	Medium	155	79	141	160	80	60	-5	-1	81	1,614
Field 15B	31	-3	+152	+270	23	66	25	Low	31	Low	297	152	270	300	0	0	-3	152	270	4,457
Field 16	54	-3	+152	+270	23	66	44	Medium	54	Medium	297	152	270	300	0	0	-3	152	270	4,516
Field 17	32	-3	+152	+20	23	66	25	Low	32	Low	297	152	270	300	0	250	-3	152	20	9,478
Field 18	26	-3	+107	-80	23	66	23	Low	26	Low	297	152	270	300	45	350	-3	107	-80	6,715
Field 19	28	-3	+152	+270	23	66	23	Low	28	Low	297	152	270	300	0	0	-3	152	270	3,060
Field 20	30	-3	+152	+70	23	66	25	Low	30	Low	297	152	270	300	0	200	-3	152	70	6,418
Field 21	21	-5	-41	+101	12	35	20	Low	21	Low	155	79	141	160	120	40	-5	-41	101	3,150
Field 21A	22	-5	-1	+141	12	35	20	Low	22	Low	155	79	141	160	80	0	-5	-1	141	2,421
Field 21B	28	-3	+107	+70	23	66	25	Low	28	Low	297	152	270	300	45	200	-3	107	70	1,783
Field 22	25	-5	+49	+81	12	35	20	Low	25	Low	155	79	141	160	30	60	-5	49	81	5,462
Field 23	53	-3	+152	-80	23	66	44	Medium	53	Medium	297	152	270	300	0	350	-3	152	-80	8,349
Field 24	51	-3	+107	-30	23	66	44	Medium	51	Medium	297	152	270	300	45	300	-3	107	-30	2,377
Field 32	53	-3	+152	+20	23	66	44	Medium	53	Medium	297	152	270	300	0	250	-3	152	20	2,971
Field 33	31	-5	+79	+141	12	35	23	Low	31	Low	155	79	141	160	0	0	-5	79	141	621
Field 34	30	-3	+152	+70	23	66	25	Low	30	Low	297	152	270	300	0	200	-3	152	70	4,011
Field 35	26	-3	+107	+20	23	66	23	Low	26	Low	297	152	270	300	45	250	-3	107	20	5,467
Field 36	63	-3	+42	+270	23	66	59	Medium	63	Medium	297	152	270	300	110	0	-3	42	270	2,763
Farm Totals																				166,830
Available																				69,470
Surpluses/Deficits (+/-)																				-97,359

Arkansas Nutrient Managemnt Plann

Planner:	Monica Hancock
Plan Description:	C & H Hog Farms, Inc

Beta Test Version for Use by Select Planners working wit

Nutrient Management Plans for the application of manure to
litter production for the farm, estimates the P Index risk value
allocation of nutrients to the various receiving fields, and esti

Fields Shown	Total Annual Summary				utrient Budget - - - - - - Per Field Nutrient Budget - - - - - - Per Field Nutrient Budget - - - - - - Per Field Nutrient Budget - - -								- - - Manure Distribution Summary, Units Applied by Field and Source - - - - - - Manure Distribut					
													SourcesSourcesSourcesSourcesSourcesSourcesSourcesSourcesSourcesSourcesSou					
													Pond 1 M50518					
					lication Rate Totals		Nutrient Recommendation (lb/field)			Surpluses / Deficits (+/-)			1000 gal					
50	PI	Nutrient Balance (+/-)											Nov-Feb		March-June		July-Oct	
					P2O5 (lb/field)	K2O (lb/field)	N (lb/field)	P2O5 (lb/field)	K2O (lb/field)	N (lb/field)	P2O5 (lb/field)	K2O (lb/field)	Per Acre	Per Field	Per Acre	Per Field	Per Acre	Per Field
Field	Value	N	P2O5	K2O														
Field 1	20	-5	+79	+141	666	1,183	1,344	0	0	-41	666	1,183	0.0	0.0	5.0	42.0	0.0	0.0
Field 2	22	-5	+79	+141	476	845	960	0	0	-29	476	845	0.0	0.0	5.0	30.0	0.0	0.0
Field 3	57	-3	+152	-30	2,010	3,559	3,960	0	3,960	-38	2,010	-401	0.0	0.0	9.5	125.4	0.0	0.0
Field 4	20	-5	+79	+141	571	1,014	1,152	0	0	-35	571	1,014	0.0	0.0	5.0	36.0	0.0	0.0
Field 5	54	-3	+152	+20	1,477	2,615	2,910	0	2,425	-28	1,477	190	0.0	0.0	9.5	92.2	0.0	0.0
Field 6	21	-5	+79	+141	444	788	896	0	0	-27	444	788	0.0	0.0	5.0	28.0	0.0	0.0
Field 6A	21	-5	+79	+141	626	1,112	1,264	0	0	-38	626	1,112	0.0	0.0	5.0	39.5	0.0	0.0
Field 7	57	-3	+152	-30	9,516	16,850	18,750	0	18,750	-180	9,516	-1,900	0.0	0.0	9.5	593.8	0.0	0.0
Field 7A	50	-3	+107	-80	4,309	7,630	8,490	1,274	9,905	-82	3,035	-2,275	0.0	0.0	9.5	268.9	0.0	0.0
Field 8	29	-3	+152	+20	1,096	1,941	2,160	0	1,800	-21	1,096	141	0.0	0.0	9.5	68.4	0.0	0.0
Field 8A	55	-3	+152	-30	213	377	420	0	420	-4	213	-43	0.0	0.0	9.5	13.3	0.0	0.0
Field 9	56	-3	+152	-30	3,837	6,794	7,560	0	7,560	-73	3,837	-766	0.0	0.0	9.5	239.4	0.0	0.0
Field 9A	54	-3	+152	+20	1,568	2,777	3,090	0	2,575	-30	1,568	202	0.0	0.0	9.5	97.9	0.0	0.0
Field 10	29	-3	+152	+20	2,147	3,801	4,230	0	3,525	-41	2,147	276	0.0	0.0	9.5	134.0	0.0	0.0
Field 10A	59	-3	+152	+20	2,497	4,421	4,920	0	4,100	-47	2,497	321	0.0	0.0	9.5	155.8	0.0	0.0
Field 11	18	-5	+79	+101	1,126	1,999	2,272	0	568	-69	1,126	1,431	0.0	0.0	5.0	71.0	0.0	0.0
Field12	57	-3	+152	+20	1,736	3,073	3,420	0	2,850	-33	1,736	223	0.0	0.0	9.5	108.3	0.0	0.0
Field13	32	-3	+152	+270	1,766	3,127	3,480	0	0	-33	1,766	3,127	0.0	0.0	9.5	110.2	0.0	0.0
Field 13A	31	-3	+152	+270	4,674	8,277	9,210	0	0	-89	4,674	8,277	0.0	0.0	9.5	291.7	0.0	0.0
Field 13B	30	-3	+152	+270	1,309	2,319	2,580	0	0	-25	1,309	2,319	0.0	0.0	9.5	81.7	0.0	0.0
Field 14	31	-3	+152	+70	1,233	2,184	2,430	0	1,620	-23	1,233	564	0.0	0.0	9.5	77.0	0.0	0.0
Field 15	31	-3	+152	+70	3,426	6,066	6,750	0	4,500	-65	3,426	1,566	0.0	0.0	9.5	213.8	0.0	0.0
Field 15A	35	-5	-1	+81	825	1,464	1,664	832	624	-50	-7	840	0.0	0.0	5.0	52.0	0.0	0.0
Field 15B	31	-3	+152	+270	2,284	4,044	4,500	0	0	-43	2,284	4,044	0.0	0.0	9.5	142.5	0.0	0.0
Field 16	54	-3	+152	+270	2,314	4,098	4,560	0	0	-44	2,314	4,098	0.0	0.0	9.5	144.4	0.0	0.0
Field 17	32	-3	+152	+20	4,857	8,600	9,570	0	7,975	-92	4,857	625	0.0	0.0	9.5	303.1	0.0	0.0
Field 18	26	-3	+107	-80	3,441	6,093	6,780	1,017	7,910	-65	2,424	-1,817	0.0	0.0	9.5	214.7	0.0	0.0
Field 19	28	-3	+152	+270	1,568	2,777	3,090	0	0	-30	1,568	2,777	0.0	0.0	9.5	97.9	0.0	0.0
Field 20	30	-3	+152	+70	3,289	5,823	6,480	0	4,320	-62	3,289	1,503	0.0	0.0	9.5	205.2	0.0	0.0
Field 21	21	-5	-41	+101	1,610	2,858	3,248	2,436	812	-98	-826	2,046	0.0	0.0	5.0	101.5	0.0	0.0
Field 21A	22	-5	-1	+141	1,237	2,196	2,496	1,248	0	-75	-11	2,196	0.0	0.0	5.0	78.0	0.0	0.0
Field 21B	28	-3	+107	+70	914	1,618	1,800	270	1,200	-17	644	418	0.0	0.0	9.5	57.0	0.0	0.0
Field 22	25	-5	+49	+81	2,791	4,956	5,632	1,056	2,112	-170	1,735	2,844	0.0	0.0	5.0	176.0	0.0	0.0
Field 23	53	-3	+152	-80	4,278	7,576	8,430	0	9,835	-81	4,278	-2,259	0.0	0.0	9.5	267.0	0.0	0.0
Field 24	51	-3	+107	-30	1,218	2,157	2,400	360	2,400	-23	858	-243	0.0	0.0	9.5	76.0	0.0	0.0
Field 32	53	-3	+152	+20	1,523	2,696	3,000	0	2,500	-29	1,523	196	0.0	0.0	9.5	95.0	0.0	0.0
Field 33	31	-5	+79	+141	317	563	640	0	0	-19	317	563	0.0	0.0	5.0	20.0	0.0	0.0
Field 34	30	-3	+152	+70	2,055	3,640	4,050	0	2,700	-39	2,055	940	0.0	0.0	9.5	128.3	0.0	0.0
Field 35	26	-3	+107	+20	2,801	4,961	5,520	828	4,600	-53	1,973	361	0.0	0.0	9.5	174.8	0.0	0.0
Field 36	63	-3	+42	+270	1,416	2,507	2,790	1,023	0	-27	393	2,507	0.0	0.0	9.5	88.4	0.0	0.0
Farm Totals					85,460	151,380	168,898	10,344	111,546	-2,068	75,116	39,834						
Available					33,325	62,976												
Surpluses/Deficits (+/-)					-52,135	-88,404												

Arkansas Nutrient Managemnt Plann

Planner:	Monica Hancock
Plan Description:	C & H Hog Farms, Inc

Beta Test Version for Use by Select Planners working wit

Nutrient Management Plans for the application of manure to
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ion Summary, Units Applied by Field and Source - - - - - - Manure Distribution Summary, Units Applied by Field and Source - - - - - - Manure Distribution Summary, Units Applied by Field and Source - - -

ırcesSources

Fields Shown	Total Annual Summary						Pond 2 M50519								Dry		Liquid		--- Season 1
					Annual		1000 gal								ton		1000 gal		
50	PI	Nutrient Balance (+/-)			Per Acre	Per Field	Nov-Feb Per Acre	Nov-Feb Per Field	March-June Per Acre	March-June Per Field	July-Oct Per Acre	July-Oct Per Field	Annual Per Acre	Annual Per Field	Annual Per Acre	Annual Per Field	Annual Per Acre	Annual Per Field	Units/ac
Field	Value	N	P2O5	K2O															
Field 1	20	-5	+79	+141	5.0	42.0	0	0	0	0	7	59	7	59	0.0	0.0	12.0	100.8	
Field 2	22	-5	+79	+141	5.0	30.0	0	0	0	0	7	42	7	42	0.0	0.0	12.0	72.0	
Field 3	57	-3	+152	-30	9.5	125.4	0	0	0	0	14	178	14	178	0.0	0.0	23.0	303.6	
Field 4	20	-5	+79	+141	5.0	36.0	0	0	0	0	7	50	7	50	0.0	0.0	12.0	86.4	
Field 5	54	-3	+152	+20	9.5	92.2	0	0	0	0	14	131	14	131	0.0	0.0	23.0	223.1	
Field 6	21	-5	+79	+141	5.0	28.0	0	0	0	0	7	39	7	39	0.0	0.0	12.0	67.2	
Field 6A	21	-5	+79	+141	5.0	39.5	0	0	0	0	7	55	7	55	0.0	0.0	12.0	94.8	
Field 7	57	-3	+152	-30	9.5	593.8	0	0	0	0	14	844	14	844	0.0	0.0	23.0	1437.5	
Field 7A	50	-3	+107	-80	9.5	268.9	0	0	0	0	14	382	14	382	0.0	0.0	23.0	650.9	
Field 8	29	-3	+152	+20	9.5	68.4	0	0	0	0	14	97	14	97	0.0	0.0	23.0	165.6	
Field 8A	55	-3	+152	-30	9.5	13.3	0	0	0	0	14	19	14	19	0.0	0.0	23.0	32.2	
Field 9	56	-3	+152	-30	9.5	239.4	0	0	0	0	14	340	14	340	0.0	0.0	23.0	579.6	
Field 9A	54	-3	+152	+20	9.5	97.9	0	0	0	0	14	139	14	139	0.0	0.0	23.0	236.9	
Field 10	29	-3	+152	+20	9.5	134.0	0	0	0	0	14	190	14	190	0.0	0.0	23.0	324.3	
Field 10A	59	-3	+152	+20	9.5	155.8	0	0	0	0	14	221	14	221	0.0	0.0	23.0	377.2	
Field 11	18	-5	+79	+101	5.0	71.0	0	0	0	0	7	99	7	99	0.0	0.0	12.0	170.4	
Field12	57	-3	+152	+20	9.5	108.3	0	0	0	0	14	154	14	154	0.0	0.0	23.0	262.2	
Field13	32	-3	+152	+270	9.5	110.2	0	0	0	0	14	157	14	157	0.0	0.0	23.0	266.8	
Field 13A	31	-3	+152	+270	9.5	291.7	0	0	0	0	14	414	14	414	0.0	0.0	23.0	706.1	
Field 13B	30	-3	+152	+270	9.5	81.7	0	0	0	0	14	116	14	116	0.0	0.0	23.0	197.8	
Field 14	31	-3	+152	+70	9.5	77.0	0	0	0	0	14	109	14	109	0.0	0.0	23.0	186.3	
Field 15	31	-3	+152	+70	9.5	213.8	0	0	0	0	14	304	14	304	0.0	0.0	23.0	517.5	
Field 15A	35	-5	-1	+81	5.0	52.0	0	0	0	0	7	73	7	73	0.0	0.0	12.0	124.8	
Field 15B	31	-3	+152	+270	9.5	142.5	0	0	0	0	14	203	14	203	0.0	0.0	23.0	345.0	
Field 16	54	-3	+152	+270	9.5	144.4	0	0	0	0	14	205	14	205	0.0	0.0	23.0	349.6	
Field 17	32	-3	+152	+20	9.5	303.1	0	0	0	0	14	431	14	431	0.0	0.0	23.0	733.7	
Field 18	26	-3	+107	-80	9.5	214.7	0	0	0	0	14	305	14	305	0.0	0.0	23.0	519.8	
Field 19	28	-3	+152	+270	9.5	97.9	0	0	0	0	14	139	14	139	0.0	0.0	23.0	236.9	
Field 20	30	-3	+152	+70	9.5	205.2	0	0	0	0	14	292	14	292	0.0	0.0	23.0	496.8	
Field 21	21	-5	-41	+101	5.0	101.5	0	0	0	0	7	142	7	142	0.0	0.0	12.0	243.6	
Field 21A	22	-5	-1	+141	5.0	78.0	0	0	0	0	7	109	7	109	0.0	0.0	12.0	187.2	
Field 21B	28	-3	+107	+70	9.5	57.0	0	0	0	0	14	81	14	81	0.0	0.0	23.0	138.0	
Field 22	25	-5	+49	+81	5.0	176.0	0	0	0	0	7	246	7	246	0.0	0.0	12.0	422.4	
Field 23	53	-3	+152	-80	9.5	267.0	0	0	0	0	14	379	14	379	0.0	0.0	23.0	646.3	
Field 24	51	-3	+107	-30	9.5	76.0	0	0	0	0	14	108	14	108	0.0	0.0	23.0	184.0	
Field 32	53	-3	+152	+20	9.5	95.0	0	0	0	0	14	135	14	135	0.0	0.0	23.0	230.0	
Field 33	31	-5	+79	+141	5.0	20.0	0	0	0	0	7	28	7	28	0.0	0.0	12.0	48.0	
Field 34	30	-3	+152	+70	9.5	128.3	0	0	0	0	14	182	14	182	0.0	0.0	23.0	310.5	
Field 35	26	-3	+107	+20	9.5	174.8	0	0	0	0	14	248	14	248	0.0	0.0	23.0	423.2	
Field 36	63	-3	+42	+270	9.5	88.4	0	0	0	0	14	126	14	126	0.0	0.0	23.0	213.9	
Farm Totals						5,339						7,573		7,573				12,913	
Available						2,624								2,624				2,624	
Surpluses/Deficits (+/-)						-2,715								-4,949					

Section 6

Record Keeping Forms

Example Table for Recordkeeping

Copy of ADEQ's Annual Report Form

ARKANSAS RECORD KEEPING REQUIREMENTS

The Arkansas Department of Environmental Quality (ADEQ) requires that the following test results and records be submitted to them annually by May 30th from any person operating a liquid waste management and disposal system under Regulation 5. All sampling and analysis shall be in accordance with the University of Arkansas Cooperative Extension Service guidelines. Reports must be submitted on forms provided by ADEQ and a blank copy of the form is included in this section.

1. Records shall be kept on all waste/wastewater applications. A log shall be kept at the facility showing dates, volumes or weights, destinations and acreage over which the wastes are applied.
2. A representative sample of the waste/wastewater shall be collected once per year and analyzed for the following parameters: pH, total nitrogen, ammonia nitrogen, potassium, phosphorous, water extractable phosphorous (WEP), and percent solids. The results shall be included in the final yearly report.
3. The soils of each field where liquid animal waste has been land applied shall be sampled and analyzed at least once every five (5) years for the following parameters: pH, Potassium, Phosphorous and Nitrates.

It should be noted that these are ADEQ requirements and any failure to produce or obtain the reports shall be deemed a violation of Regulation No. 5 and the permit.

The following table is provided as a convenience and may be used for record keeping. If the owner/operator has a reliable record keeping system in place that meets the Arkansas Record Keeping requirements, then that method shall be used.

ANIMAL WASTE LAND APPLICATION RECORD
FOR PERMITTED CONFINED ANIMAL FACILITIES

PERMITTEE:_____ PERMIT NUMBER:_____

APPLICATION METHOD:_____

Field Name or/and Number	Date Applied	Crop Type	Area Applied (acres)	Volume Applied (gallons)

NOTE: Facility record; **DO NOT MAIL THIS**; Keep this record at the facility.
Make additional copies of this table as needed.

ARKANSAS DEPARTMENT OF ENVIRONMENTAL QUALITY

ANNUAL REPORT FORM FOR PERMITTED CONFINED ANIMAL FACILITIES

REPORTING PERIOD:
_____

PERMITTEE NAME: _____ PERMIT NUMBER: _____

PHONE NUMBER: _____ AFIN NUMBER:
_____

FACILITY TYPE AND SIZE: _____
(ie., 200 Cow Dairy, 2,500 Swine Finishing, 80,000 Bird Layer Operation, etc.)

WASTE DISPOSAL SYSTEM CONSISTS OF:
_____
(ie., Holding Pond, Holding Pond & Settling Basin, Concrete Holding Tank, etc.)

WASTE APPLICATION METHOD: _____
(ie., Tank Spreader, Irrigation System, etc.)

NO. OF APPLICATION FIELDS: _____

TOTAL AVAILABLE ACREAGE: _____

WASTEWATER SAMPLE LOCATION: _____
(Lagoon During Pumping or Field During Application)

YOU MUST SUBMIT A COPY OF THE **WASTEWATER ANALYSIS** FOR EACH SAMPLE PROVIDED TO THE COOPERATIVE EXTENSION SERVICE OR A PRIVATE LAB. THE WASTEWATER ANALYSIS MUST INCLUDE: pH (su), TOTAL NITROGEN, AMMONIA NITROGEN, TOTAL POTASSIUM, TOTAL PHOSPHORUS, AND PERCENT SOLIDS.

IN ADDITION, YOU MUST SUBMIT A COPY OF THE **SOIL ANALYSIS** FOR EACH FIELD WITH THIS FORM. THE SOIL ANALYSIS MUST INCLUDE: pH (su), POTASSIUM (lbs/ac), PHOSPHORUS (lbs/ac), AND NITRATES (lbs/ac). AT LEAST ONE SOIL ANALYSIS SHOULD BE DONE FOR EACH 30 ACRE TRACT.

PLEASE COMPLETE THE TABLE ON THE BACK FOR THE LAND APPLICATION REPORT. YOU MUST SIGN AND DATE THIS REPORT AND SUBMIT IT TO THE DEPARTMENT PRIOR TO MAY 30th OF EACH YEAR. PLEASE KEEP A COPY OF THIS REPORT, THE SOIL ANALYSIS, AND THE WASTEWATER ANALYSIS FOR YOUR RECORD AT THE FACILITY.

I CERTIFY UNDER PENALTY OF LAW THAT I HAVE EXAMINED AND AM FAMILIAR WITH THE INFORMATION SUBMITTED HEREIN AND BASED ON MY INQUIRY OF THOSE INDIVIDUALS IMMEDIATELY RESPONSIBLE FOR OBTAINING THE INFORMATION, I BELIEVE THE SUBMITTED INFORMATION IS TRUE, ACCURATE AND COMPLETE. I AM AWARE THAT THERE ARE SIGNIFICANT PENALTIES FOR SUBMITTING FALSE INFORMATION.

_____ _____ _____
OWNER OR OPERATOR (Please Print) **SIGNATURE** **DATE**

Mail complete annual report form and annual application report to:

ANNUAL ANIMAL WASTE LAND APPLICATION REPORT

PERMITTEE NAME: _____ PERMIT NUMBER: _____

Field Name or/and Number	Crop Type	Total* Area Applied (acres)	Total** Volume Applied (gallons)	Total*** Nitrogen (lbs/1000 gal.)	Calculated Nitrogen Applied (lbs/ac)
(1)	(2)	(3)	(4)	(5)	(6)

*** Total available area is the area where manure was applied during the reporting period (this data can be obtained from the management plan).**
**** Total volume applied is the total volume applied to the field during the whole reporting period (this data can be obtained from record sheet).**
***** Total Nitrogen concentration (lbs/1000 gallons) can be obtained from the wastewater analysis sheet.**

Column (6) = Nitrogen Applied (lbs/ac) = Column(4) X Column(5) ÷ Column (3) ÷ 1,334

NOTE: You may make additional copies of this table as needed.

Mail complete annual report form and annual application report to:
Arkansas Department of Environmental Quality
Permits Branch, Water Division
5301 Northshore Drive
North Little Rock, AR 72118

Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report - October 2013 to December 2013

DEMONSTRATING AND MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

The mission of the **Division of Agriculture** is to advance the stewardship of natural resources and the environment, cultivate the improvement of agriculture and agribusiness, develop leadership skills and productive citizenship among youth and adults, enhance economic security and financial responsibility among the citizens of the state, ensure a safe, nutritious food supply, improve the quality of life in communities across Arkansas, and strengthen Arkansas families.

Dr. Mark J. Cochran

Vice President for Agriculture

DEMONSTRATING AND MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Executive Summary

This first Quarterly Report of the U of A Division of Agriculture's Big Creek Research and Extension Team, documents our activities and progress in establishing a research and monitoring program on the C&H Farm and in Big Creek Watershed, compliant with State funding received on October 1, 2013. Our work and progress during the first three months has focused on gaining a better understanding of the C&H Farm within the context of the Big Creek Watershed. We have undertaken a systematic approach to getting information on soils, underlying substrata, and background water quality information. To this end, during the first quarter we have: acquired landowner permission to conduct research and monitoring on three fields permitted to receive manure; better characterized the soils, topography, and underlying shallow layers of these fields including: 1) a Ground Penetrating Radar (GPR) assessment provided by NRCS, to determine if this non-invasive technology could help us identify subsurface features that could influence the fate and transport of surface applied nutrients, 2) fine (0.25 acre) grid-soil sampling of these fields to examine the spatial variability of nutrients within fields; 3) conducted a preliminary water quality monitoring of Big Creek upstream and downstream of the C&H Farm and of a spring on the property to determine baseline chemical, composition of these waters, and 4) initiated discussions with C&H Farms to identify manure and nutrient management options for evaluation by the project

Collecting this information will guide future efforts to monitor surface and subsurface movement on the farm in the most reliable and rigorous manner possible. This is needed to assess potential impacts of the C&H Farm on water quality and to respond to the farm's request for assistance in responding to identified concerns. Our findings to date are summarized below.

GPR Survey

Results from the GPR survey two fields showed that this technique / tool holds promise in defining features in the strata underlying the application fields in a non-invasive manner, which warrants further, more detailed characterization. While the survey indicated changes in subsurface strata, interpretations such as gravel lenses and dissolution cavities, are only indications at the present time, as actual ground truthing with invasive observational coring has not been conducted yet.

The GPR survey did demonstrate that soil properties such as soil depth to bedrock, were consistent with NRCS soil mapping unit description already available, which shows the soil depth being greater on Creek-side Field 5 than Field 1. Fields 12 is still to be completed, but so far GPR results indicate that at least 49 inches of soil overlies any bedrock which is consistent with soil pedons described in the NRCS soil survey.

A more detailed and exhaustive survey of the application fields, coupled with other soil tests, such as hydraulic conductivity and infiltration measurements, will be conducted in the coming year to make reliable conclusions on the underlying geology and presence of karst features.

Grid Soil Sampling

Fields 1 (80 samples) and 5 (270 samples) were sampled for soil nutrients by a grid pattern representing 0.25 acre blocks of each field. The concentration of phosphorus in the surface soil varied across these fields, as is typical of grazed pastures and is consistent with previous surveys of soil phosphorus variability across pastures in Northwest Arkansas and Eastern Oklahoma.

To help put soil phosphorus levels in perspective, the mean soil phosphorus in the top 4 inches for all grid samples was 41 mg/kg for Field 1 and 54 mg/kg for Field 5. Based on the U of A Division of Agriculture's fertility guidelines for a mixture of cool and warm season grasses, Field 1 would require additional phosphorus for a typical hay production yield of 3 tons/acre. Field 5 is in the optimal range of soil phosphorus levels (i.e., 50 - 60 mg/kg) for warm season grasses such as Bermudagrass.

Water Quality Monitoring

Water quality monitoring of Big Creek and a spring since September 2013, showed concentrations of nitrogen and phosphorus were only slightly greater than detection limits. This is expected for nutrient flows in a watershed that has historically had minimal land use disturbance and is still predominantly forested. Water sample collection was primarily during baseflow (flow derived from groundwater and in the absence of surface runoff contributions or storm flow) conditions in Big Creek and reflect the general impact of the landscape within the watershed on Big Creek water chemistry. E. Coli and total Coliform amounts were more highly variable reflecting periodic inputs from several potential sources in the Big Creek Watershed.

Manure Sampling

Analysis of holding pond manure samples exhibited typical holding pond trends with nutrient concentrations (phosphorus and nitrogen) increasing with pond depth. However, as the relative increase in nitrogen was greater than phosphorus, the nitrogen/phosphorus ratio of manure slurry in the top 6 inches of the pond, more closely matches manure nutrients to crop nutrient needs. Land applying this slurry is more likely to meet crop nitrogen needs with acceptable phosphorus applications, while bottom slurries are suitable for a manure banking approach, where the slurry would be applied to more distant fields on alternate years. Preliminary assessment of pond slurry composition demonstrates that, without the addition of mechanical and/or chemical separation approaches, natural gravity separation provides nutrient management opportunities to more closely match applied manure nutrients to crop nutrient needs.

Future Plans

During the second quarter, installation of surface and subsurface monitoring equipment will take place, along with continuous flow and water quality sampling equipment on springs, ephemeral streams, and Big Creek within the confines of the C&H Farm operation. In addition, manure chemical treatment field testing and analysis will take place to guide manure/nutrient management options identification and evaluation. Finally, progress has been made to establish an independent and unbiased review of our work plan by a panel of international experts in the areas of karst hydro-geochemistry and dye-tracer studies, watershed hydrology, soil and water quality monitoring, and farm nutrient management. This should occur in late spring/early summer, 2014.

Big Creek Research Team

Media Contact

Mary Hightower, Assistant Director of Communications and Marketing, Cooperative Extension Service

Faculty

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Rick Cartwright, Ph.D., Professor – Associate Director of Extension for Agriculture and Natural Resources

Mark Cochran, Ph.D., – Vice President, University of Arkansas System Division of Agriculture.

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Nathan McKinney, Ph.D., – Assistant Director, Agriculture Experiment Station

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Thad Scott, Ph.D., Associate Professor - Water quality, transport of contaminants to and within water bodies

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians

The Big Creek Research and Extension Team are ably supported by several excellent Program Technicians based in Little Rock and Fayetteville.

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Introduction

This research project will evaluate the sustainable management of nutrients from the C&H Farm operation (subsequently referred to as C&H, to include animal facilities and permitted land application fields). The study includes the following major tasks:

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 including springs, ephemeral streams, creeks and ground water.
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.

To address the long-term sustainability of C&H, the project will measure soil fertility levels of all permitted fields at frequent intervals. This combined with nutrient levels in monitored wells will guide adaptive manure management decisions to address field and environmental sustainability concerns. The project will also assess the feasibility of manure treatment, which is regarded as addressing nutrient imbalance concerns and has the potential to provide the farm with cost-beneficial alternatives for the sustainable use and export of treated manures.

The plan of research meets the level of funding currently available. Other important methods of investigation, such as the use of dye-tracer tests, will provide valuable information on possible rapid by-pass flow pathways common in karst dominated areas and will be included in years 2 and 3, when water flows on the operation will be better understood. See Figure 1 for a conceptual description of the karst watershed. With additional funding, dye-tracer tests would be conducted at sites identified from year 1 studies. Finally, a broad pool of expertise from the partner organizations will be brought together for work plan implementation and periodic review.

This information will be a short-term assessment and it must be noted that funds allocated below will not cover long-term monitoring, sample analysis, and assessment of land use impacts on area waters. Additional funds would be needed for sample collection and labor to continue monitoring for a minimum of five years. This time frame is recognized by NRCS, EPA, and general scientific community to be the minimum required to accurately assess any impacts and overcome annual weather fluctuations.

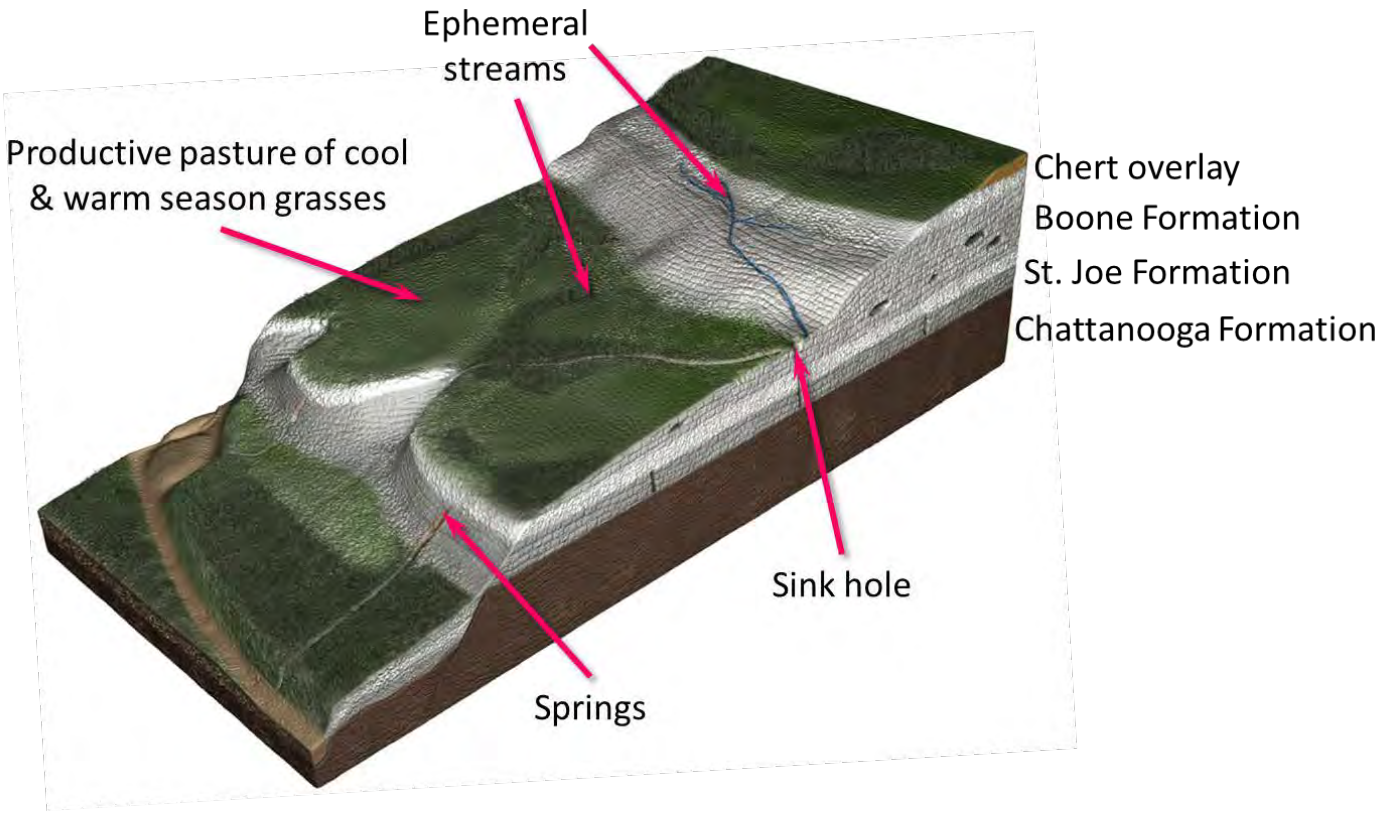
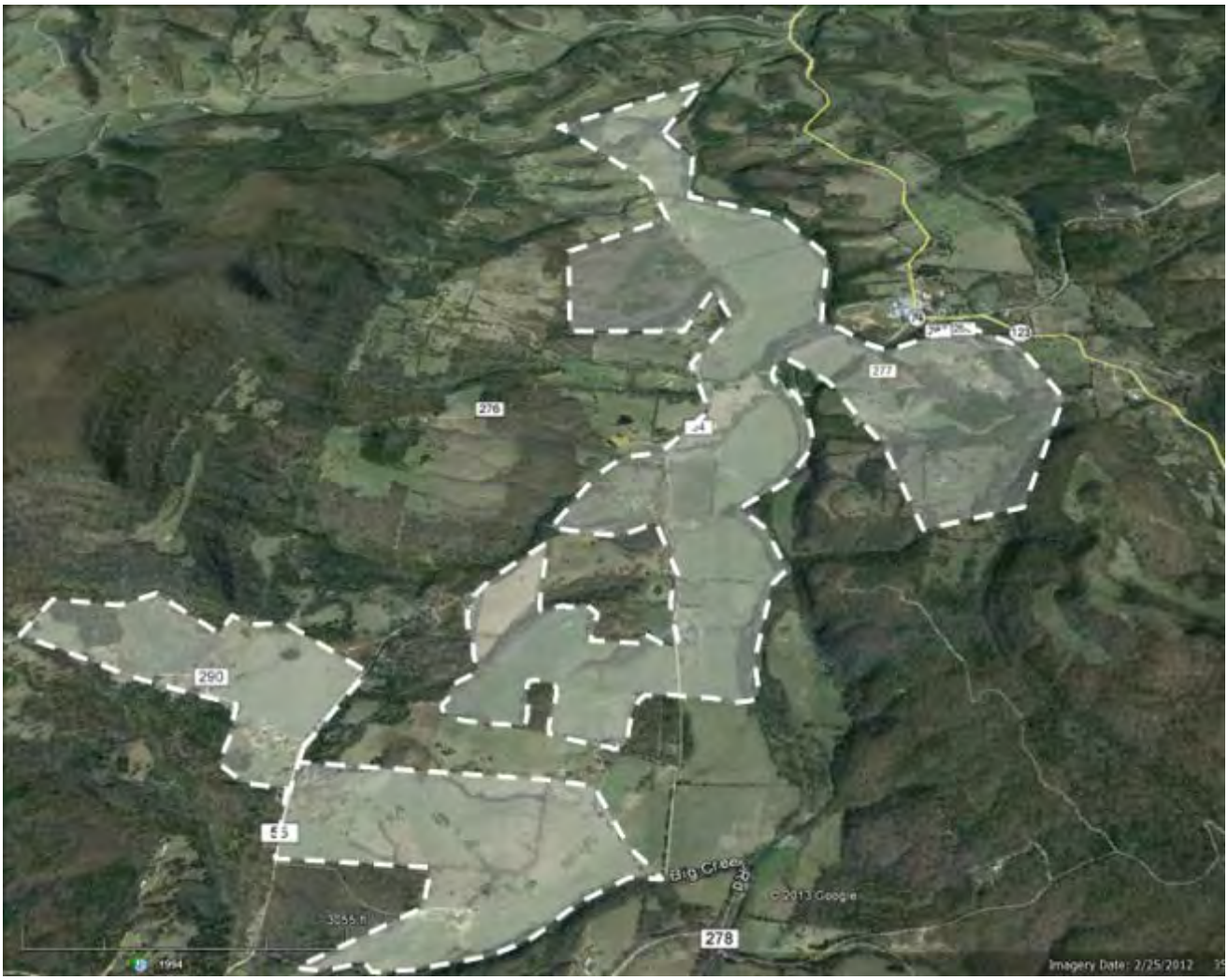


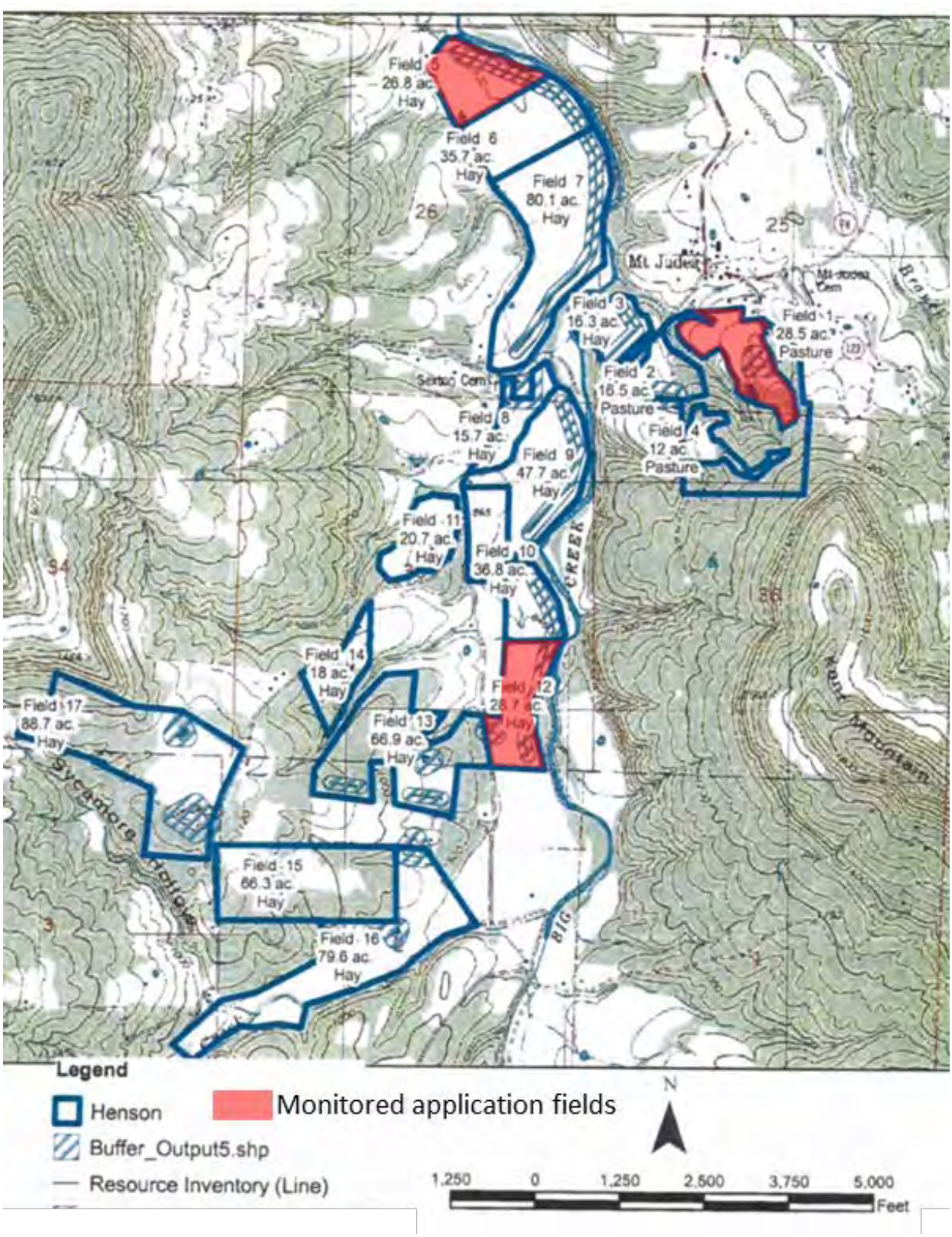
Figure 1. Simple conceptual description of the Karst features in in the Ozark Highlands.

The C&H Farm location

The C&H Farm and permitted fields are located in Mt. Judea, Newton County, AR as shown on Maps 1 and 2. This research project will focus on three permitted application fields, which give a range in landscape position, topography, and soil fertility levels representative of the overall operation (Maps 1 and 2, and Photo 1). A topographic map of the site is presented in Map 3. The soils mapped by NRCS, Newton County on the C&H operation are shown in Map 4, and Table 1. A description of the soils made by NRCS, Newton County is provided in Appendix 1. The physical properties and dimensions of the fields where surface and subsurface flow will be determined are given in Table 2, along with Maps 2 and 5. Water quality assessment of Big Creek above and below the farm will provide baseline information (Map 6).

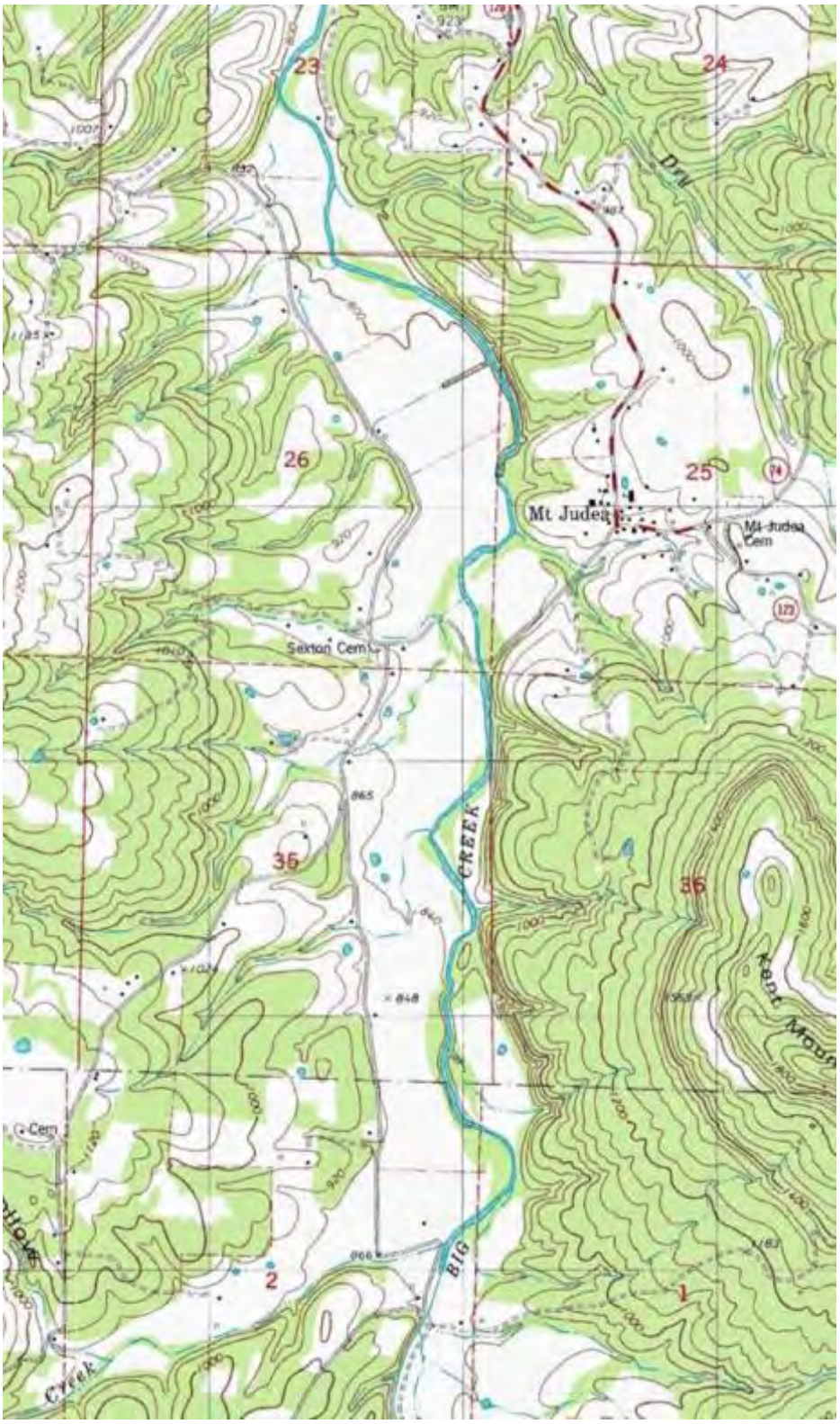


Map 1. Location of the C&H Farm operation, Mt. Judea, Newton County, AR.



Map 2. Location of monitored fields on the C&H operation Mt. Judea, Newton County, AR.

Photo 1. Recent aerial photo of the Mt. Judea, Newton County, AR region.



Map 3. Topographic map of Mt. Judea, Newton County, AR region.

Map 4. Soil type distribution in the vicinity of the C&H Farm operation Mt. Judea, Newton County, AR.

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Newton County, Arkansas
Survey Area Data: Version 12, Dec 19, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 5, 2010—Jun 30, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

USDA Natural Resources Conservation Service

Web Soil Survey
National Cooperative Soil Survey

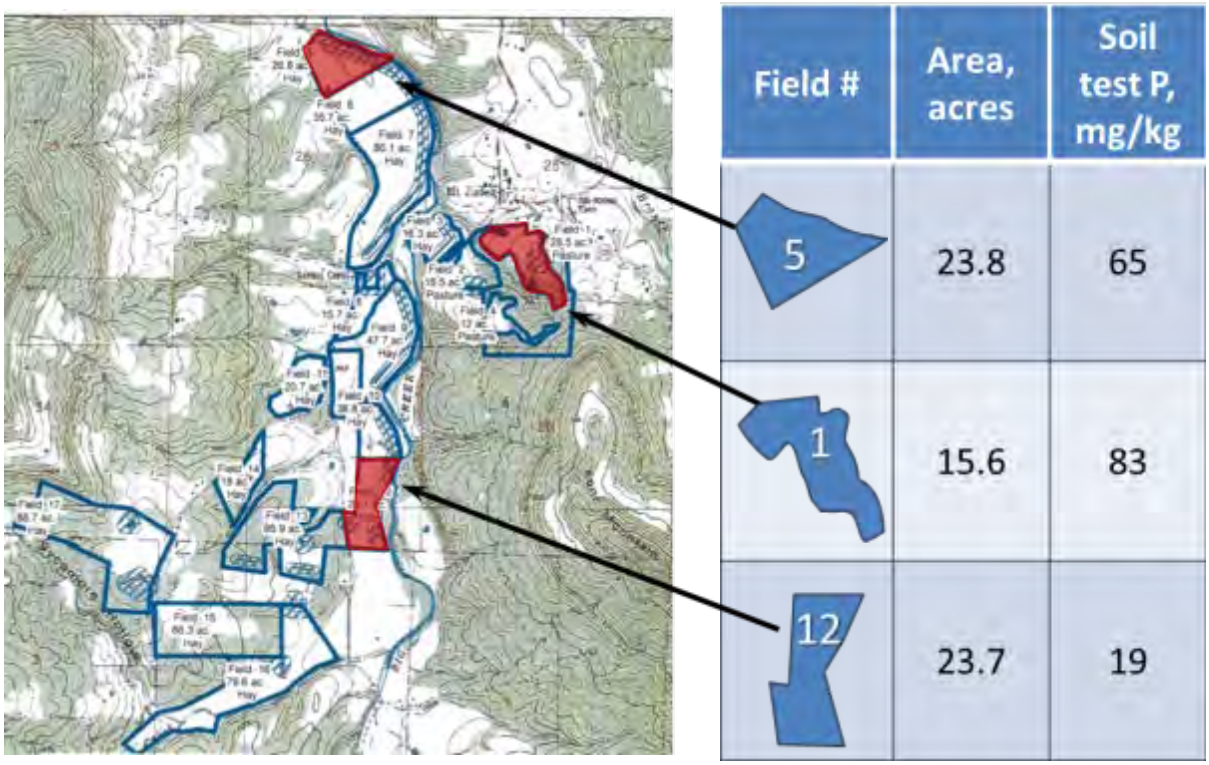
1/21/2014
Page 2 of 4

Table 1. Key for the soil distribution Map 4.

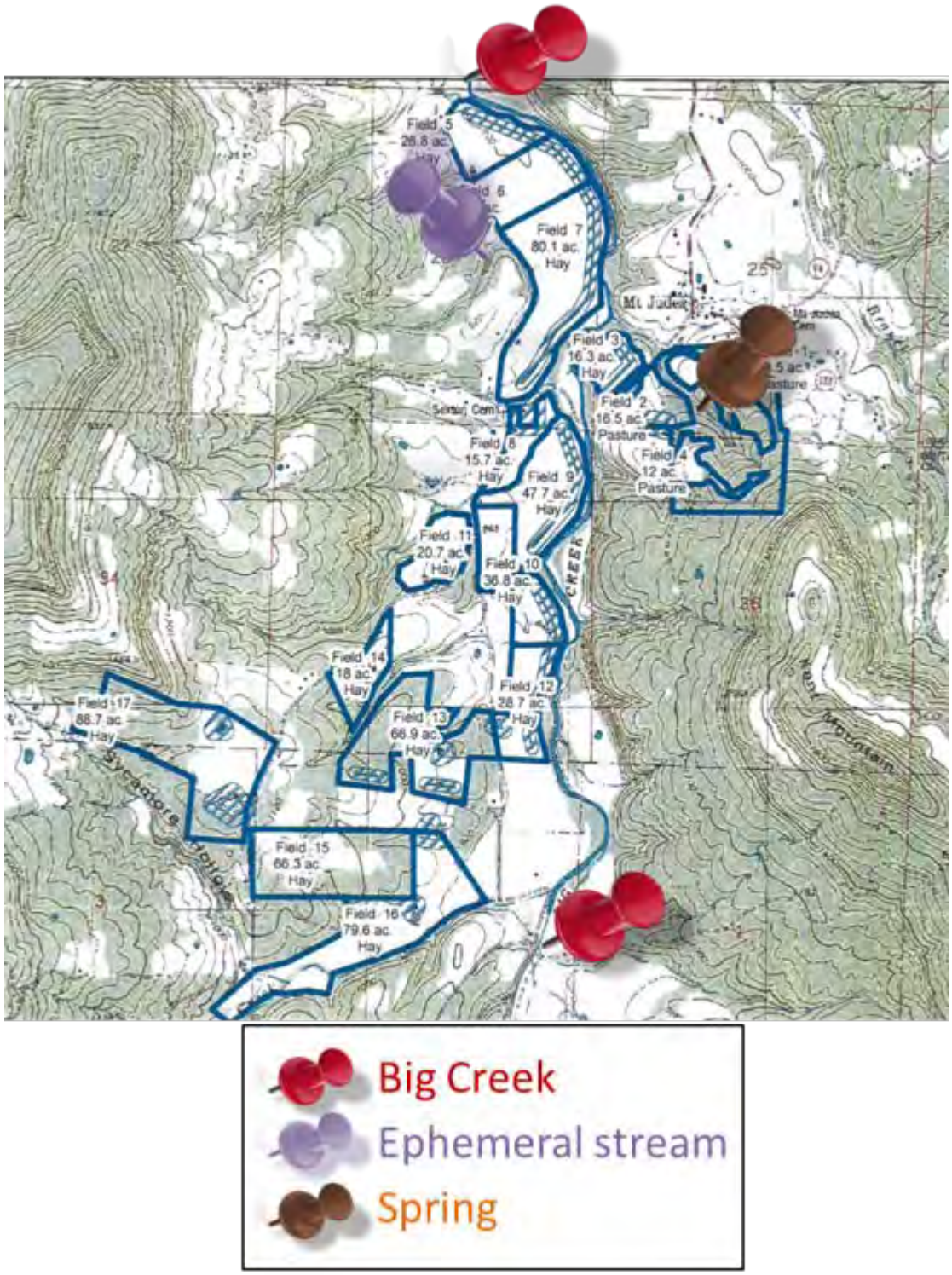
Table 2. Properties of fields where surface and subsurface flow will be determined.

	Field 1	Field 5	Field 12
¼ section	SW	NE	SE
Section	25	26	35
Township	15N	15N	15N
Range	20W	20W	20W
Latitude	35.917	35.928	35.901
Longitude	-93.058	-93.071	-93.069
Available acres	15.6	23.8	23.7
Soil type	Noark very cherty slit loam	Razort loam	Spadra loam
Soil test P, ppm	83	65	19
Field slope, %	5.3	0.2	2.0
Erosion, tons/acre [a]	0.12	0.05	0.05

[a] Erosion estimated by RUSLE 1.



Map 5. Location of monitored fields and soil test P levels on the C&H Farm operation Mt. Judea, Newton County, AR.



Map 6. Location of water sampling locations on and adjacent to the C&H Farm operation Mt. Judea, Newton County, AR.

United States Department of Agriculture
Natural Resources Conservation Service

Ground Penetrating Radar (GPR) Survey Report, November, 2013

Purpose and Overview:

A series of ground penetrating radar surveys were conducted near Mount Judea, AR on November 7th and 8th, 2013, on two different fields to investigate soil properties.

Participants:

Lawrence Berry	(University of AR, Crop, Soil and Environmental Sciences Department)
Dr. Kris Brye	(Professor of Applied Soil Physics and Pedology, University of Arkansas)
Dr. Mike Daniels	(Professor, Extension Water Quality, University of AR Division of Agriculture)
Cory Halmark	(University of AR Extension)
Josh Hesselbein	(University of AR Extension)
Wes Tuttle	(Geophysical Soil Scientist, NRCS)
Richard Vaught	(Soils Scientist and GPR operator, NRCS)

Activities, Field 1:

1. A SIR-3000 Ground-Penetrating Radar (GPR) system (Geophysical Survey Systems Inc) with 200-Mhz antenna was used at this site (Photos 1 and 2).
2. A metal plate was buried at the site at a depth of 50-cm to calibrate the instrument and to ground-truth soil conditions. A second hole was hand dug to 50-cm to further ground-truth soil conditions.
3. Conditions were too rocky at the site to successfully use a Giddings soil probe to a depth of deeper than 20-cm.
4. Two 90-m transects were laid out. The transects were flagged at 10-m intervals.
5. Transect/GPR survey #18 proceeded in a generally north easterly direction, up hill, where slopes ranged from 3 to 15 % or greater (Figure 2).
6. Transect/GPR survey #20 ran at a right angle to transect #18, and traveled in a north westerly direction, where slopes ranged from 3-5% (Figure 2).

Photo 2. Preparing a transect for the Ground Penetrating Radar assessment at C&H Farm.

Photo 3. Conducting the Ground Penetrating Radar assessment at C&H Farm.

Figure 2. Location of ground penetrating radar surveys at field 1 near Mount Judea, AR. Surveys were 90-m in length.

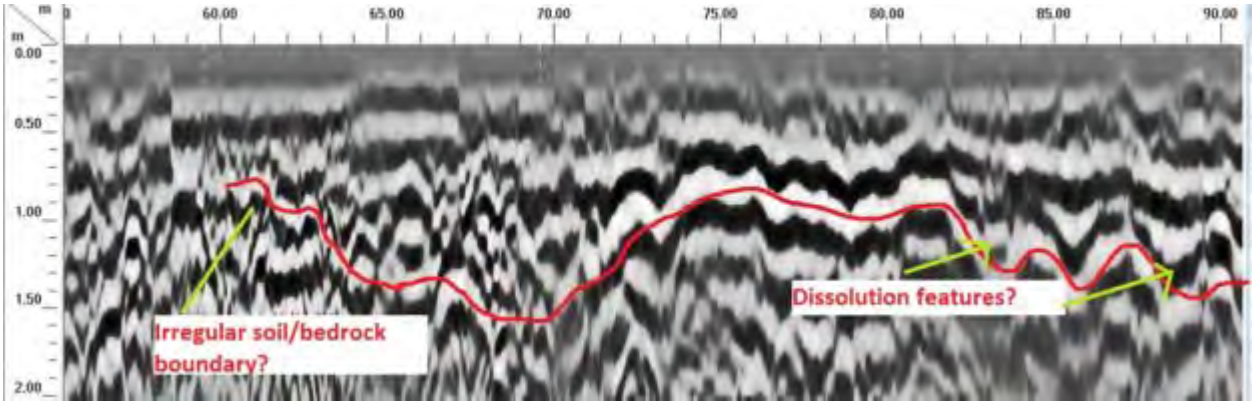


Figure 3. Possible solution features on the end sections of survey 18.

Summary, Field 1, Transect 18

1. Soils observed at the site seemed to agree with the Newton county soil survey, and resembled the Noark series, which is formed in residuum and colluvium of clayey limestone.
2. The radar records from this site are of good interpretative quality. Several features that were not readily evident in the field became more noticeable after processing the data.
3. Excavation to identify many of the subsurface features was not feasible due to rocky conditions. Thus, it should be noted that most features "observed" in the radar record have not been verified in the field.
4. The radar record indicates that soil features across survey 18 are not homogenous, which is not surprising, since the landform changed across the survey.
5. The data suggests that there could be an irregularly shaped boundary between soil and bedrock across the survey (Figures 4 and 5). This apparent contact is wavy in nature, and resembles the dissolution features that are manifested in cutter and pinnacle karst.
6. Depth to bedrock and karst features appear to be more shallow near the top of the hill surveyed, which would conform to standard soil landscape models for the area.

Summary, Field 1, Transect 20

1. The radar record suggests (as was verified at both test holes) that there is a horizon boundary that is mostly located in the vicinity of 50-cm. This horizon was observed to be a BC horizon, heavy silt loam or silty clay loam, with approximately 60% coarse fragments.
2. The radar record suggests an irregularly shaped boundary between soil and bedrock across the survey (Figure 5). This apparent contact is wavy in nature, and resembles the dissolution features that are manifested in cutter and pinnacle karst.

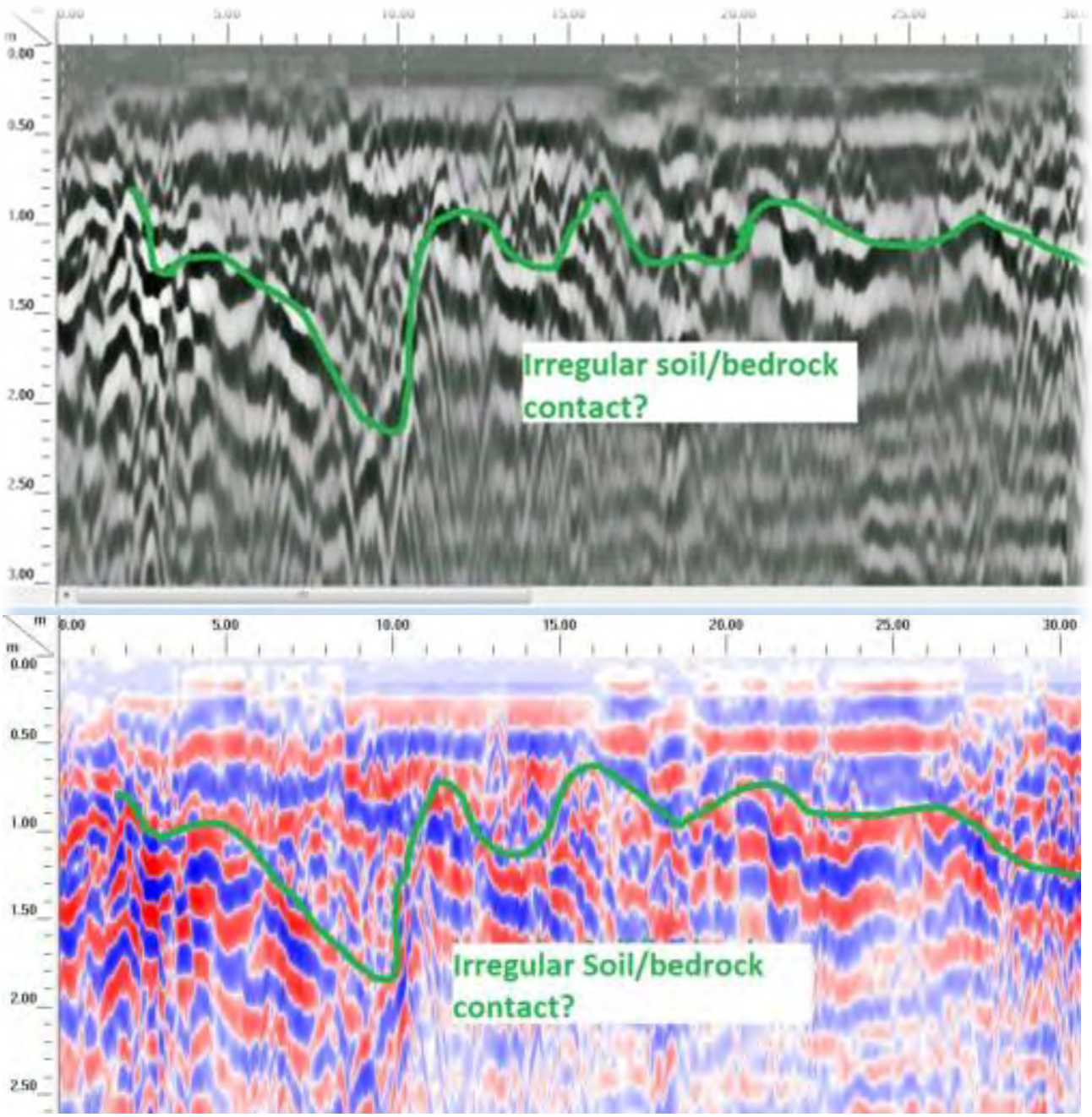


Figure 4. Two different representations of possible soil/bedrock interface at the beginning of survey 18.

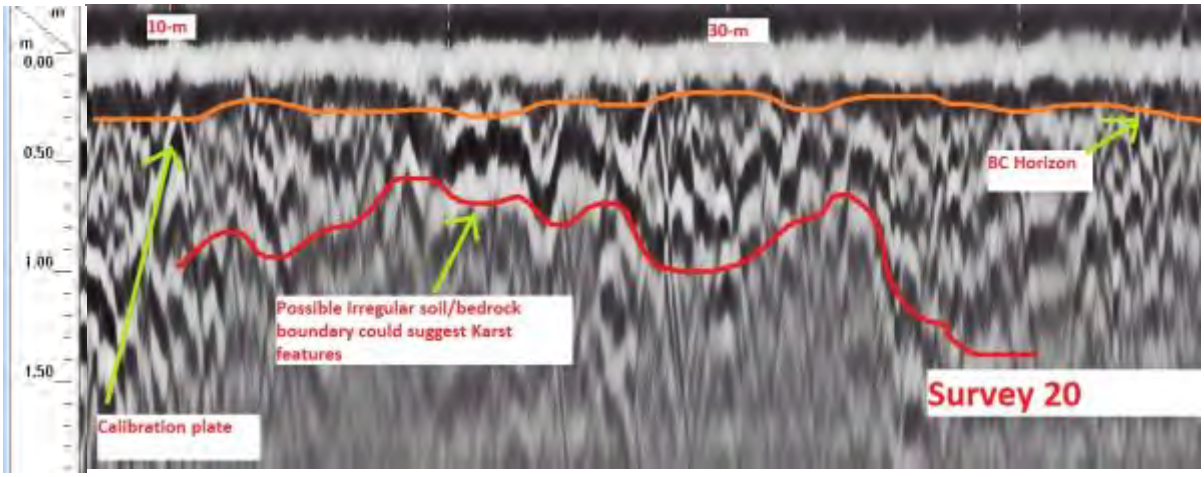


Figure 5. The apparent soil/bedrock contact was wavy in nature across survey 20.

Field Number 5, Surveys 27, 28 and 29

Activities, Field 5

1. A SIR-3000 Ground-Penetrating Radar (GPR) system (Geophysical Survey Systems Inc.) with 400-mhz antenna was used at this site.
2. A metal plate was buried at the site at a depth of 50-cm to calibrate the instrument and to ground-truth soil conditions.
3. A series of three transects were laid out and flagged at 10-m increments perpendicular to Big Creek, progressing from a portion of a toe slope, over a terrace to the flood plain. The bulk of the transects were located on the terrace (Figure 6).
4. Three holes were hand dug on survey 27 to observe soil conditions.
5. Four holes were bored with a Giddings soil probe to a depth of around 80-cm along each of the transects to collect samples and to ground-truth the radar survey.

Figure 6. Field 5.

Summary, Transect 27

1. The radar record and field observations indicated an argillic layer beginning in the vicinity of 25-cm over much of the transect. Field textures for this layer were mostly silt loam.
2. The radar record shows a contrasting layer at a depth near 50 to 60-cm over much of the transect. Field observations found that clay content increased near this depth consistently, changing from silt loam or fine sandy loam to clay, clay loam, or silty clay loam at greater depths.
3. Coarse fragment content observed in most of the borings was less than 10%. The Giddings probe worked well due to lack of fragments.
4. An anomaly was noted on the radar record near the end of survey 27, near the 160-m mark. Boring with the Giddings probe was not possible at this location, due to coarse fragment content. Further digging with a spade showed that coarse fragment content was 40-60% at a depth of 30-cm. Heavy coarse fragment content made further digging unfeasible due to time constraints.
5. Based on the radar records, field observation, and proximity to the creek, the area with an increase in coarse fragment content could be a gravel lens.

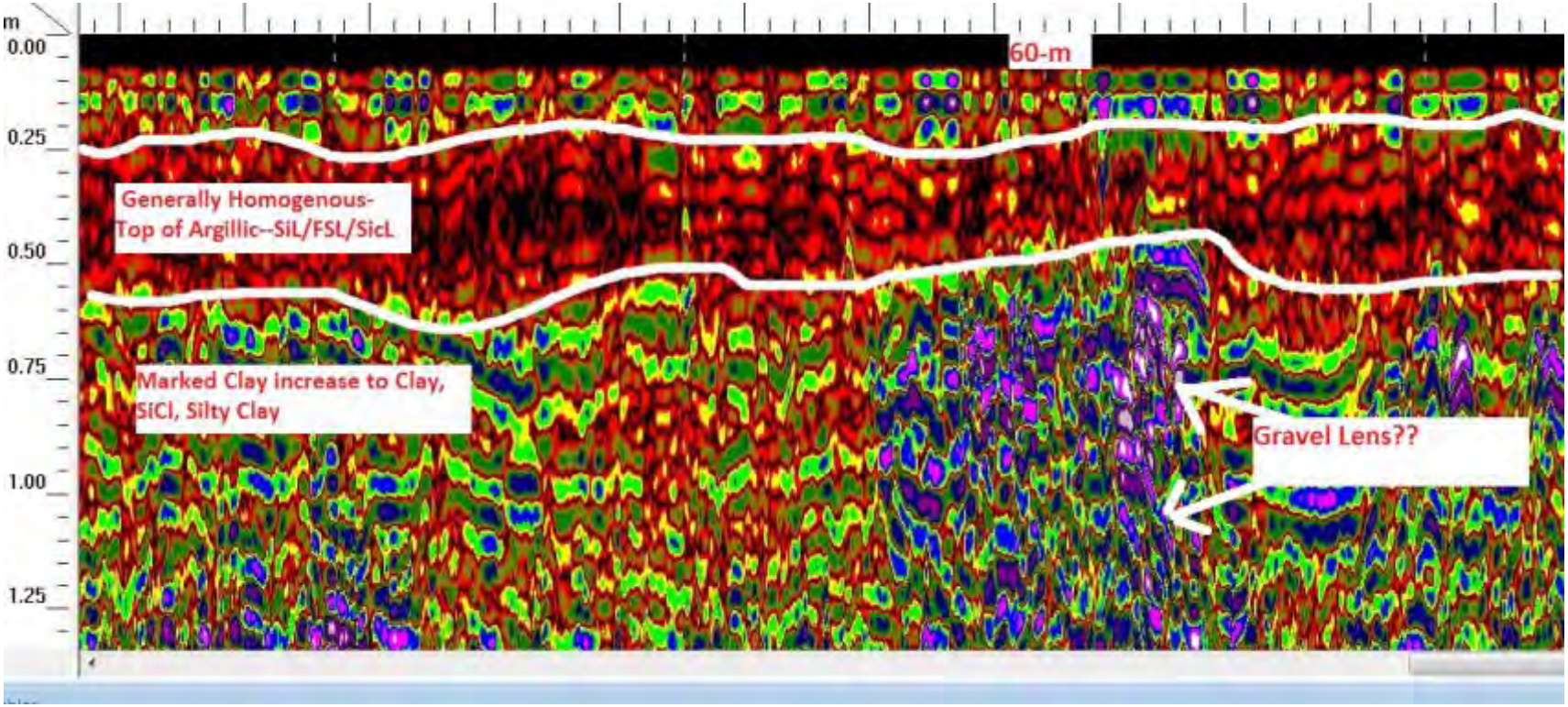


Figure 7. A marked increase in coarse fragments was observed in the field at the 60-m mark of survey 27.

Summary, Transect 28

1. Much like survey 27, the radar record and field observations indicated an argillic layer beginning at around 25-cm over much of the transect. Field textures for this layer were mostly silt loam.
2. The beginning portion of the transect occurred on a toe-slope. The radar record suggests that the soil-bedrock interface could be wavy in nature, which may suggest cutter and pinnacle karst (Figure 8).
3. The radar record shows a contrasting layer at a depth of around 50 to 60-cm over much of the transect. Field observations found that clay content increased near this depth consistently, changing from silt loam or fine sandy loam to clay, clay loam, or silty clay loam at greater depths (Figure 9).
4. Signatures from portions of this radar record resembled the area from transect 27 where coarse fragment content greatly increased. These areas could contain gravel lenses in the subsurface (Figure 9).
5. Based on field observations, soils near the end of the survey (closer to the creek) were younger and less developed.

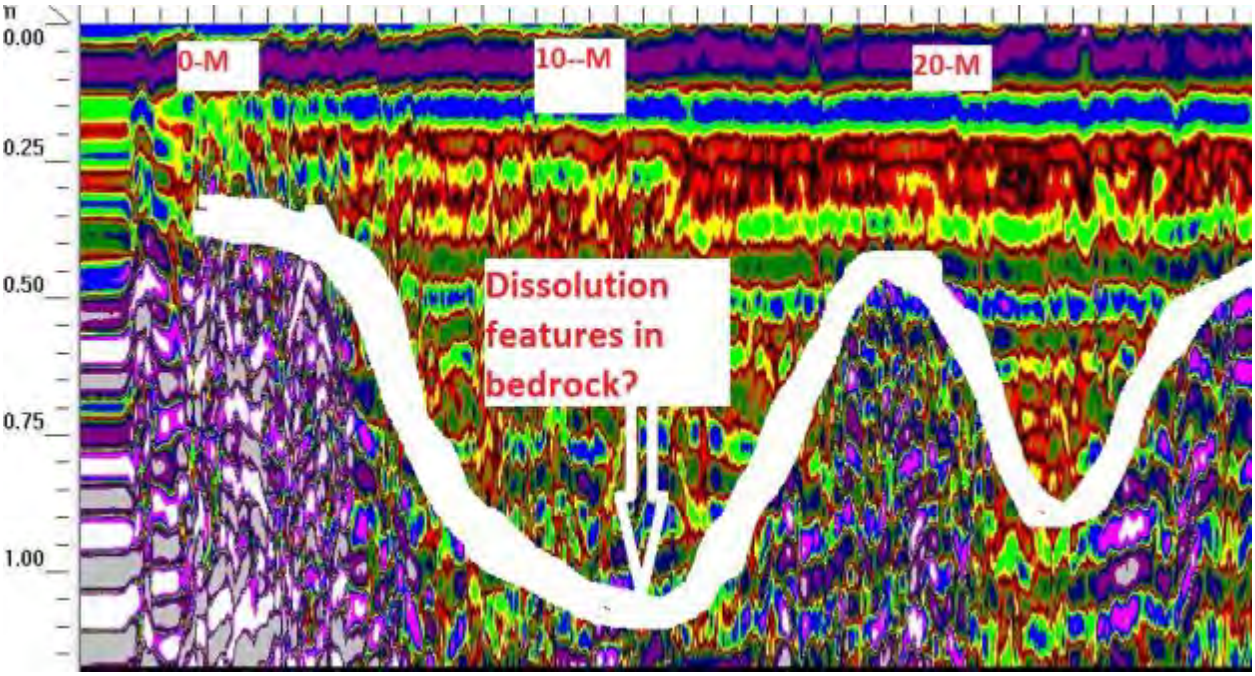


Figure 8. The first portion of transects 27-28 began on a toe-slope. The transect then dropped down onto a terrace. The toe-slope portion (above) may be underlain by dissolution features.

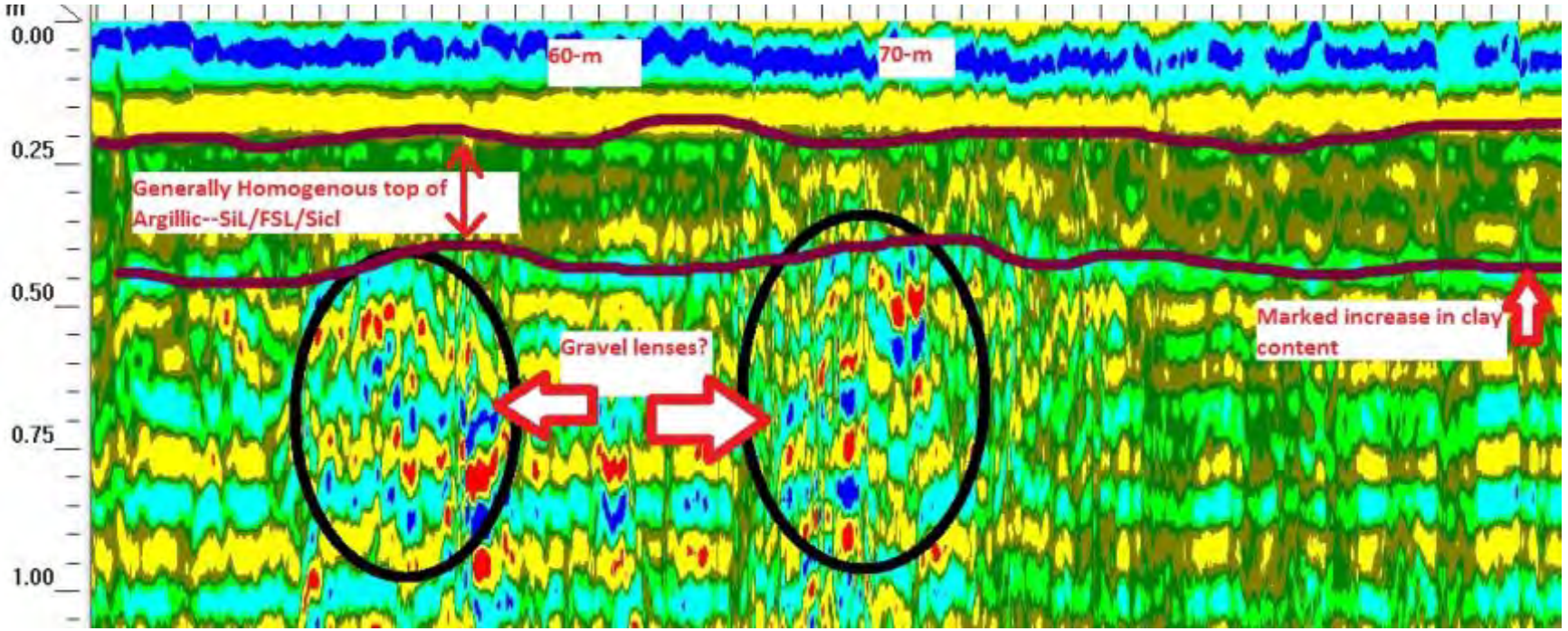


Figure 9. From survey 28. The right hand portion of the radar record seems to exemplify the overall nature of the field: a layer of silt loam or fine sandy loam, which transitions to clay or silty clay at around 50-cm. Possible gravel lenses were detected between 50-m and 70-m on the transect.

Summary, Transect 29

1. Much like surveys 27 and 28, the radar record and field observations indicated an argillic layer beginning at around 25-cm over much of the transect. Field textures for this layer were mostly silt loam.
2. The beginning portion of the transect occurred on a toe-slope. The radar record suggests that the soil-bedrock interface could be wavy in nature, which would be indicative of cutter and pinnacle karst.
3. The radar record shows a contrasting layer at a depth of around 50 to 60-cm over much of the transect. Field observations found that clay content increased near this depth consistently, changing from silt loam or fine sandy loam to clay, clay loam, or silty clay loam at greater depths (Figure 10).
4. There were no potential gravel lenses observed on this radar record.
5. Based on field observations, soils near the end of the survey (closer to the creek) were younger and less developed.

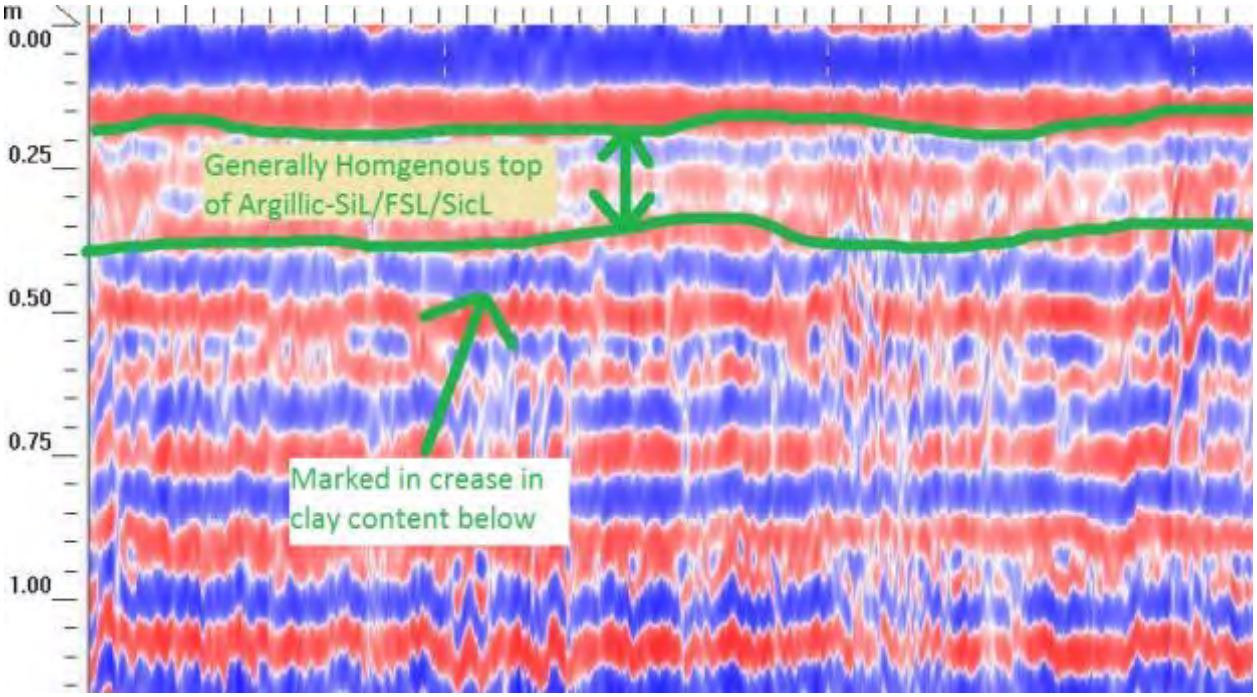


Figure 10. Typical portion of the radar record from survey 29, along the terrace/flood plain NRCS report and brief interpretation.

Summary of GPR Analysis of Fields 1 and 5

Results from this preliminary GPR survey along several transects in application fields showed that this methodology can be useful for evaluating variability and/or uniformity in the top 1 to 2 m of underlying soil/geologic material and holds promise for helping define other unique features in the strata underlying the application fields in a non-invasive manner. Although results are strictly preliminary at this point, additional, more detailed characterization and investigation of the application fields with the GPR technology are warranted and planned. While the survey indicated changes in subsurface strata along numerous preliminary transects, interpretations of these changes as being gravel lenses and/or dissolution features, are inconclusive at the present time, as actual ground truthing with invasive observational coring has not been conducted yet.

The preliminary GPR survey demonstrated that the apparent soil depth to bedrock was consistent with NRCS soil mapping unit descriptions already available, which show the soil depth being greater on the Big Creek side of Field 5 than in Field 1. In all transects conducted, GPR results indicated that at least 49 inches of soil overlies any bedrock, which is consistent with soil pedons described in the NRCS soil survey of this area in the watershed.

A more detailed and exhaustive survey of the application fields, coupled with other soil tests and characterizations, such as hydraulic conductivity and infiltration measurements, will be conducted in the coming year to make reliable conclusions on the underlying geology and presence of karst features.

Soil Sampling and Analyses

Each of the application fields were are monitoring were grid soil sampled prior to any manure application from the new operation. The grid size is approximately 0.25 acres and seven soil-depths increments will be collected to include 0 to 4", 4 to 8", 8 to 12", 12 to 18", 18 to 24", 24 to 30", and 30 to 36" where possible with a Giddings soil probe. Combining the three fields and sampling increments, we will eventually collect approximately 2800 soil samples that will be used to construct detailed soil nutrient, texture, pH, organic matter, and potassium concentration maps by depth. A grid network was overlain on each field to determine the point of sampling, which was noted by GPS. Each sample-hole remaining after the soil core was removed was carefully back-filled with commercial top soil (see Map 5). Where rock stopped the core penetrating below a specific layer, no sample was taken.

All soil samples were shipped to the University of Arkansas, Marianna Soil Test Laboratory for analysis (http://www.uark.edu/depts/soiltest/NewSoilTest/index.htm). This Laboratory serves Arkansas and provides accurate and timely soil analyses and unbiased nutrient management guidelines that are based on the best available science. In terms of quality control and assurance, the Laboratory is a member of The North American Proficiency Testing Program (a program of the Soil Science Society of America), which assists soil, plant and water testing laboratories in their performance through inter-laboratory sample exchanges and a statistical evaluation of the analytical data. The program guidelines have been developed for the agricultural laboratory industry by representatives from groups familiar with and involved in standardizing methods and developing nutrient recommendations for soil and plant analysis methods within the U.S. and Canada.

A complete description of the nationally standardized methods for soil handling, preparation, and analysis used for all samples collected in this project, can be found at http://www.uark.edu/depts/soiltest/NewSoilTest/lab_methods.htm

As of December 31, 2013, Fields 1 and 5 had been soil sampled and initial routine soil test analyses conducted at the Division of Agriculture University of Arkansas Soil Testing Laboratory. We used the same sample packaging and analyses that farmers in Arkansas use to test for soil fertility levels that guide fertilizer recommendations. Field 12 has not been grid sampled due to the cold and wet weather limiting access to the fields, without the probe equipment damaging the pasture.

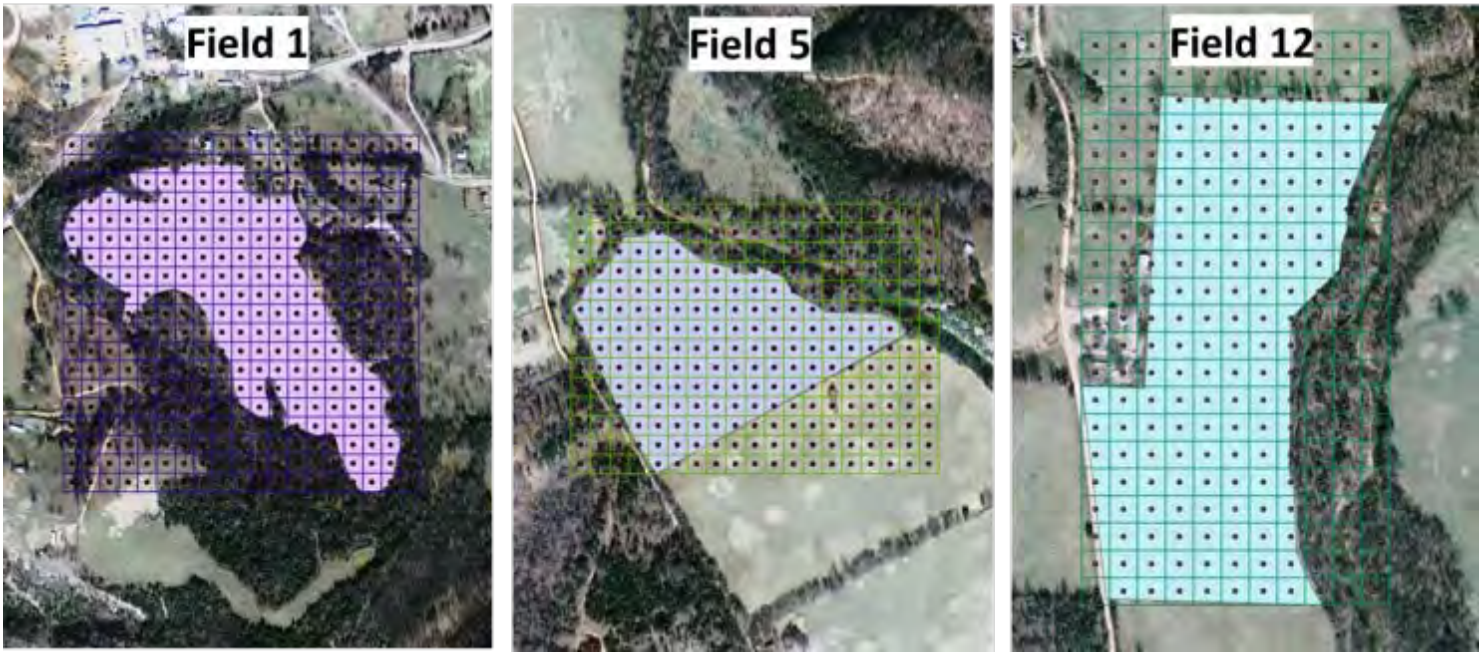
The measured nutrient concentrations of all individual soil analyses are listed in the Appendix 2 (Tables 4, 5, 6, 7, 8, 9, 10, 11, and 12). Average, minimum, and maximum values are given below in Table 3, along with the original values from the C&H NMP. The distribution of soil test phosphorus (measured as Mehlich-3 extractable soil phosphorus) in the surface 4 inches of soil are graphically represented in Map 8 for Field 1 and Map 9 for Field 5. As expected, soil test phosphorus is not evenly distributed across these grazed fields.

To help put soil phosphorus levels in perspective, the mean soil phosphorus in the top 4 inches for all grid samples was 41 mg/kg for Field 1 and 54 mg/kg for Field 5. Based on the U of A Division of Agriculture's fertility guidelines for a mixture of cool and warm season grasses, Field 1 would require additional phosphorus for a typical hay production yield of 3 tons/acre. Field 5 is in the optimal range of soil phosphorus levels (i.e., 50 - 60 mg/kg) for a warm season grass, such as Bermudagrass.

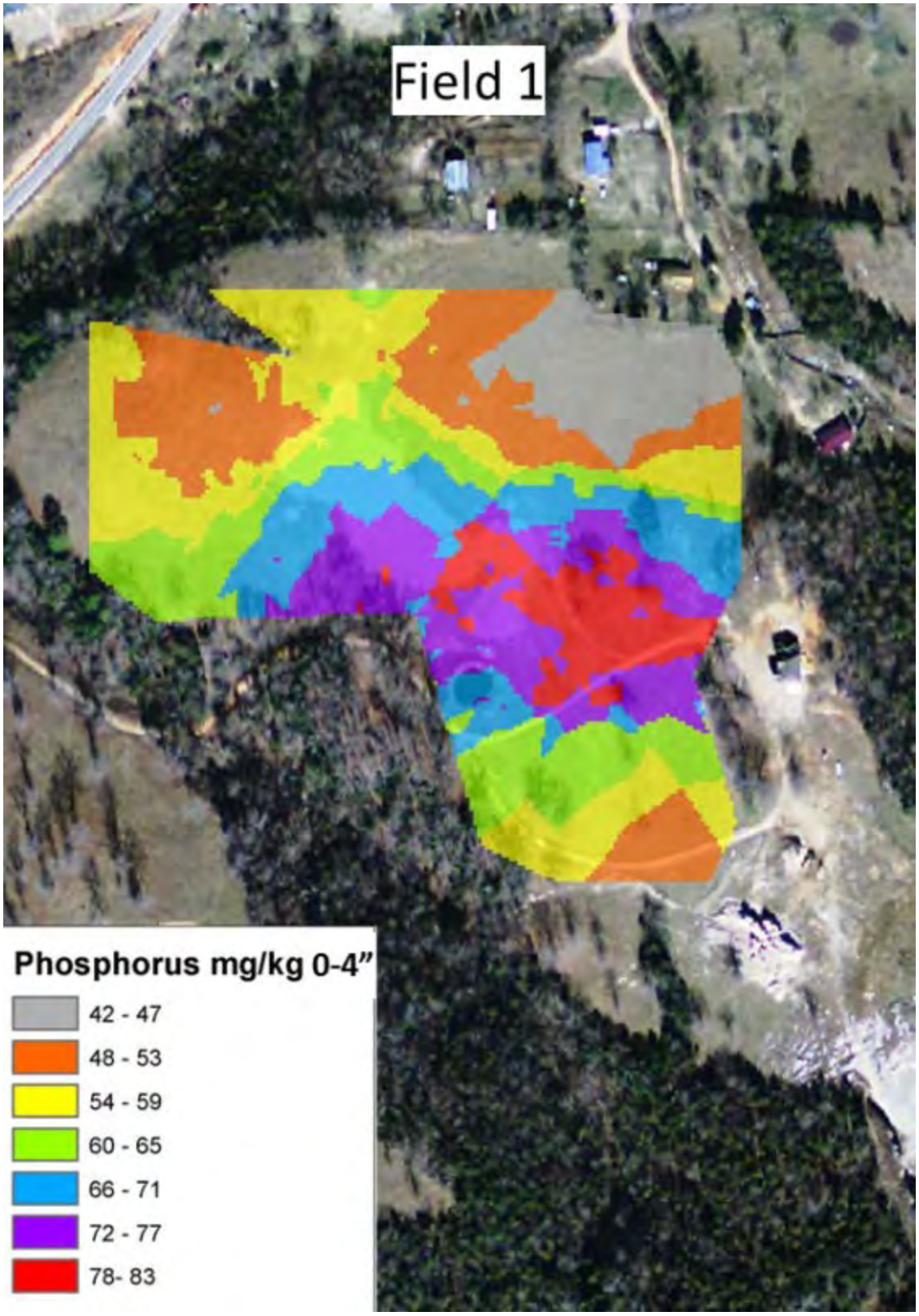
Table 3. Average soil test phosphorus concentrations in the surface 0 to 4 inches of each field and when sampled during the Comprehensive Nutrient Management Plan (CNMP) development.

Soil depth, inches	Field 1	Field 5	Field 12
	--------- mg/kg ----------		
Original NMP	83	65	19
0 - 4	41	54	NS
4 – 8	17	32	NS
8 – 12	10	28	NS
12 – 18	NS	34	NS
18 – 24	NS	6	NS
24 – 30	NS	19	NS

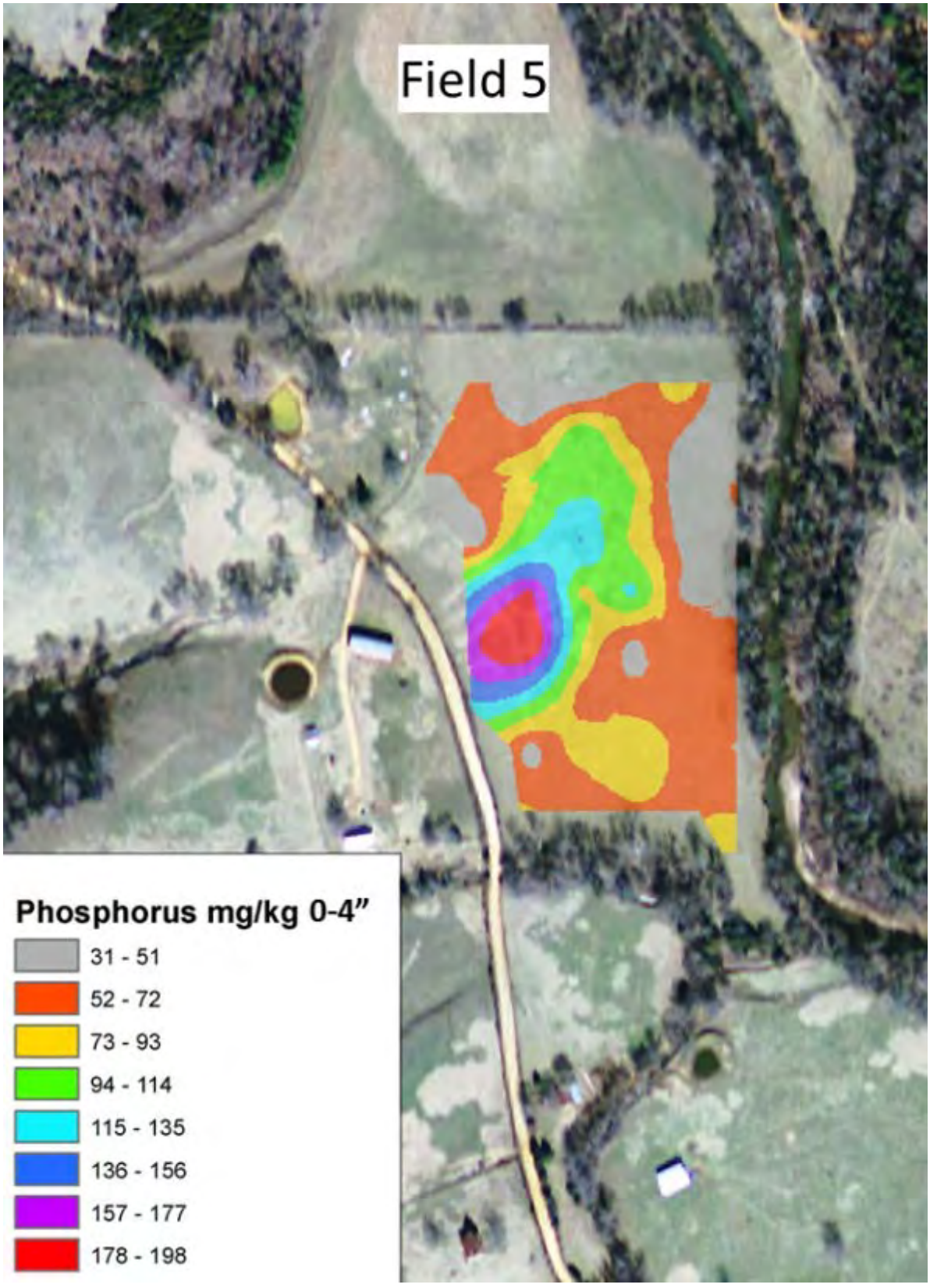
NS – Not sampled.



Map 7. Gridded layout of the sampled fields on the C&H Farm operation Mt. Judea, Newton County, AR.



Map 8. Soil phosphorus distribution of the 0 to 4 inch depth for Field 1.



Map 9. Soil phosphorus distribution of the 0 to 4 inch depth for Field 5.

Manure Slurry Sampling and Analysis

To help guide initial adaptive manure management decisions samples of the manure slurry from the C&H lagoon were collected on September 24, 2013 for chemical analysis. A foot valve liquid manure sampler was used to collect samples of slurry from the top 6 inches of slurry, the bottom of the lagoon, and from the entire depth profile of the lagoon (Photo 4). Additional information on manure sampling is given in Appendix 3. Results of this slurry sampling are given in Table 4 and the distribution of chemical constituents with lagoon depth is given in Figure 11. This information was shared with C&H's owners as part of the adaptive manure management discussions.

Photo 4. Foot valve manure sampler as used to collect samples from the C&H lagoon.

Table 4. Chemical properties of manure slurry taken from the C&H lagoon on 09/24/2013.

Parameter	0 – 6“	Bottom	Profile
pH	7.8	7.6	7.7
Electrical conductivity µmohos/cm	10020	9880	10060
Solids. %	0.63	2.99	2.56
Concentration on a mg/L as-is basis			
Total N	763.0	1565.0	1514.0
Total P	134.7	1139.3	527.5
Water extractable P	88.4	162.6	137.7
Total K	1080.4	158.8	1054.3
Total Ca	35.0	925.3	379.6
Ammonium-N	731.0	758.0	875.0
Nitrate-N	<0.7	<0.7	<0.7
Total Mg	12.3	556.5	228.8
Total S	35.0	214.6	106.8
Total Fe	12.9	346.8	156.6
Total Mn	6.6	24.2	10.1
Total Zn	1.95	46.9	19.7
Total Cu	0.28	5.2	2.3
Content on a lbs/1000 gallon as-is basis			
Total N	6.36	13.04	12.61
Total P as P_2O_5	2.57	21.73	10.06
Water extractable P	0.74	1.35	1.15
Total K as K_2O	10.80	11.58	10.54
Total Ca	0.29	7.71	3.16
Ammonium-N	6.09	6.31	7.29
Nitrate-N	<0.0006	<0.0006	<0.0006

Parameter	0 – 6“	Bottom	Profile
Total Mg	0.10	4.64	1.91
Total S	0.29	1.79	0.89
Total Fe	0.11	2.89	1.30
Total Mn	0.05	0.20	0.08
Total Zn	0.02	0.39	0.16
Total Cu	0.002	0.04	0.02

* lbs/1000gal P2O5 = mg/l Total P on "as-is" basis multiplied by 2.29*0.00833
* lbs/1000gal K2O = mg/l Total K on "as-is" basis multiplied by 1.2*0.00833
* Water Extractable P: 1:100 solids to H2O ratio, I hour shake, centrifuged, filtered, acidified, analysis by ICP.

Collection and analysis of manure samples from the holding pond / lagoon on the C&H Farm, representing the top water, bottom slurry, and entire profile, generated chemical profiles typical of other holding ponds associated with hog production. That is, nitrogen and phosphorus concentrations of the manure increased with water depth (Table 4 and Figure 11). However, phosphorus concentrations increased at a greater rate than did concentrations of nitrogen. The result of the relatively greater phosphorus increase than nitrogen increase with pond depth is that the nitrogen / phosphorus ratio is greater for surface liquid than bottom slurries. As a consequence, the higher nitrogen / phosphorus ratio of the surface water is closer to the ratio of these nutrients required by pastures on the C&H Farm. Thus, land application of top water from the pond to farm pastures will more likely meet both the nitrogen and phosphorus needs of the pasture and avoid application of phosphorus surplus to plant needs. The higher concentration and lower nitrogen / phosphorus ratio of bottom slurries will lend application of that slurry on a manure banking approach, where the slurry would be applied on alternate years to fields more distant from Big Creek. Even without the addition of mechanical and/or chemical separation approaches, the observed natural gravity separation of slurry and its constituents, provides farm nutrient management opportunities to closely match manure nutrients to crop nutrient needs.

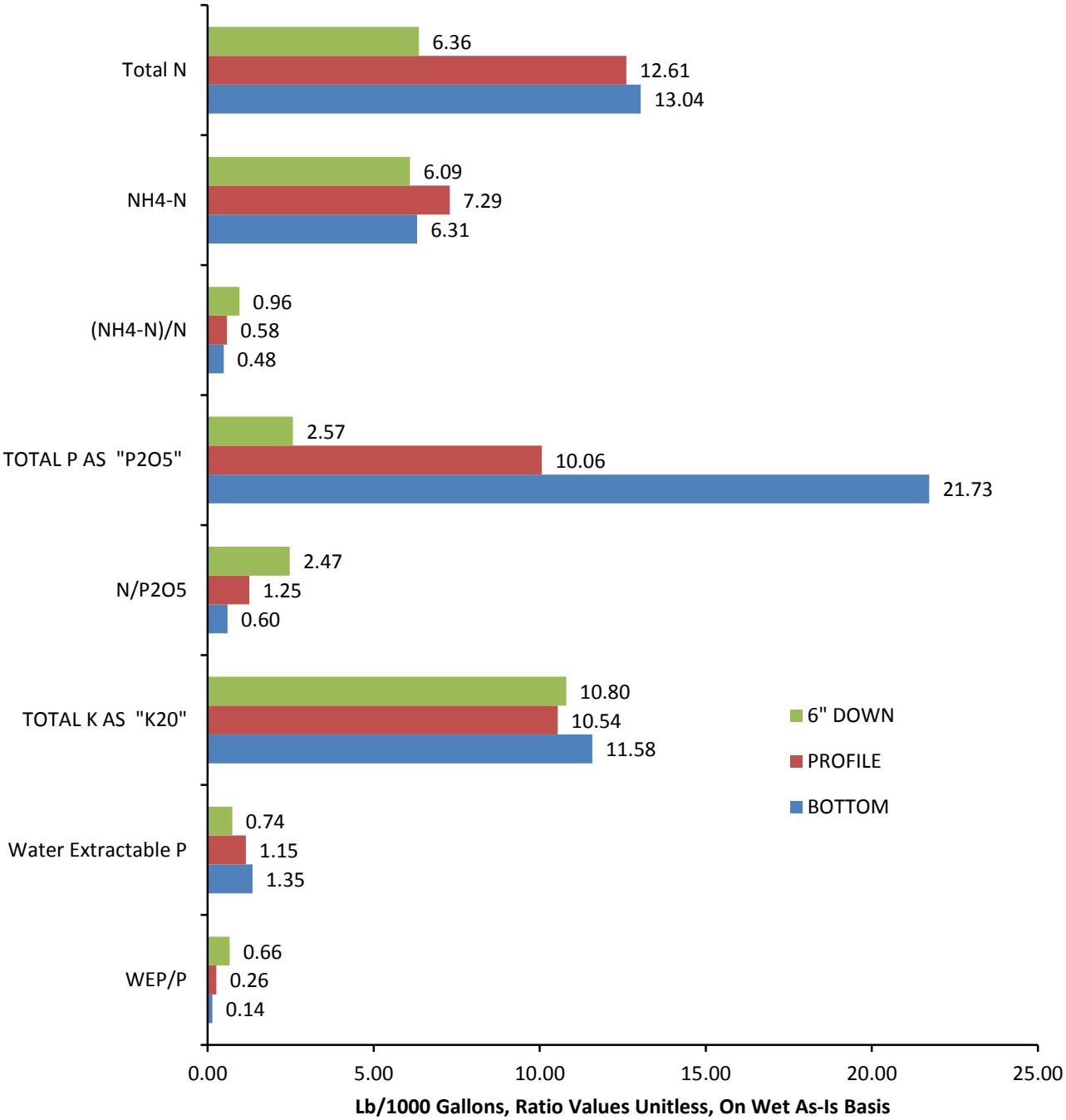


Figure 11. Distribution of nitrogen, phosphorus and potassium with depth in the manure lagoon, sampled on September 24, 2013.

Water Sampling and Analyses

Sampling Locations

Water quality sampling was initiated on September 24th, 2013, prior to the formal start of the project at five locations (Map 10). These sites were;

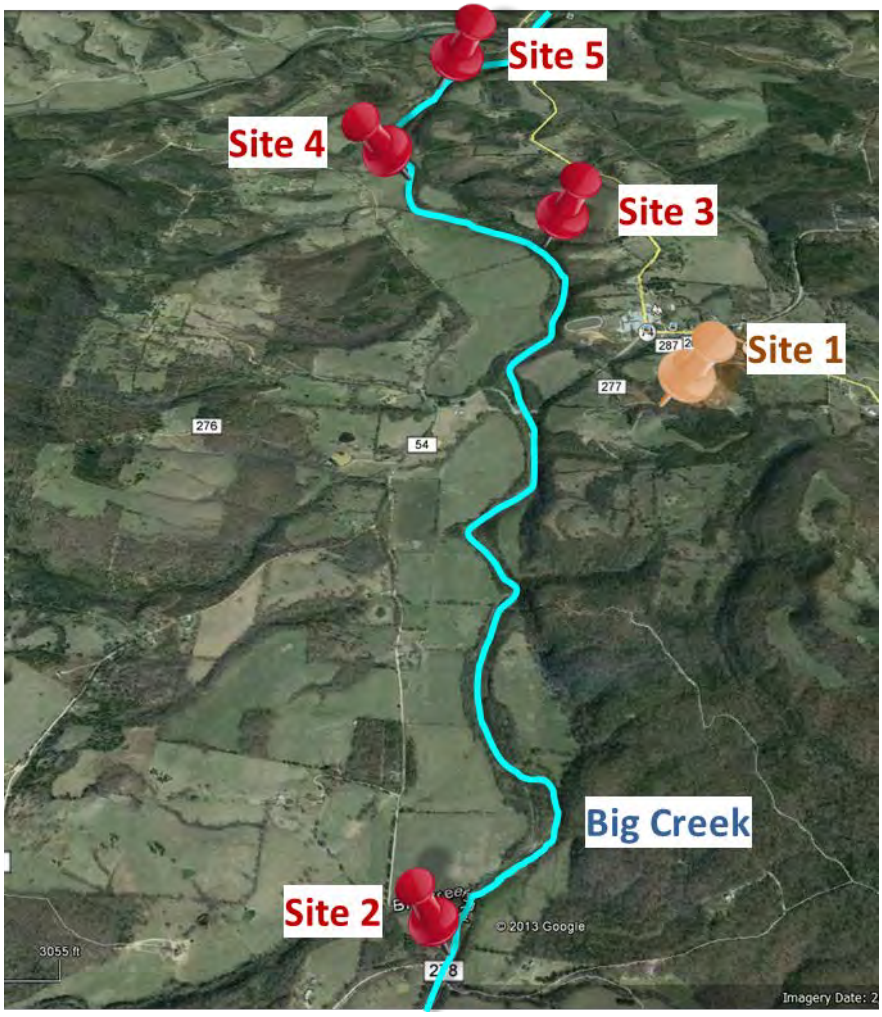
Site 1. A spring below application field 1 – Photo 4,

Site 2. Big Creek upstream of the C&H Farm operation – Photo 5,

Site 3. Big Creek upstream of the barn – Photo 6,

Site 4. Big Creek downstream of the barn – Photo 7, and

Site 5. Big Creak downstream of the C&H Farm operation Photo 8.



Map 10. Location of water quality sampling sites on Big Creek and spring below application Field 1.

Photo 5. The spring sampled adjacent to Big Creek on the C&H Farm.

Photo 6. The Big Creek sampling site upstream of the C&H Farm during baseflow.

Photo 7. The Big Creek sampling site upstream of the C&H Farm barn during baseflow.

Photo 8. The Big Creek sampling site downstream of the C&H Farm barn during baseflow.

Photo 9. The Big Creek sampling site downstream of the C&H Farm during baseflow.

Sampling Protocols and Analyses

The chemical composition of water samples collected prior to December 31, 2013 is given in Table 5. The following procedure was used to collect, prepare and analyze all water samples;

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted.
6. Samples were placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
7. Analyses included Dissolved Phosphorus (EPA 365.2), Total Phosphorus (APHA 4500-P), Ammonia (EPA 351.2), Nitrate (EPA 300.0), Total Nitrogen (APHA 4500-P), Total Suspended Solids (EPA 160.2), E. Coli (APHA 9223, B) and Total Coliforms (APHA 9223, B).

Table 5. Water quality analyses at each sample site. Coliform units are Most Probable Number (MPN) per 100 mL of water.

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved phosphorus	Total phosphorus	Ammonia-nitrogen	Nitrate-nitrogen	Total nitrogen	Total suspended solids	E_ coli	Total coliform
			---------- mg/L ----------						--- MPN/100 mL ---	
9/12/2013	**9/12/2013**	**Base flow**								
10:45	15:30	Upstream farm	0.016	0.030	0.06	0.367	0.50	3.0	6.3	>2420
11:15	15:30	Upstream barn	0.010	0.022	0.05	0.356	0.54	5.8	4.1	4040.0
10:50	15:30	Downstream barn	0.019	0.026	0.05	0.632	0.78	1.2	1.0	488.4
13:00	15:30	Downstream farm	0.010	0.022	0.04	0.396	0.62	1.7	16.0	>2420
9/20/2013	**9/20/2013**	**Base flow**								
10:50	16:08	Spring	0.006	0.020	0.03	0.384	0.50	4.7	72.7	5040
11:15	16:08	Upstream farm	0.009	0.022	0.03	0.247	0.36	1.1	80.9	9870
11:20	16:08	Upstream barn	0.015	0.024	0.04	0.356	0.42	1.2	1203	26130
12:20	16:08	Downstream barn	0.024	0.032	0.06	0.757	0.85	1.3	218.7	2430
12:50	16:08	Downstream farm	0.013	0.022	0.05	0.442	0.53	1.1	548	17230
9/24/2013	**9/24/2013**	**Base flow**								
10:55	16:15	Spring	0.004	0.024	0.00	0.122	0.35	50.0	8.5	>2420

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved phosphorus	Total phosphorus	Ammonia-nitrogen	Nitrate-nitrogen	Total nitrogen	Total suspended solids	E_ coli	Total coliform
11:40	16:15	Upstream farm	0.011	0.014	0.03	0.444	2.20	17.9	39	1120
11:15	16:15	Upstream barn	0.007	0.024	0.00	0.330	0.41	1.6	42	>2419
11:20	16:15	Downstream barn	0.017	0.032	1.77	0.790	0.76	0.7	42	816
12:40	16:15	Downstream farm	0.007	0.028	0.01	0.511	0.58	1.5	5	>2420
10/1/2013	**10/1/2013**	**Base flow**								
9:45	14:42	Spring	0.001	0.162	0.00	0.108	0.41	89.2	4	920
10:00	14:42	Upstream farm	0.011	0.038	0.02	0.236	0.34	2.2	8	1300
10:15	14:42	Upstream barn	0.006	0.032	0.03	0.235	0.40	6.7	82	5200
10:35	14:42	Downstream barn	0.018	0.032	0.00	0.837	0.80	1.1	19	649
10:55	14:42	Downstream farm	0.009	0.034	0.02	0.514	0.65	3.6	2620	10810
10/9/2013	**10/9/2013**	**Base flow**								
9:00	13:52	Spring	0.011	0.054	0.00	0.088	0.28	29.1	3	1413
9:30	13:52	Upstream farm	0.016	0.034	0.00	0.497	0.73	7.1	11	2419
9:45	13:52	Upstream barn	0.016	0.030	0.00	0.385	0.53	6.2	194	4730

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved phosphorus	Total phosphorus	Ammonia-nitrogen	Nitrate-nitrogen	Total nitrogen	Total suspended solids	E_ coli	Total coliform
10:00	13:52	Downstream barn	0.017	0.02	0.00	0.868	0.82	0.4	29	1986
10:20	13:52	Downstream farm	0.006	0.038	0.00	0.618	0.77	13.6	28	3450
10/15/2013	**10/15/2013**	**Storm flow**								
11:13	15:47	Spring	0.010	0.250	0.15	0.086	0.58	66.9	1401	19863
12:24	15:47	Upstream farm	0.018	0.026	0.00	1.041	0.96	1.1	759	>2419
12:47	15:47	Upstream barn	0.019	0.036	0.06	0.839	0.99	2.1	472	8664
13:13	15:47	Downstream barn	0.033	0.244	0.12	1.280	1.44	89.2	959	12997
13:34	15:47	Downstream farm	0.067	0.316	0.20	0.677	1.07	101.1	1334	19863
10/22/2013	**10/22/2013**	**Base flow**								
10:10	15:31	Spring	0.005	0.086	0.10	0.307	0.53	36.4	1733	>2419
10:30	15:31	Upstream farm	0.014	0.034	0.00	0.345	0.32	0.3	186	299
10:45	15:31	Upstream barn	0.016	0.024	0.03	0.575	0.60	1.2	411	11190
11:00	15:31	Downstream barn	0.016	0.022	0.00	0.786	0.77	0.1	150	2419
11:20	15:31	Downstream farm	0.012	0.020	0.04	0.723	0.76	0.7	87	292

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved phosphorus	Total phosphorus	Ammonia-nitrogen	Nitrate-nitrogen	Total nitrogen	Total suspended solids	E_ coli	Total coliform
10/31/2013	**10/31/2013**	**Base flow**								
11:00	15:15	Spring	0.003	0.404	0.14	0.321	1.02	400.9	91	32550
10:45	15:15	Upstream farm	0.012	0.032	0.00	0.242	0.32	1.1	66	1986
10:15	15:15	Upstream barn	0.007	0.044	0.04	0.246	0.38	2.3	261	6310
10:00	15:15	Downstream barn	0.018	0.022	0.11	0.519	0.53	0.9	14	218
10:30	15:15	Downstream farm	0.012	0.024	0.03	0.443	0.45	1.4	Leaked	Leaked
11/6/2013	**11/6/2013**	**Base flow**								
8:35	14:35	Spring	0.013	0.130	0.10	0.062	0.72	21.2	8570	34480
9:00	14:35	Upstream farm	0.032	0.074	0.03	0.432	0.61	4.7	4080	28510
9:10	14:35	Upstream barn	0.020	0.038	0.00	0.184	0.27	2.5	579	13330
9:45	14:35	Downstream barn	0.040	0.164	0.12	0.413	0.67	32.9	3180	36090
10:00	14:35	Downstream farm	0.041	0.154	0.12	0.286	0.60	28.4	3500	43520
11/12/2013	**11/12/2013**	**Base flow**								
10:56	16:28	Spring	0.006	0.022	0.05	2.449	2.39	8.9	48	2750

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved phosphorus	Total phosphorus	Ammonia-nitrogen	Nitrate-nitrogen	Total nitrogen	Total suspended solids	E_ coli	Total coliform
11:35	16:28	Upstream farm	0.011	0.010	0.00	0.169	0.22	1.0	45	1986
12:15	16:28	Upstream barn	0.012	0.014	0.09	0.221	0.33	1.4	36	1733
13:03	16:28	Downstream barn	0.012	0.012	0.00	0.295	0.34	0.5	21	1046
13:35	16:28	Downstream farm	0.011	0.010	0.00	0.242	0.31	0.0	24	>2419
11/19/2013	**11/19/2013**	**Base flow**								
9:20	14:35	Spring	0.007	0.022	0.02	3.063	3.06	4.4	579	9880
9:45	14:35	Upstream farm	0.010	0.026	0.00	0.123	0.22	0.7	435	2400
10:05	14:35	Upstream barn	0.011	0.028	0.00	0.175	0.32	0.3	172	>2419
10:35	14:35	Downstream barn	0.011	0.028	0.00	0.231	0.34	0.5	238	2419
10:55	14:35	Downstream farm	0.009	0.024	0.02	0.172	0.28	1.0	194	4410
11/26/2013	**11/26/2013**	**Base flow**								
10:35	14:40	Spring	0.007	0.018	0.00	1.69	1.70	4.5	86	1553
10:45	14:40	Upstream farm	0.013	0.018	0.00	0.135	0.14	0.4	77	1203
11:06	14:40	Upstream barn	0.014	0.016	0.00	0.19	0.20	0.7	249	1986

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved phosphorus	Total phosphorus	Ammonia-nitrogen	Nitrate-nitrogen	Total nitrogen	Total suspended solids	E_ coli	Total coliform
11:30	14:40	Downstream barn	0.014	0.018	0.03	0.3	0.33	1.3	40	613
11:45	14:40	Downstream farm	0.013	0.016	0.00	0.231	0.24	1.2	36	2419
12/3/2013	**12/3/2013**	**Base flow**								
8:30	13:23	Spring	0.007	0.046	0.04	1.048	1.37	26.9	25	1986
8:45	13:23	Upstream farm	0.007	0.012	0.00	0.152	0.25	0.5	27	435
9:00	13:23	Upstream barn	0.009	0.012	0.00	0.21	0.28	0.3	29	548
9:15	13:23	Downstream barn	0.010	0.018	0.00	0.295	0.35	0.6	248	687
9:35	13:23	Downstream farm	0.006	0.012	0.00	0.225	0.28	0.5	12	>2419

The water quality data in Table 4 for the monitored spring and Big Creek above and below the boundary of the permitted fields of the C&H Farm only is given in Table 6.

Table 6. Water quality analyses at the spring and in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application fields (see Map 12).

Sample location relative to farm	Dissolved phosphorus	Total phosphorus	Ammonia-nitrogen	Nitrate-nitrogen	Total nitrogen	Total suspended solids	E_ coli	Total coliform
	mg/L						MPN/100 mL	
9/12/2013 Base flow								
Upstream	0.016	0.030	0.06	0.367	0.50	3.0	6	>2420
Downstream	0.010	0.022	0.04	0.396	0.62	1.7	16	>2420
9/20/2013 Base flow								
Spring	0.006	0.020	0.03	0.384	0.50	4.7	73	5040
Upstream	0.009	0.022	0.03	0.247	0.36	1.1	81	9870
Downstream	0.013	0.022	0.05	0.442	0.53	1.1	548	17230
9/24/2013 Base flow								
Spring	0.004	0.024	0.00	0.122	0.35	50.0	9	>2420
Upstream	0.021	0.140	0.03	0.444	2.20	17.9	39	1120
Downstream	0.007	0.028	0.01	0.511	0.58	1.5	5	>2420
10/1/2013 Base flow								
Spring	0.001	0.162	0.00	0.108	0.41	89.2	4	920.8
Upstream	0.011	0.038	0.02	0.236	0.34	2.2	8	1300
Downstream	0.009	0.034	0.02	0.514	0.65	3.6	2620	10810
10/9/2013 Base flow								
Spring	0.011	0.054	0.00	0.088	0.28	29.1	3	1413.6

Sample location relative to farm	Dissolved phosphorus	Total phosphorus	Ammonia-nitrogen	Nitrate-nitrogen	Total nitrogen	Total suspended solids	E_ coli	Total coliform
Upstream	0.016	0.034	0.00	0.497	0.73	7.1	11	2419.6
Downstream	0.006	0.038	0.00	0.618	0.77	13.6	28	3450.0
10/15/2013 Storm flow								
Spring	0.010	0.250	0.15	0.086	0.58	66.9	1401	19863.0
Upstream	0.018	0.026	0.00	1.041	0.96	1.1	759	>2419.6
Downstream	0.067	0.316	0.20	0.677	1.07	101.1	1334	19863.0
10/22/2013 Base flow								
Spring	0.005	0.086	0.10	0.307	0.53	36.4	1733	>2419.6
Upstream	0.014	0.034	0.00	0.345	0.32	0.3	186	299.0
Downstream	0.012	0.020	0.04	0.723	0.76	0.7	87	292.0
10/31/2013 Base flow								
Spring	0.003	0.404	0.14	0.321	1.02	400.9	91	32550.0
Upstream	0.012	0.032	0.00	0.242	0.32	1.1	66	1986.3
Downstream	0.012	0.024	0.03	0.443	0.45	1.4	Leaked	Leaked
11/6/2013 Base flow								
Spring	0.013	0.130	0.10	0.062	0.72	21.2	8570	34480.0
Upstream	0.032	0.074	0.03	0.432	0.61	4.7	4080	28510.0
Downstream	0.041	0.154	0.12	0.286	0.60	28.4	3500	43520.0
11/12/2013 Base flow								
Spring	0.006	0.022	0.05	2.449	2.39	8.90	48	2750.0
Upstream	0.011	0.010	0.00	0.169	0.22	1.00	45	1986.3

Sample location relative to farm	Dissolved phosphorus	Total phosphorus	Ammonia-nitrogen	Nitrate-nitrogen	Total nitrogen	Total suspended solids	E_ coli	Total coliform
Downstream	0.011	0.010	0.00	0.242	0.31	0.0	24	>2419.2
11/19/2013 Base flow								
Spring	0.007	0.022	0.02	3.063	3.06	4.4	579	9880.0
Upstream	0.010	0.026	0.00	0.123	0.22	0.7	435	2400.0
Downstream	0.009	0.024	0.02	0.172	0.28	1.0	194	4410.0
11/26/2013 Base flow								
Spring	0.007	0.018	0.00	1.69	1.70	4.5	86	1553.1
Upstream	0.013	0.018	0.00	0.135	0.14	0.4	77	1203.3
Downstream	0.013	0.016	0.00	0.231	0.24	1.2	36	2419.2
12/3/2013 Base flow								
Spring	0.007	0.046	0.04	1.048	1.37	26.9	25	1986.3
Upstream	0.007	0.012	0.00	0.152	0.25	0.5	27	435.2
Downstream	0.006	0.012	0.00	0.225	0.28	0.5	12	>2419.2

Future Plan of Work

Field Evaluation - Land Application Sites

Assess water flow directions and risk of nutrient and bacteria losses from three fields (Fields 1, 5, and 12) that will be used to land apply manure. On each field:

1. Complete the detailed topographic survey of the application fields to better understand surface water flow patterns and the most appropriate location for surface runoff collection and monitoring wells / piezometer devices.
2. Conduct annual grid soil sampling to develop dynamic soil nutrient maps for the monitored application fields (i.e., Fields 1, 5, and 12). Use results to develop a balanced/sustainable soil fertility strategic plan.

3. Conduct inventory of soil physical properties, to include but not limited to surface infiltration, subsurface hydraulic conductivity, bulk density, phosphorus sorption isotherms, and particle size analysis in the three application fields.
4. Install bermed surface runoff area (>2 acres) to collect and monitor surface runoff, with weather station (Maps 11, 12, and 13) as and where appropriate. Collect surface runoff and measure nitrogen, phosphorus, pH, sediment, and bacteria (E. coli) for one year.
5. Install two transects of piezometers across the two stream-side fields (i.e., #5 and 12) to automatically and continuously determine if subsurface water is moving to or away from the adjacent river (Maps 12 and 13). These will be installed according to standard NRCS protocols and described in more detail in Appendix 4 (see Figures 12 and 13). Piezometers will be installed so that there is minimal piping or equipment above ground that could interfere or influence with day to day farm operations on that field.
6. Periodically determine plant uptake by collecting plant and hay samples for tissue analysis and determine yield (dry matter mass for a pre-determined area.
7. Determine nutrient application rate by determining nutrient content of swine effluent before land application via manure application and determine volume of effluent being applied to known monitoring area.

Water Quality Assessment of Springs, Ephemeral Streams, and Creeks in the Operation

Measure nutrient, bacteria, and sediment concentrations in: a) an ephemeral stream that drains runoff from around the animal production facility and slurry holding ponds, b) springs connected to land application fields, and c) Big Creek at upstream and downstream of farm (see Map 11).

1. Continuously monitor flow and automatically collect water samples at a road culvert draining the subwatershed containing the animal houses and manure holding ponds.
2. Install a calibrated stream gauge for continuous flow measurement and collect Big Creek water samples on at least a biweekly basis above and below the C&H farm boundary. At the same sate, deploy an automatic water sampler in Big Creek that will collect storm flow samples.
3. Deploy sondes at the spring and Big Creek sampling locations to continuously determine dissolved oxygen (DO), excess partial pressure of carbon dioxide ($EpCO_2$), electrical conductivity (EC), and temperature of the water. Diurnal, seasonal, and storm event fluctuations of water $EpCO_2$, DO, EC, and temperature can be used to examine the rates of respiration and photosynthesis linked to changing nutrient status and organic matter loading and to also identify possible sources of new and old water at these locations. Similarly, a longitudinal survey downstream between upper and lower sampling points in Big Creek under baseflow, can locate potential sites where water is entering the Creek from the surrounding landscape. That is, $EpCO_2$ will increase (and pH will drop), with the input of spring water into Big Creek.

Manure Treatment via Solids and Chemical Separation: A Case Study to Evaluate Cost Benefits of Alternative Manure Management Options

Continue current discussions with the owners of the C&H Farm to explore potential long-term, economically viable, options to modify current manure management practices in the general areas of:

1. Separating manure liquids and solids along with their differential management;
2. Retaining sufficient nitrogen to meet crop needs;
3. Exporting excess phosphorus off the farm;
4. Mitigating off site odor;
5. Not exceeding the current physical, economic, labor, and management resources of the farm; and
6. Operating within the constraints of the appropriate environmental regulations.

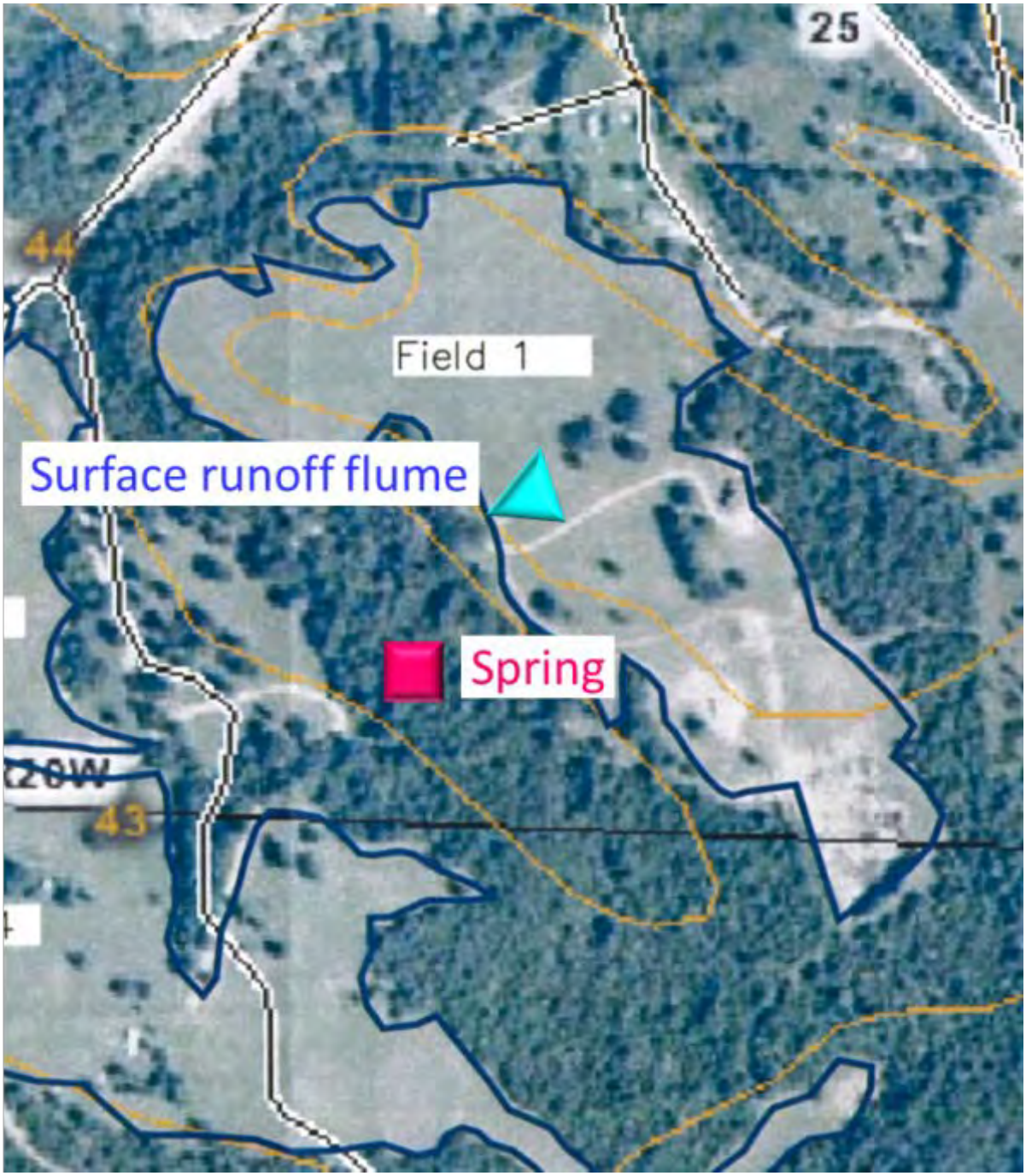
The project will identify management options to meet the above objectives. It is anticipated that the options will include but not be limited to:

- Mechanical separation manure solids from liquids with or without chemicals as a precursor for off-farm transport of separated solids; and
- Selective application of higher phosphorus content slurries and lower phosphorus content liquids to different fields that minimizes any loss of nutrient loss.

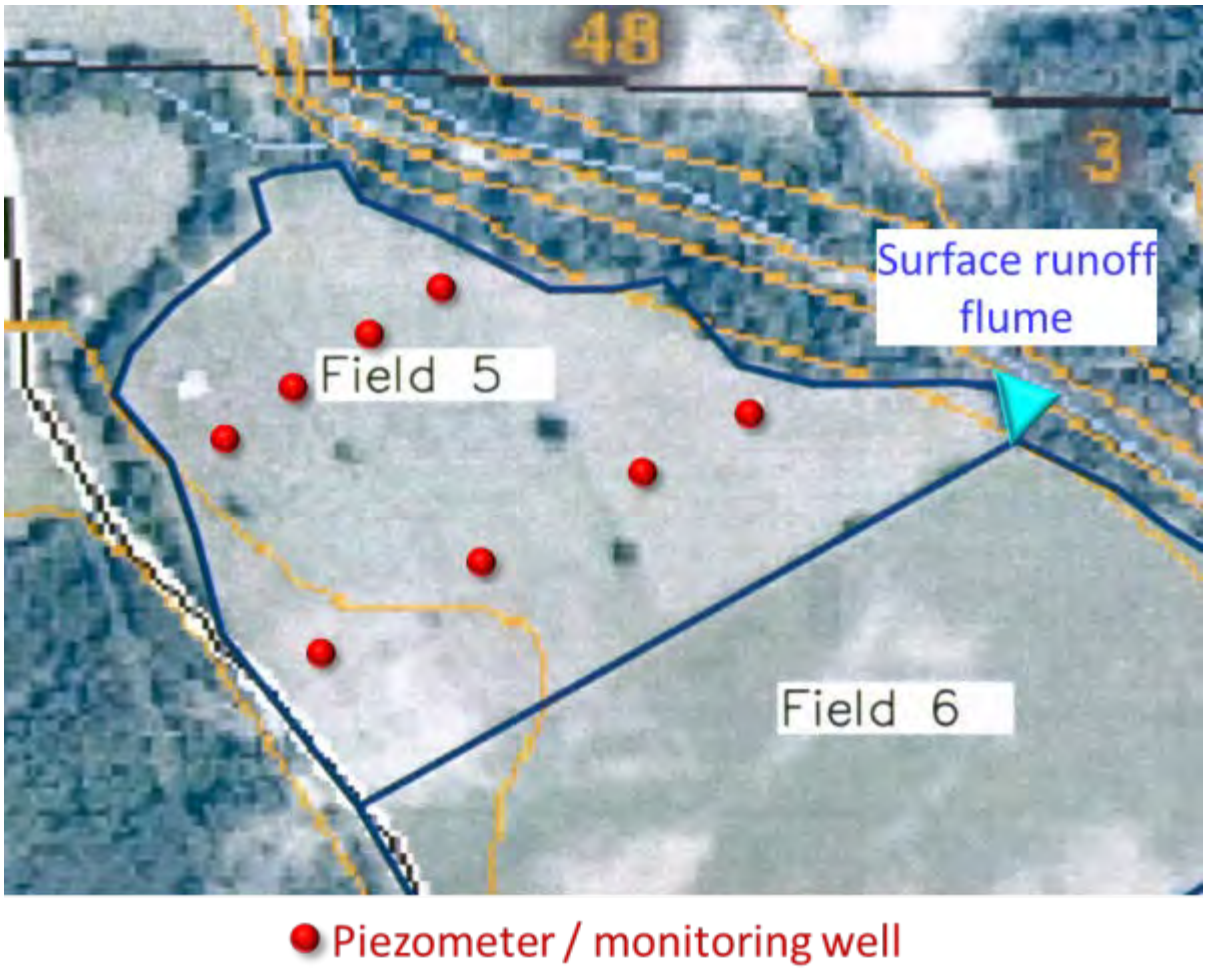
For the management options identified, their initial and long-term costs will be estimated and an assessment of their implementation impacts made. Available literature and other information resources will be utilized in this process. However, there will be a need for laboratory and onsite tests/trials. This is especially true when evaluating manure solid-liquid separation and/or chemical use. Based on current discussions development of field chemical tests and lab analysis will begin soon. The results of these tests will guide decisions that may lead to additional larger scale implementation trials.

Project Outcomes

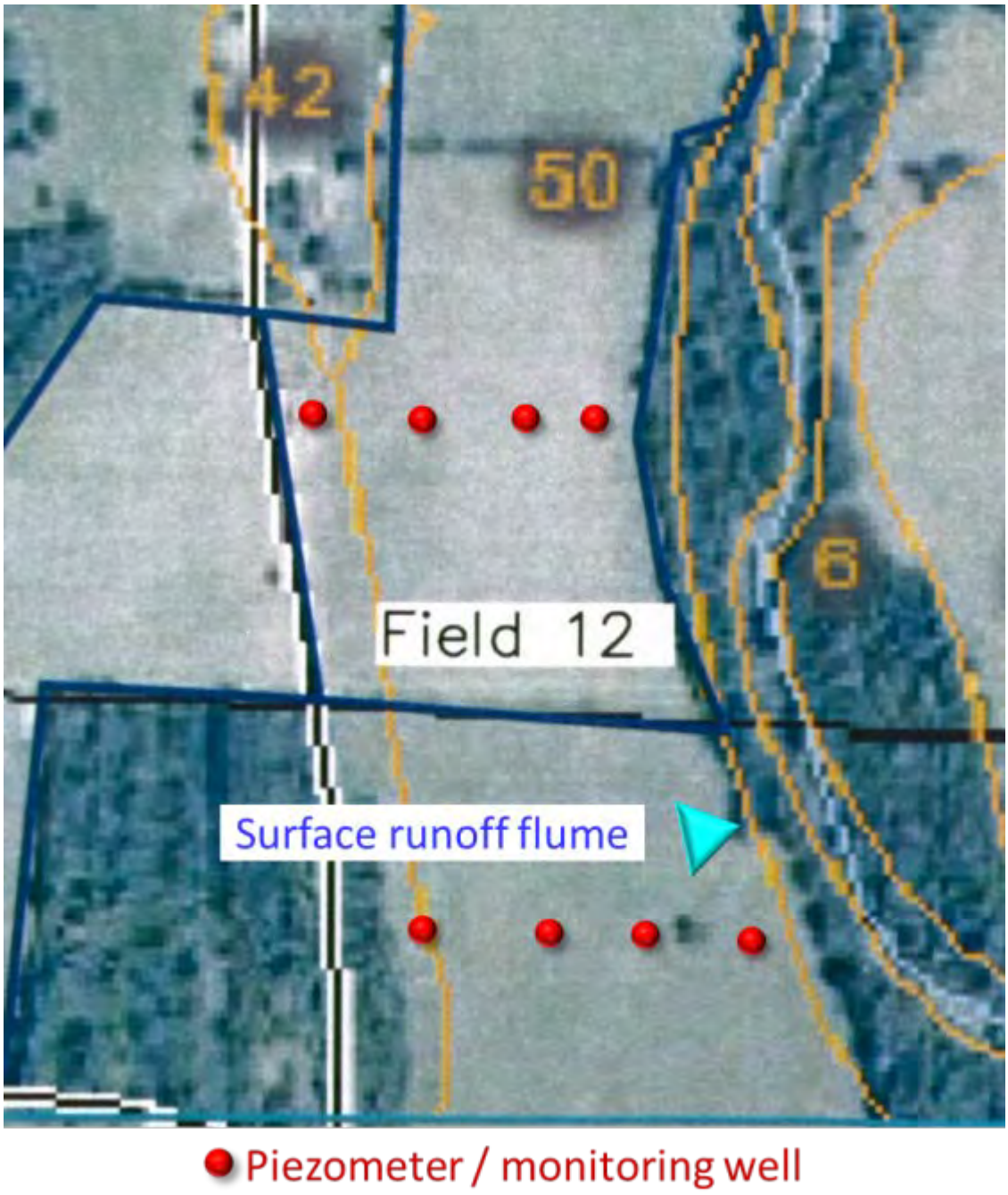
1. Research project documenting the field and manure management options evaluated and the details of their evaluation.
2. Will provide C&H Farm input for their decision on appropriate options to undertake manure treatment and export, in terms of cost and labor considerations.
3. A sustainable management blueprint for C&H Farm operation.
4. Documentation of any environmental impacts and details of actions taken to eliminate them.
5. A five-year assessment of C&H. If the majority of those five years are abnormal weather years, consideration should be given to extend the assessment in order to obtain a true representation of Operation impacts.



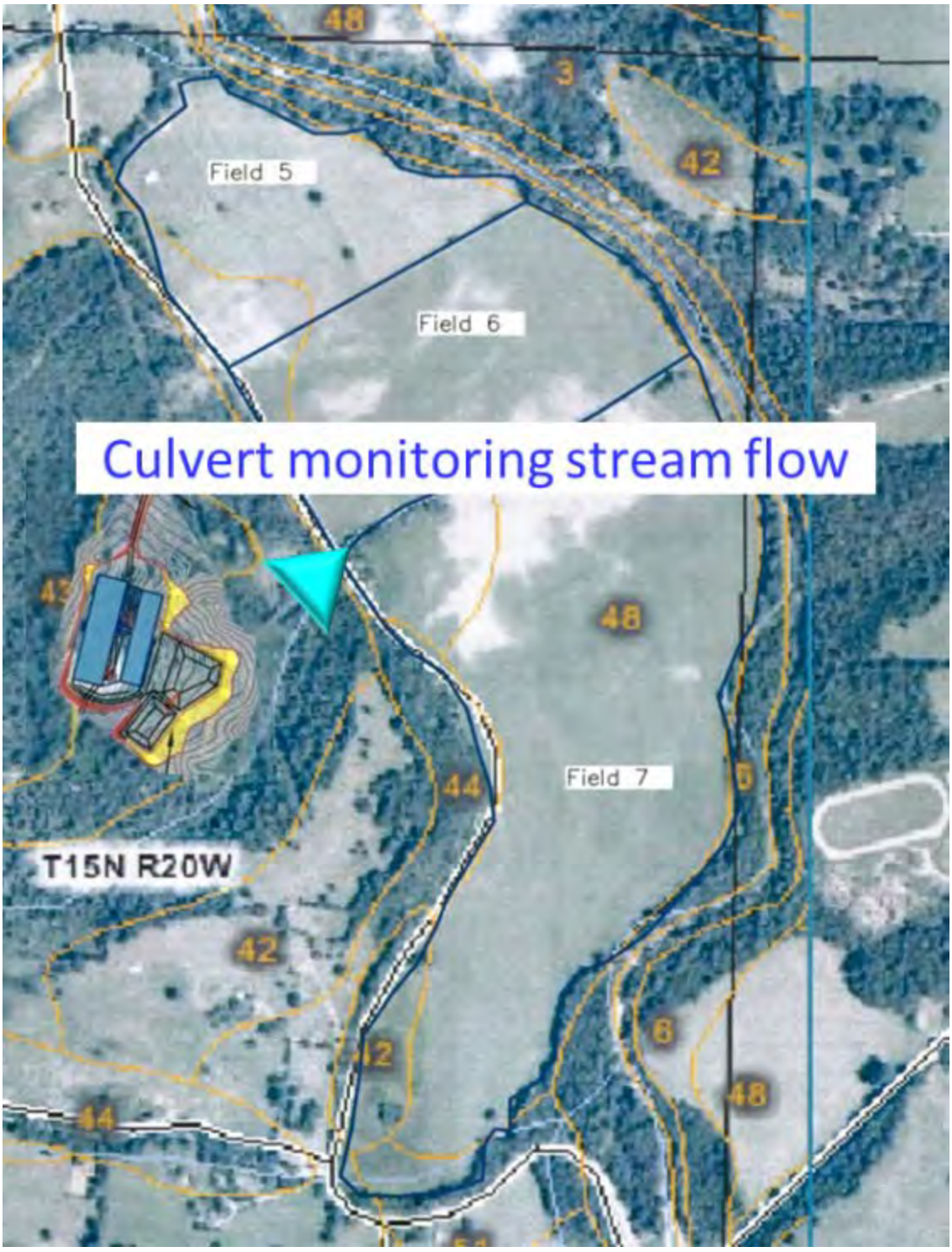
Map 11. Potential sampling locations for Field 1.



Map 12. Potential sampling locations for Field 5.



Map 13. Potential sampling locations for Field 12.



Map 14. Potential sampling locations for culvert monitoring.

Figure 12. Standard installations for soil studies of (1A) a piezometer and (1B) a water-table well (NRCS, 2008).

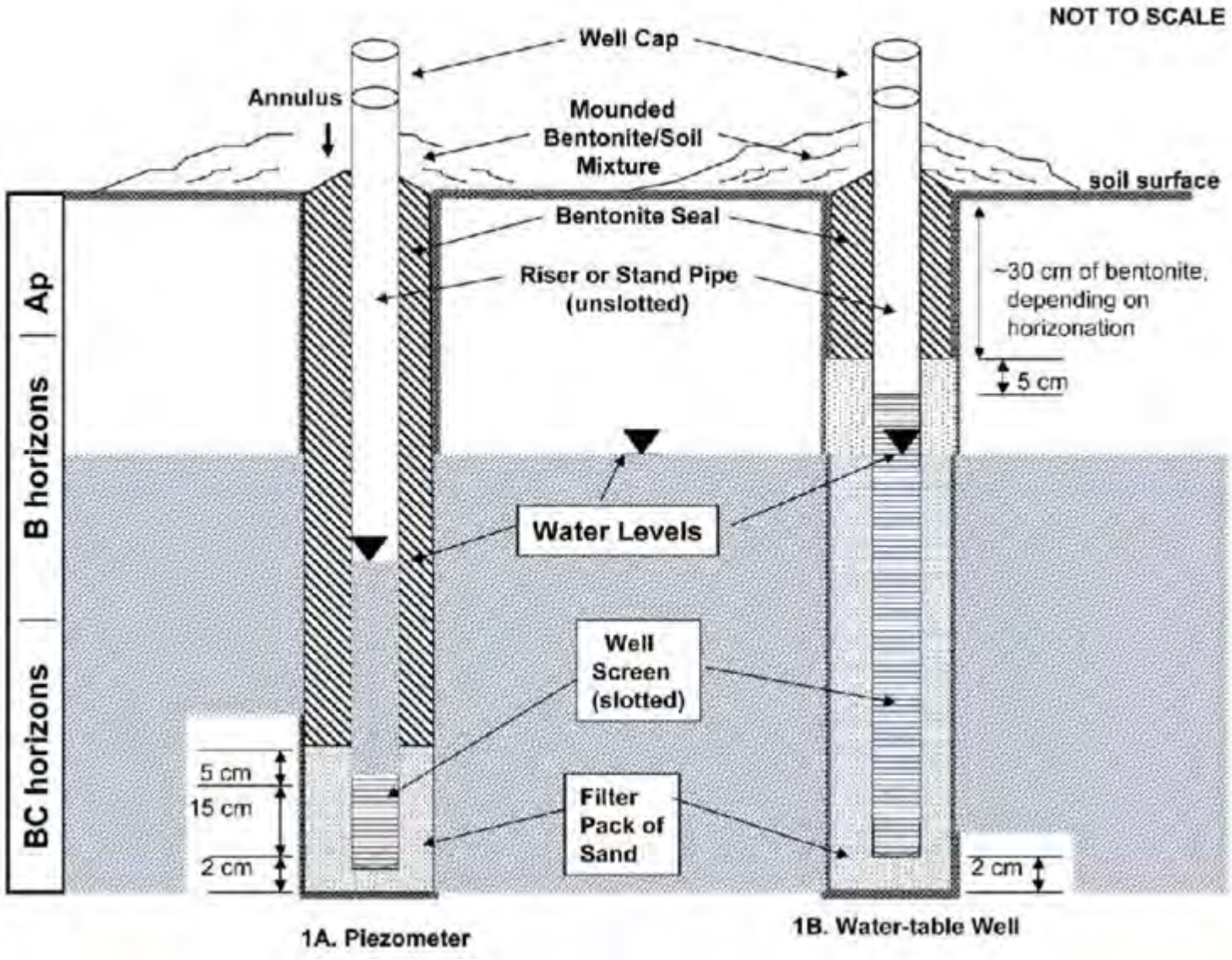
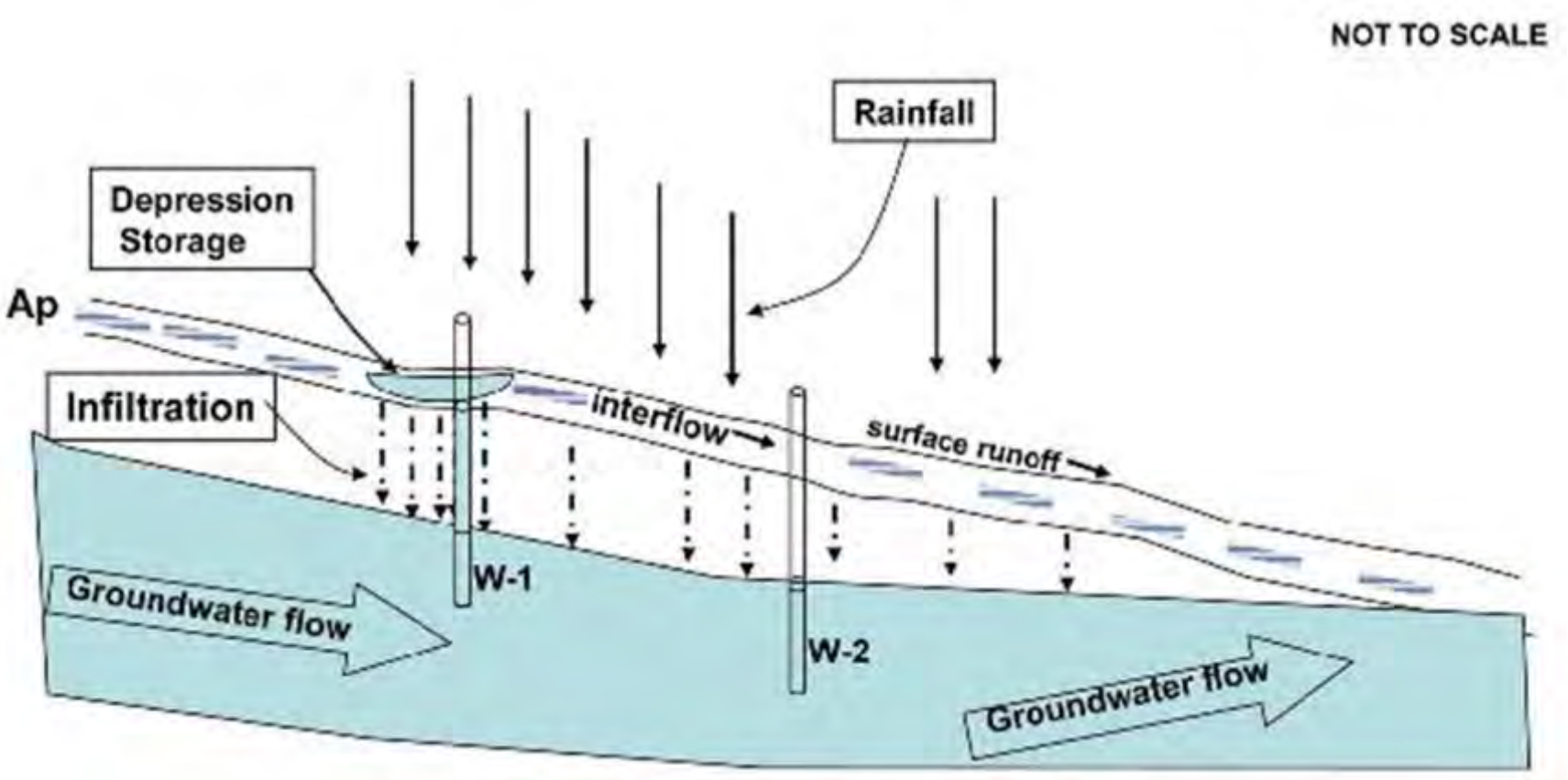


Figure 13. Schematic diagram of paths of water flow significant to shallow water monitoring studies in sloping landscapes. A combination of depression storage and interflow at small scales may be short-lived but can be significant enough to cause bypass flow down poorly protected well risers (W-1). Figure modified from Kirkby (1969).



Appendix 1 - Soil Mapping Unit Description from NRCS, Newton County, AR

[Minor map unit components are excluded from this report]

Map unit: 1 - Arkana very cherty silt loam, 3 to 8 percent slopes

Component: Arkana (100%)

The Arkana component makes up 100 percent of the map unit. Slopes are 3 to 8 percent. This component is on hillslopes and hills. The parent material consists of clayey residuum weathered from cherty limestone. Depth to a root restrictive layer, bedrock, lithic, is 20 to 40 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is very low. Available water to a depth of 60 inches is very low. Shrink-swell potential is high. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 6e. This soil does not meet hydric criteria.

Map unit: 2 - Arkana-Moko complex, 8 to 20 percent slopes

Component: Arkana (50%)

The Arkana component makes up 50 percent of the map unit. Slopes are 8 to 20 percent. This component is on hillslopes and hills. The parent material consists of clayey residuum weathered from cherty limestone. Depth to a root restrictive layer, bedrock, lithic, is 20 to 40 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is very low. Available water to a depth of 60 inches is very low. Shrink-swell potential is high. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 6e. This soil does not meet hydric criteria.

Component: Moko (35%)

The Moko component makes up 35 percent of the map unit. Slopes are 8 to 20 percent. This component is on hillslopes and hills. The parent material consists of loamy residuum weathered from cherty limestone. Depth to a root restrictive layer, bedrock, lithic, is 6 to 20 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. This component is in the R116AY001AR Limestone Ledge ecological site. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: 3 - Arkana-Moko complex, 20 to 40 percent slopes

Component: Arkana (45%)

The Arkana component makes up 45 percent of the map unit. Slopes are 20 to 40 percent. This component is on hillslopes and hills. The parent material consists of clayey residuum weathered from cherty limestone. Depth to a root restrictive layer, bedrock, lithic, is 20 to 40 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is very low. Available water to a depth of 60 inches is very low. Shrink-swell potential is high. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: 3 - Arkana-Moko complex, 20 to 40 percent slopes

Component: Moko (45%)

The Moko component makes up 45 percent of the map unit. Slopes are 20 to 40 percent. This component is on hillslopes and hills. The parent material consists of loamy residuum weathered from cherty limestone. Depth to a root restrictive layer, bedrock, lithic, is 6 to 20 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. This component is in the R116AY001AR Limestone Ledge ecological site. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: 6 - Ceda-Kenn complex, frequently flooded

Component: Ceda (55%)

The Ceda component makes up 55 percent of the map unit. Slopes are 0 to 3 percent. This component is on flood plains and hills. The parent material consists of gravelly alluvium. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is frequently flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 7w. This soil does not meet hydric criteria.

Component: Kenn (30%)

The Kenn component makes up 30 percent of the map unit. Slopes are 0 to 3 percent. This component is on flood plains and hills. The parent material consists of loamy alluvium derived from sandstone and shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is moderate. This soil is frequently flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 5w. This soil does not meet hydric criteria.

Map unit: 7 - Clarksville very cherty silt loam, 20 to 50 percent slopes

Component: Clarksville (100%)

The Clarksville component makes up 100 percent of the map unit. Slopes are 20 to 50 percent. This component is on hillsides and hills. The parent material consists of clayey residuum weathered from cherty limestone. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is somewhat excessively drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: 8 - Eden-Newnata complex, 8 to 20 percent slopes

Component: Eden (55%)

The Eden component makes up 55 percent of the map unit. Slopes are 8 to 20 percent. This component is on hillslopes and hills. The parent material consists of clayey residuum weathered from limestone and shale. Depth to a root restrictive layer, bedrock, paralithic, is 20 to 40 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is very low. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 6e. This soil does not meet hydric criteria.

Component: Newnata (30%)

The Newnata component makes up 30 percent of the map unit. Slopes are 8 to 20 percent. This component is on hillslopes and hills. The parent material consists of residuum weathered from limestone and shale. Depth to a root restrictive layer, bedrock, lithic, is 40 to 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is moderate. Shrink-swell potential is high. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 6s. This soil does not meet hydric criteria.

Map unit: 9 - Eden-Newnata complex, 20 to 40 percent slopes

Component: Eden (50%)

The Eden component makes up 50 percent of the map unit. Slopes are 20 to 40 percent. This component is on mountain slopes and hills. The parent material consists of clayey residuum weathered from limestone and shale. Depth to a root restrictive layer, bedrock, paralithic, is 20 to 40 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is very low. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic

matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 7e. This soil does not meet hydric criteria.

Component: Newnata (40%)

The Newnata component makes up 40 percent of the map unit. Slopes are 20 to 40 percent. This component is on mountain slopes and hills. The parent material consists of residuum weathered from limestone and shale. Depth to a root restrictive layer, bedrock, lithic, is 40 to 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is moderate. Shrink-swell potential is high. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: 11 - Enders gravelly loam, 3 to 8 percent slopes

Component: Enders (80%)

The Enders component makes up 80 percent of the map unit. Slopes are 3 to 8 percent. This component is on hillslopes and hills. The parent material consists of clayey residuum weathered from acid shale. Depth to a root restrictive layer, bedrock, paralithic, is 40 to 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is very low. Available water to a depth of 60 inches is moderate. Shrink-swell potential is high. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 4e. This soil does not meet hydric criteria.

Map unit: 12 - Enders gravelly loam, 8 to 15 percent slopes

Component: Enders (80%)

The Enders component makes up 80 percent of the map unit. Slopes are 8 to 15 percent. This component is on hillslopes on hills. The parent material consists of clayey residuum weathered from acid shale. Depth to a root restrictive layer, bedrock, paralithic, is 40 to 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is very low. Available water to a depth of 60 inches is moderate. Shrink-swell potential is high. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 6e. This soil does not meet hydric criteria.

Map unit: 13 - Enders stony loam, 3 to 15 percent slopes

Component: Enders (85%)

The Enders component makes up 85 percent of the map unit. Slopes are 3 to 15 percent. This component is on hillslopes and hills. The parent material consists of clayey residuum weathered from acid shale. Depth to a root restrictive layer, bedrock, paralithic, is 40 to 60 inches. The natural drainage

class is well drained. Water movement in the most restrictive layer is very low. Available water to a depth of 60 inches is moderate. Shrink-swell potential is high. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 6s. This soil does not meet hydric criteria.

Map unit: 14 - Enders stony loam, 15 to 40 percent slopes

Component: Enders (80%)

The Enders component makes up 80 percent of the map unit. Slopes are 15 to 40 percent. This component is on hillslopes and hills. The parent material consists of clayey residuum weathered from acid shale. Depth to a root restrictive layer, bedrock, paralithic, is 40 to 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is very low. Available water to a depth of 60 inches is moderate. Shrink-swell potential is high. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: 15 - Enders-Leesburg complex, 8 to 20 percent slopes

Component: Enders (60%)

The Enders component makes up 60 percent of the map unit. Slopes are 8 to 20 percent. This component is on hillslopes and hills. The parent material consists of clayey residuum weathered from acid shale. Depth to a root restrictive layer, bedrock, paralithic, is 40 to 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is low. Available water to a depth of 60 inches is moderate. Shrink-swell potential is high. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 6s. This soil does not meet hydric criteria.

Component: Leesburg (30%)

The Leesburg component makes up 30 percent of the map unit. Slopes are 8 to 20 percent. This component is on mountains. The parent material consists of loamy colluvium derived from sandstone and shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 6s. This soil does not meet hydric criteria.

Map unit: 16 - Enders-Leesburg complex, 20 to 40 percent slopes

Component: Enders (50%)

The Enders component makes up 50 percent of the map unit. Slopes are 20 to 40 percent. This component is on hillslopes and hills. The parent material consists of clayey residuum weathered from acid shale. Depth to a root restrictive layer, bedrock, paralithic, is 40 to 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is low. Available water to a depth of 60 inches is moderate. Shrink-swell potential is high. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Component: Leesburg (40%)

The Leesburg component makes up 40 percent of the map unit. Slopes are 20 to 40 percent. The parent material consists of loamy colluvium derived from sandstone and shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: 25 - Linker-Mountainburg complex, 8 to 20 percent slopes

Component: Linker (50%)

The Linker component makes up 50 percent of the map unit. Slopes are 8 to 20 percent. This component is on mountains and hills. The parent material consists of loamy residuum weathered from sandstone. Depth to a root restrictive layer, bedrock, lithic, is 20 to 40 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 6e. This soil does not meet hydric criteria.

Component: Mountainburg (45%)

The Mountainburg component makes up 45 percent of the map unit. Slopes are 8 to 20 percent. This component is on mountains and hills. The parent material consists of gravelly and stony, loamy residuum weathered from sandstone and siltstone. Depth to a root restrictive layer, bedrock, lithic, is 12 to 20 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R117XY004AR Sandstone Ridge ecological site. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: 26 - Moko-Rock outcrop complex, 15 to 50 percent slopes

Component: Moko (50%)

The Moko component makes up 50 percent of the map unit. Slopes are 15 to 50 percent. This component is on hillslopes and hills. The parent material consists of loamy residuum weathered from cherty limestone. Depth to a root restrictive layer, bedrock, lithic, is 6 to 20 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. This component is in the R116AY001AR Limestone Ledge ecological site. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Component: Rock outcrop (40%)

Generated brief soil descriptions are created for major soil components. The Rock outcrop is a miscellaneous area.

Map unit: 35 - Nella-Enders stony loams, 8 to 20 percent slopes

Component: Nella (45%)

The Nella component makes up 45 percent of the map unit. Slopes are 8 to 20 percent. This component is on mountains and hills. The parent material consists of loamy colluvium derived from sandstone and shale and/or loamy residuum weathered from sandstone and shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 6s. This soil does not meet hydric criteria.

Component: Enders (40%)

The Enders component makes up 40 percent of the map unit. Slopes are 8 to 20 percent. This component is on mountains and hills. The parent material consists of clayey residuum weathered from acid shale. Depth to a root restrictive layer, bedrock, paralithic, is 40 to 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is very low. Available water to a depth of 60 inches is moderate. Shrink-swell potential is high. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 6s. This soil does not meet hydric criteria.

Map unit: 36 - Nella-Enders stony loams, 20 to 40 percent slopes

Component: Nella (50%)

The Nella component makes up 50 percent of the map unit. Slopes are 20 to 40 percent. This component is on mountain slopes and hills. The parent material consists of loamy colluvium derived from sandstone and shale and/or loamy residuum weathered from sandstone and shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Component: Enders (35%)

The Enders component makes up 35 percent of the map unit. Slopes are 20 to 40 percent. This component is on mountain slopes and hills. The parent material consists of clayey residuum weathered from acid shale. Depth to a root restrictive layer, bedrock, paralithic, is 40 to 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is very low. Available water to a depth of 60 inches is moderate. Shrink-swell potential is high. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: 37 - Nella-Steprock complex, 8 to 20 percent slopes

Component: Nella (50%)

The Nella component makes up 50 percent of the map unit. Slopes are 8 to 20 percent. This component is on hillsides and hills. The parent material consists of loamy colluvium derived from sandstone and shale and/or loamy residuum weathered from sandstone and shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 6s. This soil does not meet hydric criteria.

Component: Steprock (35%)

The Steprock component makes up 35 percent of the map unit. Slopes are 8 to 20 percent. This component is on hillsides and hills. The parent material consists of skeletal loamy residuum weathered from sandstone. Depth to a root restrictive layer, bedrock, paralithic, is 20 to 40 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 6s. This soil does not meet hydric criteria.

Map unit: 38 - Nella-Steprock-Mountainburg very stony loams, 20 to 40 percent slopes

Component: Nella (45%)

The Nella component makes up 45 percent of the map unit. Slopes are 20 to 40 percent. This component is on hillslopes and hills. The parent material consists of loamy colluvium derived from sandstone and shale and/or loamy residuum weathered from sandstone and shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Component: Steprock (25%)

The Steprock component makes up 25 percent of the map unit. Slopes are 20 to 40 percent. This component is on hillslopes and hills. The parent material consists of skeletal loamy residuum weathered from sandstone. Depth to a root restrictive layer, bedrock, paralithic, is 20 to 40 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: 38 - Nella-Steprock-Mountainburg very stony loams, 20 to 40 percent slopes

Component: Mountainburg (15%)

The Mountainburg component makes up 15 percent of the map unit. Slopes are 20 to 40 percent. This component is on hillslopes and hills. The parent material consists of gravelly and stony, loamy residuum weathered from sandstone and siltstone. Depth to a root restrictive layer, bedrock, lithic, is 12 to 20 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R117XY004AR Sandstone Ridge ecological site. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: 39 - Nella-Steprock-Mountainburg very stony loams, 40 to 60 percent slopes

Component: Nella (45%)

The Nella component makes up 45 percent of the map unit. Slopes are 40 to 60 percent. This component is on hillslopes and hills. The parent material consists of loamy colluvium derived from

sandstone and shale and/or loamy residuum weathered from sandstone and shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Component: Steprock (20%)

The Steprock component makes up 20 percent of the map unit. Slopes are 40 to 60 percent. This component is on hillslopes and hills. The parent material consists of skeletal loamy residuum weathered from sandstone. Depth to a root restrictive layer, bedrock, paralithic, is 20 to 40 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Component: Mountainburg (10%)

The Mountainburg component makes up 10 percent of the map unit. Slopes are 40 to 60 percent. This component is on hillsides and hills. The parent material consists of loamy residuum weathered from sandstone. Depth to a root restrictive layer, bedrock, lithic, is 12 to 20 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R117XY004AR Sandstone Ridge ecological site. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: 42 - Noark very cherty silt loam, 3 to 8 percent slopes

Component: Noark (100%)

The Noark component makes up 100 percent of the map unit. Slopes are 3 to 8 percent. This component is on hillsides and hills. The parent material consists of clayey residuum weathered from cherty limestone. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 4e. This soil does not meet hydric criteria.

Map unit: 43 - Noark very cherty silt loam, 8 to 20 percent slopes

Component: Noark (100%)

The Noark component makes up 100 percent of the map unit. Slopes are 8 to 20 percent. This component is on hillsides and hills. The parent material consists of clayey residuum weathered from cherty limestone. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 6e. This soil does not meet hydric criteria.

Map unit: 44 - Noark very cherty silt loam, 20 to 40 percent slopes

Component: Noark (100%)

The Noark component makes up 100 percent of the map unit. Slopes are 20 to 40 percent. This component is on hillslopes and hills. The parent material consists of clayey residuum weathered from cherty limestone. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 7e. This soil does not meet hydric criteria.

Map unit: 48 - Razort loam, occasionally flooded

Component: Razort (95%)

The Razort component makes up 95 percent of the map unit. Slopes are 0 to 3 percent. This component is on flood plains and hills. The parent material consists of loamy alluvium. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is low. This soil is occasionally flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2w. This soil does not meet hydric criteria.

Map unit: 49 - Riverwash, frequently flooded

Component: Riverwash (95%)

Generated brief soil descriptions are created for major soil components. The Riverwash is a miscellaneous area.

Map unit: 50 - Spadra loam, occasionally flooded

Component: Spadra (95%)

The Spadra component makes up 95 percent of the map unit. Slopes are 0 to 3 percent. This component is on flood plains and hills. The parent material consists of loamy alluvium derived from sandstone and shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is occasionally flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2w. This soil does not meet hydric criteria.

Map unit: 51 - Spadra loam, 2 to 5 percent slopes

Component: Spadra (95%)

The Spadra component makes up 95 percent of the map unit. Slopes are 2 to 5 percent. This component is on stream terraces and hills. The parent material consists of loamy alluvium derived from sandstone and shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: 54 - Water

Component: Water (100%)

A general description for water bodies.

Appendix 3 – Soil Profile Analyses from Grid Sampling of Application Fields

Table 7. Soil analyses of 0 to 4 inch samples collected from Field 1. P is phosphorus, K is potassium, Ca is calcium, Mg is magnesium, Na is sodium, Fe is iron, Cu is copper, Zn is zinc, and B is boron.

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
						mg/kg							
166760	126	7.3	30	183	8465	142	14	23	35	230	1	4.7	1.1
166776	142	7.8	32	104	5672	78	12	11	61	108	0.5	3.9	0.5
166702	143	6.7	99	571	1821	116	28	15	232	117	0.4	4	0.7
166703	144	7.8	18	123	7643	92	43	13	44	156	0.9	2.3	0.6
166752	145	6.5	28	80	2741	110	16	20	76	86	0.5	3	0.4
167144	162	6.1	83	706	1415	158	22	22	159	266	0.9	5.6	0.6
166704	163	6.3	98	597	2478	227	10	25	172	251	0.7	8	0.7
166694	180	6.5	22	144	1298	89	14	13	118	374	0.6	2.6	0.3
166715	181	7	100	329	2229	144	13	18	134	232	0.9	6.1	0.6
166716	182	6.6	59	469	2007	150	14	21	101	267	1	9.7	0.7
166698	198	6.6	82	405	2022	152	12	18	149	360	1.1	7.1	0.7
166699	199	6.9	50	84	1667	85	12	17	121	346	0.6	4.2	0.3
166714	200	6.1	57	151	1613	139	14	23	101	532	0.4	3	0.4
166713	201	6	44	107	1700	158	19	22	94	316	0.8	7.5	0.5
167143	212	4.4	49	53	456	53	16	17	188	31	0.2	2.2	0.2
166721	213	6	52	108	1398	96	10	17	70	50	0.2	1.8	0.2
166722	214	5.3	102	163	1072	122	9	21	107	97	0.3	3.5	0.2
166712	215	5.5	93	187	922	95	12	19	200	148	0.3	3.1	0.4
166710	216	6.6	50	84	1598	77	17	15	127	106	0.5	2.4	0.4
166711	217	6.2	67	191	1290	143	20	19	148	214	0.5	4.3	0.4
166708	218	7	77	245	1310	127	13	16	128	326	0.4	4	0.5
166707	219	6.3	169	771	2073	216	17	29	128	258	0.6	10.6	0.9
166706	221	5.5	100	90	1357	131	44	19	141	257	0.7	9.4	0.3

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
166728	231	6.6	80	189	1454	110	14	15	117	84	0.4	3.6	0.4
166723	232	7	48	277	1898	107	12	16	78	129	0.4	2.7	0.4
166724	233	6.8	56	223	1503	110	20	16	110	174	0.5	3.3	0.5
166727	234	6.4	41	61	1200	71	12	16	116	289	0.4	2.1	0.3
166725	235	6.3	109	707	1502	144	16	28	170	318	1	9.1	0.6
166726	236	6.5	56	420	1442	145	12	20	105	219	0.7	4.8	0.4
166718	237	6.8	82	366	2051	150	18	24	124	173	0.8	6.9	0.5
166720	238	6.4	55	93	1730	105	13	17	95	280	0.6	5	0.4
166736	240	5.4	60	88	889	69	10	17	119	171	0.2	3.3	0.2
166737	241	6.3	71	314	1638	94	9	17	97	193	0.3	5.3	0.4
166738	249	6.3	66	143	1247	84	8	17	114	122	0.3	3.3	0.4
166739	250	7.5	39	148	2056	62	7	13	84	238	0.4	2.1	0.4
166740	251	5.8	35	269	675	61	10	20	115	388	0.3	2.5	0.3
166732	252	6.5	63	208	1149	128	12	17	118	381	0.8	4.1	0.4
166733	253	6.7	90	251	1649	139	11	17	111	362	0.9	6.1	0.5
166734	254	5.9	54	238	1275	131	11	20	153	253	1.1	5.1	0.4
166735	255	7.3	77	675	4064	161	10	26	52	380	0.8	5.6	0.9
166730	256	6.6	52	231	1591	120	14	19	109	188	0.6	3.7	0.4
166745	257	5.5	54	174	955	107	17	18	124	190	0.7	6	0.2
166746	258	6	30	49	1299	44	12	13	89	244	0.3	2.1	0.2
166764	259	5.7	81	52	941	69	12	15	110	168	0.4	3.9	0.2
166763	260	6.7	37	121	3098	176	10	20	64	341	0.8	7.5	0.6
166759	268	5.2	58	44	641	47	12	16	166	130	0.5	2.5	0.2
166749	269	5.5	44	67	801	76	10	16	96	316	0.5	2.3	0.3
166750	270	5.7	53	67	1046	62	11	18	89	360	0.5	2.2	0.2
166747	271	6.4	33	127	1230	83	8	15	86	444	0.5	2.3	0.4
166748	272	7	62	172	1767	156	10	19	90	448	0.9	4.2	0.5
166768	273	7.4	52	473	2717	123	8	22	70	321	0.8	4.3	0.5

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
166742	274	6.4	56	373	4822	230	16	19	40	308	0.9	3.8	0.7
166743	275	6.3	28	66	1665	89	15	15	94	231	0.6	2.7	0.3
166751	276	6.2	46	51	1510	74	13	18	95	222	0.4	3.6	0.2
166772	278	6.6	32	88	2359	86	11	19	79	486	0.5	3.3	0.3
166691	287	5.9	65	63	1231	72	25	17	144	137	0.4	2.5	0.3
166692	288	6.2	55	78	1620	101	11	18	129	235	0.5	2.9	0.5
166775	289	5.6	36	62	1337	79	10	15	96	164	0.2	2	0.2
166754	291	6.1	40	161	1284	149	12	20	130	361	0.6	4.1	0.4
166761	292	7	42	109	2258	95	10	17	80	462	1	6.4	0.4
166762	293	7	45	224	3777	166	9	17	45	339	0.9	5.5	0.5
166755	294	6.7	40	136	2241	117	10	19	86	330	0.6	6.2	0.4
166757	295	6.9	36	248	2385	134	12	23	92	363	0.6	4.7	0.5
166758	296	5.3	49	48	736	63	11	18	169	309	0.4	3.1	0.2
166771	297	6.8	30	83	2047	59	10	14	79	269	0.3	3.3	0.3
166766	309	5.4	66	71	848	107	16	16	115	131	0.4	3.9	0.3
166767	310	5.4	72	73	605	92	10	20	128	326	0.4	4.1	0.2
166773	311	5.8	88	101	1181	96	11	21	124	346	0.5	3.2	0.3
166769	312	6.2	37	86	1835	126	11	19	83	511	0.8	4.3	0.3
166770	313	7.5	70	83	4550	127	19	18	50	311	0.9	6.1	0.5
166774	314	6.4	51	72	1430	99	11	17	79	311	0.6	3.3	0.3
Mean, mg/kg		6.85	41	128	4948	121	13	20	57	271	0.8	4.0	0.7
Minimum, mg/kg		4.4	18	44	456	44	7	11	35	31	0.2	1.8	0.2
Maximum, mg/kg		7.8	169	771	8465	230	44	29	232	532	1.1	10.6	1.1
Standard deviation, mg/kg		0.64	15	78	4974	30	2	4	31	57	0.3	1.0	0.6
Coefficient of variation, %		9.34	36	62	101	25	18	21	55	21	35.0	24.8	81.4

Table 8. Soil analyses of 4 to 8 inch samples collected from Field 1. P is phosphorus, K is potassium, Ca is calcium, Mg is magnesium, Na is sodium, Fe is iron, Cu is copper, Zn is zinc, and B is boron.

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
						mg/kg							
166695	180	6.4	11	71	1002	75	17	10	108	354	0.6	2	0.3
166700	199	6.6	25	41	1024	62	14	9	104	310	0.4	1.6	0.2
166709	218	6.6	24	117	861	71	13	9	141	303	0.3	1.6	0.3
166731	256	6.6	22	112	1226	97	13	9	94	269	0.4	2.9	0.2
166744	275	6.6	14	51	1440	54	11	10	86	193	0.5	1.5	0.2
166756	294	6.9	22	68	1853	89	14	15	77	297	0.6	3.3	0.2
Mean, mg/kg		6.65	17	70	1428	82	16	13	93	326	0.6	2.7	0.3
Minimum, mg/kg		6.4	11	41	861	54	11	9	77	193	0.3	1.5	0.2
Maximum, mg/kg		6.9	25	117	1853	97	17	15	141	354	0.6	3.3	0.3
Standard deviation, mg/kg		0.35	8	2	602	10	2	4	22	40	0.0	0.9	0.1
Coefficient of variation, %		5.26	47	3	42	12	14	28	24	12	0.0	34.7	28.0

Table 9. Soil analyses of 8 to 12 inch samples collected from Field 1. P is phosphorus, K is potassium, Ca is calcium, Mg is magnesium, Na is sodium, Fe is iron, Cu is copper, Zn is zinc, and B is boron.

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	Bo
							mg/kg						
166696	180	6.2	7	69	836	67	13	9	129	415	0.4	0.9	0.2
166701	199	6.5	12	45	936	70	11	6	114	322	0.3	1	0.2
166719	237	7	12	228	3587	139	25	8	59	102	0.4	0.6	0.3
Mean, mg/kg		6.60	10	149	2212	103	19	9	94	259	0.4	0.8	0.3
Minimum, mg/kg		6.2	7	45	836	67	11	6	59	102	0.3	0.6	0.2
Maximum, mg/kg		7	12	228	3587	139	25	9	129	415	0.4	1	0.3
Standard deviation, mg/kg		0.57	4	112	1945	51	8	1	49	221	0.0	0.2	0.1
Coefficient of variation, %		8.64	37	76	88	49	45	8	53	86	0.0	28.0	28.0

Table 10. Soil analyses of 0 to 4 inch samples collected from Field 5. P is phosphorus, K is potassium, Ca is calcium, Mg is magnesium, Na is sodium, Fe is iron, Cu is copper, Zn is zinc, and B is boron.

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
						mg/kg							
179511	25	6.2	76	322	2847	164	21	10	141	94	2.3	10.2	0.4
179516	34	6.6	64	100	1680	95	11	10	137	153	1.2	3.2	0.1
178394	35	6.8	54	109	3266	114	9	9	106	71	2.2	5.7	0.2
178398	36	6.5	66	179	3605	146	18	13	142	54	2.2	7.4	0.2
178403	37	6	61	145	2852	131	12	9	160	37	1.6	5.1	0.1
178408	47	6.6	48	104	1337	82	8	11	122	218	0.8	3.3	0.1
178413	48	6.2	76	162	2894	155	12	11	151	62	1.9	7.2	0.2
178415	49	6.4	78	207	3637	183	15	13	110	79	2.1	7.5	0.3
178421	50	6.1	61	110	2563	155	13	11	153	41	1.4	7.8	0.1
178425	51	6.2	52	146	2594	112	10	9	115	50	1.5	4.8	0
178431	59	6.2	122	251	1330	116	17	18	142	350	1	5.9	0.2
178436	61	5.9	58	133	2443	148	17	10	164	31	1.3	6.9	0.2
178442	62	6.1	57	120	2811	129	11	10	150	26	2	5.6	0.1
178447	73	6.5	179	344	1613	172	5	21	135	363	0.8	10.4	0.2
178451	74	6.2	82	365	1784	98	7	17	141	107	1.4	6.4	0.2
178456	75	6.4	49	166	2935	137	7	9	109	50	1.8	7.8	0.1
178460	76	5.8	65	144	2634	151	7	12	212	39	1.6	7.9	0.2
178466	85	6.4	118	119	1215	90	45	14	136	315	0.8	3.5	0.2
178470	86	6.1	156	529	889	104	15	20	162	276	0.7	5.8	0.2
178472	87	6.5	74	203	2651	164	5	10	129	63	1.5	7.5	0.2
178476	88	6.5	105	565	2744	213	9	21	149	47	1.7	7.9	0.4
178482	89	6.5	48	253	2515	132	6	11	122	88	1.5	5.3	0.3
178485	98	6.7	43	76	2853	104	8	12	74	119	1.7	4.2	0.1
178492	99	6.5	95	136	1950	142	56	15	119	146	1.4	6.4	0.2
178495	100	6.2	116	125	1129	86	43	10	133	158	1	3.7	0.1

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
178497	101	6.5	75	168	1709	101	12	12	120	157	1.4	5	0.2
178502	102	6.9	48	71	3078	106	9	13	119	170	2.1	6.4	0.6
178508	110	6.5	44	160	2711	151	9	13	96	113	2	7.6	0.3
178510	111	6.6	62	197	2708	135	12	16	99	100	1.9	5.2	0.3
178515	113	6.3	95	167	1854	122	15	15	126	106	1.1	5.8	0.3
178519	114	6.9	84	129	2647	134	16	17	135	123	1.4	9.3	0.7
178526	115	6.7	40	47	2129	79	11	14	143	157	1.2	5	0.6
178532	116	7.4	56	75	1698	88	8	9	105	132	0.7	3.9	0.3
178536	124	6.5	62	112	3003	128	15	15	103	154	1.9	7	0.4
178539	125	6.5	56	95	2281	110	29	15	100	139	2	6.4	0.5
178544	126	6.7	98	124	2398	136	17	16	132	162	1.7	7.4	0.6
178547	127	6.9	60	138	2446	105	10	15	143	186	1.5	6.5	0.7
178553	128	7.1	51	137	1864	76	10	13	117	166	1	9.7	0.5
178555	129	7.5	31	46	2118	48	26	8	114	147	0.9	3.4	0.4
178560	137	6.7	59	104	2892	154	16	17	85	143	2	7.3	0.6
178565	138	6.8	34	91	2755	95	12	13	82	178	2.1	4.2	0.4
178570	139	6.5	37	80	2224	100	9	14	102	162	1.6	4.6	0.5
178576	140	6.8	53	160	1839	70	9	13	125	175	1.1	4.5	0.6
178581	141	7	78	73	2205	121	22	15	130	196	1.3	6	0.7
178389	142	6.7	31	36	2190	68	23	10	117	159	1.2	5.2	0.3
Mean, mg/kg		6.45	54	179	2519	116	22	10	129	127	1.8	7.7	0.4
Minimum, mg/kg		5.8	31	36	889	48	5	8	74	26	0.7	3.2	0
Maximum, mg/kg		7.5	179	565	3637	213	56	21	212	363	2.3	10.4	0.7
Standard deviation, mg/kg		0.35	32	202	465	68	1	0	17	46	0.8	3.5	0.1
Coefficient of variation, %		5.43	59	113	18	59	6	0	13	36	44.6	46.0	20.0

Table 11. Soil analyses of 4 to 8 inch samples collected from Field 5. P is phosphorus, K is potassium, Ca is calcium, Mg is magnesium, Na is sodium, Fe is iron, Cu is copper, Zn is zinc, and B is boron.

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
							mg/kg						
179512	25	6.4	42	192	2927	118	54	7	127	77	2.9	6.9	0.3
179517	34	6.6	45	41	1577	42	50	7	104	100	1.3	2	0
178395	35	6.4	33	92	2964	86	12	6	93	64	2.4	4.6	0.1
178399	36	6.1	36	114	3270	105	16	8	106	38	2.5	4	0
178404	37	5.8	49	129	2870	124	13	10	150	34	2.3	4.3	0
178409	47	6.3	22	71	1005	67	7	6	104	148	0.8	16.2	0
178416	49	6.7	41	131	4381	101	17	8	95	91	2.2	6.3	0.2
178422	50	6.1	30	98	2877	117	16	7	124	39	2	4.7	0
178426	51	5.9	33	119	2873	89	12	8	100	58	2	3.8	0
178432	59	6.3	49	144	921	48	6	10	113	243	1	4.1	0
178437	61	6	37	115	2754	126	11	8	143	36	2.3	4.9	0.1
178443	62	6.2	36	102	3093	109	11	7	111	35	2.6	5	0.1
178448	73	6.3	73	175	861	70	6	11	109	246	1.2	7	0
178452	74	6.2	67	176	2139	96	8	13	125	84	2.1	5.6	0.1
178457	75	6.4	28	143	3379	135	15	7	96	41	2.6	4.5	0
178461	76	5.6	42	111	2661	133	16	10	184	32	2.4	7.9	0.1
178467	85	6.4	57	80	981	44	27	8	122	233	0.8	2.2	0
178471	86	5.9	96	315	589	52	7	12	113	200	0.9	3.2	0
178473	87	6.4	41	169	2823	132	20	7	95	38	2	3.9	0
178478	88	6.1	36	127	2754	109	11	12	101	43	2.1	3.9	0
178483	89	6.7	50	151	2927	144	12	9	100	49	1.7	3.8	0.1
178486	98	6.8	17	59	2361	61	10	7	62	96	1.8	1.8	0
178493	99	6.4	46	55	1819	88	16	8	78	130	1.9	3.3	0
178496	100	6.3	98	67	1267	68	23	7	125	136	1.4	2.4	0

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
178498	101	6.6	43	82	1800	74	15	7	97	132	1.7	3.3	0
178503	102	6.8	23	63	2477	78	9	7	93	99	2	4.2	0.2
178509	110	6.3	15	104	3322	116	11	9	69	115	2.6	4.6	0.2
178511	111	6.3	14	116	3031	65	13	8	68	128	2.4	2.5	0.1
178516	113	6.4	70	94	1972	107	35	9	101	97	1.3	4.3	0.2
178520	114	6.8	46	82	1922	81	11	9	118	88	1.2	4.4	0.3
178527	115	6.8	20	38	2056	54	9	10	116	114	1.3	3.6	0.5
178533	116	7.2	28	46	1640	56	8	6	115	101	0.9	3	0.2
178538	124	6.6	17	73	2889	56	29	9	70	115	2.4	16.7	0.5
178540	125	6.8	25	80	2168	71	18	8	77	119	1.9	2.9	0.2
178545	126	6.8	50	79	2347	81	15	10	97	154	2.4	5.3	0.3
178548	127	7	30	50	1981	69	10	9	125	157	1.4	4.1	0.4
178554	128	7	21	74	1746	43	42	8	102	136	1.1	2.9	0.5
178556	129	7.1	21	35	1548	37	8	6	108	116	0.9	2.5	0.2
178562	137	6.6	17	68	2730	58	18	11	84	154	2.3	12.3	0.4
178566	138	6.7	11	81	2769	50	29	8	68	149	2.3	1.9	0.3
178571	139	6.7	14	67	2419	62	11	8	97	178	2.2	3.5	0.3
178577	140	7.1	33	62	1363	43	24	7	109	110	0.9	4.8	0.3
178582	141	7	34	38	1685	46	10	8	117	164	1.3	4.3	0.4
178390	142	6.8	21	28	1338	27	8	4	108	112	0.9	7.6	0
Mean, mg/kg		6.60	32	110	2133	73	31	6	118	95	1.9	7.3	0.2
Minimum, mg/kg		5.6	11	28	589	27	6	4	62	32	0.8	1.8	0
Maximum, mg/kg		7.2	98	315	4381	144	54	13	184	246	2.9	16.7	0.5
Standard deviation, mg/kg		0.28	15	116	1124	64	33	2	13	25	1.4	0.5	0.2
Coefficient of variation, %		4.24	46	105	53	89	105	39	11	26	74.2	6.8	140.0

Table 12. Soil analyses of 8 to 12 inch samples collected from Field 5. P is phosphorus, K is potassium, Ca is calcium, Mg is magnesium, Na is sodium, Fe is iron, Cu is copper, Zn is zinc, and B is boron.

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
							mg/kg						
179513	25	6.1	33	159	3411	124	26	5	99	55	2.6	4.5	0.1
179518	34	6.7	36	50	1445	34	11	5	93	64	1	1.2	0
178396	35	6.5	21	130	4104	95	15	6	95	52	2.9	3.6	0.1
178400	36	6.1	23	143	3790	104	17	8	98	42	2.4	3.4	0.1
178406	37	5.4	42	158	3067	125	18	12	129	27	2.3	3	0
178410	47	6.6	24	65	1162	100	24	3	113	93	0.8	0.9	0
178414	48	6.6	23	133	4357	110	40	7	116	67	2.1	3.9	0.2
178418	49	7.1	11	121	4154	57	16	5	74	105	2.3	4	0.3
178423	50	6.2	22	119	3375	95	16	6	96	32	2.3	2.8	0
178427	51	5.7	30	127	3330	93	21	9	94	30	2.1	3	0
178433	59	6.6	30	91	824	31	31	6	118	209	0.9	3.6	0
178438	61	5.8	21	119	3024	113	17	6	95	32	2.2	7.7	0
178444	62	6.3	26	122	3266	113	14	7	100	41	2.5	3.4	0.1
178449	73	6.5	59	144	765	43	5	8	123	236	1	0.9	0
178454	74	6.3	36	137	2919	121	16	9	102	83	2.4	4.9	0.2
178458	75	6.2	28	140	3769	148	14	7	93	36	2.9	3.1	0
178462	76	5.3	42	140	2727	123	20	12	193	25	2.2	4.4	0
178468	85	6.5	46	61	910	25	11	4	139	165	0.5	0.7	0
178474	87	6.3	30	123	3392	119	18	4	89	33	1.7	3.9	0
178479	88	5.9	22	93	2971	99	15	10	93	35	1.9	2.8	0
178484	89	6.4	37	152	3089	155	11	7	77	39	2.1	4	0
178487	98	6.7	10	69	2474	49	10	7	70	113	2	2.9	0
178494	99	6.5	23	61	1979	64	28	7	78	131	2	2.8	0
178499	101	6.5	25	68	2073	77	29	5	80	100	1.9	2.8	0

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
178504	102	6.7	24	92	2946	96	12	6	97	77	2.4	3.8	0.2
178512	111	6.4	5	86	3016	33	16	5	55	86	1.8	1.2	0
178517	113	6.4	57	123	2771	138	16	7	91	48	1.2	0.9	0.1
178521	114	6.7	34	102	2023	88	16	8	114	131	1.7	4.2	0.2
178528	115	6.9	14	55	2327	62	10	8	92	99	1.6	3	0.4
178534	116	7	20	42	1539	61	10	6	117	95	0.9	3.1	0.2
178541	125	6.9	15	114	2659	64	19	6	84	82	1.9	0.8	0.2
178546	126	6.8	19	93	2896	85	35	9	82	163	2.7	4.7	0.5
178550	127	7	27	56	1615	56	86	6	120	141	1.5	2.9	0.5
178557	129	7.3	21	36	1418	41	19	5	102	117	0.9	4.1	0.1
178563	137	6.6	7	104	2964	31	19	7	74	86	2.6	1	0.3
178567	138	6.7	5	103	3189	40	16	6	62	85	1.9	1.4	0.1
178572	139	6.7	10	87	2756	60	14	7	84	174	2.4	6.2	0.3
178578	140	7	30	40	1108	34	11	5	114	107	1.1	2.8	0.1
178583	141	7	48	51	1563	41	11	6	119	156	1.4	2.9	0.2
178391	142	6.4	22	45	1554	33	10	4	114	112	1.4	2	0
Mean, mg/kg		6.25	28	102	2483	79	18	5	107	84	2.0	3.3	0.1
Minimum, mg/kg		5.3	5	36	765	25	5	3	55	25	0.5	0.7	0
Maximum, mg/kg		7.3	59	159	4357	155	86	12	193	236	2.9	7.7	0.5
Standard deviation, mg/kg		0.21	8	81	1313	64	11	1	11	40	0.8	1.8	0.1
Coefficient of variation, %		3.36	27	79	53	82	63	16	10	48	42.5	54.5	140.0

Table 13. Soil analyses of 12 to 18 inch samples collected from Field 5. P is phosphorus, K is potassium, Ca is calcium, Mg is magnesium, Na is sodium, Fe is iron, Cu is copper, Zn is zinc, and B is boron.

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
						mg/kg							
179514	25	6.3	35	159	3619	127	73	5	98	38	2.3	5	0.1
179519	34	6.4	59	87	1896	83	17	3	92	24	0.7	0.5	0
178397	35	6.7	16	139	4601	95	18	7	94	74	2.8	4.3	0.4
178401	36	6.2	19	133	3892	79	30	6	83	43	2.3	3.4	0.1
178407	37	5.2	48	156	3048	115	19	11	132	40	2.2	2.6	0
178411	47	6.2	49	100	2014	133	15	2	108	46	0.7	1.2	0
178419	49	7	9	114	3998	52	42	4	68	106	2.3	7.3	0.3
178424	50	6.2	21	108	3248	79	20	6	93	33	2.2	2.3	0
178428	51	5.8	31	128	3272	81	30	8	105	36	2.3	3.3	0
178434	59	6.3	41	74	1027	50	44	4	143	149	0.6	1.3	0
178439	61	5.9	26	124	3258	104	23	8	108	32	2.5	2.6	0.1
178445	62	6	34	128	3110	113	20	8	141	19	2.1	2.9	0.1
178450	73	6.3	41	117	697	38	6	7	136	208	0.7	2	0
178455	74	6.4	19	122	3279	112	17	6	86	57	2	3.4	0
178459	75	6.1	39	137	3336	130	26	7	94	30	2.2	2.6	0
178463	76	5.2	45	148	2873	121	38	12	243	22	2.3	2.9	0.2
178469	85	6.6	53	53	707	19	12	2	139	98	0.3	1.1	0
178480	88	6	17	125	3590	114	22	8	95	44	2.5	4.1	0.2
178488	98	6.8	8	72	2268	32	15	4	79	110	1.9	1.2	0
178500	101	6.5	26	85	2595	84	15	4	85	98	2.4	3.6	0
178505	102	6.3	15	117	3586	114	17	6	92	58	2.4	3	0.3
178514	111	6.5	5	116	3373	26	22	7	79	105	1.8	5.8	0.2
178518	113	6.6	61	129	3098	121	20	6	110	48	0.9	3.2	0.1
178522	114	6.7	27	114	2957	112	24	8	92	93	2.4	4	0.4

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
178529	115	6.9	13	86	3115	90	15	7	84	100	2.1	2.5	0.4
178535	116	7	30	64	1769	62	9	6	106	101	1.3	2.8	0.1
178542	125	6.9	17	121	2889	61	30	5	75	74	1.7	0.7	0.2
178551	127	6.8	22	102	2950	99	16	6	89	114	1.9	2.3	0.4
178558	129	7.1	23	46	1505	47	9	5	106	124	1.1	1.8	0.1
178564	137	6.7	6	121	3263	35	30	6	75	66	2.4	1.1	0.3
178568	138	6.7	5	107	3158	27	18	5	66	69	1.8	1.5	0.1
178574	139	6.6	8	109	3303	65	18	8	86	160	2.5	3.1	0.4
178579	140	6.9	26	68	1853	65	21	6	101	199	1.7	3.3	0.3
178584	141	6.9	50	74	2094	61	17	5	133	136	1.6	2.1	0.2
178392	142	6.5	33	72	2250	46	10	5	145	127	2	2.7	0.1
Mean, mg/kg		6.40	34	116	2935	87	42	5	122	83	2.2	3.9	0.1
Minimum, mg/kg		5.2	5	46	697	19	6	2	66	19	0.3	0.5	0
Maximum, mg/kg		7.1	61	159	4601	133	73	12	243	208	2.8	7.3	0.4
Standard deviation, mg/kg		0.14	1	62	968	57	45	0	33	63	0.2	1.6	0.0
Coefficient of variation, %		2.19	4	53	33	66	107	0	27	76	9.8	42.3	0.0

Table 14. Soil analyses of 18 to 24 inch samples collected from Field 5. P is phosphorus, K is potassium, Ca is calcium, Mg is magnesium, Na is sodium, Fe is iron, Cu is copper, Zn is zinc, and B is boron.

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
						mg/kg							
179515	25	6.5	42	156	3756	136	78	3	118	37	2.3	3.8	0.2
179520	34	5.7	59	97	1401	111	21	4	106	15	0.6	0.8	0
178402	36	6.5	20	138	4317	74	25	6	88	51	2.2	10.1	0.2
178412	47	6.1	45	119	2011	180	20	3	95	27	0.6	1	0
178420	49	7	8	120	4131	42	40	4	70	99	2.1	4	0.5
178430	51	5.7	35	150	3653	79	23	7	107	47	2	5.9	0
178435	59	6.2	51	75	1011	63	24	3	125	93	0.3	2.8	0
178440	61	6.1	19	128	3450	97	25	8	108	43	2.6	5.1	0.1
178446	62	5.8	34	132	3376	108	24	11	118	26	2.5	3.2	0.2
178464	76	5.4	33	132	3240	113	36	9	169	32	2.2	3	0
178475	87	6.4	16	114	3252	76	22	4	86	62	1.9	3.4	0.2
178481	88	5.9	25	118	3288	102	23	6	110	47	2.2	3.4	0.1
178490	98	6.7	14	76	2148	25	20	2	61	62	1.5	0.6	0
178506	102	6.3	20	117	3861	127	21	6	83	43	2.1	3	0.2
178523	114	6.4	32	119	3326	123	22	8	95	60	2.3	3.5	0.3
178530	115	6.8	14	101	3450	102	13	8	88	90	2.2	6	0.4
178543	125	6.8	20	120	2928	61	28	5	76	58	1.4	0.7	0.1
178552	127	6.9	19	90	2525	85	32	5	85	82	1.4	1.4	0.3
178559	129	6.5	38	77	2050	55	14	6	115	133	1.8	2	0.2
178569	138	6.8	6	105	2975	20	19	4	72	68	1.6	0.8	0.1
178575	139	6.6	8	116	3433	64	18	8	79	153	2.7	3.2	0.4
178580	140	6.8	19	88	2870	88	16	7	97	176	2.3	4.7	0.6
Mean, mg/kg		6.65	31	122	3313	112	47	5	108	107	2.3	4.3	0.4

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
Minimum, mg/kg		5.4	6	75	1011	20	13	2	61	15	0.3	0.6	0
Maximum, mg/kg		7	59	156	4317	180	78	11	169	176	2.7	10.1	0.6
Standard deviation, mg/kg		0.21	16	48	626	34	44	3	15	98	0.0	0.6	0.3
Coefficient of variation, %		3.16	53	39	19	30	93	57	14	92	0.0	15.1	70.0

Table 15. Soil analyses of 24 to 30 inch samples collected from Field 5. P is phosphorus, K is potassium, Ca is calcium, Mg is magnesium, Na is sodium, Fe is iron, Cu is copper, Zn is zinc, and B is boron.

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
						mg/kg							
178491	98	6.5	21	100	2708	32	23	2	61	41	1.7	0.9	0
178507	102	6.2	23	114	3624	131	24	6	94	49	2.3	2.9	0.1
178524	114	6.6	35	140	3755	144	21	9	99	54	2.3	4.7	0.3
178531	115	6.6	16	88	2861	79	18	7	104	103	1.8	4.7	0.3
Mean, mg/kg		6.55	19	94	2785	56	21	5	83	72	1.8	2.8	0.2
Minimum, mg/kg		6.2	16	88	2708	32	18	2	61	41	1.7	0.9	0
Maximum, mg/kg		6.6	35	140	3755	144	24	9	104	103	2.3	4.7	0.3
Standard deviation, mg/kg		0.07	4	8	108	33	4	4	30	44	0.1	2.7	0.2
Coefficient of variation, %		1.07	19	9	4	60	17	79	37	61	4.0	96.1	140.0

Appendix 3 – Protocols for Sampling Liquid Manures

UNIVERSITY OF ARKANSAS DIVISION OF AGRICULTURE
Cooperative Extension Service

Sampling Liquid Manure

Karl VanDevender, Ph.D., P.E.
Professor, Extension Engineer

Liquid animal manure sampling can be an important management tool. Proper sampling provides the producer with nutrient analysis results that can be used in a sound farm fertilization program. Nutrient analysis of manure, in conjunction with soil sampling, helps determine how much manure should be applied to fields to maintain adequate fertility while minimizing potential environmental problems such as ground and surface water pollution. However manure applications should not exceed the maximum application rates in a manure management plan until sufficient data can be collected to justify revising the plan.

When to Sample

Liquid animal manure should be sampled for nutrient analysis as close to land application time as possible. This helps ensure that the reported nutrient content accurately reflects what is being applied to the land. If the manure is sampled as it is being land applied, the results will not be available to govern present application rates. It does, however, provide information for future land applications of animal manure, if the manure management remains fairly constant over time.

How to Collect a Liquid Manure Sample

During Land Application

The easiest way to collect liquid animal manure samples is to collect the manure as it is being land applied. This approach ensures what is sample reflects what is applied. Randomly place catch pans in the field to collect the liquid manure as it is land applied by an irrigation system or honey wagon. Flexible rubber feed pans work well. Immediately after the manure has been applied, collect the manure from the catch pans, combine in a bucket to make one composite sample and mix well by stirring. This bucket will be the source of the manure sent for analysis.

From a Storage Facility

If collecting liquid animal manure samples during land application is not possible, collect the samples from the storage facility. Liquid animal manure storage facilities have a tendency for the manure to stratify with the solids settling to the bottom and the liquids remaining on top. It is also not uncommon for some solids to form a floating crust. This stratification affects the manure nutrient concentrations in the storage facility. The nitrogen and potassium will be more concentrated in the top liquid, while the phosphorus will be more concentrated in the settled solids. This stratification of nutrient concentrations increases the challenge of getting samples that represent what will be applied to a particular field. If the liquids from the top and middle of the profile will be applied, only this material should be sampled. If the settled solids will be applied, then they should be sampled. However, if the manure is to be agitated before pumping, as has been the traditional recommendation, the sample should contain representative proportions of manure from the top, middle, and bottom. The idea is to collect a sample of an entire column of manure to represent the manure after agitation.

If agitating the manure prior to sampling is not possible, an alternative approach is to make a sampler to collect the required sub-samples. The sub-samples are then mixed to represent the manure after agitation. The easiest to construct is simply a container such as a cup, attached to the end of a pole. Liquids from the manure surface can be simply scooped up. To collect liquids from the middle depths, or settled solids, the container is held up side down, trapping air, until the desired sampling depth is reached. Then the container is rotated, releasing the air and collecting the sample. When collecting a sample of the entire profile of the manure, sub-samples are collected and mixed in a bucket.

- over -

A sampler design that automatically collects a sample of the entire profile uses 10 foot, 1 ½ inch PVC pipe with a PVC ball valve at the bottom. The handle of the ball valve is replaces with a lever arm about 2 feet long. The free end of the lever arm is attached to the end of a 10 foot, 1 inch PVC pipe. The lever arm and smaller pipe allow the ball valve to be operated while holding to top of the sampler. To use the sampler the valve is opened and the sampler is inserted (in a line, not and arc) into the manure. When the foot of the valve is at the bottom of the settled solids, it is closed. Then the sample of the entire manure profile can be removed from the manure and placed in a bucket.

Sketch of Cup Sampler

Sketch of Foot Valve Sampler

Whichever sampler is used, at least 8 locations around the manure storage unit should be sampled and mixed in a bucket to serve as a final composite sample. This bucket will be the source of the manure sent for analysis

Getting the Sample Analyzed

After thoroughly mixing the final composite sample, fill a one liter plastic bottle half full. These bottles may be obtained from your county Extension office. Never fill the bottle more than half full to allow for gas expansion of the sample and to prevent the bottle from exploding. Keep the samples as cool as possible until you can take them to your county Extensions office for shipping to the University of Arkansas lab for analysis. There you will get assistance in filling out an information sheet on your manure sample. There is a fee to have the sample analyzed. While the sample can be sent to a private lab, the fees are often higher. If you are required by the Arkansas Department of Environmental Equality (ADEQ) to sample your liquid animal manure as part of your Regulation No. 5 permit, make sure that you inform the individual helping you with the paperwork so the correct set of analyses can be performed. In addition to the analyses to determine the fertilizer value of manure, it is recommended to analyze for the amount of phosphorus in the manure that is water soluble. Water soluble phosphorus is needed to evaluate the potential environmental risk associated with phosphorus application rates specified in manure management plans. Having good farm based information should help planners develop plans tailored to and individual farm.

Key Points to Remember

The important things to remember in collecting a liquid animal manure sample are:

- Collect a sample that best represents the nutrient content of the manure in that storage facility and what will be applied. If only the top water is to be applied it should be sampled. If the storage unit will be agitated prior to application the sample should contain material from the entire depth profile.
- Only fill the sample bottle ½ full.
- Keep the sample cool prior to shipping.
- Ship the sample to the lab as soon as possible.

Handout, April 27, 2010

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Appendix 4 - Piezometer and Monitoring Well Installation

At each site, a series of three (3) piezometers will be installed. Piezometers containing water-level sensors (Water Logger WL-15 units from Global Water) will be installed near just below the root zone (about 12 inches deep), at approximately the bottom impermeable layer or groundwater level (about 15 feet or approximately at the Big Creek bed elevation), and equidistant from the first two piezometers. A bucket auger will used to describe the soil profile upon excavation to install the deepest piezometers. The piezometers containing the water-level sensors will consist of 5-cm (2-inch) diameter Schedule 40 PVC pipe, which will be slotted in the bottom 10 cm of the pipe to facilitate water flow. Sand will be placed in the bottom of the hole and along the outside of the PVC pipe up to the top level of the slots in the pipe. Bentonite chips will be placed above the sand along the outside of the PVC pipe to the soil surface to ensure no preferential movement of water along the well casing. Data will be downloaded from each WL-15 unit using a laptop computer once approximately every month. Water-table heights will be measured manually each time the datalogger is downloaded to confirm the sensors' accuracy.

NOTE - Piezometers will be installed so that there is minimal piping or equipment above ground that could interfere with day to day farm operations on that field.

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Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report - October 2013 to December 2013

DEMONSTRATING AND MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Addendum

The Division of Agriculture offers its programs to all eligible persons regardless of race, color, national origin, religion, gender, age, disability, marital or veteran status, or any other legally protected status, and is an Affirmative Action/Equal Opportunity Employer.

Addendum

The Quarterly Report for the Big Creek Research and Extension Team activity for October 1 to December 31, 2013 contained fields that were incorrectly identified in the original Comprehensive Nutrient Management Plan. The following maps correctly designate all fields that we currently have permission to collect soil and water samples from and which we accessed to date and will continue to in compliance with our stated tasks.

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Map 6. Location of water sampling locations on and adjacent to the C&H Farm operation Mt. Judea, Newton County, AR (Page 19) ... 5

Map 7. Gridded layout of the sampled fields on the C&H Farm operation Mt. Judea, Newton County, AR (Page 34). ... 6

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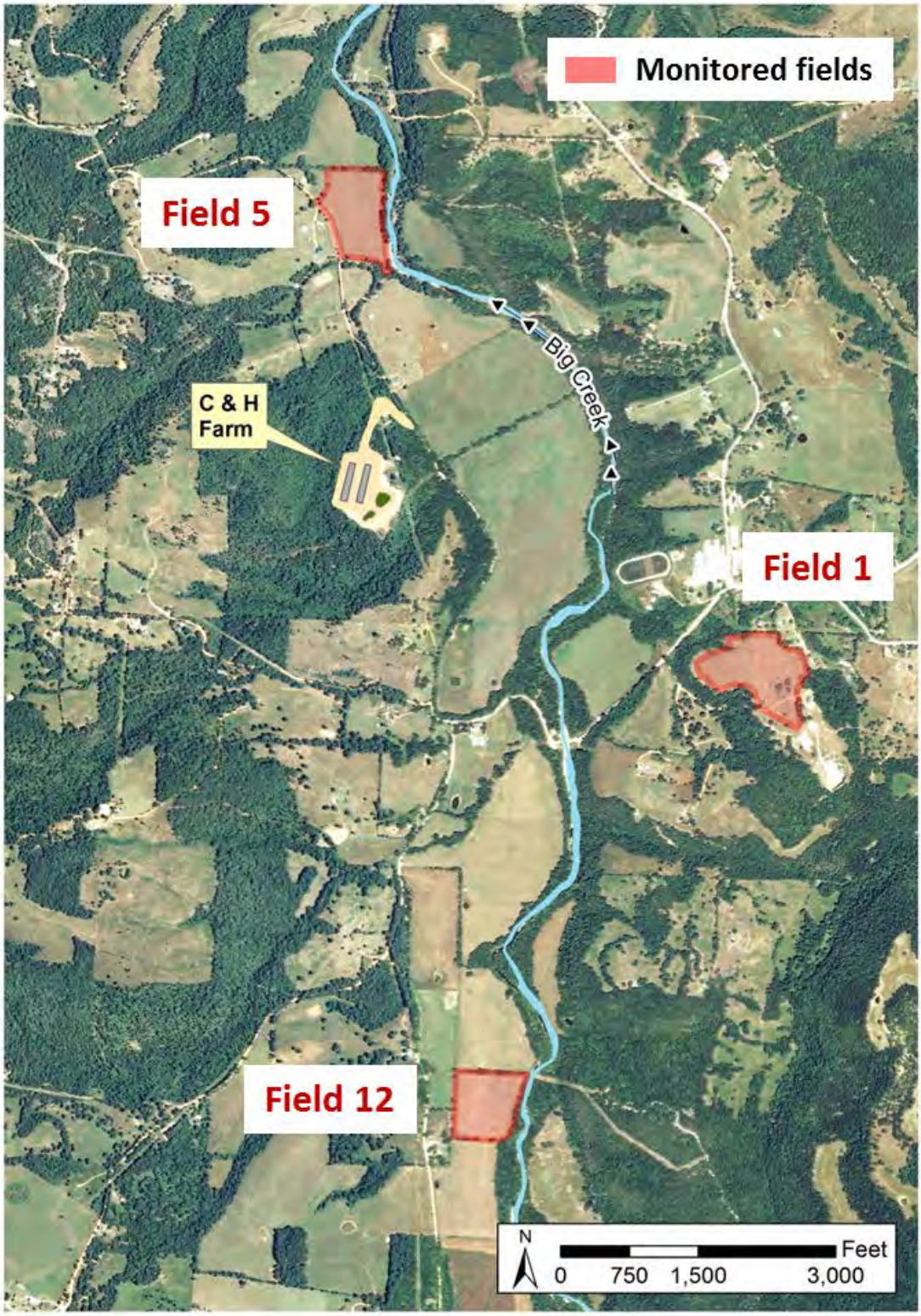
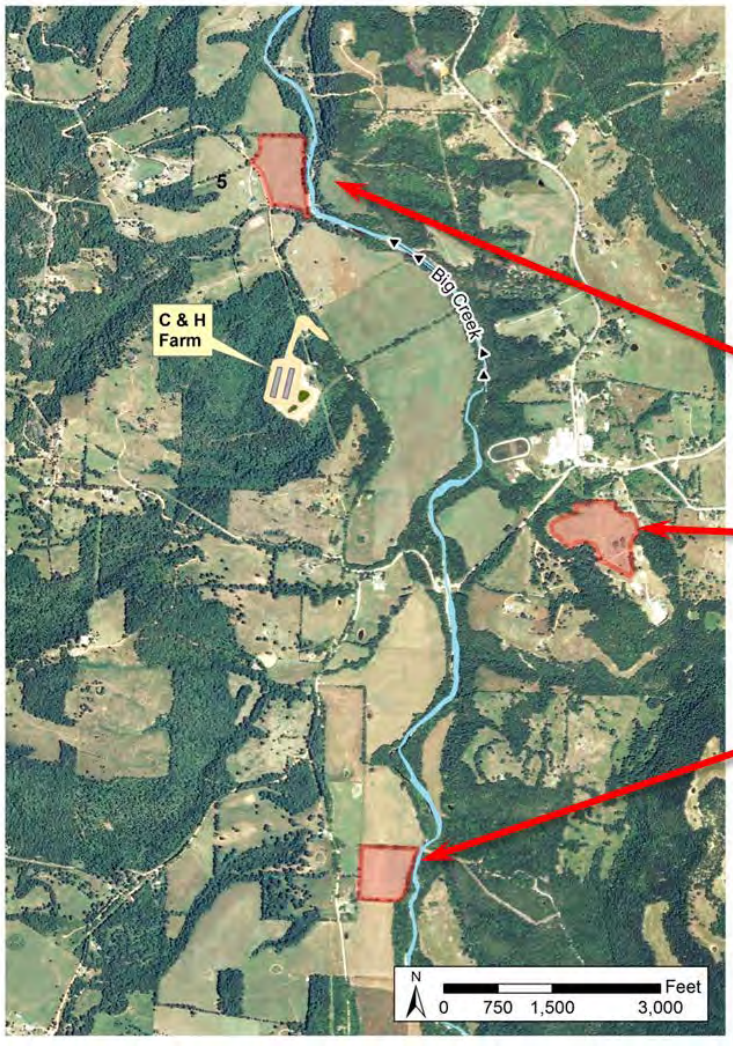
Map 2. Location of monitored fields on the C&H operation Mt. Judea, Newton County, AR (Page 13).



Map 5. Location of monitored fields and soil test P levels on the C&H Farm operation Mt. Judea, Newton County, AR (Page 18).

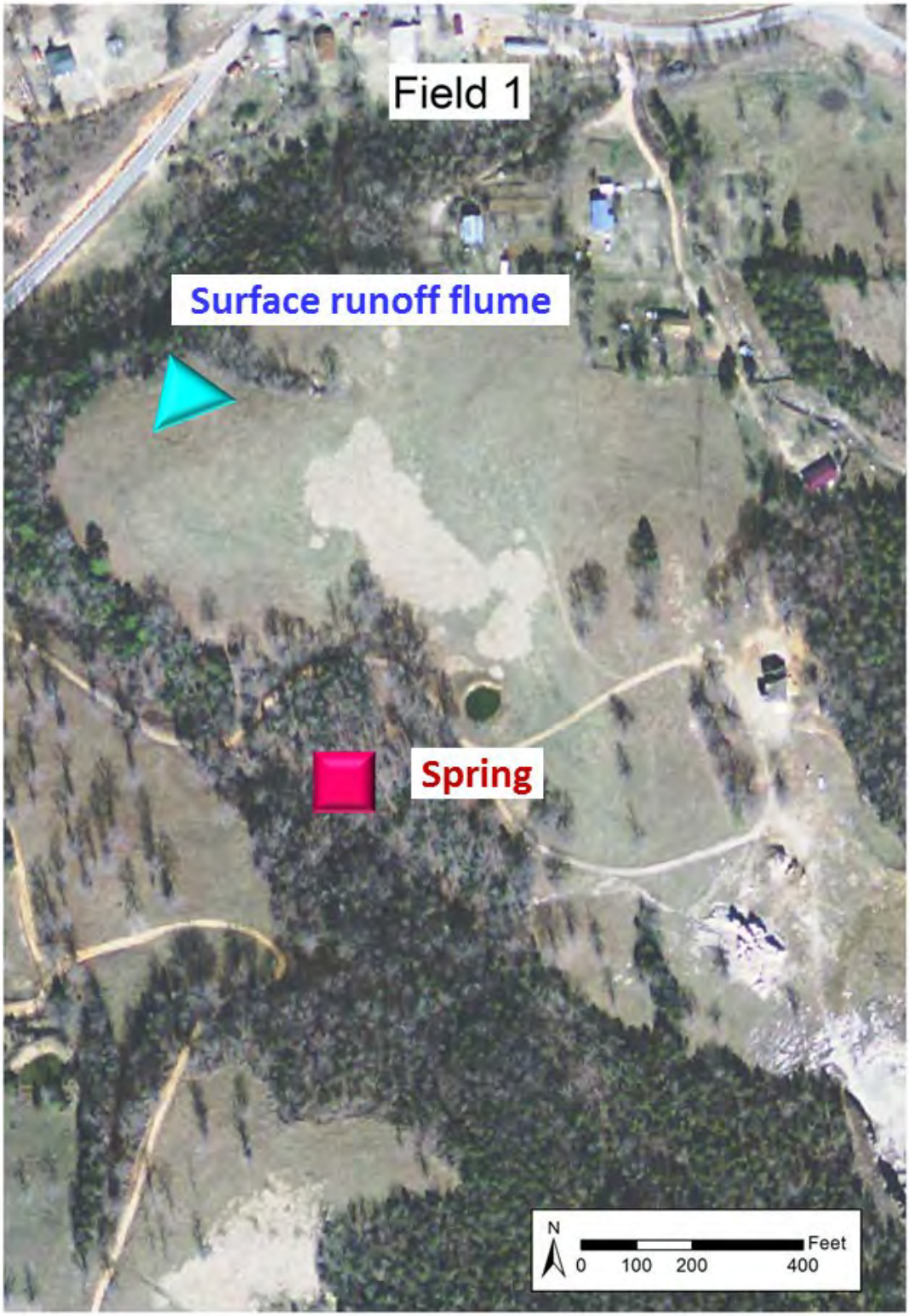


Field #	Area, acres	Soil test P, mg/kg
5	23.8	65
1	15.6	83
12	23.7	19

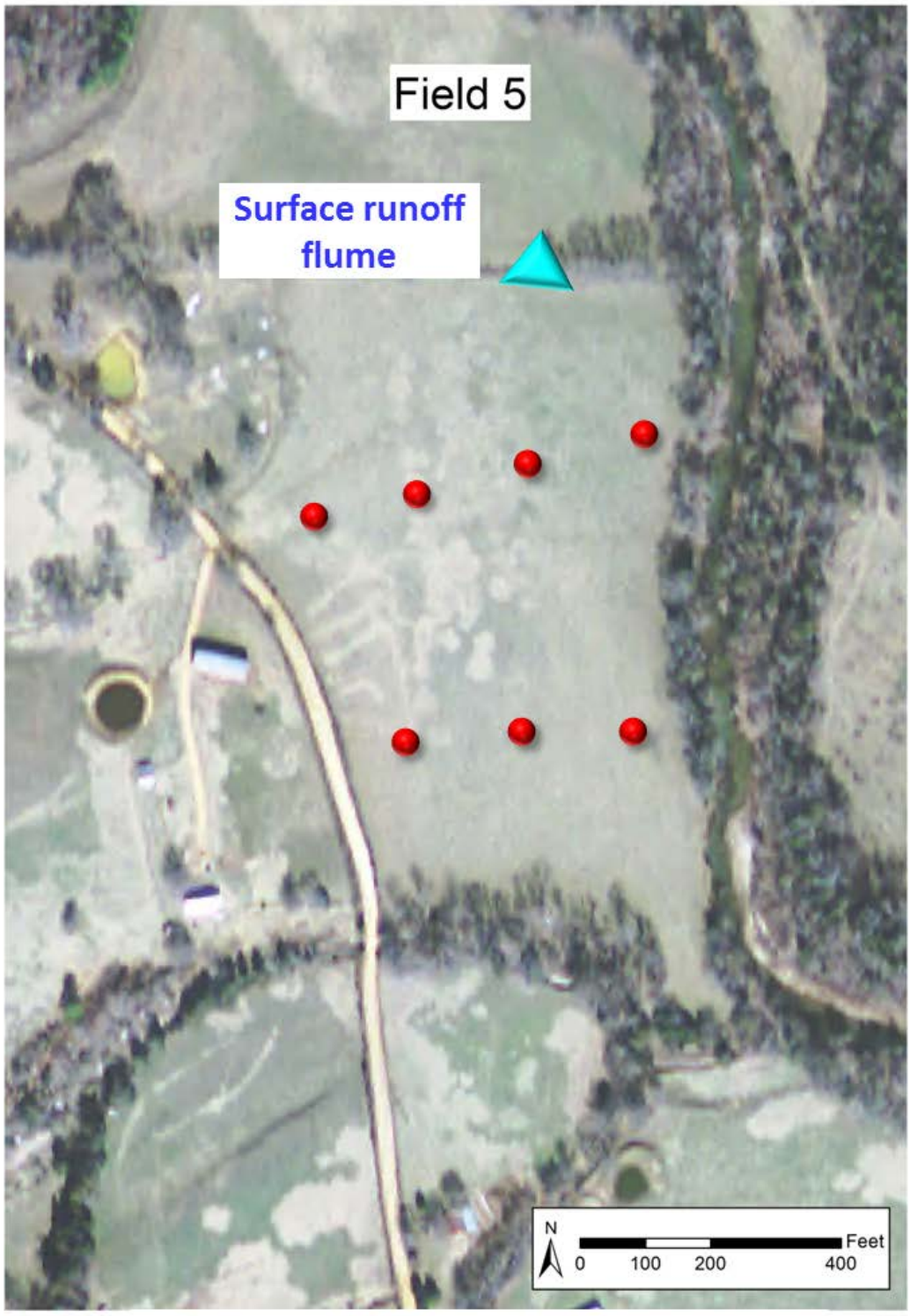
Map 6. Location of water sampling locations on and adjacent to the C&H Farm operation Mt. Judea, Newton County, AR (Page 19).

Map 7. Gridded layout of the sampled fields on the C&H Farm operation Mt. Judea, Newton County, AR (Page 34).

Map 11. Potential sampling locations for Field 1 (Page 59).



Map 12. Potential sampling locations for Field 5 (Page 60).



Map 13. Potential sampling locations for Field 12 (Page 61).

Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – January 1 to March 31, 2014

DEMONSTRATING AND MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

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Dr. Mark J. Cochran
Vice President for Agriculture

DEMONSTRATING AND MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Executive Summary

This is the second Quarterly Report of the Big Creek Research and Extension Team that details progress made from January 1 through March 31, 2014.

1. Permission was obtained and signed Memorandums of Understandings (MOUs) were obtained with the landowners of Fields 1 and 12, to install flumes and piezometers to monitor flow and nutrients in surface runoff and water infiltrating through the soil profile. Instrumentation of Field 1 was completed and Field 12 is ongoing. Permission and signed MOUs were obtained for land above and below the C&H Farm to install flow gauging stations that will be instrumented with continuous and storm flow samplers to monitor nutrient and suspended sediment concentrations.
2. An agreement was obtained to cooperate with U.S. Geological Survey to calibrate and operate the Big Creek gauging stations.
3. An agreement was also reached with C&H to sample a groundwater well adjacent to the slurry holding ponds. Data will be available in the next quarter.
4. Flow monitoring equipment and autosamplers were installed on the culvert draining the subwatershed that the C&H livestock operation and holding ponds.
5. The surface 0 to 4 inch soil test P concentrations ranged from 17 to 147 mg P/kg, with an average of 63 mg/kg.
6. Base flow sampling of Big Creek continued every two weeks above and below the C&H Farm, and a spring below monitored Field 1. Dissolved P concentration ranged from 0.006 to 0.010 mg/L at the spring, 7 to 14 in Big Creek above the C&H Farm, and 7 to 15 mg/L downstream of the Farm. Total coliform raged from 308 to 1733 MPN/ 100 mL in spring water, 210 to 980 MPN/100 mL upstream of C&H, and 272 to 1300 MPN/100 mL downstream of C&H.
7. A second set of manure samples from Pond 1 and a first set from Pond 2 were collected, which further document the naturally occurring manure solids and nutrient stratification with depth and from the first pond to the second. The resulting difference in manure composition, may allow application of nutrients to more closely match forage nutrient needs.
8. Work has begun on quantifying manure volume and nutrient production. Water meters were installed to measure barn wash water added to the manure. Historical monthly precipitation and evaporation information was also obtained. This information, in conjunction with animal population information, will be used in nutrient application and solids separation calculations.

Big Creek Research Team

Faculty

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Rick Cartwright, Ph.D., Professor – Associate Director of Extension for Agriculture and Natural Resources

Mark Cochran, Ph.D., – Vice President, University of Arkansas System Division of Agriculture.

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Jun Lui, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Nathan McKinney, Ph.D., – Assistant Director, Agriculture Experiment Station

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Thad Scott, Ph.D., Associate Professor - Water quality, transport of contaminants to and within water bodies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians

The Big Creek Research and Extension Team are ably supported by several excellent Program Technicians based in Little Rock and Fayetteville.

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Introduction

This research project will evaluate the impact and sustainable management of the C&H Farm operation (subsequently referred to as C&H, to include animal facilities and permitted land application fields) on the water quality of Big Creek. The study includes the following major tasks:

1. Monitor the fate and transport of nitrogen (N), phosphorus (P), sediment, 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 water quality of Big Creek below the C&H Farm as well as emerging springs and ephemeral streams.
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.

The project will measure soil fertility levels of all permitted fields annually, to determine the impact of current manure management on nutrient balances (i.e., any potential accumulation). This combined with nutrient levels in surface runoff and monitored wells on Fields 1 and 12 (an additional Field will be added with landowner permission), will guide adaptive manure management decisions to address field and environmental sustainability concerns. The project will also assess the feasibility of manure treatment, which is regarded as addressing nutrient imbalance concerns on all farms similar to C&H, which has the potential to provide the farm with cost-beneficial alternative for the sustainable use and export of treated manures off the farm and/or out of the watershed.

The plan of research meets the level of funding currently available. Other important methods of investigation, such as the use of dye-tracer tests, will provide valuable information on possible rapid by-pass flow pathways common in karst dominated areas will be conducted.

This information will be a short-term assessment and it must be noted that funds allocated below will not cover long-term monitoring, sample analysis, and assessment of land use impacts on area waters. Additional funds would be needed for sample collection and labor to continue monitoring for a minimum of five years. This time frame is recognized by the Environmental Protection Agency (EPA), Natural Resources Conservation Service (NRCS), and general scientific community to be the minimum required to accurately assess any impacts and overcome annual weather fluctuations.

Soil Sampling and Analysis

Grid soil sampling of Field 12 was conducted as per Figure 1. The grid size is approximately 0.25 acres and seven soil-depths increments were collected to include 0 to 4", 4 to 8", 8 to 12", 12 to 18", 18 to 24", 24 to 30", and 30 to 36" where possible with a Giddings soil probe. A grid network was overlain on each field to determine the point of sampling, which was noted by GPS. Each sample-hole remaining after the soil core was removed was carefully back-filled with commercial top soil (see Figure 1). Where rock stopped the core penetrating below a specific layer, no sample was taken.

The actual analyses of each core sample and depth are given in Appendix (Table 6, 7, 8, 9, and 10) and averages in Table 1. Table 1 contains average values for Fields 1 and 5 already completed in the first quarter of this project. The distribution of soil test P in the surface 4 inches of soil of Fields 1, 5, and 12 are given in Figures 2, 3, and 4, respectively.

Table 1. Average soil test P concentrations in the surface 0 to 4 inches of each field and when sampled during the Comprehensive Nutrient Management Plan (CNMP) development.

Soil depth, inches	Field 1	Field 5	Field 12
	--------- mg/kg ----------		
Original NMP	83	65	19
0 - 4	41	54	63
4 – 8	17	32	36
8 – 12	10	28	26
12 – 18	NS †	34	24
18 – 24	NS	6	35
24 – 30	NS	19	NS

† NS is Not Sampled.

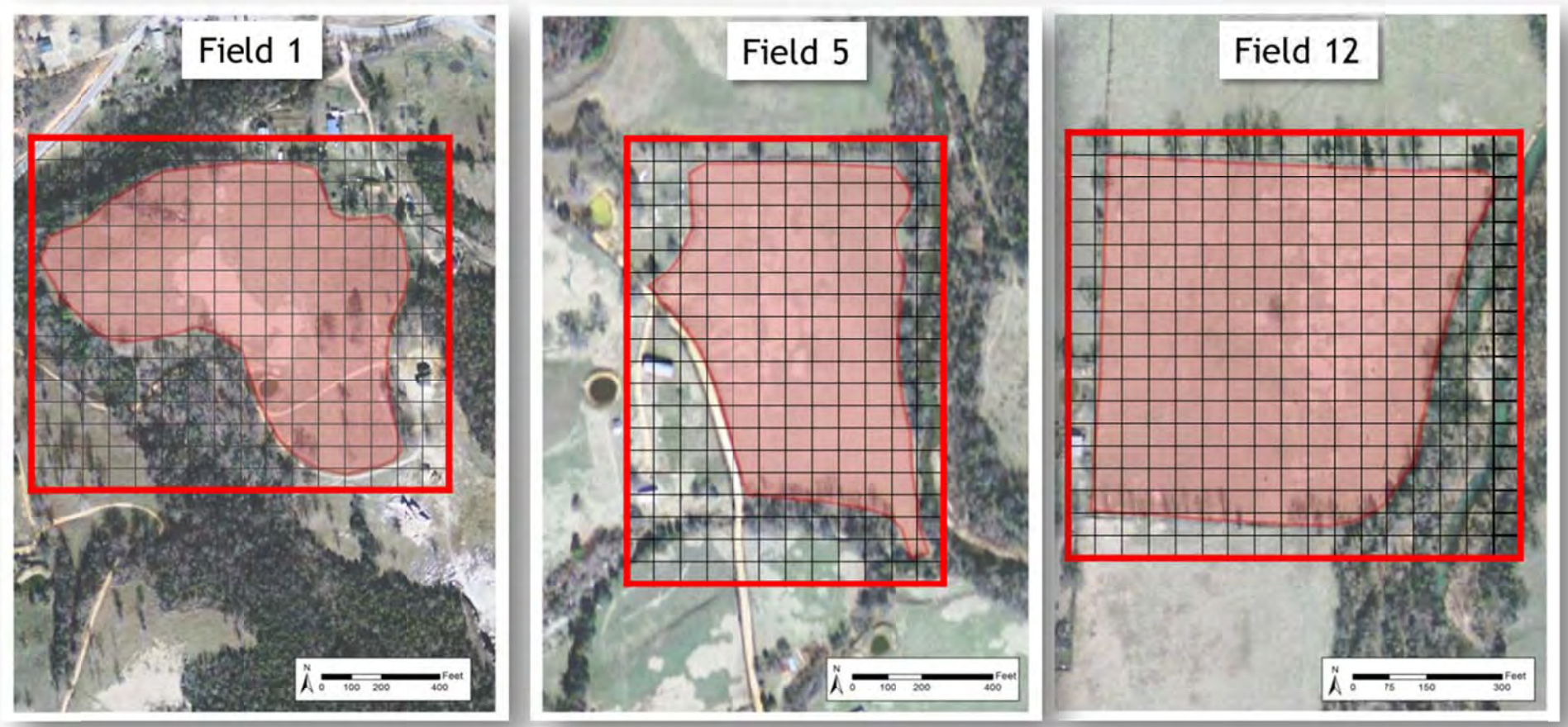

Figure 1. Gridded layout of the sampled Field 1, 5, and 12 on the C&H Farm operation Mt. Judea, Newton County, AR.

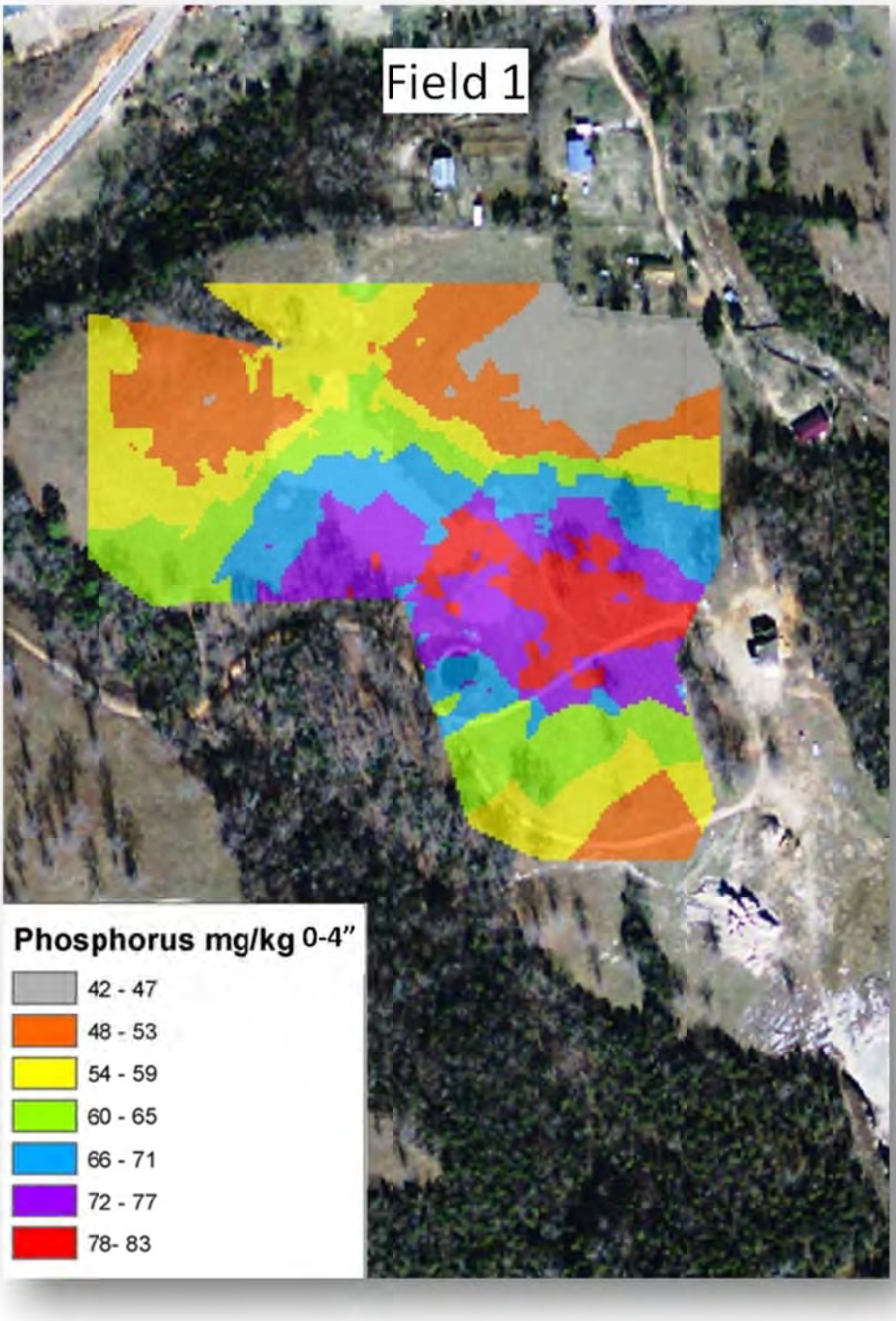

Figure 2. Soil P distribution of the 0 to 4 inch depth for Field 1 on the C&H Farm operation Mt. Judea, Newton County, AR.

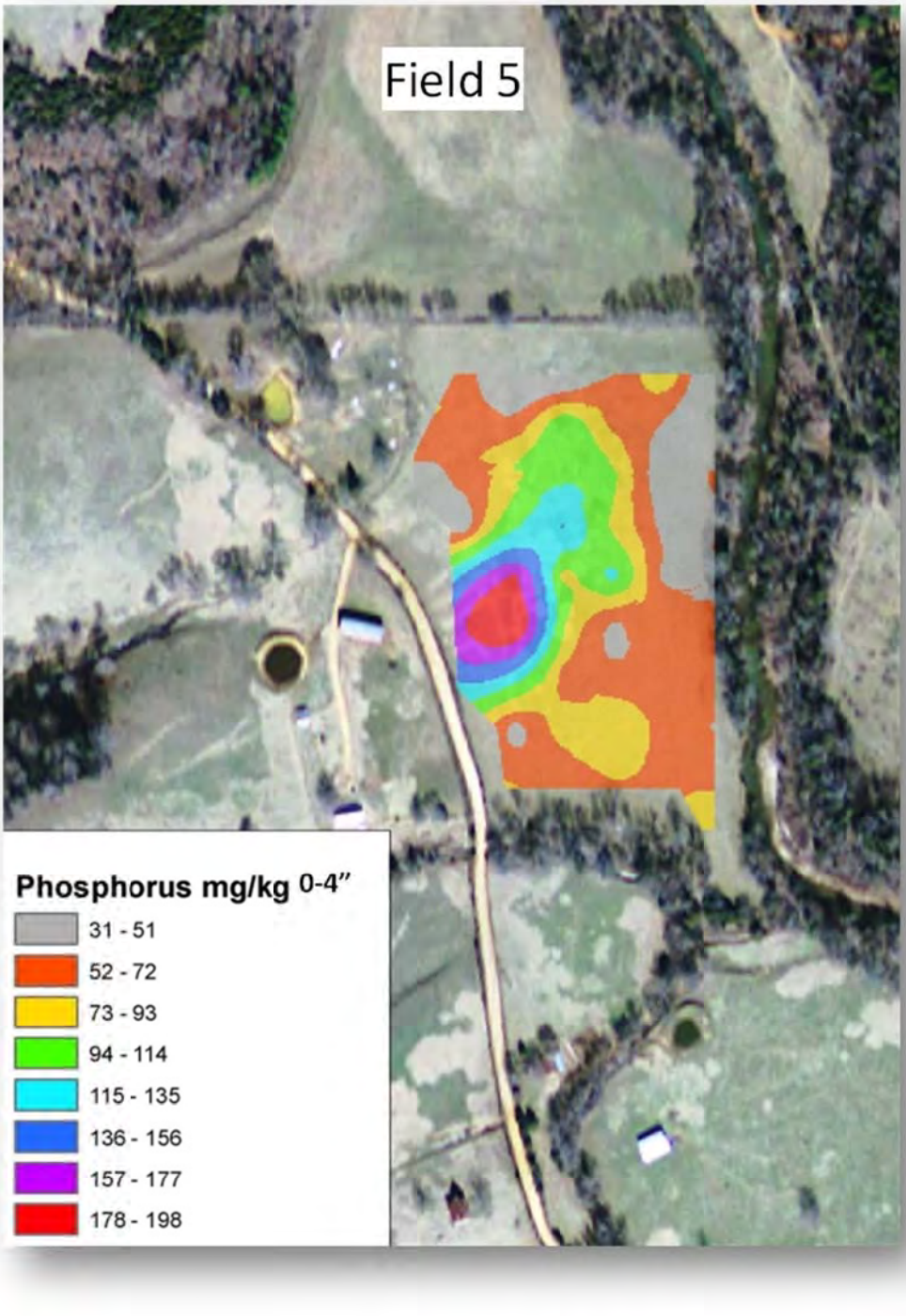

Figure 3. Soil P distribution of the 0 to 4 inch depth for Field 5 on the C&H Farm operation Mt. Judea, Newton County, AR.3.

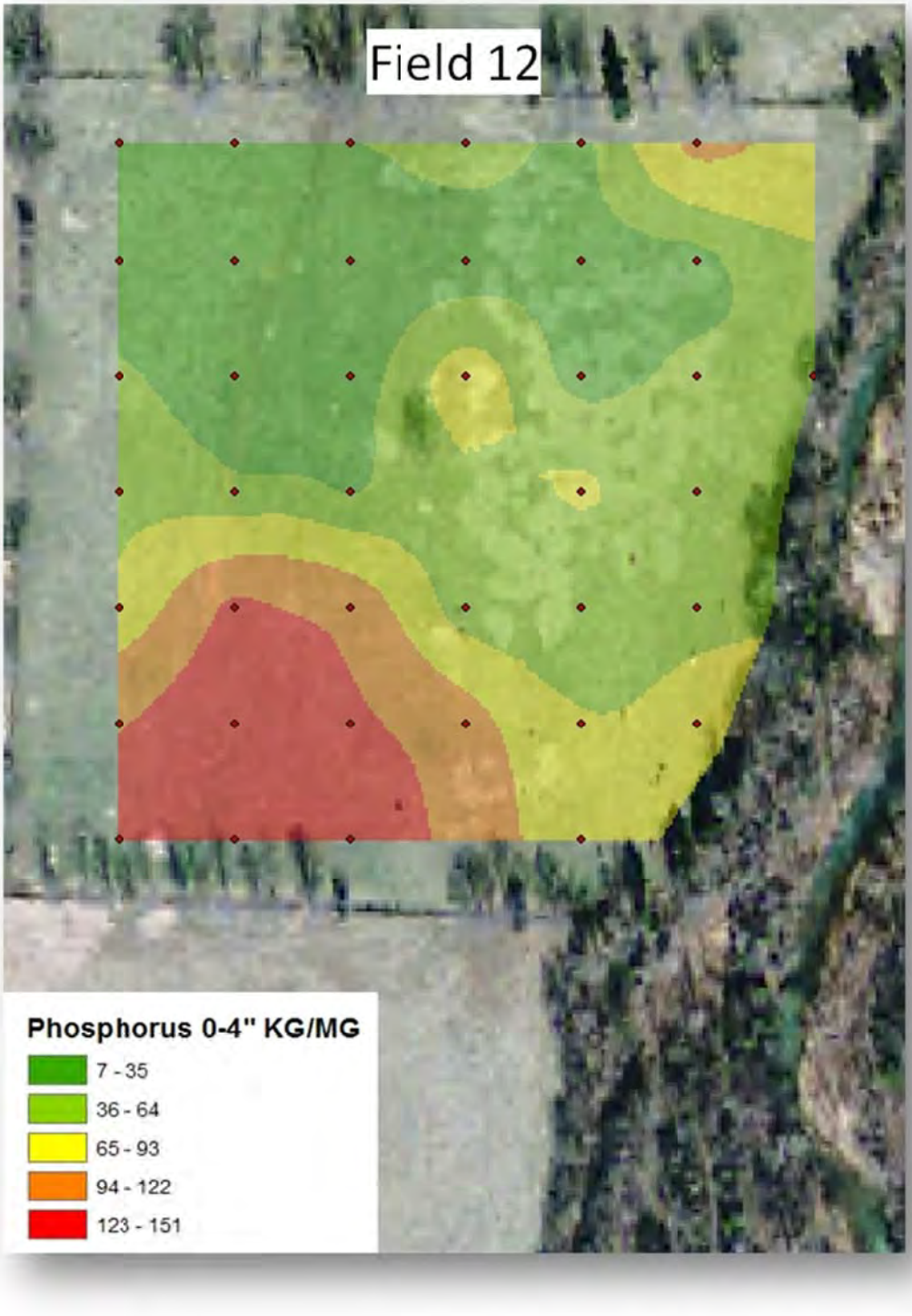

Figure 4. Soil P distribution of the 0 to 4 inch depth for Field 12 on the C&H Farm operation Mt. Judea, Newton County, AR.

Manure Slurry Sampling and Analysis

To provide additional information for the adaptive manure management decision process a second set of manure samples were collected on March 10, 2014. The water level in Pond 1 had reached the point that it flowed across the spill way into Pond 2. Thus, the March 10, 2014 samples were drawn from Ponds 1 and 2

As with the first sampling event, a foot valve liquid manure sampler was used to collect composite samples representing manure from 6 inches below the water surface (top water), from within the settled solids at the bottom of the pond (bottom slurry), and from the water surface to the bottom of the pond including the settled solids (pond profile). Each composite sample was composed of multiple subsamples from various locations around the pond. These subsamples were mixed to compose a sample representing the top water, pond profile, and bottom slurry of Ponds 1 and 2 obtained and hand-delivered on the day of collection to the UofA Agricultural Diagnostics Service Laboratory (Table 2 Figures 5, 6, and 7)

As with the September 24, 2013 samples the March 10, 2014 collection and analysis of manure samples from Ponds 1 and 2, representing the top water, bottom slurry, and entire profile, generated chemical profiles typical of other manure storages associated with swine production. That is, N and P concentrations of the manure increased with water depth (Figures 6 and 7).

However, P concentrations increased at a greater rate than did N concentrations. The resulting higher N / P ratio of the surface water is closer to the ratio of these nutrients required by pastures on the C&H Farm. Thus, land application of top water from a pond to farm pastures will more likely meet both the N and P needs of the pasture and avoid application of P surplus to plant needs. The higher concentration and lower N / P ratio of bottom slurries will lend to application of that slurry on a manure banking approach, where the slurry would be applied on alternate years to fields more distant from the C&H Farm and Big Creek.

Even without the addition of mechanical and/or chemical separation approaches, the observed natural gravity separation of slurry and its constituents, provides farm nutrient management opportunities to more closely match manure nutrients to crop nutrient needs. In addition, the higher nutrient concentrations of Pond 1 over Pond 2 confirm that Pond 1 is functioning as settling basin, in that it retains a significant portion of the manure solids and nutrients. This provides additional differential manure management opportunities pertaining to land application.

Manure Production Determination

The volume of manure produced by livestock is largely determined by the average animal population characteristics, freshwater additions (if any), spilled drinking water (if any), and pen wash-down water. In addition, any precipitation directly into manure storage or via surface runoff will increase manure volume. Discussions with C&H management revealed that the farm used “wet/dry” feeders so that any animal drinking water spillage would fall into feed troughs to be consumed with the feed. As a result there will be effectively no spilled drinking water adding to manure volume.

Estimates for pen-wash down water were provided in the form of the number of pressure washers, the flow rates in gallons per minute, and the average time spent washing each day. As a more direct determination of pen-wash water additions to the manure was desired, two standard water meters were purchased and installed to measure all the water used by two pressure washers used in the barns (Figure 8 and 9).

Future meter readings and the date of the readings will provide measured information on the amount of water used on a daily basis to wash the animal pens and added to the manure volume. To quantify potential precipitation additions to the manure volume planning is in progress to determine as the built dimensions and elevations of Ponds 1 and 2. This information and historical rainfall information (Table 3) will be included in the information used to estimate potential precipitation additions to the manure volume.

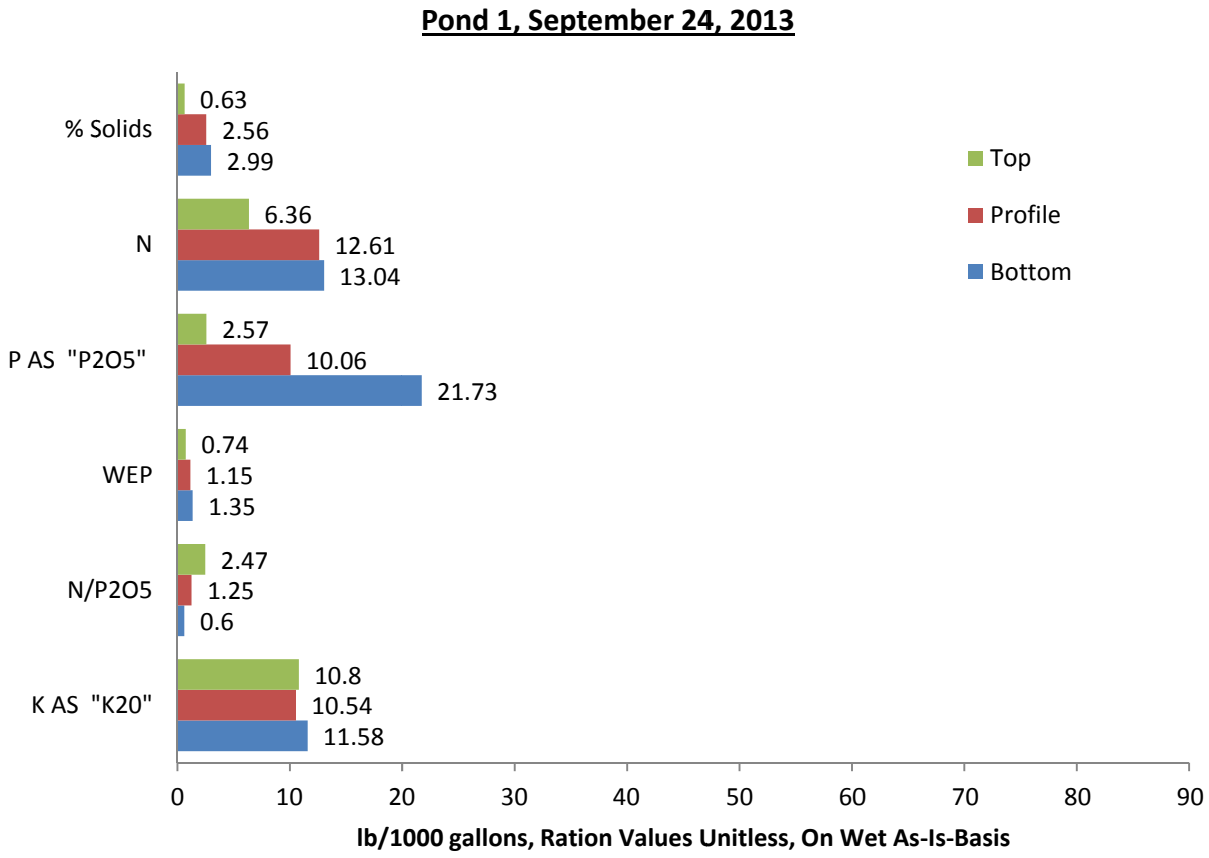

Figure 5. Select Chemical properties of manure samples collected from pond 1 on September 24, 2013.

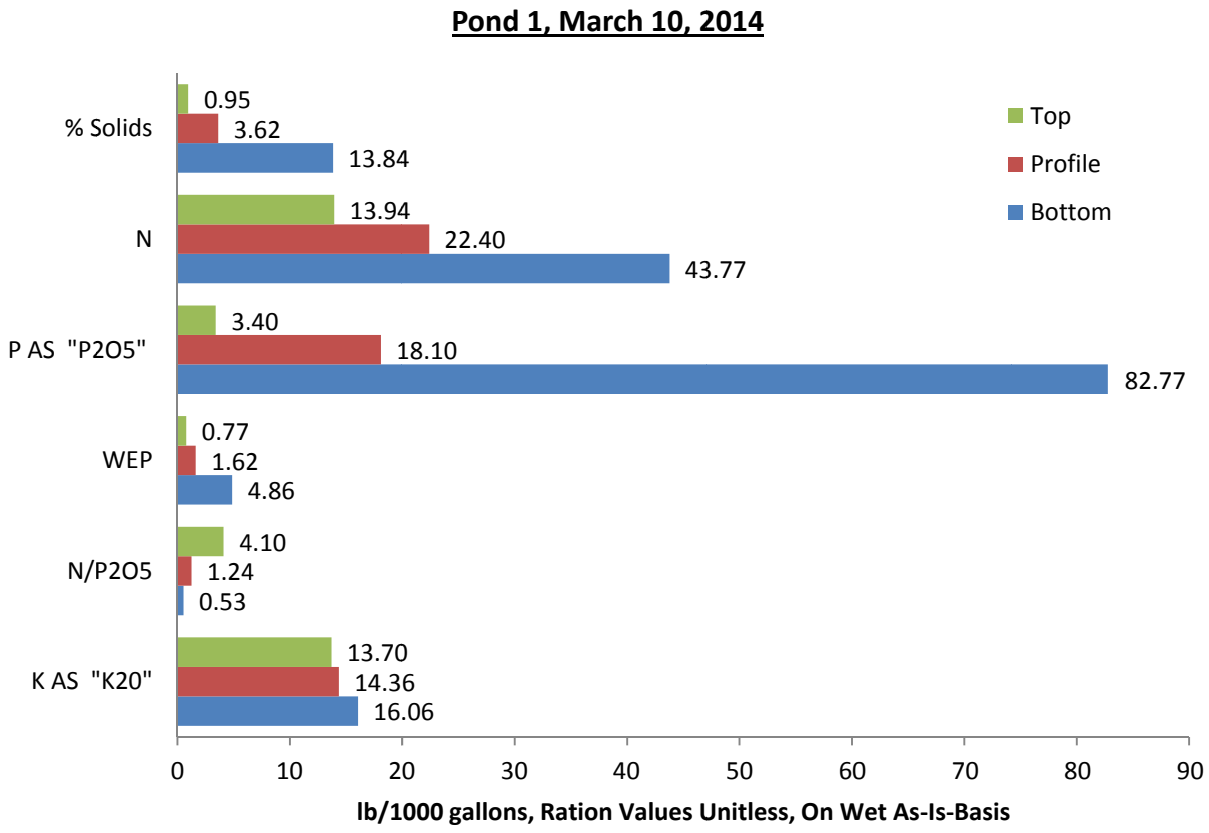

Figure 6. Select chemical properties of manure samples collected from pond 1 on March 10, 2014.

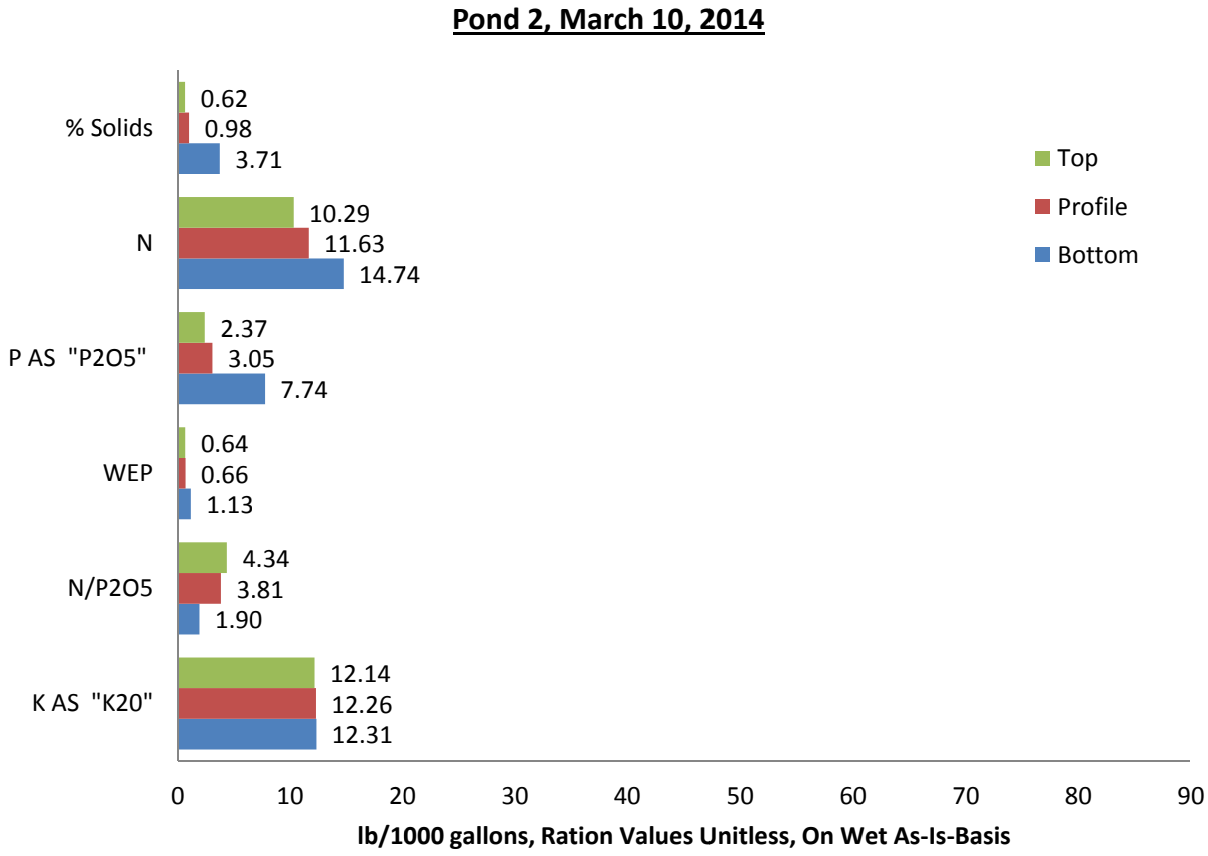

Figure 7. Select Chemical properties of manure samples collected from pond 2 on March 10, 2014.

Table 2. Chemical properties of manure samples collected from ponds 1 and 2 on September 24th, 2013 and March 10, 2014.

	Sample Date								
	September 24th, 2013			March 10th, 2014					
	Pond 1			Pond 1			Pond 2		
	0 – 6”	Profile	Bottom	0 – 6”	Profile	Bottom	0 – 6”	Profile	Bottom
pH	7.8	7.7	7.6	7.8	7.5	7.3	8.0	7.9	7.8
Electrical conductivity (umhos/cm)	10020	10060	9880	14830	14770	10860	12640	12490	12370
Solids (%)	0.63	2.56	2.99	0.95	3.62	13.84	0.62	0.98	3.71
Total N (lbs/1000 gal)	6.36	12.61	13.04	13.94	22.40	43.77	10.29	11.63	14.74
NH_4-N (lbs/1000 gal)	6.09	7.29	6.31	12.45	13.14	13.44	9.79	10.42	10.28
NO_3-N (lbs/1000 gal)	<0.006 †	<0.006	<0.006	<0.001	<0.001	<0.001	0.002	<0.001	<0.001
Total P as "P_2O_5" (lbs/1000 gal)	2.57	10.06	21.73	3.40	18.10	82.77	2.37	3.05	7.74
WEP (lbs/1000 gal)	0.74	1.15	1.35	0.77	1.62	4.86	0.64	0.66	1.13
Total K as "K_20" (lbs/1000 gal)	10.80	10.54	11.58	13.70	14.36	16.06	12.14	12.26	12.31
Total Ca (lbs/1000 gal)	0.29	3.16	7.71	1.26	7.66	41.65	0.66	1.15	3.87
NH_4-N / Total N	0.96	0.58	0.48	0.89	0.59	0.31	0.95	0.90	0.70
WEP / Total P	0.66	0.26	0.14	0.52	0.20	0.13	0.62	0.50	0.33
N / P_2O_5	2.47	1.25	0.60	4.10	1.24	0.53	4.34	3.81	1.90
N:P_2O_5:K_2O ratio	2:1:4	1:1:1	1:2:1	4:1:4	2:1:1	3:5:1	4:1:5	4:1:4	2:1:2

† "<" indicate the NO_3-N value is below detection limits.

Table 3. Historical annual precipitation information for Newton Co. Arkansas. Extracted from NRCS's Animal Waste Management Software program version 2.4.0.

Month	Precipitation	Evaporation
January	2.06	0.72
February	2.75	1.08
March	4.58	2.52
April	3.97	3.60
May	5.06	4.68
June	3.27	4.68
July	2.94	5.40
August	2.74	5.04
September	4.15	3.24
October	3.47	2.88
November	3.88	1.44
December	3.55	0.72
Totals	42.42	36.00

Figure 8. One of the standard water meters with hose adapters and mounting base installed to measure water use during pressure washing to clean animal pens.

Figure 9. Two water meters purchased and installed on March 20th, 2014 to measure pen wash down water additions to manure volume. Initial meters readings were 126.6 and 80.2 gallons for meter 1 and 2.

Water Sampling and Analyses

Sampling Locations

Topographic surveys of permitted Fields 1 and 12 were conducted to determine the appropriate location for edge-of-field surface runoff collection flumes. Figure 10 shows the low point on Field 1 where the flume was sited. The location for a similar flume on Field 12 is shown on Figure 11 and construction will begin as soon as the Field dries to allow construction without damaging or rutting any of the farmed field.

Water quality sampling was initiated on September 24, 2013, prior to the formal start of the project (Figure 12). Since January 1 and reported in the 1st Quarterly Report, installation of an edge-of-field surface runoff monitoring equipment was completed and became operational April 2, 2014, as shown in Figure 13. Additionally runoff volume and auto-sampling equipment was also installed on an ephemeral stream draining a sub-watershed in which the C&H Farm operations and swine slurry storage lagoons are located, as shown in Figure 12. These sites are;

Site 1. Edge-of field monitoring on Field 1 permitted to receive slurry – Figure 13.

Site 2. Edge-of field monitoring on Field 5a – still to be determined

Site 3. Edge-of field monitoring on Field 12 permitted to receive slurry – still to be completed

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities – Figure 14.

Site 5. Spring below Field 1 – Figure 15.

Site 6. Big Creek upstream of the C&H Farm operation – Figure 16.

Site 7. Big Creak downstream of the C&H Farm operation – Figure 17.

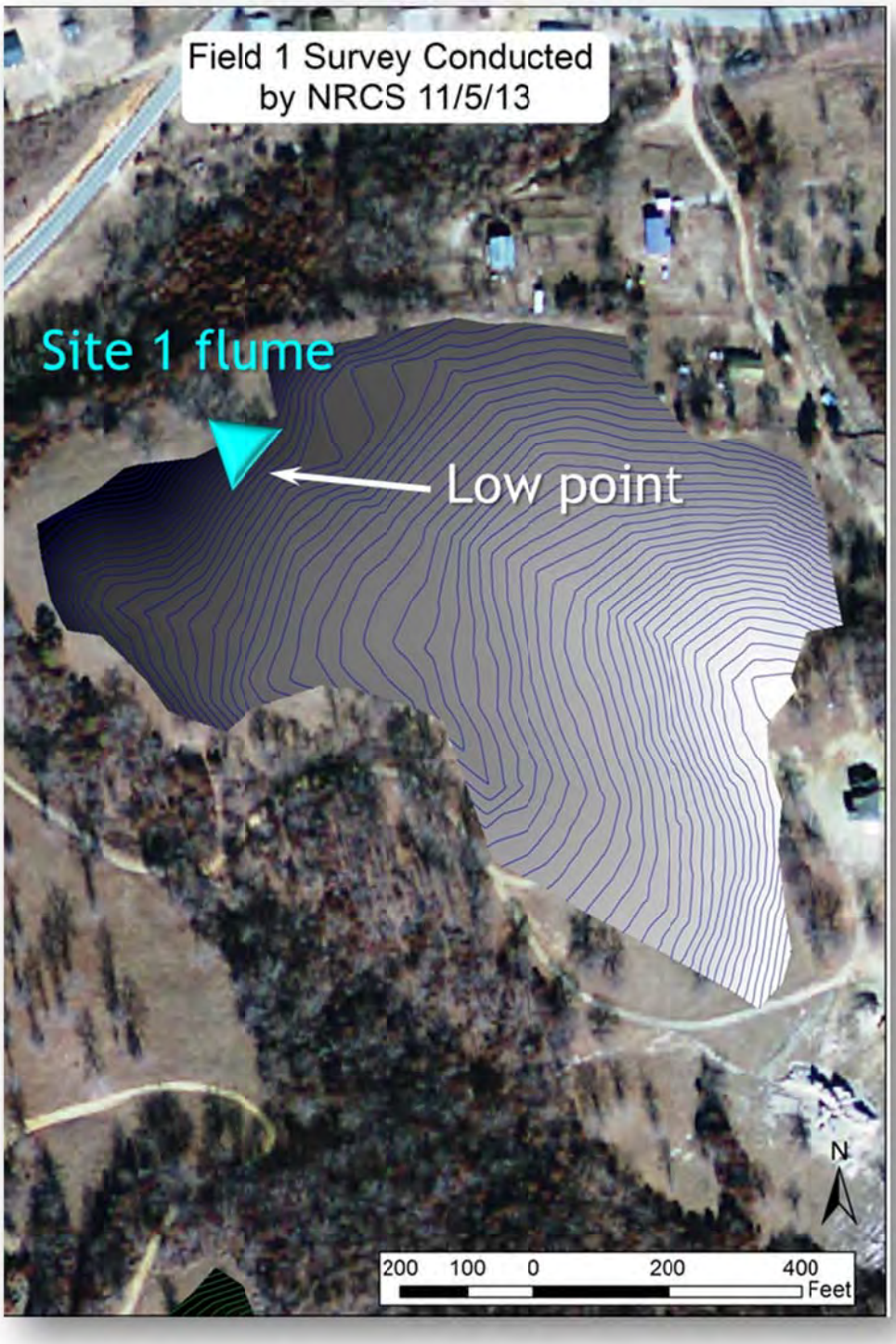

Figure 10. Location of water quality sampling sites on Big Creek and spring below application Field 1.

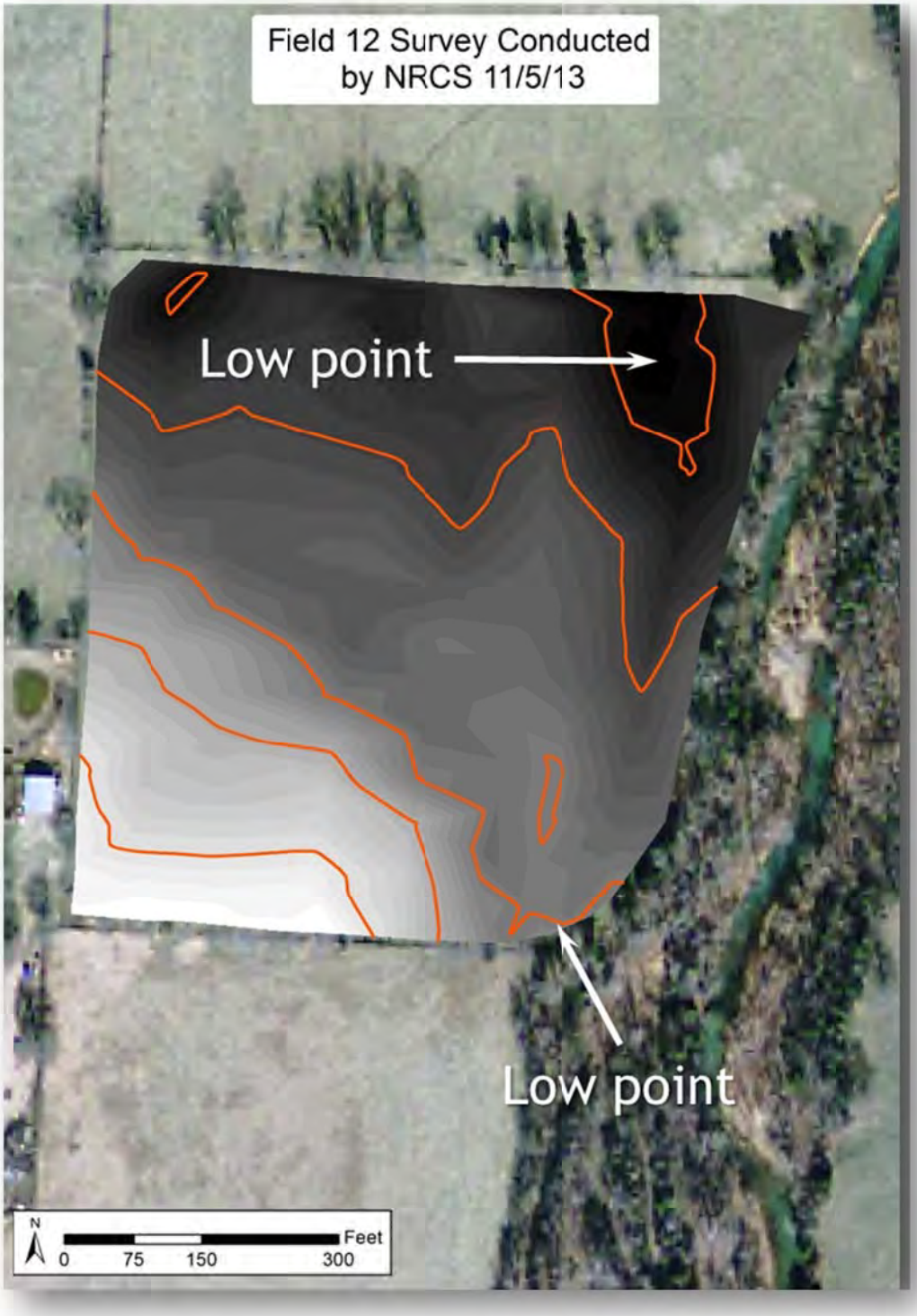

Figure 11. Topographic elevation map showing low point where any surface runoff would leave Field 12 on the C&H Farm.

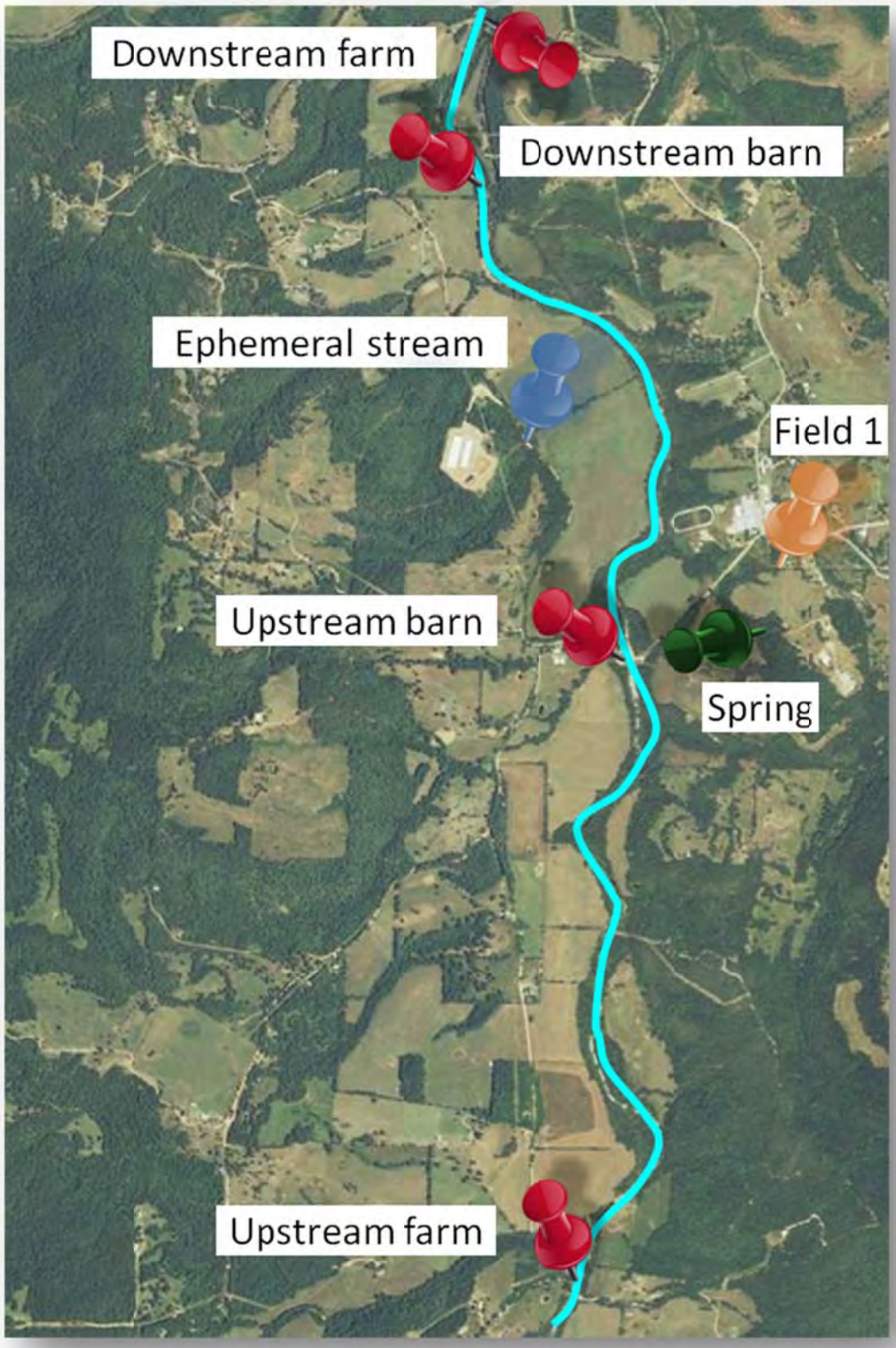

Figure 12. Location of water quality sampling sites on Big Creek and the C&H Farm.

Figure 13. Edge-of-field surface runoff flume on Field 1 on the C&H Farm.

Figure 14. The culvert sampling an ephemeral stream draining a subwatershed containing the C&H Farm operation facilities.

Figure 15. The spring sampled adjacent to Big Creek on the C&H Farm.

Figure 16. The Big Creek sampling site upstream of the C&H Farm during baseflow.

Figure 177. The Big Creek sampling site downstream of the C&H Farm during baseflow.

Sampling Protocols and Analyses

The chemical composition of water samples collected prior to December 31, 2013 is given in Table 4. The following procedure was used to collect, prepare and analyze all water samples;

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted.
6. Samples were placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
7. Analyses included Dissolved Phosphorus (EPA 365.2), Total Phosphorus (APHA 4500-P), Ammonia (EPA 351.2), Nitrate (EPA 300.0), Total Nitrogen (APHA 4500-P), Total Suspended Solids (EPA 160.2), E. Coli (APHA 9223, B) and Total Coliforms (APHA 9223, B).

Table 4. Water quality analyses at each sample site. Coliform units are Most Probable Number (MPN) per 100 mL of water.

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	E. coli	Total coliform
			---------- mg/L ----------						--- MPN/100 mL ---	
9/12/2013	**9/12/2013**	**Base flow**								
10:45	15:30	Upstream farm	0.016	0.030	0.06	0.367	0.50	3.0	6.3	>2420
11:15	15:30	Upstream barn	0.010	0.022	0.05	0.356	0.54	5.8	4.1	4040.0
10:50	15:30	Downstream barn	0.019	0.026	0.05	0.632	0.78	1.2	1.0	488.4
13:00	15:30	Downstream farm	0.010	0.022	0.04	0.396	0.62	1.7	16.0	>2420
9/20/2013	**9/20/2013**	**Base flow**								
10:50	16:08	Spring	0.006	0.020	0.03	0.384	0.50	4.7	72.7	5040
11:15	16:08	Upstream farm	0.009	0.022	0.03	0.247	0.36	1.1	80.9	9870
11:20	16:08	Upstream barn	0.015	0.024	0.04	0.356	0.42	1.2	1203	26130
12:20	16:08	Downstream barn	0.024	0.032	0.06	0.757	0.85	1.3	218.7	2430
12:50	16:08	Downstream farm	0.013	0.022	0.05	0.442	0.53	1.1	548	17230
9/24/2013	**9/24/2013**	**Base flow**								

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	E. coli	Total coliform
10:55	16:15	Spring	0.004	0.024	0.00	0.122	0.35	50.0	8.5	>2420
11:40	16:15	Upstream farm	0.011	0.014	0.03	0.444	2.20	17.9	39	1120
11:15	16:15	Upstream barn	0.007	0.024	0.00	0.330	0.41	1.6	42	>2419
11:20	16:15	Downstream barn	0.017	0.032	1.77	0.790	0.76	0.7	42	816
12:40	16:15	Downstream farm	0.007	0.028	0.01	0.511	0.58	1.5	5	>2420
10/1/2013	**10/1/2013**	**Base flow**								
9:45	14:42	Spring	0.001	0.162	0.00	0.108	0.41	89.2	4	920
10:00	14:42	Upstream farm	0.011	0.038	0.02	0.236	0.34	2.2	8	1300
10:15	14:42	Upstream barn	0.006	0.032	0.03	0.235	0.40	6.7	82	5200
10:35	14:42	Downstream barn	0.018	0.032	0.00	0.837	0.80	1.1	19	649
10:55	14:42	Downstream farm	0.009	0.034	0.02	0.514	0.65	3.6	2620	10810
10/9/2013	**10/9/2013**	**Base flow**								
9:00	13:52	Spring	0.011	0.054	0.00	0.088	0.28	29.1	3	1413
9:30	13:52	Upstream farm	0.016	0.034	0.00	0.497	0.73	7.1	11	2419

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	E. coli	Total coliform
9:45	13:52	Upstream barn	0.016	0.030	0.00	0.385	0.53	6.2	194	4730
10:00	13:52	Downstream barn	0.017	0.02	0.00	0.868	0.82	0.4	29	1986
10:20	13:52	Downstream farm	0.006	0.038	0.00	0.618	0.77	13.6	28	3450
10/15/2013	**10/15/2013**	**Storm flow**								
11:13	15:47	Spring	0.010	0.250	0.15	0.086	0.58	66.9	1401	19863
12:24	15:47	Upstream farm	0.018	0.026	0.00	1.041	0.96	1.1	759	>2419
12:47	15:47	Upstream barn	0.019	0.036	0.06	0.839	0.99	2.1	472	8664
13:13	15:47	Downstream barn	0.033	0.244	0.12	1.280	1.44	89.2	959	12997
13:34	15:47	Downstream farm	0.067	0.316	0.20	0.677	1.07	101.1	1334	19863
10/22/2013	**10/22/2013**	**Base flow**								
10:10	15:31	Spring	0.005	0.086	0.10	0.307	0.53	36.4	1733	>2419
10:30	15:31	Upstream farm	0.014	0.034	0.00	0.345	0.32	0.3	186	299
10:45	15:31	Upstream barn	0.016	0.024	0.03	0.575	0.60	1.2	411	11190
11:00	15:31	Downstream	0.016	0.022	0.00	0.786	0.77	0.1	150	2419

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	E. coli	Total coliform
		barn								
11:20	15:31	Downstream farm	0.012	0.020	0.04	0.723	0.76	0.7	87	292
10/31/2013	**10/31/2013**	**Base flow**								
11:00	15:15	Spring	0.003	0.404	0.14	0.321	1.02	400.9	91	32550
10:45	15:15	Upstream farm	0.012	0.032	0.00	0.242	0.32	1.1	66	1986
10:15	15:15	Upstream barn	0.007	0.044	0.04	0.246	0.38	2.3	261	6310
10:00	15:15	Downstream barn	0.018	0.022	0.11	0.519	0.53	0.9	14	218
10:30	15:15	Downstream farm	0.012	0.024	0.03	0.443	0.45	1.4	Leaked	Leaked
11/6/2013	**11/6/2013**	**Base flow**								
8:35	14:35	Spring	0.013	0.130	0.10	0.062	0.72	21.2	8570	34480
9:00	14:35	Upstream farm	0.032	0.074	0.03	0.432	0.61	4.7	4080	28510
9:10	14:35	Upstream barn	0.020	0.038	0.00	0.184	0.27	2.5	579	13330
9:45	14:35	Downstream barn	0.040	0.164	0.12	0.413	0.67	32.9	3180	36090
10:00	14:35	Downstream farm	0.041	0.154	0.12	0.286	0.60	28.4	3500	43520

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	E. coli	Total coliform
11/12/2013	**11/12/2013**	**Base flow**								
10:56	16:28	Spring	0.006	0.022	0.05	2.449	2.39	8.9	48	2750
11:35	16:28	Upstream farm	0.011	0.010	0.00	0.169	0.22	1.0	45	1986
12:15	16:28	Upstream barn	0.012	0.014	0.09	0.221	0.33	1.4	36	1733
13:03	16:28	Downstream barn	0.012	0.012	0.00	0.295	0.34	0.5	21	1046
13:35	16:28	Downstream farm	0.011	0.010	0.00	0.242	0.31	0.0	24	>2419
11/19/2013	**11/19/2013**	**Base flow**								
9:20	14:35	Spring	0.007	0.022	0.02	3.063	3.06	4.4	579	9880
9:45	14:35	Upstream farm	0.010	0.026	0.00	0.123	0.22	0.7	435	2400
10:05	14:35	Upstream barn	0.011	0.028	0.00	0.175	0.32	0.3	172	>2419
10:35	14:35	Downstream barn	0.011	0.028	0.00	0.231	0.34	0.5	238	2419
10:55	14:35	Downstream farm	0.009	0.024	0.02	0.172	0.28	1.0	194	4410
11/26/2013	**11/26/2013**	**Base flow**								
10:35	14:40	Spring	0.007	0.018	0.00	1.69	1.70	4.5	86	1553

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	E. coli	Total coliform
10:45	14:40	Upstream farm	0.013	0.018	0.00	0.135	0.14	0.4	77	1203
11:06	14:40	Upstream barn	0.014	0.016	0.00	0.19	0.20	0.7	249	1986
11:30	14:40	Downstream barn	0.014	0.018	0.03	0.3	0.33	1.3	40	613
11:45	14:40	Downstream farm	0.013	0.016	0.00	0.231	0.24	1.2	36	2419
12/3/2013	**12/3/2013**	**Base flow**								
8:30	13:23	Spring	0.007	0.046	0.04	1.048	1.37	26.9	25	1986
8:45	13:23	Upstream farm	0.007	0.012	0.00	0.152	0.25	0.5	27	435
9:00	13:23	Upstream barn	0.009	0.012	0.00	0.21	0.28	0.3	29	548
9:15	13:23	Downstream barn	0.010	0.018	0.00	0.295	0.35	0.6	248	687
9:35	13:23	Downstream farm	0.006	0.012	0.00	0.225	0.28	0.5	12	>2419
12/17/2013	**12/17/2013**	**After snow melt**								
9:35	14:03	Spring	0.007	0.042	0.05	0.367	0.65	2.0	248.1	2419.2
10:00	14:03	Upstream farm	0.010	0.036	0.06	0.180	0.27	1.2	248.1	2419.2
10:10	14:03	Upstream barn	0.011	0.032	0.02	0.379	0.48	0.7	157.6	>2419.2

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	E. coli	Total coliform
10:30	14:03	Downstream barn	0.008	0.032	0.03	0.393	0.50	1.6	127.4	2419.2
10:50	14:03	Downstream farm	0.008	0.032	0.00	0.325	0.43	2.1	148.3	>2419.2
1/2/2014	**1/2/2014**	**Base flow**								
10:45	14:19	Spring	0.006	0.024	0.05	3.348	3.24	0.5	ND	ND
10:55	14:19	Upstream farm	0.009	0.022	0.01	0.223	0.25	0.7	ND	ND
11:10	14:19	Upstream barn	0.012	0.024	0.00	0.437	0.47	0.3	ND	ND
11:25	14:19	Downstream barn	0.012	0.024	0.00	0.543	0.58	0.8	ND	ND
11:50	14:19	Downstream farm	0.012	0.036	0.00	0.485	0.54	0.8	ND	ND
1/7/2014	**1/7/2014**	**Base flow**								
10:10	13:43	Spring	0.008	0.024	0.00	2.364	2.32	1.3	20.9	1413.6
10:20	13:43	Upstream farm	0.014	0.022	0.02	0.204	0.27	0.8	66.3	307.6
10:30	13:43	Upstream barn	0.017	0.022	0.00	0.363	0.43	0.3	24.3	344.8
10:50	13:43	Downstream barn	0.015	0.022	0.00	0.497	0.54	1.1	21.1	290.9
11:10	13:43	Downstream farm	0.015	0.028	0.00	0.413	0.46	0.2	18.3	325.5

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	E. coli	Total coliform
1/14/2014	**1/14/2014**	**Base flow**								
11:35	15:35	Spring	0.010	0.042	0.00	1.974	2.09	2.3	24.3	1732.9
12:15	15:35	Upstream farm	0.008	0.028	0.01	0.156	0.25	0.3	151.5	980.4
11:50	15:35	Upstream barn	0.008	0.030	0.03	0.211	0.73	0.9	238.2	920.8
12:50	15:35	Downstream barn	0.008	0.028	0.02	0.332	0.43	0.5	156.5	1119.9
13:15	15:35	Downstream farm	0.008	0.026	0.05	0.310	0.39	0.5	95.9	1299.7
1/21/2014	**1/21/2014**	**Base flow**								
8:10	15:00	Spring	0.008	0.006	0.02	2.107	2.10	0.9	5.2	613.1
8:30	15:00	Upstream farm	0.009	0.010	0.00	0.130	0.22	0.0	55.7	290.9
8:20	15:00	Upstream barn	0.010	0.010	0.01	0.211	0.28	0.3	51.2	488.4
8:45	15:00	Downstream barn	0.011	0.012	0.01	0.339	0.45	1.0	49.6	249.9
9:05	15:00	Downstream farm	0.010	0.014	0.01	0.301	0.36	0.5	131.3	410.6
1/29/2014	**1/29/2014**	**Base flow**								
10:20	14:15	Spring	0.009	0.024	0.00	0.851	0.86	1.4	3.1	325.5

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	E. coli	Total coliform
10:40	14:15	Upstream farm	0.007	0.028	0.00	0.125	0.15	0.6	10.9	248.1
10:30	14:15	Upstream barn	0.007	0.024	0.01	0.195	0.24	0.0	28.2	290.9
11:00	14:15	Downstream farm	0.007	0.024	0.00	0.282	0.28	0.0	<1	275.0
2/13/2014	**2/13/2014**	**Base flow**								
8:30	13:22	Spring	0.009	0.024	0.00	0.654	0.73	5.1	<1	461.1
8:50	13:22	Upstream farm	0.009	0.016	0.00	0.107	0.15	0.9	68.9	238.2
8:40	13:22	Upstream barn	0.011	0.014	0.00	0.135	0.23	0.9	31.4	260.2
9:10	13:22	Downstream farm	0.009	0.014	0.00	0.241	0.28	0.4	9.8	290.9
2/19/2014	**2/19/2014**	**Base flow**								
9:15	14:36	Spring	0.006	0.020	0.02	0.574	0.62	0.8	1.0	365.4
10:17	14:36	Upstream farm	0.008	0.018	0.00	0.048	0.10	0.4	111.9	325.5
9:30	14:36	Upstream barn	0.009	0.018	0.00	0.070	0.15	0.5	45.5	235.9
11:30	14:36	Downstream farm	0.007	0.016	0.00	0.109	0.17	0.3	8.5	272.3

Date & time sample collected	Date & time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	E. coli	Total coliform
2/27/14	**2/27/14**	**Base flow**								
10:40	15:10	Spring	0.007	0.106	0.06	0.594	0.82	70	<1	307.6
11:03	15:10	Upstream farm	0.008	0.022	0.02	0.066	0.22	2.1	29.5	209.8
11:40	15:10	Upstream barn	0.008	0.016	0.00	0.084	0.11	0.3	14.8	235.9
12:22	15:10	Downstream farm	0.007	0.014	0.00	0.112	0.16	0.6	2.00	547.5

The water quality data in Table 4 for the monitored spring and Big Creek above and below the boundary of the permitted fields of the C&H Farm only is given in Table 5.

Table 5. Water quality analyses at the spring and in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application fields (see Map 12).

Sample location relative to farm	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	E. coli	Total coliform
	---------- mg/L ----------						--- MPN/100 mL ---	
9/12/2013 Base flow								
Upstream	0.016	0.030	0.06	0.367	0.50	3.0	6	>2420
Downstream	0.010	0.022	0.04	0.396	0.62	1.7	16	>2420
9/20/2013 Base flow								
Spring	0.006	0.020	0.03	0.384	0.50	4.7	73	5040
Upstream	0.009	0.022	0.03	0.247	0.36	1.1	81	9870
Downstream	0.013	0.022	0.05	0.442	0.53	1.1	548	17230
9/24/2013 Base flow								
Spring	0.004	0.024	0.00	0.122	0.35	50.0	9	>2420
Upstream	0.021	0.140	0.03	0.444	2.20	17.9	39	1120
Downstream	0.007	0.028	0.01	0.511	0.58	1.5	5	>2420
10/1/2013 Base flow								
Spring	0.001	0.162	0.00	0.108	0.41	89.2	4	920.8
Upstream	0.011	0.038	0.02	0.236	0.34	2.2	8	1300
Downstream	0.009	0.034	0.02	0.514	0.65	3.6	2620	10810
10/9/2013 Base flow								
Spring	0.011	0.054	0.00	0.088	0.28	29.1	3	1413.6

Sample location relative to farm	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	E. coli	Total coliform
Upstream	0.016	0.034	0.00	0.497	0.73	7.1	11	2419.6
Downstream	0.006	0.038	0.00	0.618	0.77	13.6	28	3450.0
10/15/2013 Storm flow								
Spring	0.010	0.250	0.15	0.086	0.58	66.9	1401	19863.0
Upstream	0.018	0.026	0.00	1.041	0.96	1.1	759	>2419.6
Downstream	0.067	0.316	0.20	0.677	1.07	101.1	1334	19863.0
10/22/2013 Base flow								
Spring	0.005	0.086	0.10	0.307	0.53	36.4	1733	>2419.6
Upstream	0.014	0.034	0.00	0.345	0.32	0.3	186	299.0
Downstream	0.012	0.020	0.04	0.723	0.76	0.7	87	292.0
10/31/2013 Base flow								
Spring	0.003	0.404	0.14	0.321	1.02	400.9	91	32550.0
Upstream	0.012	0.032	0.00	0.242	0.32	1.1	66	1986.3
Downstream	0.012	0.024	0.03	0.443	0.45	1.4	Leaked	Leaked
11/6/2013 Base flow								
Spring	0.013	0.130	0.10	0.062	0.72	21.2	8570	34480.0
Upstream	0.032	0.074	0.03	0.432	0.61	4.7	4080	28510.0
Downstream	0.041	0.154	0.12	0.286	0.60	28.4	3500	43520.0
11/12/2013 Base flow								
Spring	0.006	0.022	0.05	2.449	2.39	8.90	48	2750.0
Upstream	0.011	0.010	0.00	0.169	0.22	1.00	45	1986.3

Sample location relative to farm	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	E. coli	Total coliform
Downstream	0.011	0.010	0.00	0.242	0.31	0.0	24	>2419.2
11/19/2013 Base flow								
Spring	0.007	0.022	0.02	3.063	3.06	4.4	579	9880.0
Upstream	0.010	0.026	0.00	0.123	0.22	0.7	435	2400.0
Downstream	0.009	0.024	0.02	0.172	0.28	1.0	194	4410.0
11/26/2013 Base flow								
Spring	0.007	0.018	0.00	1.69	1.70	4.5	86	1553.1
Upstream	0.013	0.018	0.00	0.135	0.14	0.4	77	1203.3
Downstream	0.013	0.016	0.00	0.231	0.24	1.2	36	2419.2
12/3/2013 Base flow								
Spring	0.007	0.046	0.04	1.048	1.37	26.9	25	1986.3
Upstream	0.007	0.012	0.00	0.152	0.25	0.5	27	435.2
Downstream	0.006	0.012	0.00	0.225	0.28	0.5	12	>2419.2
12/17/2013 After snow melt								
Spring	0.007	0.042	0.05	0.367	0.65	2.0	248.1	2419.2
Upstream	0.010	0.036	0.06	0.180	0.27	1.2	248.1	2419.2
Downstream	0.008	0.032	0.00	0.325	0.43	2.1	148.3	>2419.2
1/2/2014 Base flow								
Spring	0.006	0.024	0.05	3.348	3.24	0.5	ND	ND
Upstream	0.009	0.022	0.01	0.223	0.25	0.7	ND	ND
Downstream	0.012	0.036	0.00	0.485	0.54	0.8	ND	ND

Sample location relative to farm	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	E. coli	Total coliform
1/7/2014 Base flow								
Spring	0.008	0.024	0.00	2.364	2.32	1.3	20.9	1413.6
Upstream	0.014	0.022	0.02	0.204	0.27	0.8	66.3	307.6
Downstream	0.015	0.028	0.00	0.413	0.46	0.2	18.3	325.5
1/14/2014 Base flow								
Spring	0.010	0.042	0.00	1.974	2.09	2.3	24.3	1732.9
Upstream	0.008	0.028	0.01	0.156	0.25	0.3	151.5	980.4
Downstream	0.008	0.026	0.05	0.310	0.39	0.5	95.9	1299.7
1/21/2014 Base flow								
Spring	0.008	0.006	0.02	2.107	2.10	0.9	5.2	613.1
Upstream	0.009	0.010	0.00	0.130	0.22	0.0	55.7	290.9
Downstream	0.010	0.014	0.01	0.301	0.36	0.5	131.3	410.6
1/29/2014 Base flow								
Spring	0.009	0.024	0.00	0.851	0.86	1.4	3.1	325.5
Upstream	0.007	0.028	0.00	0.125	0.15	0.6	10.9	248.1
Downstream	0.007	0.024	0.00	0.282	0.28	0.0	<1	275.0
2/13/2014 Base flow								
Spring	0.009	0.024	0.00	0.654	0.73	5.1	<1	461.1
Upstream	0.009	0.016	0.00	0.107	0.15	0.9	68.9	238.2
Downstream	0.009	0.014	0.00	0.241	0.28	0.4	9.8	290.9
2/19/2014 Base flow								

Sample location relative to farm	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	E. coli	Total coliform
Spring	0.006	0.020	0.02	0.574	0.62	0.8	1.0	365.4
Upstream	0.008	0.018	0.00	0.048	0.10	0.4	111.9	325.5
Downstream	0.007	0.016	0.00	0.109	0.17	0.3	8.5	272.3
2/27/14	**Base flow**							
Spring	0.007	0.106	0.06	0.594	0.82	70	<1	307.6
Upstream	0.008	0.022	0.02	0.066	0.22	2.1	29.5	209.8
Downstream	0.007	0.014	0.00	0.112	0.16	0.6	2.00	547.5

ND is no data collected.

Future Plan of Work

1. Instrument Field 12 with piezometers and surface runoff monitoring equipment as on Field 1.
2. Complete installation of automatic flow and water sampling equipment on Big Creek upstream and downstream of the C&H Farm. These sites coordinate with the ongoing weekly baseflow sampling that has been conducted since early September. This is being done in partnership with USGS, who we have funded to have a permanent gauging station downstream of the C&H Farm that provides real-time flow information, to conform with all USGS gauging sites across the State.
3. Deploy sondes at the spring and above permanent USGS gauging stations on Big Creek sampling locations to continuously determine dissolved oxygen (DO), excess partial pressure of carbon dioxide ($EpCO_2$), electrical conductivity (EC), and temperature of the water. Diurnal, seasonal, and storm event fluctuations of water $EpCO_2$, DO, EC, and temperature can be used to examine the rates of respiration and photosynthesis linked to changing nutrient status and organic matter loading and to also identify possible sources of new and old water at these locations. Similarly, a longitudinal survey downstream between upper and lower sampling points in Big Creek under baseflow, can locate potential sites where water is entering the Creek from the surrounding landscape. That is, $EpCO_2$ will increase (and pH will drop), with the input of spring water into Big Creek.
4. Interpret GPR information from Field 12 completed this quarter and present next quarter.
5. Continue to collect runoff, spring, and stream samples after each rainfall event from the autosamplers and manually collect baseflow samples every two weeks from the well, spring, and streams, for analysis of N, P, sediment, and bacteria (E. coli and total coliform from baseflow grab samples).
6. Conduct dye-tracer tests on the C&H Farm in cooperation with a Geologist with experience and training in conducting dye-tracer tests.
7. Periodically determine plant uptake by collecting plant and hay samples for tissue analysis and determine yield (dry-matter mass for a pre-determined area).
8. Determine nutrient application rate by determining nutrient content of swine effluent before land application via manure application and determine volume of effluent being applied to known monitoring area.

Manure Treatment via Solids and Chemical Separation: A Case Study to Evaluate Cost Benefits of Alternative Manure Management Options

Continue current discussions with the owners of the C&H Farm to explore potential long-term, economically viable, options to modify current manure management practices in the general areas of:

1. Separating manure liquids and solids along with their differential management;
2. Retaining sufficient nitrogen to meet crop needs;
3. Exporting excess P off the farm;

4. Mitigating off-site odor;
5. Not exceeding the current physical, economic, labor, and management resources of the farm; and
6. Operating within the constraints of the appropriate environmental regulations.

The project will identify management options to meet the above objectives. It is anticipated that the options will include but not be limited to:

- Mechanical separation manure solids from liquids with or without chemicals as a precursor for off-farm transport of separated solids; and
- Selective application of higher P content slurries and lower P content liquids to different fields that minimizes any loss of nutrient loss.

For the management options identified, their initial and long-term costs will be estimated and an assessment of their implementation impacts made. Available literature and other information resources will be utilized in this process. However, there will be a need for laboratory and onsite tests/trials. This is especially true when evaluating manure solid-liquid separation and/or chemical use. Based on current discussions development of field chemical tests and lab analysis will begin soon. The results of these tests will guide decisions that may lead to additional larger scale implementation trials.

Table 6. Soil analyses of 0 to 4 inch samples collected from Field 12.

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
						mg/kg							
24422	9	5.9	138	115	776	81	10	18	149	186	1.2	3.2	0.2
24427	10	6.0	143	196	763	79	7	14	138	226	0.9	3.2	0.2
24432	11	5.6	147	88	681	68	13	17	155	245	1.2	2.4	0.1
24438	13	6.0	65	70	1621	98	9	13	128	181	1.4	3.7	0.3
24443	17	5.7	117	117	721	72	10	15	146	187	0.8	2.1	0.1
24449	18	5.9	147	223	726	93	12	17	145	231	0.8	2.7	0.2
24452	19	5.7	126	174	608	94	7	14	154	197	0.8	2.6	0.1
24456	20	5.7	101	96	1169	101	9	17	151	177	1.3	2.7	0.2
24461	21	5.8	61	61	1367	82	10	14	153	168	1.2	2.4	0.2
24466	22	5.3	71	56	734	67	9	13	261	157	0.7	2.5	0.1
24472	25	5.5	60	57	788	62	8	17	107	218	0.8	1.3	0.1
24476	26	5.6	128	202	690	80	7	17	151	172	1.0	2.6	0.1
24480	27	5.8	109	69	956	75	10	16	143	159	0.9	2.1	0.3
24486	28	5.8	45	54	1441	87	12	14	117	170	1.2	1.8	0.2
24491	29	5.6	39	60	993	73	9	12	151	193	1.0	2.1	0.1
24497	30	5.6	53	212	873	69	14	12	155	165	0.7	2.6	0.1
24502	33	5.3	53	29	743	43	9	10	167	131	0.7	2.2	0.0
24508	34	6.1	43	76	1530	83	9	12	134	184	1.4	3.3	0.2
24513	35	6.0	37	81	1207	90	10	13	102	143	1.0	1.9	0.1
24519	37	5.8	63	62	1039	65	13	18	118	190	1.6	2.1	0.1
24524	38	5.8	52	45	828	49	9	15	92	119	0.9	3.0	0.1
24530	41	5.9	43	50	1318	49	14	15	101	185	1.5	1.4	0.2
24535	42	6.0	30	70	1781	105	14	15	102	98	1.6	5.7	0.2
24540	43	6.2	29	67	1767	83	17	14	108	173	1.5	1.5	0.3

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
24546	44	5.6	73	88	1048	86	8	15	136	154	1.1	2.2	0.1
24551	45	5.8	30	47	1143	81	19	11	113	149	1.1	2.8	0.2
24557	46	5.8	47	212	820	52	10	13	133	121	0.7	2.0	0.2
24562	47	5.9	42	76	1838	117	11	15	96	96	1.4	2.4	0.3
24563	49	6.1	24	59	1953	84	12	13	83	64	1.5	1.5	0.3
24569	50	5.9	19	54	1758	77	19	12	87	84	1.6	1.1	0.2
24574	51	6.3	17	56	1908	85	17	10	87	96	1.6	1.8	0.2
24580	52	6.3	30	43	1537	55	12	10	100	109	1.5	1.4	0.1
24585	53	6.1	33	54	1416	56	13	10	102	110	1.5	1.8	0.1
24591	54	6.1	32	43	970	57	15	8	115	106	1.2	1.5	0.1
24596	57	6.0	26	53	1120	38	10	8	108	102	1.7	1.5	0.1
24602	58	6.0	36	58	1338	63	9	10	101	78	1.3	1.3	0.1
24607	59	5.9	39	40	853	56	9	9	116	103	1.1	1.5	0.1
24612	60	6.0	52	98	1357	106	12	12	107	88	1.7	1.6	0.2
24617	61	6.0	34	72	1453	85	11	13	118	122	1.3	1.7	0.2
24622	62	6.0	97	282	1723	148	12	16	139	69	1.5	2.6	0.3
Mean, mg/kg		5.86	63	92	1184	77	11	13	127	148	1.2	2.2	0.2
Minimum, mg/kg		5.30	17	29	608	38	7	8	83	64	0.7	1.1	0.0
Maximum, mg/kg		6.30	147	282	1953	148	19	18	261	245	1.7	5.7	0.3
Standard deviation, mg/kg		0.23	40	62	405	21	3	3	32	48	0.3	0.8	0.1
Coefficient of variation, %		3.97	63	67	34	28	27	20	25	32	26.4	37.6	46.6

Table 7. Soil analyses of 4 to 8 inch samples collected from Field 12.

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
						mg/kg							
24423	9	6.4	47	47	650	26	6	11	94	103	0.7	0.8	0
24428	10	5.8	73	112	663	39	6	11	110	145	0.8	2.2	0.1
24434	11	5.9	81	47	678	38	9	12	123	177	1.1	2.4	0.1
24439	13	6	32	56	1447	58	9	11	117	98	1.4	1.7	0.2
24444	17	5.8	69	64	670	43	8	11	100	119	0.7	0.9	0
24450	18	5.6	102	106	682	51	16	14	128	154	0.8	1.6	0.1
24453	19	5.7	62	127	601	49	9	11	108	105	0.7	1.2	0
24458	20	5.7	36	70	1307	57	10	14	106	72	1.4	1	0.2
24462	21	5.9	27	62	1489	52	15	11	105	82	1.5	1	0.1
24467	22	5.3	62	37	488	28	8	8	160	101	0.5	0.9	0
24473	25	5.8	32	41	713	24	7	12	80	114	0.7	0.4	0
24477	26	5.7	88	115	723	57	7	14	121	111	0.8	1.2	0.1
24482	27	5.9	77	45	879	41	8	12	116	118	0.9	1.1	0.1
24487	28	6.1	13	73	1778	52	12	11	90	64	1.1	0.5	0.2
24492	29	5.8	17	55	1315	40	13	11	119	147	1.3	1.1	0.2
24498	30	5.8	26	45	767	33	10	8	105	78	0.5	0.8	0
24503	33	6	38	27	675	24	6	6	121	81	0.6	1	0
24509	34	6.1	21	54	1670	65	8	9	111	144	1.5	1.7	0.2
24514	35	6.1	17	65	1297	63	11	10	97	117	1.1	2.8	0
24520	37	5.9	47	49	1171	48	13	15	98	112	1.7	9.6	0.1
24525	38	6	23	42	785	29	8	11	73	67	0.6	0.4	0
24531	41	6.3	32	43	1257	32	13	12	90	132	1.7	3.4	0.1
24536	42	5.9	18	77	2257	111	16	15	107	75	2	2.2	0.3
24542	43	6.4	15	59	1681	50	19	11	92	115	1.5	0.8	0.2

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
24547	44	5.3	39	82	926	66	9	15	110	106	1.2	1	0
24552	45	5.9	17	54	1404	70	13	11	103	127	1.4	1	0.2
24558	46	6	35	116	630	28	9	9	99	77	0.6	0.7	0
24564	49	6.1	15	67	2386	81	19	14	87	30	1.6	0.8	0.3
24570	50	5.9	12	51	1844	68	17	11	72	44	1.3	0.7	0.2
24575	51	6.3	9	79	2453	105	15	10	92	78	1.8	1.4	0.4
24581	52	6.2	22	49	1419	54	13	9	99	89	1.5	1.1	0.1
24586	53	6.2	16	66	1631	59	11	10	97	81	1.5	0.9	0.1
24592	54	6.2	19	60	1552	47	12	8	113	85	1.6	1.3	0.2
24597	57	6.1	33	63	1375	46	15	9	104	79	1.8	1.8	0.1
24603	58	6.1	28	64	1360	67	10	9	94	53	1.3	0.8	0.1
24608	59	6	24	42	848	36	8	7	108	96	1.2	0.9	0
24614	60	6.1	23	92	1432	102	12	12	101	55	1.6	0.6	0.1
24618	61	6.1	17	60	1440	67	13	11	95	100	1.5	1	0.1
24623	62	5.9	48	202	1841	116	12	14	100	44	1.6	1.1	0.2
Mean, mg/kg		5.96	36	68	1235	54	11	11	104	97	1.2	1.4	0.1
Minimum, mg/kg		5.30	9	27	488	24	6	6	72	30	0.5	0.4	0.0
Maximum, mg/kg		6.40	102	202	2453	116	19	15	160	177	2.0	9.6	0.4
Standard deviation, mg/kg		0.25	24	32	523	23	4	2	16	33	0.4	1.5	0.1
Coefficient of variation, %		4.14	65	47	42	43	32	20	15	34	35.1	104.2	89.1

Table 8. Soil analyses of 8 to 12 inch samples collected from Field 12.

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
							mg/kg						
24424	9	6	82	63	713	45	7	14	101	139	1	1.3	0.1
24429	10	6	42	96	607	29	7	9	95	104	0.6	0.9	0
24435	11	6.2	44	49	716	24	8	8	107	117	0.8	0.6	0
24440	13	6.1	22	78	1755	72	20	11	103	73	1.5	1.5	0.2
24446	17	5.8	50	77	681	40	9	9	107	88	0.4	0.9	0
24451	18	5.8	53	65	673	34	6	10	101	91	0.6	0.5	0
24454	19	5.8	45	106	712	39	8	9	99	78	0.6	0.3	0
24459	20	5.9	21	80	1779	56	11	15	104	53	1.4	0.7	0.2
24463	21	5.8	32	72	1493	49	12	13	102	48	1.4	0.4	0.1
24468	22	5.2	39	46	481	23	8	8	126	95	0.6	1.6	0
24474	25	5.9	22	52	781	23	9	9	90	93	0.5	0.2	0
24478	26	5.7	46	128	681	42	9	12	94	70	0.7	0.4	0
24483	27	6.1	34	52	1121	31	8	11	93	72	1.1	0.6	0
24488	28	6.1	13	86	1787	76	13	11	103	90	0.9	0.5	0.2
24494	29	6	10	74	1760	48	15	9	104	96	1.4	3	0.2
24499	30	5.9	11	57	1297	40	13	13	89	49	0.9	0.4	0.1
24504	33	6.1	30	34	720	25	8	5	124	96	0.7	1.6	0
24510	34	6.1	14	70	2050	78	11	9	105	119	1.8	1.5	0.2
24515	35	6.3	10	82	1722	75	16	11	93	71	1.3	0.3	0.1
24521	37	5.9	28	48	1104	44	10	12	88	60	1.4	1.3	0.1
24526	38	6	19	40	643	22	9	7	69	43	0.2	0.5	0
24532	41	6.1	26	52	1505	34	13	12	91	93	2	2.8	0.2
24537	42	5.9	14	79	2443	118	18	15	103	44	1.9	0.9	0.3
24543	43	6.5	12	75	1849	53	18	10	90	63	1.6	0.5	0.1

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
24548	44	5.2	18	104	1219	75	12	19	106	73	1.3	1.5	0.1
24554	45	6.1	11	74	1752	79	15	11	108	112	1.5	1.3	0.2
24559	46	6	24	71	936	41	10	10	98	86	1	0.7	0.1
24566	49	6.1	16	63	2099	66	21	15	90	13	1.6	0.6	0.1
24571	50	5.9	10	69	2043	78	22	15	86	21	1.3	0.5	0.1
24576	51	6.3	7	88	2536	104	19	10	98	58	1.7	0.8	0.3
24582	52	6	20	60	1768	77	17	13	100	60	1.6	1.1	0.2
24587	53	6.1	18	71	1493	74	17	9	100	53	1.3	0.7	0.1
24593	54	6.2	13	61	1805	54	11	9	105	55	1.5	1.1	0.2
24598	57	5.9	39	65	1301	51	14	9	99	54	1.5	0.9	0.1
24604	58	6.1	31	76	1468	69	12	9	96	41	1.2	0.5	0.1
24609	59	6.1	25	53	942	42	10	7	120	107	1.3	1.2	0
24615	60	6.2	25	85	1559	108	13	11	105	41	1.3	0.8	0.1
24619	61	6.1	10	71	1899	90	14	13	87	61	1.3	0.9	0.2
24624	62	5.9	19	164	1848	109	12	15	88	25	1.4	0.5	0.1
Mean, mg/kg			5.98	26	73	1378	57	12	11	99	72	1.2	0.9
Minimum, mg/kg			5.20	7	34	481	22	6	5	69	13	0.2	0.2
Maximum, mg/kg			6.50	82	164	2536	118	22	19	126	139	2.0	3.0
Standard deviation, mg/kg			0.24	16	24	562	26	4	3	11	29	0.4	0.6
Coefficient of variation, %			4.08	61	33	41	46	34	26	11	40	37.2	65.6

Table 9. Soil analyses of 12 to 18 inch samples collected from Field 12.

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
						mg/kg							
24425	9	6.1	50	54	674	29	11	7	107	77	0.5	0.8	0
24430	10	6.1	40	101	656	33	8	7	103	85	0.4	1	0
24436	11	6.3	59	60	817	28	12	6	121	86	0.6	0.3	0
24441	13	6.1	19	88	1909	75	15	12	99	61	1.2	0.8	0.3
24447	17	5.9	57	79	746	39	12	8	113	64	0.2	0.3	0
24455	19	6	61	80	942	43	13	7	103	45	0.3	0.3	0
24460	20	6.1	14	75	1699	57	14	14	93	28	1.2	0.6	0.1
24464	21	5.3	38	80	1308	55	14	16	110	40	1.2	0.4	0
24470	22	5.2	20	87	1151	45	9	16	118	73	1.3	0.6	0.1
24475	25	5.9	28	48	616	26	11	6	89	61	0.1	0.5	0
24479	26	5.8	33	185	646	35	8	11	90	53	0.5	0.3	0
24484	27	6.2	24	62	1349	39	13	10	94	58	1.3	0.7	0.1
24489	28	6.1	23	57	1630	51	11	12	100	89	1.3	1	0.2
24495	29	6.3	12	82	1821	66	16	9	104	76	1.2	0.9	0.1
24500	30	5.7	11	78	1674	55	13	15	93	36	0.8	0.6	0
24506	33	6.1	29	59	1385	42	9	8	144	108	1.3	1.1	0.1
24511	34	6.4	11	78	1934	85	13	10	107	86	1.6	2.6	0.2
24516	35	6.1	11	80	1765	86	24	12	87	41	1.1	0.2	0.1
24522	37	5.8	27	57	1622	61	12	16	87	47	1.5	0.4	0.2
24527	38	5.6	40	56	644	27	13	10	94	33	0.2	2.5	0
24533	41	6	20	50	1832	46	16	12	92	50	1.9	3.9	0.2
24538	42	5.9	11	80	2372	116	19	17	100	25	1.6	0.6	0.2
24544	43	6.6	18	77	1703	57	14	9	89	41	1.3	3.7	0.1
24549	44	5.4	11	85	1457	81	14	17	97	41	1	0.5	0.1

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
24555	45	6	9	79	1640	79	16	10	99	67	1.3	1	0.1
24560	46	5.7	16	80	1440	64	13	11	103	81	1.3	0.7	0.1
24567	49	5.8	11	63	1630	46	20	16	91	14	1.1	0.4	0
24572	50	5.9	8	70	1711	70	24	13	87	28	1	0.4	0.1
24578	51	6.2	9	89	2387	100	22	10	98	59	1.7	0.9	0.3
24583	52	5.4	19	63	1671	78	20	17	111	49	1.7	0.9	0.1
24588	53	5.6	18	80	1380	86	25	11	100	45	1.1	0.6	0
24594	54	6.1	12	67	2121	74	15	10	105	35	1.4	0.7	0.2
24599	57	5.9	44	68	1202	61	16	8	101	43	1.2	0.5	0
24605	58	6.3	29	66	1186	54	12	7	85	24	0.6	0.5	0
24610	59	5.9	14	60	1730	72	16	9	119	54	1.5	1.1	0.2
24616	60	5.7	33	84	1334	94	16	12	106	33	1	0.5	0
24620	61	6.1	8	76	1908	97	17	12	87	51	1.1	0.4	0.1
24625	62	6	13	128	1740	104	22	14	84	25	1.3	0.8	0.1
Mean, mg/kg			5.94	23.95	76.61	1458.74	62.00	14.95	11.24	100.26	52.95	1.08	0.89
Minimum, mg/kg			5.20	8.00	48.00	616.00	26.00	8.00	6.00	84.00	14.00	0.10	0.20
Maximum, mg/kg			6.60	61.00	185.00	2387.00	116.00	25.00	17.00	144.00	108.00	1.90	3.90
Standard deviation, mg/kg			0.30	15.16	23.61	477.93	23.68	4.40	3.32	12.17	21.94	0.46	0.85
Coefficient of variation, %			5.13	63.32	30.81	32.76	38.19	29.47	29.58	12.14	41.43	42.41	95.44

Table 10. Soil analyses of 18 to 24 inch samples collected from Field 12.

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
							mg/kg						
24426	9	6.1	63	55	641	33	12	6	117	57	0.3	0.6	0
24431	10	6.3	58	83	761	51	15	6	103	48	0.3	0.5	0
24437	11	6.1	90	71	847	49	16	6	119	44	0.4	1	0
24442	13	6.2	16	83	1586	75	11	11	88	32	0.8	0.4	0.1
24448	17	5.9	62	71	763	41	14	7	104	34	0.1	0.4	0
24465	21	5.2	38	79	1153	56	17	14	112	37	1	0.4	0
24471	22	5.5	13	82	1419	80	11	13	100	40	0.8	0.4	0.1
24485	27	6.3	28	70	1337	43	13	10	94	39	1.1	0.3	0
24490	28	6.1	12	93	1877	89	19	10	95	114	0.7	0.4	0.1
24496	29	6.3	14	86	1857	74	26	8	101	57	1.2	0.9	0.1
24501	30	5.7	17	95	1781	61	19	13	93	22	0.5	0.3	0
24507	33	6.2	20	66	1646	53	10	9	130	104	1.1	0.6	0.2
24512	34	6.1	12	74	1697	81	14	9	92	45	1.1	2.2	0.1
24518	35	5.9	16	86	1608	90	27	14	95	42	1.1	0.5	0.1
24523	37	6	19	62	1479	59	13	19	92	31	1.3	0.7	0.1
24528	38	4.9	46	60	443	30	13	18	102	28	0.2	0.6	0
24534	41	5.9	21	48	1837	50	17	14	90	26	1.6	0.5	0.2
24539	42	6.1	9	79	2005	102	17	17	95	21	1.3	7	0.1
24545	43	6.5	29	85	1659	77	23	7	84	27	1.1	0.3	0.1
24550	44	5.3	13	81	1342	66	17	16	98	28	0.8	2	0
24556	45	6	10	85	1622	82	18	10	95	45	0.9	0.4	0.1
24561	46	5.7	11	99	1700	67	16	9	107	53	1	0.4	0.1
24568	49	5.7	36	100	1682	118	18	15	105	129	1.7	2.2	0.2
24573	50	6	44	62	1867	104	13	14	101	157	1.6	2.9	0.3

Lab Number	Point	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
24579	51	6.2	54	50	1643	87	13	14	117	158	1.5	2.6	0.3
24584	52	5.8	83	71	1329	97	11	14	136	151	1.4	3.4	0.2
24590	53	5.7	54	43	968	91	9	11	154	143	1.3	3	0.2
24595	54	6	35	53	1351	68	10	11	121	142	1.5	2.7	0.2
24600	57	5.9	55	54	1143	78	11	11	114	114	1	2	0.2
24606	58	5.7	70	46	1064	94	9	12	140	138	1.1	3	0.1
24611	59	6.1	101	125	1408	134	9	13	134	131	1.5	3.9	0.3
24621	61	5.8	8	72	1569	66	15	12	91	47	0.7	0.3	0.1
24626	62	5.8	11	98	1558	76	11	14	84	31	0.7	0.3	0
Mean, mg/kg		5.91	35	75	1413	73	15	12	106	70	1.0	1.4	0.1
Minimum, mg/kg		4.90	8	43	443	30	9	6	84	21	0.1	0.3	0.0
Maximum, mg/kg		6.50	101	125	2005	134	27	19	154	158	1.7	7.0	0.3
Standard deviation, mg/kg		0.34	26	18	397	24	5	3	17	48	0.4	1.5	0.1
Coefficient of variation, %		5.70	74	25	28	32	31	29	16	69	43.4	105.4	86.9

The Division of Agriculture offers its programs to all eligible persons regardless of race, color, national origin, religion, gender, age, disability, marital or veteran status, or any other legally protected status, and is an Affirmative Action/Equal Opportunity Employer.

Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – April 1 to June 30, 2014

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

The mission of the **Division of Agriculture** is to advance the stewardship of natural resources and the environment, cultivate the improvement of agriculture and agribusiness, develop leadership skills and productive citizenship among youth and adults, enhance economic security and financial responsibility among the citizens of the state, ensure a safe, nutritious food supply, improve the quality of life in communities across Arkansas, and strengthen Arkansas families.

Dr. Mark J. Cochran

Vice President for Agriculture

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Executive Summary

This is the third Quarterly Report of the Big Creek Research and Extension Team that details the following progress made from April 1 through June 30, 2014.

1. Two karst hydrogeology specialists, Phil Hays and Tim Kresse, were added to the Team. Phil Hays is a Ground Water Specialist with U.S. Geological Survey, who is an expert on the use of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems. Tim Kresse is a Water Quality Specialist, also with U.S. Geological Survey, who is an expert on the natural geochemical evolution of ground water and separating these processes from anthropogenic sources of contamination. Both have extensive field experience in karst hydrogeology in the Ozarks and Boston Mountains region.
2. The Ground Penetrating Radar (GPR) of Field 12 was completed. Results suggest that an argillic layer around 25-cm and a wavy gravel layer (about 35 to 45%) around a depth of 80 to 120 cm, which is typical of the other fields surveyed adjacent to Big Creek. However, the gravel layer appears to be overlain with fine sandy loam (0 to 25 cm depth) and sandy clay loam material (25 to 80 cm depth) that is of valley and alluvial origin.
3. Completed installation of surface runoff monitoring equipment on Fields 1, 5a, and 12 and piezometers on Fields 5a and 12. We are monitoring the ongoing management of these fields and have not requested a change field management by the land owners. Thus, nutrient runoff and leaching is a function of various practices for each field, which includes grazing, mineral fertilizer application, and sine slurry application as determined by the current CNMP.
4. Base flow sampling of Big Creek continued every week above and below the C&H Farm, well adjacent to the production houses, subwatershed draining the production area, surface runoff from Field 1, and from a spring below monitored Field 1. Dissolved P concentration ranged from 0.005 to 0.074 mg/L in Big Creek upstream of C&H, 0.007 to 0.020 mg/L downstream of C&H, and 0.008 to 0.014 mg/L in well water. E. coli ranged from 57 to 921 MPN/100 mL upstream of C&H, 30 to 1553 MPN/100 mL downstream of C&H, and <1 to 11 MPN/100 mL in well water.
5. Installed continuous flow and storm sampling equipment at the up and down stream sites in collaboration with USGS. The downstream site is giving real-time, on-line stream discharge, nitrate concentrations, water temperature, and rainfall data.
6. Contracted with USGS to conduct dye-tracer studies in the Big Creek Watershed, as well as monitoring subsurface movement material from manure holding ponds.

Big Creek Research Team

Faculty

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Rick Cartwright, Ph.D., Professor – Associate Director of Extension for Agriculture and Natural Resources

Mark Cochran, Ph.D., – Vice President, University of Arkansas System Division of Agriculture.

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Phil Hays, Ph.D. Ground Water Specialist, U.S. Geological Survey and Research Professor with Geosciences Dept., University of Arkansas, application of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems

Tim Kresse, M.Sc., Water Quality Specialist, U.S. Geological Survey, natural geochemical evolution of groundwater and separating these processes from anthropogenic sources of contamination

Nathan McKinney, Ph.D., – Assistant Director, Agriculture Experiment Station

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Thad Scott, Ph.D., Associate Professor - Water quality, transport of contaminants to and within water bodies

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Jun Zhu, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians

The Big Creek Research and Extension Team are ably supported by several excellent Program Technicians based in Little Rock and Fayetteville.

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Introduction

This research project will evaluate the potential impact and sustainable management of the C&H Farm operation (subsequently referred to as C&H, to include animal facilities and permitted land application fields) on the water quality of Big Creek. The study includes the following major tasks:

1. Monitor the fate and transport of nitrogen (N), phosphorus (P), sediment, and bacteria from land-applied swine effluent to pastures.
2. Assess the potential impact of farming operations (effluent holding ponds and land-application of effluent) on the water quality of Big Creek below the C&H Farm as well as emerging springs and ephemeral streams.
3. Determine the effectiveness and sustainability of alternative manure management techniques, including solid separation, which may enhance the export of nutrients out of the watershed.

The project will measure soil fertility levels of all permitted fields annually, to determine the potential impact of current manure management on nutrient balances (i.e., any potential accumulation). This combined with nutrient levels in surface runoff and monitored wells on Fields 1, 5a, and 12, will guide adaptive manure management decisions to address field and environmental sustainability concerns. However, it must be recognized that these fields continue to be managed as they were prior to any manure application and are regularly grazed and hay cut as appropriate. Thus, sources of nutrients in surface runoff and piezometers will be influenced by a number in-field management factors in addition to manure application. The project will assess the feasibility of manure treatment that is regarded as addressing nutrient imbalance concerns on all farms similar to C&H. Manure treatment has the potential to provide the farm with cost-beneficial alternative for the sustainable use and export of treated manures off the farm and/or out of the watershed.

Ground Penetrating Radar for Field 12

Ground Penetrating Radar (GPR) Survey Report

United States Department of Agriculture
Natural Resources Conservation Service

Purpose and Overview:

A series of ground penetrating radar surveys were conducted south of Mount Judea, AR on March 24th, 2014 on a pasture adjacent to Big Creek in Newton County AR. The field is labeled as #12 on University of Arkansas reports. The field was a floodplain/terrace, and the soil at the site was mapped as Spadra loam, occasionally flooded.

Field observations from November 2013 at a similar field a few miles north of this site aided in interpreting and collecting the data.

Participants:

Lawrence Berry	Program Technician, University of Arkansas
Dr. Kris Brye	Professor of Applied Soil Physics and Pedology, University of Arkansas
Dr. Mike Daniels	Professor, Extension Water Quality, University of AR Division of Agriculture
Richard Vaught	Soils Scientist and GPR operator, NRCS
Pearl Webb	University of AR Extension
Dr. Larry West	Retired, NRCS, Lincoln, NE

Activities, Field 12:

1. Five transects were flagged on the field in an east-west direction, roughly perpendicular to Big Creek. The transects were spaced at 50 meters. Each transect was flagged at 10-m intervals, and the approximate location of each flag was recorded with a Garmin 76s GPS. All radar surveys proceeded from east to west.
2. A SIR-3000 Ground-Penetrating Radar (GPR) system (Geophysical Survey Systems Inc.) with 200-Mhz antenna was used.
3. A metal plate was buried at the site at a depth of 50-cm to calibrate the instrument and to ground-truth soil conditions. The plate was buried along transect #4.
4. Three holes were augured on both transect #3 and #4 to ground-truth soil conditions. Ground-truthing along transects #5, #6 and #7 was not possible.

Table 1. Transect information.

Survey/ Transect ID	Length (m)	Flags
3	220	23
4	210	22
5	200	21
6	190	20
7	170	18

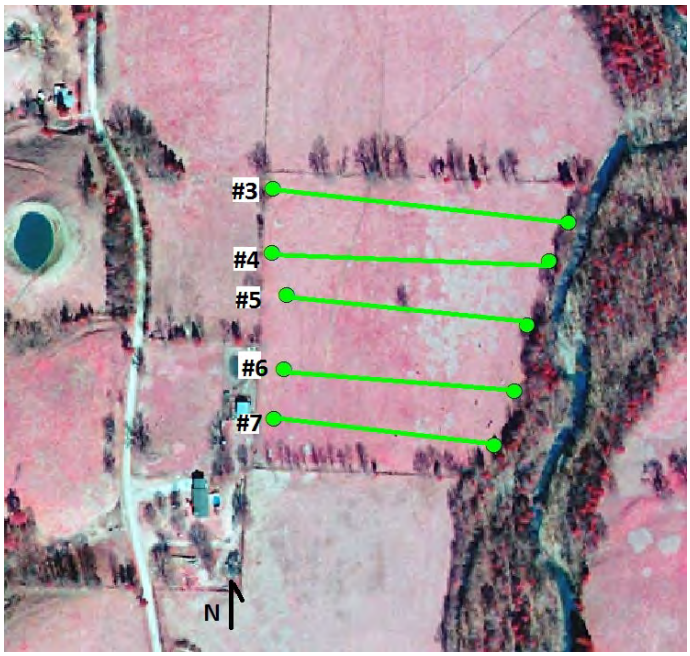


Figure 1. Location of ground penetrating radar surveys at field 12, south of Mount Judea, AR.

Summary, Field 12, Transect 3:

1. Soils observed at the site via test hole mostly agreed with the Newton County soil survey, and resembled the Spadra series, which is an Ultisol. From the county soil survey: "Spadra is a very deep, well-drained soil on stream terraces. This soil formed in loamy alluvial material derived from sandstone, siltstone, and shale. Permeability is moderate and available water capacity is high. This soil is occasionally flooded for brief periods during the winter and spring."
2. Soils observed were well drained; however, conditions were wet due to recent rains. Rafted debris, indicative of overland flow, was observed on the fence row along the north edge of the field.
3. The radar records from this site were of good interpretative quality.
4. Based on the holes augured along the transect, the radar record from this site, and from sites viewed in November 2013 along Big Creek in the same vicinity, the horizonation of the soils seems to be fairly consistent for the first 170-m of the transect.
5. An "A" horizon with a depth of around 0-20 cm seems to be consistent across most of the transect. Field textures observed were silt loam, with fine sandy loam surface texture becoming more common in closer proximity to the creek (after the 150-m mark).
6. The argillic layer along the transect commonly begins at 20-30 cm (figure 2). Field textures observed between 20-80-cm of the argillic horizon were silty clay loam.

7. The radar suggests that the solum along the transect is deeper than 1.5-m. Two test holes were augered to greater than 1-m.
8. Several hyperbola shaped anomalies were evident in the radar record, they were likely tree roots.
9. At around the 170-m mark (figure 3), the soil horizons become more wavy in nature. This change could be related to more recent scouring and deposition from Big Creek.
10. An anomaly at the 170-m mark, at around 1-m deep, could be a pocket of coarse fragments deposited by Big Creek (figure 3).
11. An anomaly was noted on the radar record at the end of survey 3 upon data collection (figure 4). It resembled possible coarse fragment deposits from the previous field visit. A test whole was augered at around the 225-m mark. The upper soil horizons (0-55-cm) were more sandy in nature than observations further from the creek along this transect. Subsurface textures were sandy loam. At 55-cm, augering was not possible due to coarse fragment content. Coarse fragment content was estimated at 35-45%.

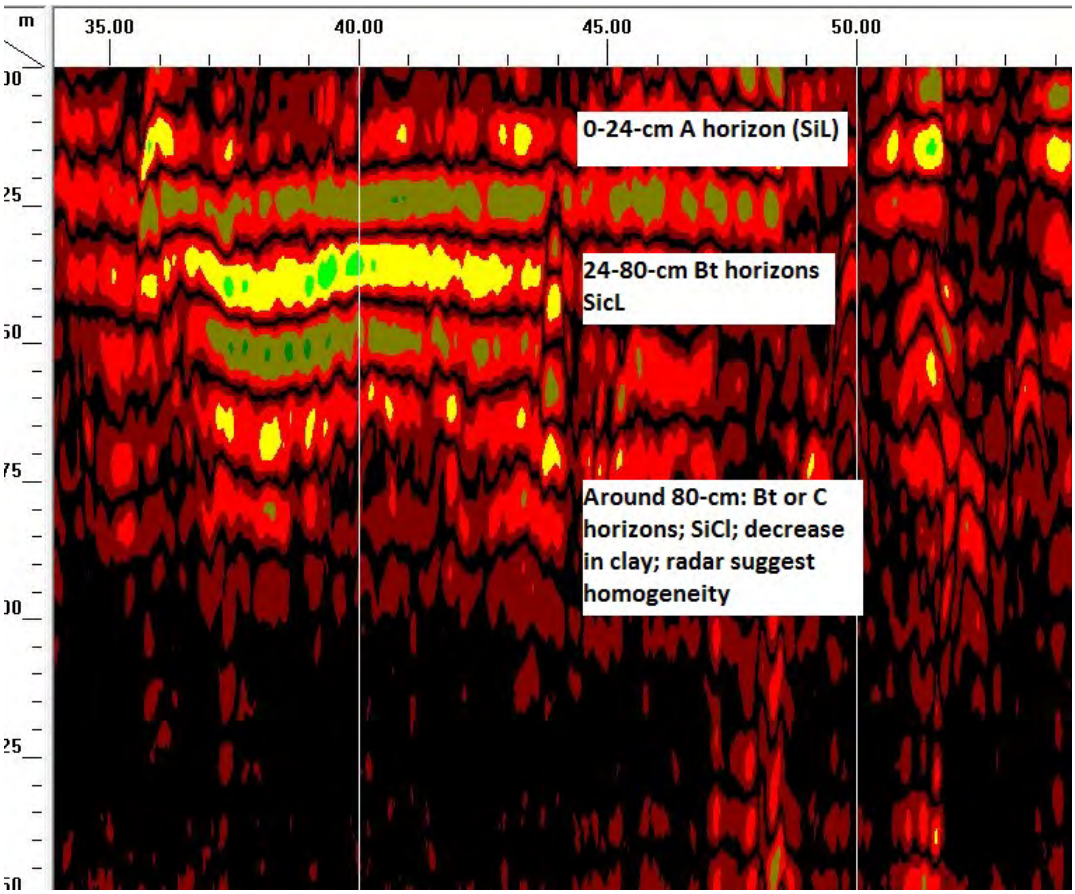


Figure 2. Typical profile from transect #3. A test hole was observed near the 50-m mark.

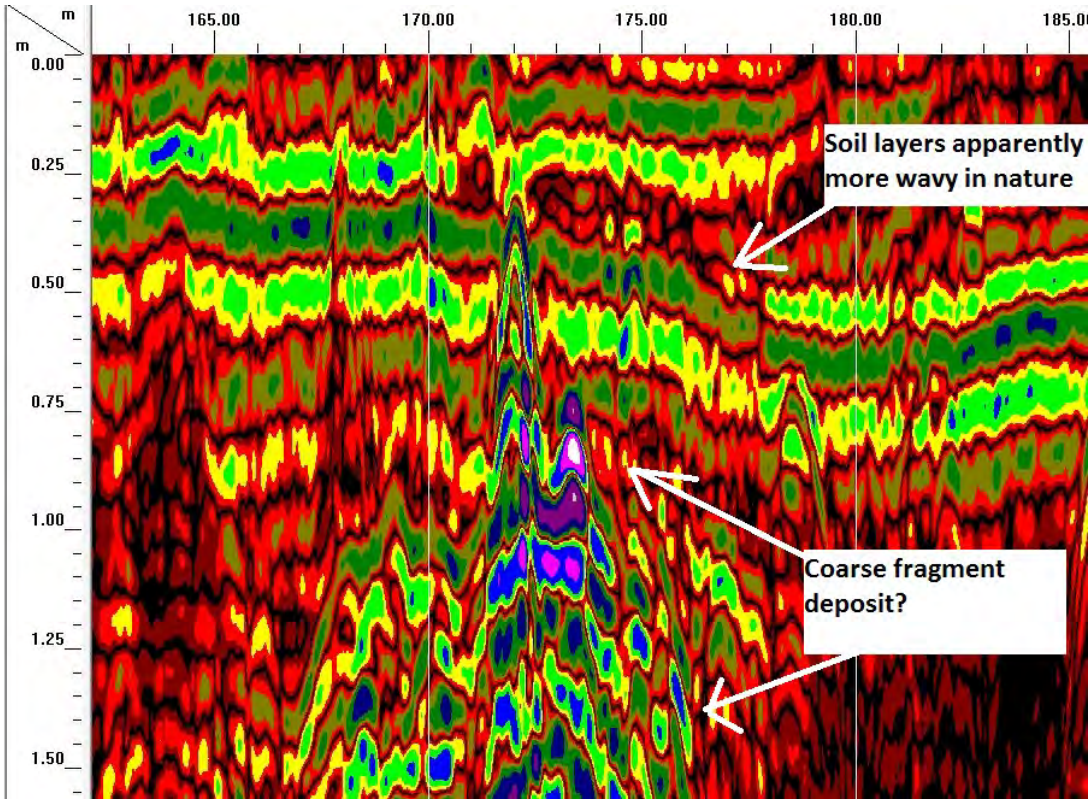


Figure 3. Along Transect 3, possible gravel layers were noted as the survey approaches Big Creek.

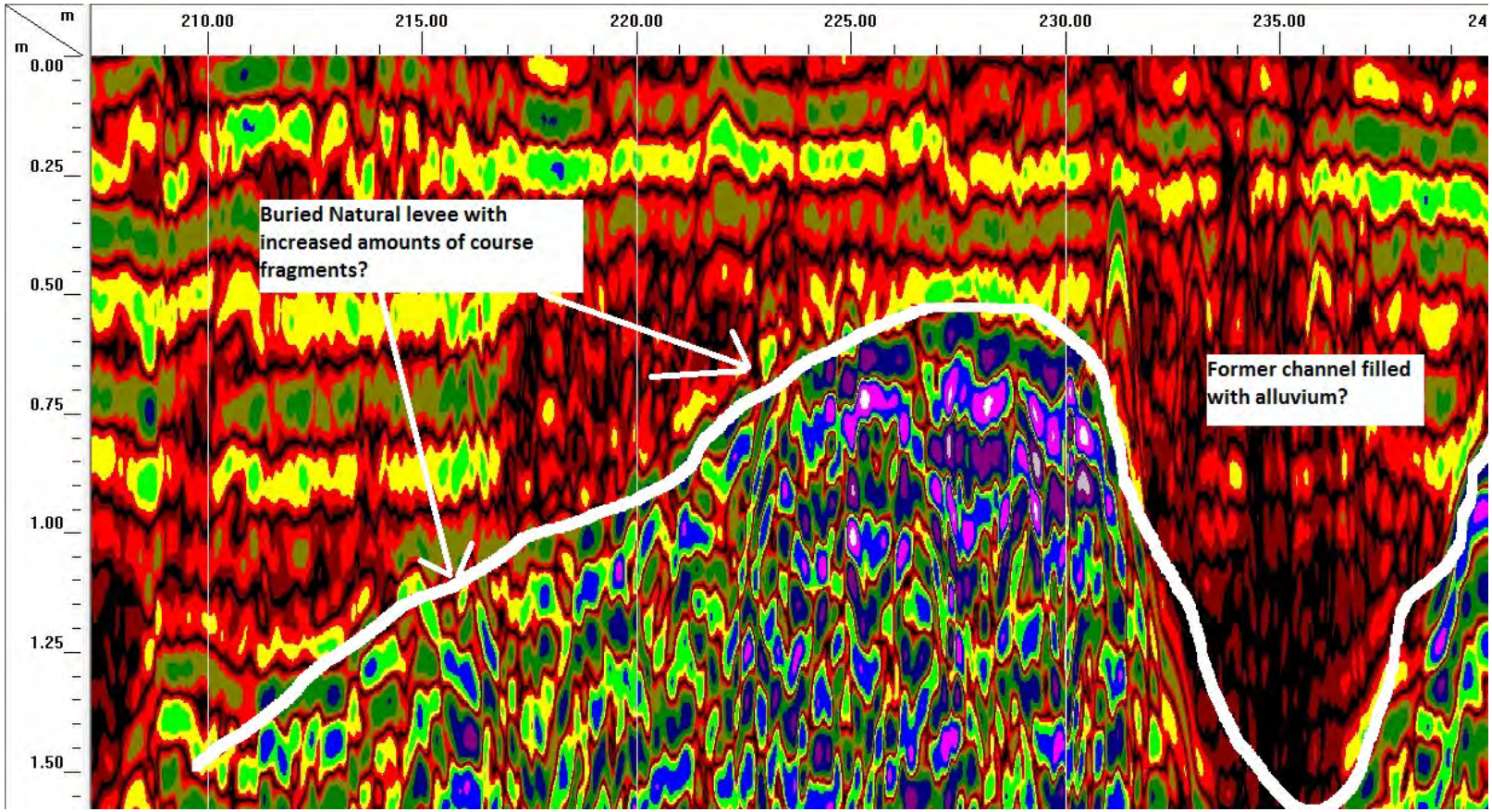


Figure 4. This anomaly at the end of Survey 3 may be a gravel bar deposited by Big Creek.

Summary, field 12, Survey #4

- The soils along this transect appear to be uniformly stratified for about the first 120-m of the survey (Figure 5).

- Test holes observed generally followed the Spadra series concept, except for one where gravels were observed in the subsoil

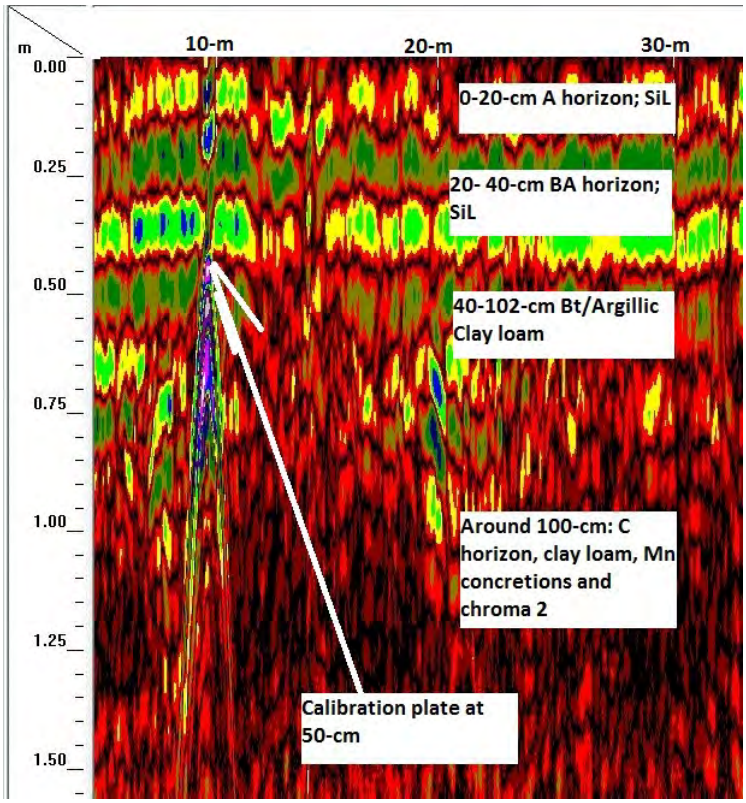


Figure 5. The first 30-m of survey number 4.

- Based on the radar record, soil horizons apparently become more wavy in nature between 120 and 130-m along the transect (Figure 6). This area is also underlain by radar signature that was found to be indicative of gravel deposits in previous test holes.

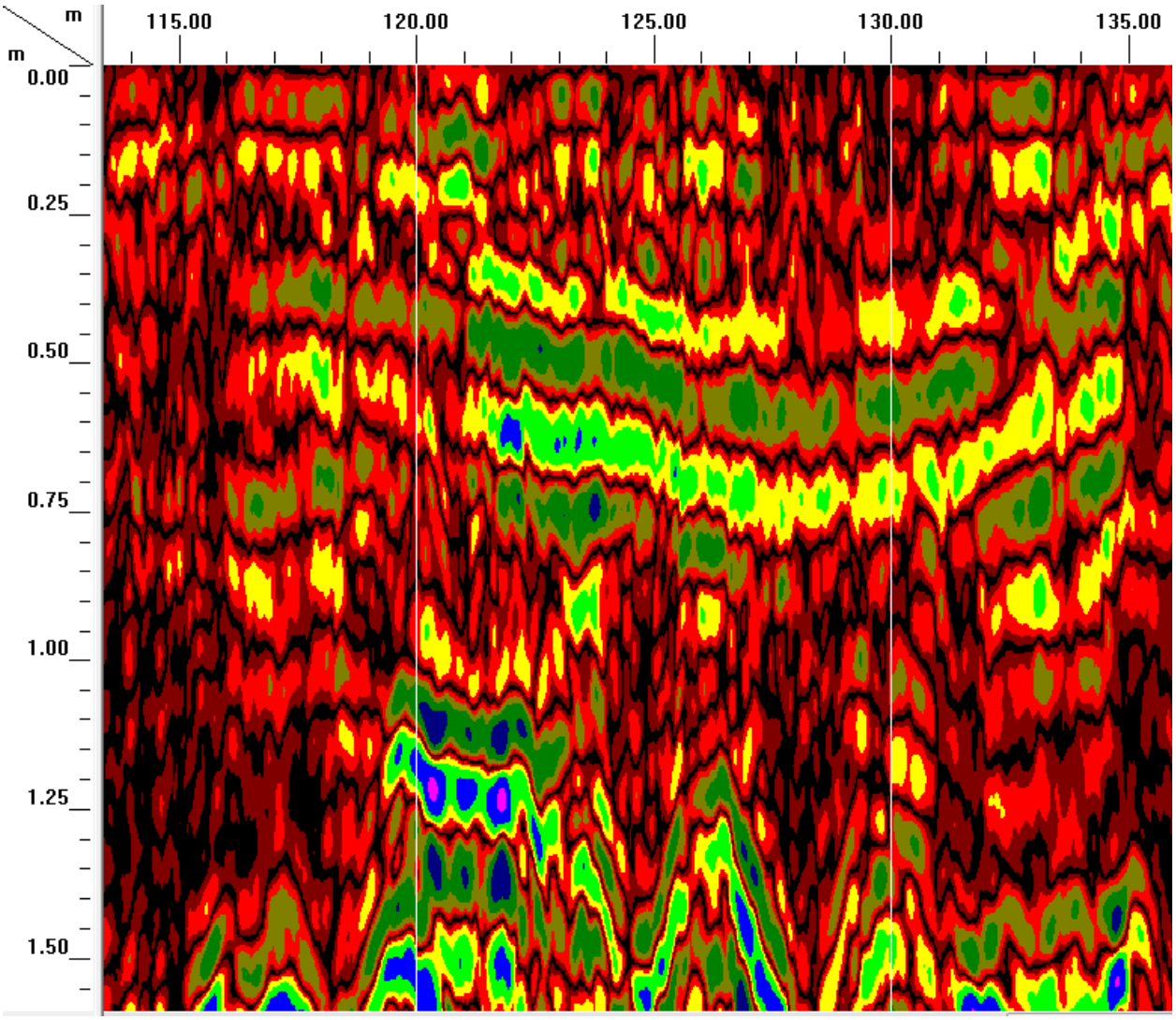


Figure 6. Features at bottom may be gravel deposits along survey number 4.

- A test hole was augured at the 200-m mark on transect 4, as summarized below. A suspected area of gravel deposition was confirmed to be present (Figure 7). The upper 80-cm was covered with loamy alluvium.

  A: 0-25-cm; Fine sandy loam
  Bt1: 25-50-cm; Sandy clay loam
  Bt2: 50-80-cm Sandy clay loam (marked clay increase)
  BC: 80-120-cm Very gravelly Sandy loam 35% fragments
  C: 120-cm plus; Very gravelly (or cobbly) Sandy loam >40% fragments

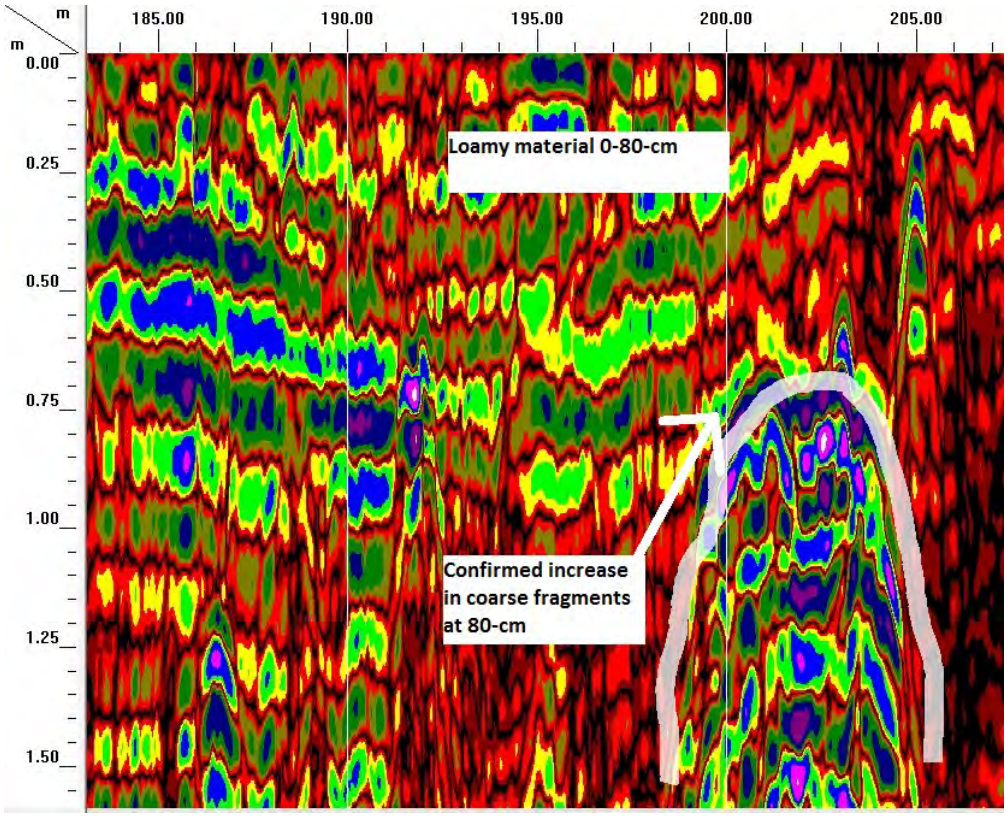


Figure 7. A subsurface horizon with increased fragment content was suspected and confirmed in the field along survey # 4.

Summary: Field 12, Survey # 5

- No points were ground-truthed along this radar survey
- The data indicates that most of this soil is uniformly layered, with a radar record resembling surveys # 3 and # 4. The survey indicates that the argillic layer usually starts around 25-cm.
- There were no anomalies associated with gravel at the end of this radar survey.
- There were highly contrasting materials noted at a depth of >1-m over the first 30-m of this transect (figure 8). This could be layers that greatly increase in clay content, or layers that increase in coarse fragments that are alluvial in nature. Less likely at this position would be “valley fill” material from nearby uplands that is overlain by alluvium.

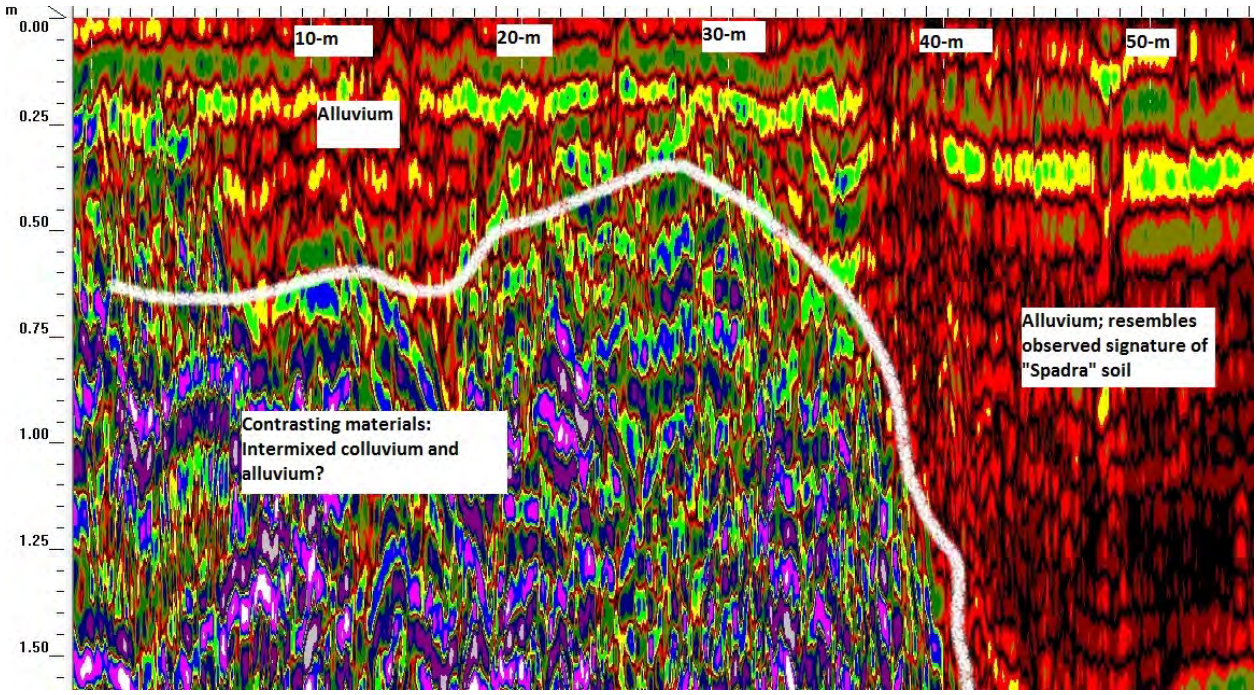


Figure 8. Contrasting, high amplitude features noted at the beginning of transect #5.

Summary: Field 12, Survey # 6

- No points were ground-truthed along this radar survey
- The data indicates that most of this soil is uniformly layered, with a radar record resembling surveys # 3 and # 4. The survey indicates that the argillic layer usually starts around 25-cm.
- There were highly contrasting materials noted at a depth of 60-cm from around the 40-m mark of this transect until around the 90-m mark (figure 9). Speculatively, this could be layers that greatly increase in clay content, or an increase in coarse fragments that are alluvial in nature.

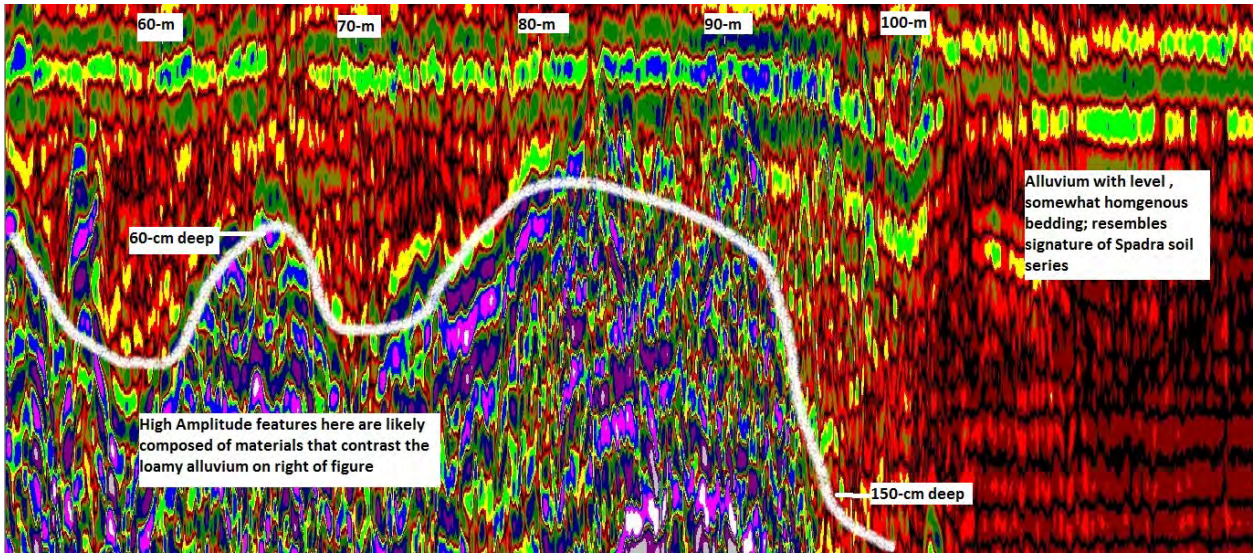


Figure 9. Contrasting materials below loamy alluvium disappear at the 100-m mark on transect #6.

Summary: Field 12, Survey # 7

a. From the 0-m to 80-m mark on this survey, the radar record suggests that most of the soil is level bedded and relatively homogenous. There are areas on this first portion of the transect that exhibit high amplitude and likely contrasting features (figure 10) that could contain higher amounts of coarse fragments or clay.

b. From the about the 80-m mark through the 130-m mark on the survey, there are subsurface deposits at depths deeper than 100-cm that contrast with what is likely loamy alluvium in the upper portion of the soil profile (Figure 11). Again, speculatively, these contrasting materials could be an increase in coarse fragments, or an increase in clay content.

c. There were no anomalies noted on the radar record from the 130-m mark to the end of the survey at 170-m (Figure 11). The radar record suggests that most of the soil is level bedded and relatively homogenous in this portion of the surey. The radar record mimics the loamy alluvium that resembled the Spadra series in surveys #3 and #4.

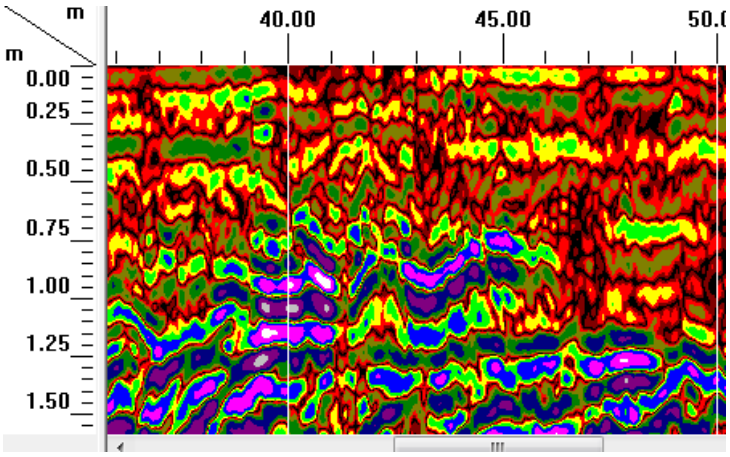


Figure 10. Purple features above could possibly be pockets of increased fragment deposition.

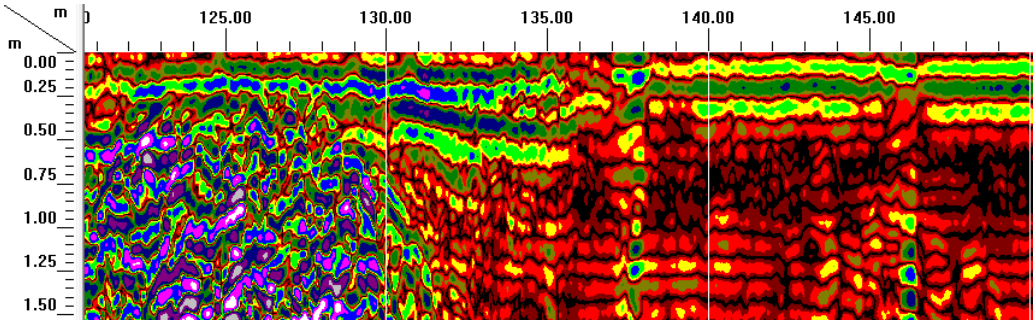


Figure 11. Highly contrasting features (left) were suggested by the radar record from the 80-m to 130-m marks along survey 7. The eastern most portion of the survey appears to be more evenly stratified and mimics similar radar signatures where fine-loamy Ultisols where observed in test holes on previous transects.

Water Sampling and Analyses

Sampling Locations

Topographic surveys of permitted Fields 1 and 12 were conducted to determine the appropriate location for edge-of-field surface runoff collection flumes. Figure 10 shows the low point on Field 1 where the flume was sited. The location for a similar flume on Field 12 is shown on Figure 11 and construction will begin as soon as the Field dries to allow construction without damaging or rutting any of the farmed field.

Water quality sampling was initiated on September 24, 2013, prior to the formal start of the project (Figure 12). Since January 1 and reported in the 1st Quarterly Report, installation of edge-of-field surface runoff monitoring equipment was completed and became operational April 2, 2014, as shown in Figure 13. Additionally runoff volume and auto-sampling equipment was also installed on an ephemeral stream draining a sub-watershed in which the C&H Farm operations and swine slurry storage lagoons are located, as shown in Figure 12. These sites are;

Site 1. Edge-of field monitoring on Field 1 permitted to receive slurry – Figure 13.

Site 2. Edge-of field monitoring on Field 5a – still to be determined

Site 3. Edge-of field monitoring on Field 12 permitted to receive slurry – still to be completed

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities – Figure 14.

Site 5. Spring below Field 1 – Figure 15.

Site 6. Big Creek upstream of the C&H Farm operation – Figure 16.

Site 7. Big Creak downstream of the C&H Farm operation – Figure 17.

USGS Stations

Big Creek Continuous Flow

Collaborating with USGS, Big Creek at the downstream site of prior water sample collection was instrumented with continuous flow gaging equipment, along with a nitrate sensor, which provided real-time flow, water temperature, water nitrate and precipitation. These data are available on-line at the following sites.

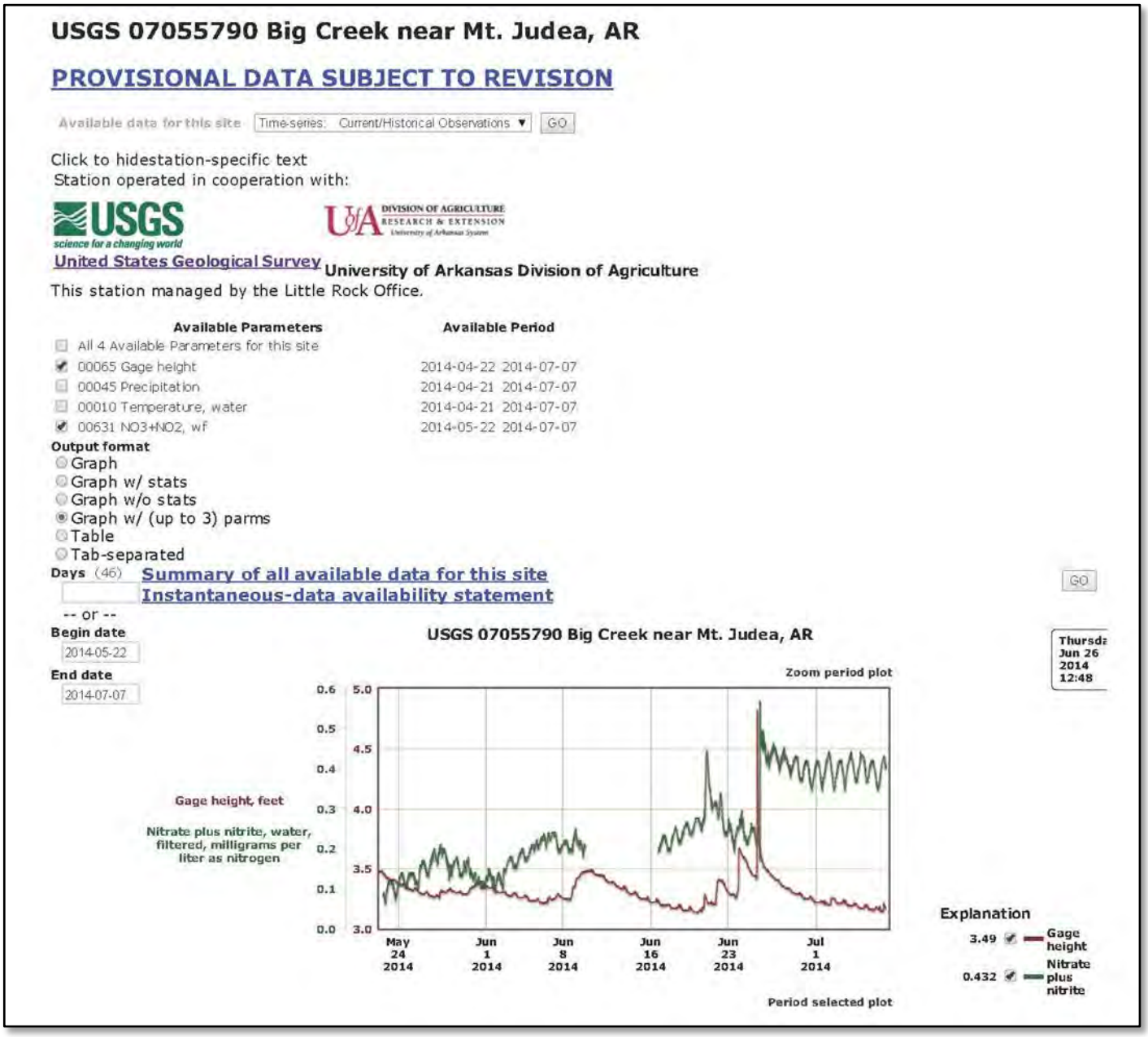
USGS 07055790 Big Creek near Mt. Judea, AR

http://waterdata.usgs.gov/ar/nwis/uv?cb_00065=on&cb_00045=on&cb_00010=on&format=gif_default&period=&begin_date=2014-04-16&end_date=2014-04-23&site_no=07055790

Big Creek Nitrate Sensor

http://waterdata.usgs.gov/ar/nwis/uv/?site_no=07055790&PARAmeter_cd=00010,00300,00095,00400,63680,00631,70301,00090,00940

Figure 12. Display of USGS gaging site on Big Creek, downstream of the C&H Farm showing continuous flow and nitrate plus nitrite concentrations since the equipment became active in May, 2014.



USGS 07055814 Big Creek at Carver, AR

http://waterdata.usgs.gov/ar/nwis/uv?cb_all_00065_00045_00010_00095_00400_63680_00300_00631=on&cb_00065=on&cb_00045=on&cb_00010=on&cb_00095=on&cb_00400=on&cb_63680=on&cb_00300=on&cb_00631=on&format=gif_default&site_no=07055814&period=&begin_date=2014-05-30&end_date=2014-06-06

Current conditions for Arkansas sites including Big Creek at Carver

http://waterdata.usgs.gov/ar/nwis/current?index_pmcode_STATION_NM=1&index_pmcode_DATETIME=2&index_pmcode_99409=3&index_pmcode_63680=4&group_key=NONE&sitefile_output_format=html_table&column_name=agency_cd&column_name=site_no&column_name=station_nm&format=html_table&sort_key_2=site_no&html_table_group_key=NONE&rdb_compression=file&list_of_search_criteria=realtime_parameter_selection

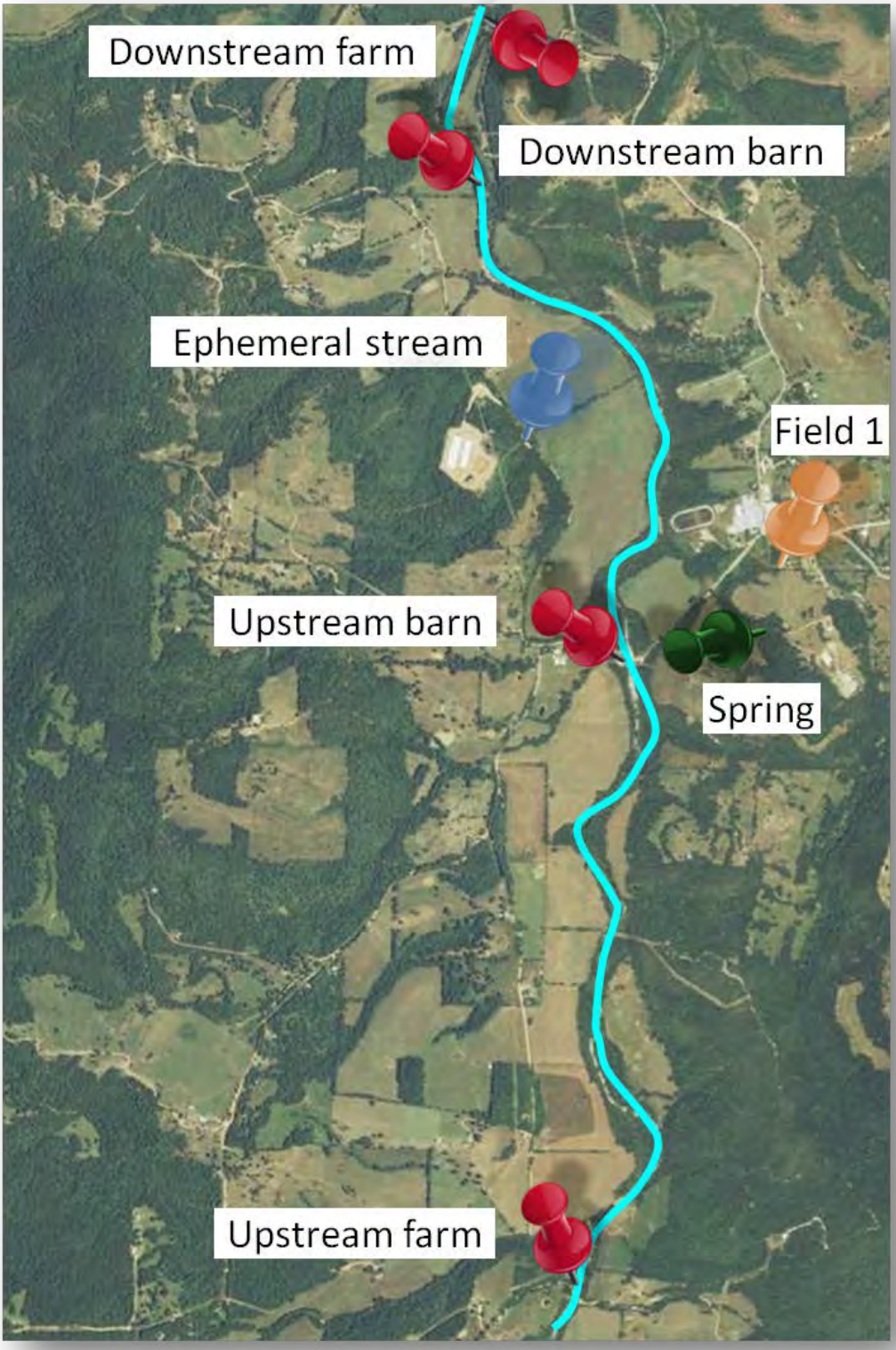


Figure 13. Location of water quality sampling sites on Big Creek and the C&H Farm.

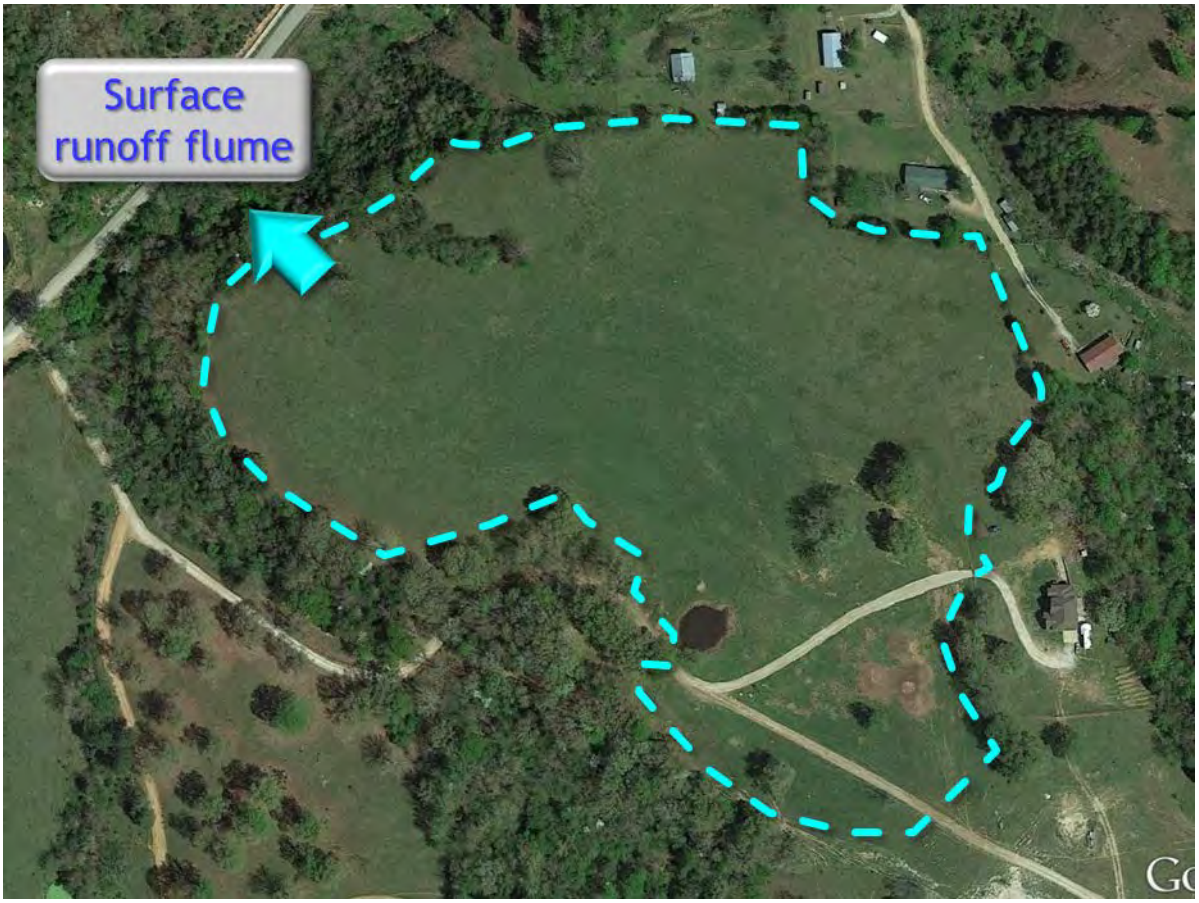


Figure 14. Surface and subsurface flow monitoring on Field 1 on the C&H Farm.

Figure 15. Edge-of-field surface runoff flume on Field 1 on the C&H Farm.

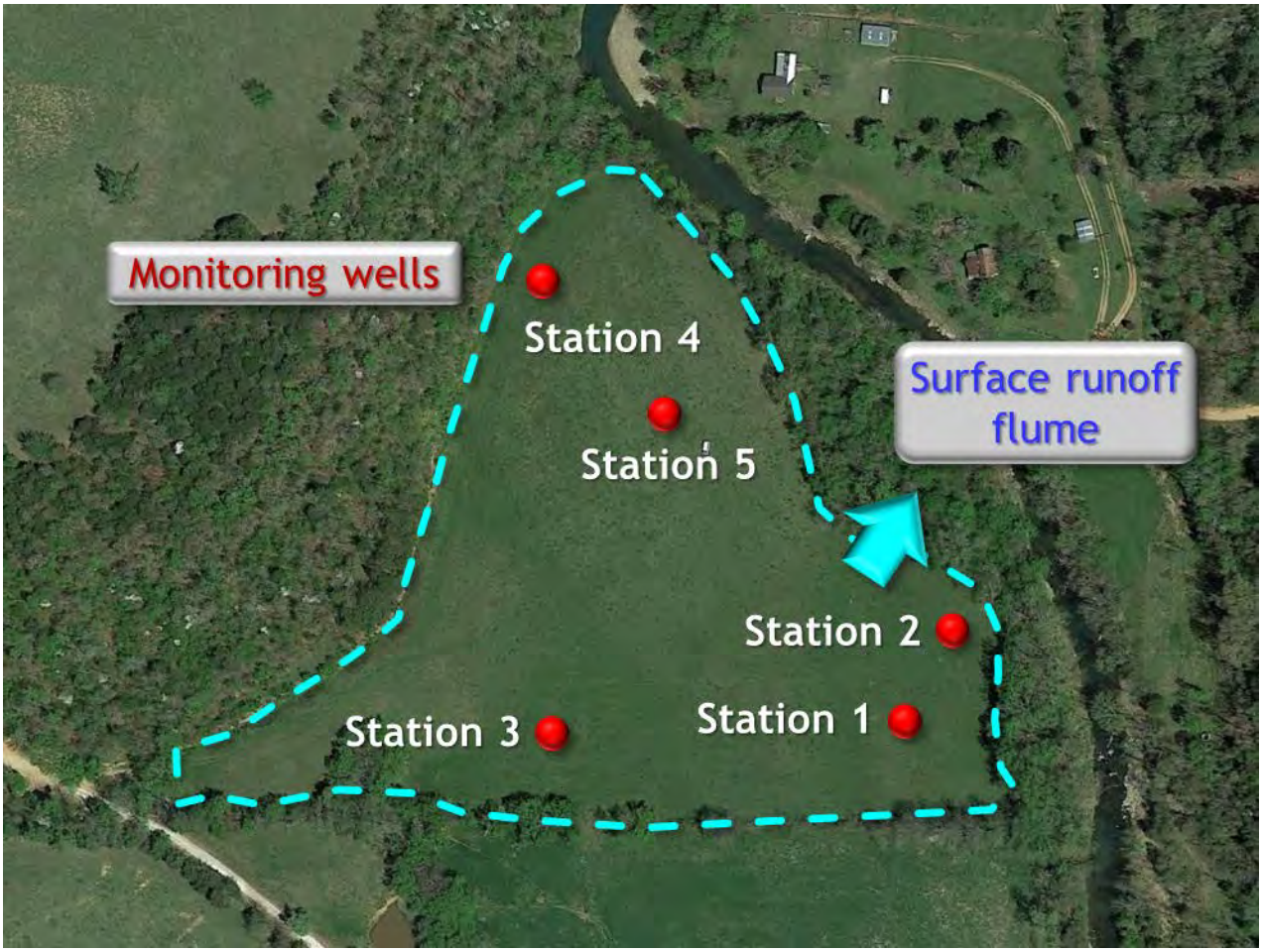


Figure 16. Surface and subsurface flow monitoring on Field 5a on the C&H Farm.

Figure 17. Edge-of-field surface runoff flume on Field 5a on the C&H Farm.

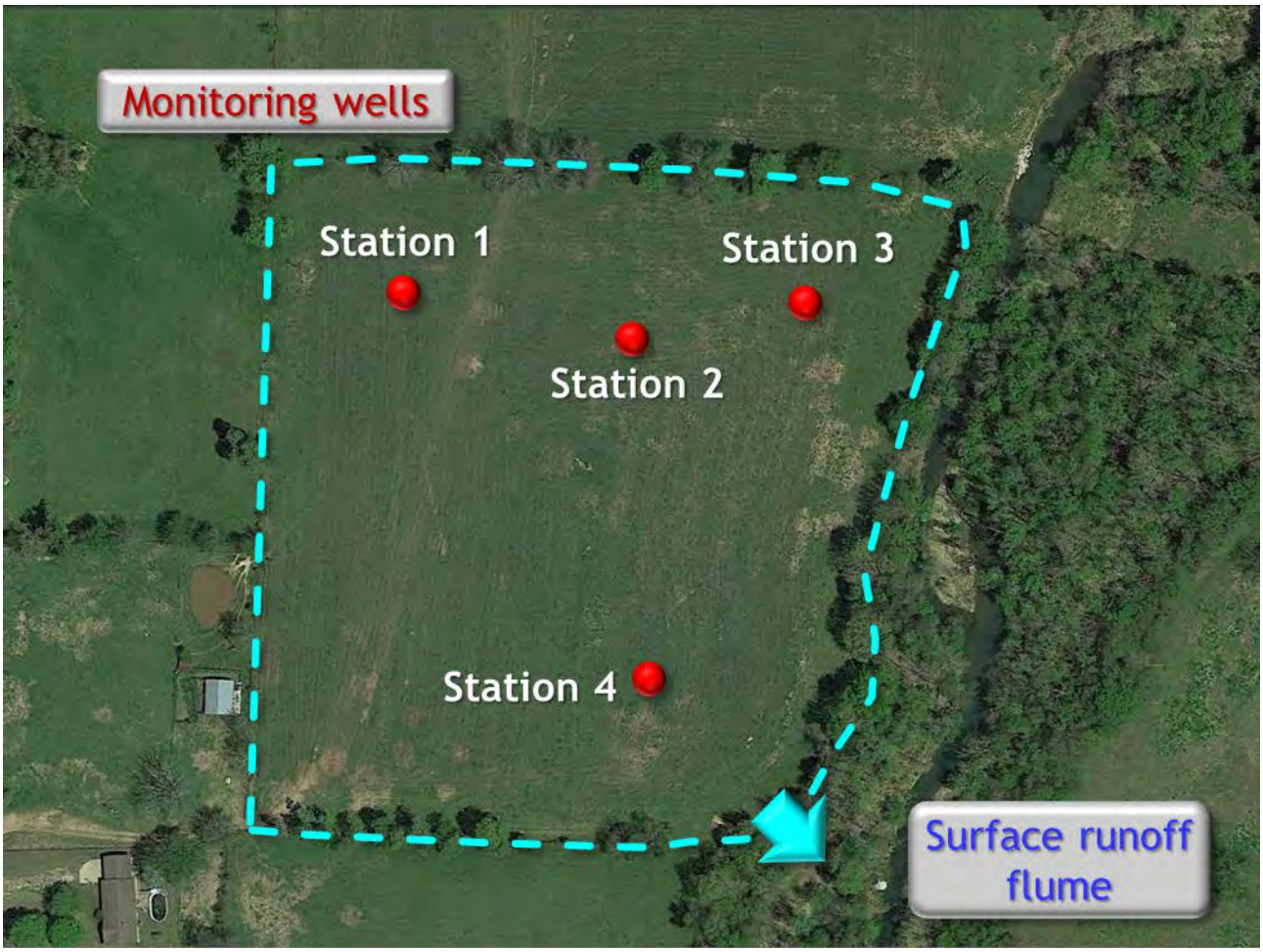


Figure 18. Surface and subsurface flow monitoring on Field 12 on the C&H Farm.

Figure 19. Edge-of-field surface runoff flume on Field 12 on the C&H Farm.

Figure 20. Installed piezometer that measures water table depth and can collect water samples from 15 and 48 inch depths.

Figure 21. The culvert sampling an ephemeral stream draining a subwatershed containing the C&H Farm operation facilities.

Figure 22. The spring sampled adjacent to Big Creek on the C&H Farm.

Figure 23. The Big Creek sampling site upstream of the C&H Farm during baseflow.

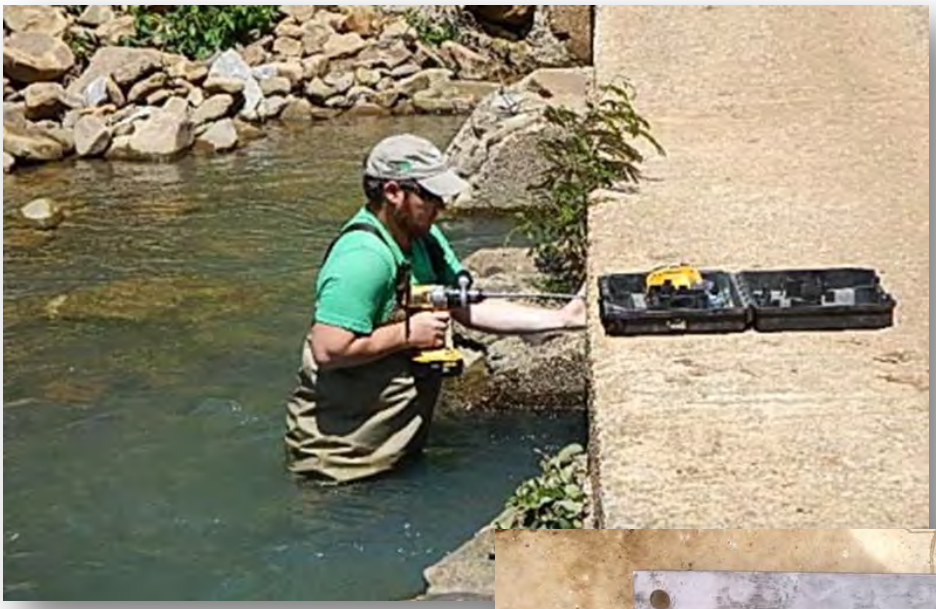


Figure 24. The Big Creek sampling station at the site upstream of the C&H Farm.

Figure 25. The Big Creek sampling site downstream of the C&H Farm during baseflow.

Figure 26. The Big Creek sampling station at the site downstream of the C&H Farm.

Figure 27. The Big Creek sampling station at the site downstream of the C&H Farm.

Sampling Protocols and Analyses

The chemical composition of water samples collected prior to June 30, 2014 is given in Tables 2, 3, and 4. The following procedure was used to collect, prepare and analyze all water samples;

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface where the stream was actively moving and well-mixed. After March 31st, 2014, samples noted as storm flow in Tables 2, 3, and 4 were collected by automatic, flow initiated ISCO[1] water samplers.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted.
6. Samples were placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
7. Analyses included Dissolved Phosphorus (EPA 365.2), Total Phosphorus (APHA 4500-P), Ammonia (EPA 351.2), Nitrate (EPA 300.0), Total Nitrogen (APHA 4500-P), Total Suspended Solids (EPA 160.2), E. Coli (APHA 9223, B) and Total Coliforms (APHA 9223, B).

[1] Mention of ISCO water samplers does not imply endorsement by the Division of Agriculture, University of Arkansas System.

Table 2. Water quality analyses at each sample site. Coliform units are Most Probable Number (MPN) per 100 mL of water.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
			---------- mg/L ----------							-- MPN/100 mL --	
9/12/2013	**9/12/2013**	**Base flow**									
10:45	15:30	Upstream farm	0.016	0.030	0.06	0.37	0.50	3.0	N.D.	6.3	>2420
11:15	15:30	Upstream barn	0.010	0.032	0.05	0.36	0.54	5.8	N.D.	4.1	4040.0
11:50	15:30	Downstream barn	0.019	0.026	0.05	0.63	0.78	1.2	N.D.	1.0	488.4
13:00	15:30	Downstream farm	0.010	0.022	0.04	0.40	0.62	1.7	N.D.	16.0	>2420
9/20/2013	**9/20/2013**	**Base flow**									
10:50	16:08	Spring	0.006	0.020	0.03	0.38	0.50	4.7	N.D.	72.7	5040
11:15	16:08	Upstream farm	0.009	0.022	0.03	0.25	0.36	1.1	N.D.	80.9	9870
11:40	16:08	Upstream barn	0.015	0.024	0.04	0.36	0.42	1.2	N.D.	1203	26130
12:20	16:08	Downstream barn	0.024	0.032	0.06	0.76	0.85	1.3	N.D.	218.7	2430
12:50	16:08	Downstream farm	0.013	0.022	0.05	0.44	0.53	1.1	N.D.	548	17230

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
9/24/2013	**9/24/2013**	**Base flow**									
10:30	16:15	Spring	0.004	0.024	0.00	0.12	0.35	50.0	N.D.	8.5	>2420
10:45	16:15	Upstream farm	0.011	0.014	0.03	0.44	0.20	17.9	N.D.	39	1120
11:00	16:15	Upstream barn	0.007	0.024	0.00	0.33	0.41	1.6	N.D.	42	>2419
12:20	16:15	Downstream barn	0.017	0.032	0.01	0.79	0.82	0.7	N.D.	42	816
12:40	16:15	Downstream farm	0.007	0.028	0.01	0.51	0.58	1.5	N.D.	5	>2420
10/1/2013	**10/1/2013**	**Base flow**								N.D.	
9:45	14:42	Spring	0.001	0.162	0.00	0.11	0.41	89.2	N.D.	4	920
10:00	14:42	Upstream farm	0.011	0.038	0.02	0.24	0.34	2.2	N.D.	8	1300
10:15	14:42	Upstream barn	0.006	0.032	0.03	0.24	0.40	6.7	N.D.	82	5200
10:35	14:42	Downstream barn	0.018	0.032	0.00	0.8	0.92	1.1	N.D.	19	649
10:55	14:42	Downstream farm	0.009	0.034	0.02	0.51	0.65	3.6	N.D.	2620	10810
10/9/2013	**10/9/2013**	**Base flow**									
9:00	13:52	Spring	0.011	0.054	0.00	0.09	0.28	29.1	N.D.	3	1413
9:30	13:52	Upstream	0.016	0.034	0.00	0.50	0.73	7.1	N.D.	11	2419

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
		farm									
9:45	13:52	Upstream barn	0.016	0.030	0.00	0.39	0.53	6.2	N.D.	194	4730
10:00	13:52	Downstream barn	0.017	0.02	0.00	0.87	0.89	0.4	N.D.	29	1986
10:20	13:52	Downstream farm	0.006	0.038	0.00	0.62	0.77	13.6	N.D.	28	3450
10/15/2013	**10/15/2013**	**Storm flow**									
11:13	15:47	Spring	0.010	0.250	0.15	0.09	0.58	66.9	N.D.	1401	19863
12:24	15:47	Upstream farm	0.018	0.026	0.00	1.02	1.03	1.1	N.D.	759	>2419
12:47	15:47	Upstream barn	0.019	0.036	0.06	0.84	0.99	2.1	N.D.	472	8664
13:13	15:47	Downstream barn	0.033	0.244	0.12	1.28	1.44	89.2	N.D.	959	12997
13:34	15:47	Downstream farm	0.067	0.316	0.20	0.68	1.07	101.1	N.D.	1334	19863
10/22/2013	**10/22/2013**	**Base flow**									
10:10	15:31	Spring	0.005	0.086	0.10	0.31	0.53	36.4	N.D.	1733	>2419
10:30	15:31	Upstream farm	0.014	0.034	0.00	0.35	0.32	0.3	N.D.	186	299
10:45	15:31	Upstream barn	0.016	0.024	0.03	0.58	0.60	1.2	N.D.	411	11190

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:00	15:31	Downstream barn	0.016	0.022	0.00	0.79	0.77	0.1	N.D.	150	2419
11:20	15:31	Downstream farm	0.012	0.020	0.04	0.72	0.76	0.7	N.D.	87	292
10/31/2013	**10/31/2013**	**Base flow**									
11:00	15:15	Spring	0.003	0.404	0.14	0.32	1.02	400.9	N.D.	91	32550
10:45	15:15	Upstream farm	0.012	0.032	0.00	0.24	0.32	1.1	N.D.	66	1986
10:15	15:15	Upstream barn	0.007	0.044	0.04	0.25	0.38	2.3	N.D.	261	6310
10:00	15:15	Downstream barn	0.018	0.022	0.11	0.52	0.66	0.9	N.D.	14	218
10:30	15:15	Downstream farm	0.012	0.024	0.03	0.44	0.45	1.4	N.D.	Leaked	Leaked
11/6/2013	**11/6/2013**	**Base flow**									
8:35	14:35	Spring	0.013	0.130	0.10	0.06	0.72	21.2	N.D.	8570	34480
9:00	14:35	Upstream farm	0.032	0.074	0.03	0.43	0.61	4.7	N.D.	4080	28510
9:10	14:35	Upstream barn	0.020	0.038	0.00	0.18	0.27	2.5	N.D.	579	13330
9:45	14:35	Downstream barn	0.040	0.164	0.12	0.41	0.67	32.9	N.D.	3180	36090
10:00	14:35	Downstream farm	0.041	0.154	0.12	0.29	0.60	28.4	N.D.	3500	43520

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11/12/2013	**11/12/2013**	**Base flow**									
10:56	16:28	Spring	0.006	0.022	0.05	2.45	2.61	8.9	N.D.	48	2750
11:35	16:28	Upstream farm	0.011	0.010	0.00	0.17	0.22	1.0	N.D.	45	1986
12:15	16:28	Upstream barn	0.012	0.014	0.09	0.22	0.33	1.4	N.D.	36	1733
13:03	16:28	Downstream barn	0.012	0.012	0.00	0.30	0.34	0.5	N.D.	21	1046
13:35	16:28	Downstream farm	0.011	0.010	0.00	0.24	0.31	0.0	N.D.	24	>2419
11/19/2013	**11/19/2013**	**Base flow**									
9:20	14:35	Spring	0.007	0.022	0.02	3.06	3.06	4.4	N.D.	579	9880
9:45	14:35	Upstream farm	0.010	0.026	0.00	0.12	0.22	0.7	N.D.	435	2400
10:05	14:35	Upstream barn	0.011	0.028	0.00	0.18	0.32	0.3	N.D.	172	>2419
10:35	14:35	Downstream barn	0.011	0.028	0.00	0.23	0.34	0.5	N.D.	238	2419
10:55	14:35	Downstream farm	0.009	0.024	0.02	0.17	0.28	1.0	N.D.	194	4410
11/26/2013	**11/26/2013**	**Base flow**									
10:35	14:40	Spring	0.007	0.018	0.00	1.69	1.70	4.5	N.D.	86	1553
10:45	14:40	Upstream farm	0.013	0.018	0.00	0.14	0.14	0.4	N.D.	77	1203

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:06	14:40	Upstream barn	0.014	0.016	0.00	0.19	0.20	0.7	N.D.	249	1986
11:30	14:40	Downstream barn	0.014	0.018	0.03	0.30	0.33	1.3	N.D.	40	613
11:45	14:40	Downstream farm	0.013	0.016	0.00	0.23	0.24	1.2	N.D.	36	2419
12/3/2013	**12/3/2013**	**Base flow**									
8:30	13:23	Spring	0.007	0.046	0.04	1.05	1.37	26.9	N.D.	25	1986
8:45	13:23	Upstream farm	0.007	0.012	0.00	0.15	0.25	0.5	N.D.	27	435
9:00	13:23	Upstream barn	0.009	0.012	0.00	0.21	0.28	0.3	N.D.	29	548
9:15	13:23	Downstream barn	0.010	0.018	0.00	0.30	0.35	0.6	N.D.	248	687
9:35	13:23	Downstream farm	0.006	0.012	0.00	0.23	0.28	0.5	N.D.	12	>2419
12/17/2013	**12/17/2013**	**After snow melt**									
9:35	14:03	Spring	0.007	0.042	0.05	0.37	0.65	2.0	N.D.	248.1	2419.2
10:00	14:03	Upstream farm	0.010	0.036	0.06	0.18	0.27	1.2	N.D.	248.1	2419.2
10:10	14:03	Upstream barn	0.011	0.032	0.02	0.38	0.48	0.7	N.D.	157.6	>2419.2
10:30	14:03	Downstream barn	0.008	0.032	0.03	0.39	0.50	1.6	N.D.	127.4	2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:50	14:03	Downstream farm	0.008	0.032	0.00	0.33	0.43	2.1	N.D.	148.3	>2419.2
PROCEEDING SAMPLES COLLECTED DURING SECOND QUARTER											
1/2/2014	**1/2/2014**	**Base flow**									
10:45	14:19	Spring	0.006	0.024	0.05	3.35	3.24	0.5	N.D.	ND	ND
10:55	14:19	Upstream farm	0.009	0.022	0.01	0.22	0.25	0.7	N.D.	ND	ND
11:10	14:19	Upstream barn	0.012	0.024	0.00	0.44	0.47	0.3	N.D.	ND	ND
11:25	14:19	Downstream barn	0.012	0.024	0.00	0.54	0.58	0.8	N.D.	ND	ND
11:50	14:19	Downstream farm	0.012	0.036	0.00	0.49	0.54	0.8	N.D.	ND	ND
1/7/2014	**1/7/2014**	**Base flow**									
10:10	13:43	Spring	0.008	0.024	0.00	2.36	2.32	1.3	N.D.	20.9	1413.6
10:20	13:43	Upstream farm	0.014	0.022	0.02	0.20	0.27	0.8	N.D.	66.3	307.6
10:30	13:43	Upstream barn	0.017	0.022	0.00	0.36	0.43	0.3	N.D.	24.3	344.8
10:50	13:43	Downstream barn	0.015	0.022	0.00	0.50	0.54	1.1	N.D.	21.1	290.9
11:10	13:43	Downstream farm	0.015	0.028	0.00	0.41	0.46	0.2	N.D.	18.3	325.5

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
1/14/2014	**1/14/2014**	**Base flow**									
11:35	15:35	Spring	0.010	0.042	0.00	1.97	2.09	2.3	N.D.	24.3	1732.9
12:15	15:35	Upstream farm	0.008	0.028	0.01	0.16	0.25	0.3	N.D.	151.5	980.4
11:50	15:35	Upstream barn	0.008	0.030	0.03	0.21	0.73	0.9	N.D.	238.2	920.8
12:50	15:35	Downstream barn	0.008	0.028	0.02	0.33	0.43	0.5	N.D.	156.5	1119.9
13:15	15:35	Downstream farm	0.008	0.026	0.05	0.31	0.39	0.5	N.D.	95.9	1299.7
1/21/2014	**1/21/2014**	**Base flow**									
8:10	15:00	Spring	0.008	0.006	0.02	2.11	2.10	0.9	N.D.	5.2	613.1
8:30	15:00	Upstream farm	0.009	0.010	0.00	0.13	0.22	0.0	N.D.	55.7	290.9
8:20	15:00	Upstream barn	0.010	0.010	0.01	0.21	0.28	0.3	N.D.	51.2	488.4
8:45	15:00	Downstream barn	0.011	0.012	0.01	0.34	0.45	1.0	N.D.	49.6	249.9
9:05	15:00	Downstream farm	0.010	0.014	0.01	0.30	0.36	0.5	N.D.	131.3	410.6
1/29/2014	**1/29/2014**	**Base flow**									
10:20	14:15	Spring	0.009	0.024	0.00	0.85	0.86	1.4	N.D.	3.1	325.5
10:40	14:15	Upstream	0.007	0.028	0.00	0.13	0.15	0.6	N.D.	10.9	248.1

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
		farm									
10:30	14:15	Upstream barn	0.007	0.024	0.01	0.20	0.24	0.0	N.D.	28.2	290.9
11:00	14:15	Downstream farm	0.007	0.024	0.00	0.28	0.28	0.0	N.D.	<1	275.0
2/13/2014	**2/13/2014**	**Base flow**									
8:30	13:22	Spring	0.009	0.024	0.00	0.65	0.73	5.1	N.D.	<1	461.1
8:50	13:22	Upstream farm	0.009	0.016	0.00	0.11	0.15	0.9	N.D.	68.9	238.2
8:40	13:22	Upstream barn	0.011	0.014	0.00	0.14	0.23	0.9	N.D.	31.4	260.2
9:10	13:22	Downstream farm	0.009	0.014	0.00	0.24	0.28	0.4	N.D.	9.8	290.9
2/19/2014	**2/19/2014**	**Base flow**									
9:15	14:36	Spring	0.006	0.020	0.02	0.57	0.62	0.8	N.D.	1.0	365.4
10:17	14:36	Upstream farm	0.008	0.018	0.00	0.05	0.10	0.4	N.D.	111.9	325.5
9:30	14:36	Upstream barn	0.009	0.018	0.00	0.07	0.15	0.5	N.D.	45.5	235.9
11:30	14:36	Downstream farm	0.007	0.016	0.00	0.11	0.17	0.3	N.D.	8.5	272.3
2/27/14	**2/27/14**	**Base flow**									
10:40	15:10	Spring	0.007	0.106	0.06	0.59	0.82	70	N.D.	<1	307.6

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:03	15:10	Upstream farm	0.008	0.022	0.02	0.07	0.22	2.1	N.D.	29.5	209.8
11:40	15:10	Upstream barn	0.008	0.016	0.00	0.08	0.11	0.3	N.D.	14.8	235.9
12:22	15:10	Downstream farm	0.007	0.014	0.00	0.11	0.16	0.6	N.D.	2.00	547.5
3/10/2014	**3/10/2014**	**Base flow/Snow melt**									
10:30	15:08	Spring	0.006	0.048	0.02	0.37	0.53	19.9	3.8	6.3	517.2
10:55	15:08	Upstream farm	0.005	0.026	0.06	0.09	0.12	0.9	1.4	52.1	275.5
11:40	15:08	Upstream barn	0.007	0.020	0.04	0.10	0.13	1.3	1.3	59.4	547.5
12:15	15:08	Downstream farm	0.004	0.026	0.04	0.12	0.21	6.1	1.2	27.8	579.4
3/18/2014	**3/18/2014**	**Storm flow**									
12:08	15:24	Spring	0.011	0.026	0.00	0.90	0.99	1.7	2.5	21.1	>2419.2
12:48	15:24	Upstream farm	0.010	0.038	0.08	0.19	0.24	2.1	1.2	50.4	435.2
12:20	15:24	Upstream barn	0.012	0.040	0.04	0.24	0.76	3.1	1.2	63.7	648.8
13:03	15:24	Downstream farm	0.014	0.040	0.06	0.31	0.38	3.4	1.7	78.8	866.4
12:36	15:24	Culvert	0.009	0.028	0.05	0.64	0.63	1.0	0.7	19.3	365.4

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
3/26/2014	**3/26/2014**	**Base flow**									
10:40	14:06	Spring	0.010	0.026	0.01	1.00	1.13	3.0	1.4	8.4	980.4
10:22	14:06	Upstream farm	0.010	0.024	0.00	0.12	0.19	0.6	0.8	43.5	517.2
10:32	14:06	Upstream barn	0.011	0.024	0.00	0.17	0.22	0.5	0.5	48.7	579.4
11:31	14:06	Downstream farm	0.011	0.026	0.00	0.25	0.30	1.2	0.7	21.8	866.4
9:55	14:06	Culvert	0.007	0.028	0.00	0.61	0.62	11.0	1.2	260.2	>2419.2
3/29/2014	**3/31/2014**	**Storm flow**									
9:40	8:42	Spring	0.006	0.044	0.00	0.29	0.51	3.3	8.1	ND	ND
10:00	8:42	Upstream farm	0.006	0.042	0.06	0.07	0.14	2.1	2.1	ND	ND
9:50	8:42	Upstream barn	0.007	0.036	0.00	0.09	0.16	1.5	2.3	ND	ND
10:35	8:42	Downstream farm	0.008	0.038	0.00	0.13	0.19	2.5	2.2	ND	ND
10:24	8:42	Culvert	0.004	0.042	0.00	0.69	0.81	3.3	4.9	ND	ND
PROCEEDING SAMPLES COLLECTED DURING THIRD QUARTER											
4/2/2014	**4/2/2014**	**Base flow**									
11:15	14:30	Spring	0.011	0.020	0.00	0.60	0.67	0.6	2.1	3.1	307.6
10:14	14:30	Upstream	0.011	0.026	0.00	0.05	0.09	1.0	0.5	60.5	613.1

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
		farm									
10:21	14:30	Upstream barn	0.012	0.028	0.00	0.08	0.11	0.7	1.4	12.1	1732.1
12:11	14:30	Downstream farm	0.010	0.024	0.00	0.11	0.14	0.8	0.6	29.5	1553.1
9:30	14:30	House well	0.014	0.024	0.00	0.50	0.50	0.1	0.8	7.5	117.2
9:30	14:30	House well, duplicate	0.014	0.020	0.04	0.50	0.49	0.3	0.7	ND	ND
9:47	14:30	Culvert	0.009	0.020	0.00	0.48	0.54	2.1	1.1	44.3	517.2
4/4/2014	**4/4/2014**	**Storm flow**									
9:07	12:19	Spring	0.014	0.052	0.02	0.39	0.59	3.9	4.9	N.D.	**N.D.**
9:40	12:19	Upstream farm	0.012	0.056	0.05	0.11	0.19	3.3	2.3	N.D.	**N.D.**
9:30	12:19	Upstream barn	0.013	0.044	0.04	0.08	0.21	5.2	2.6	N.D.	**N.D.**
10:08	12:19	Downstream farm	0.016	0.052	0.05	0.16	0.32	6.3	2.7	N.D.	**N.D.**
9:50	12:19	Culvert	0.026	0.262	0.46	0.85	2.36	908.8	6.5	N.D.	**N.D.**
4/3/2014, 4:04	12:19	Field 1	0.181	0.638	0.25	0.11	2.08	207.0	14.7	N.D.	**N.D.**
4/8/2014	**4/8/2014**	**Storm flow**									
9:15	15:24	Spring	0.016	0.018	0.00	0.53	0.59	0.7	4.7	74.9	488.4

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:25	15:24	Upstream farm	0.012	0.026	0.02	0.09	0.13	0.8	1.4	110.6	1299.7
9:58	15:24	Upstream barn	0.012	0.024	0.02	0.10	0.16	2.1	1.2	179.3	1299.7
9:05	15:24	Downstream farm	0.014	0.024	0.03	0.17	0.23	2.2	1.5	155.3	1413.6
10:15	15:24	Culvert	0.011	0.022	0.04	0.47	0.53	2.5	2.7	70.8	770.1
4/14/2014	**4/14/2014**	**Storm flow**									
9:47	13:57	Spring	0.006	0.038	0.01	0.43	0.54	0.9	4.4	172.2	>2419.2
11:17	13:57	Upstream farm	0.005	0.034	0.04	0.10	0.17	3.7	2.1	387.3	3090.0
10:38	13:57	Upstream barn	0.009	0.040	0.06	0.11	0.19	5.0	3.1	517.2	2980.0
9:35	13:57	Downstream farm	0.007	0.050	0.08	0.14	0.25	8.7	3.1	613.1	5210.0
4/13/2014, 9:57	13:57	Culvert, ISCO	0.003	0.016	0.00	0.46	0.49	4.7	1.8	8.5	195.6
10:50	13:57	Culvert	0.007	0.032	0.03	0.48	0.56	1.9	2.0	547.5	4320.0
4/22/2014	**4/22/2014**	**Base flow**									
9:40	13:57	Spring	0.013	0.020	0.00	0.59	0.66	1.7	0.9	11.0	>2419.2
10:21	13:57	Upstream farm	0.074	0.888	0.00	0.00	0.09	1.2	0.5	126.6	1203.3
10:10	13:57	Upstream barn	0.009	0.022	0.01	0.09	0.10	0.8	0.5	95.9	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
9:25	13:57	Downstream farm	0.020	0.024	0.01	0.13	0.17	1.6	0.6	66.3	>2419.2
11:00	13:57	House well	0.008	0.022	0.00	0.49	0.55	0.3	0.0	9.8	770.1
10:47	13:57	Culvert	0.004	0.012	0.00	0.45	0.50	1.0	0.0	47.9	>2419.2
5/1/2014	**5/1/2014**	**Base flow**									
10:09	13:05	Spring	0.007	0.012	0.00	0.51	0.57	1.4	1.0	52.1	1986.3
10:29	13:05	Upstream farm	0.006	0.018	0.00	0.07	0.09	1.9	1.0	96.0	3050.0
10:19	13:05	Upstream barn	0.007	0.014	0.04	0.10	0.10	2.2	0.4	73.8	4310.0
9:58	13:05	Downstream farm	0.007	0.008	0.05	0.12	0.11	1.5	0.9	62.4	3990.0
10:49	13:05	House well	0.012	0.012	0.08	0.47	0.52	0.7	0.5	<1	116.9
10:44	13:05	Culvert	0.005	0.010	0.00	0.45	0.50	1.5	0.6	90.5	4790.0
5/8/2014	**5/8/2014**	**Base flow**									
13:00	15:32	Spring	0.009	0.020	0.00	0.39	0.48	11.1	1.0	8.6	5560.0
12:45	15:32	Upstream farm	0.013	0.020	0.06	0.09	0.09	1.2	0.9	57.3	5120.0
12:53	15:32	Upstream barn	0.008	0.016	0.01	0.12	0.14	1.4	0.9	34.1	5760.0
13:13	15:32	Downstream farm	0.008	0.028	0.03	0.16	0.55	4.7	1.0	19.9	14760.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:34	15:32	House well	0.008	0.010	0.18	0.44	0.68	0.3	1.4	<1	<1
5/9/2014	**5/9/2014**	**Storm flow**									
10:05	13:54	Spring	0.009	0.030	0.02	0.16	0.36	5.8	4.0	ND	ND
10:42	13:54	Upstream farm	0.008	0.030	0.00	0.07	0.10	1.5	0.7	ND	ND
11:22	13:54	Upstream barn	0.008	0.020	0.06	0.10	0.10	2.0	0.7	ND	ND
9:52	13:54	Downstream farm	0.008	0.018	0.00	0.15	0.17	2.1	0.6	ND	ND
5/8/2014, 13:54	13:54	Field 1	0.079	0.312	0.17	0.21	1.63	125.9	9.6	ND	ND
5/13/2014	**5/13/2014**	**Storm flow**									
9:33	13:15	Spring	0.008	0.062	0.06	0.25	0.45	3.8	4.3	435.2	7280.0
10:38	13:15	Upstream farm	0.008	0.062	0.00	0.10	0.23	10.1	2.9	920.8	13130.0
10:05	13:15	Upstream barn	0.008	0.074	0.06	0.11	0.30	11.8	5.7	1046.2	15290.0
9:22	13:15	Downstream farm	0.010	0.086	0.07	0.13	0.38	19.4	5.6	1553.1	29090.0
10:13	13:15	House well	0.008	0.020	0.06	0.46	0.49	0.5	0.5	<1	18.9
10:20	13:15	Culvert	0.007	0.060	0.12	0.51	0.70	5.1	2.6	307.6	10760.0
5/12/2014, 16:26	13:15	Field 1	0.190	0.366	0.10	0.13	1.33	42.1	10.2	ND	ND

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
5/19/2014	**5/19/2014**	**Base flow**									
13:17	15:38	Spring	0.007	0.018	0.00	0.64	0.70	3.7	0.8	27.5	>2419.2
12:11	15:38	Upstream farm	0.006	0.024	0.05	0.10	0.16	1.9	0.5	133.3	2419.2
13:10	15:38	Upstream barn	0.008	0.020	0.00	0.00	0.10	1.5	0.5	95.9	4710.0
13:30	15:38	Downstream farm	0.008	0.018	0.00	0.11	0.14	2.0	0.3	53.7	4220.0
12:46	15:38	House well	0.011	0.016	0.03	0.49	0.49	0.2	0.4	11.0	123.6
12:41	15:38	Culvert	0.008	0.020	0.08	0.52	0.55	0.8	0.3	204.6	5940

N.D. is No Data. On March 10, 2014 Dissolved Organic Carbon measurement was initiated in all collected water samples.

The water quality data in Table 2 for the monitored spring and Big Creek above and below the boundary of the permitted fields of the C&H Farm only is given in Table 3.

Table 3. Water quality analyses at the spring and in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application fields (see Figure 13).

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
	---------- mg/L ----------							-- MPN/100 mL --	
9/12/2013 Base flow									
Upstream	0.016	0.030	0.06	0.37	0.50	3.0	N.D.	6	>2420
Downstream	0.010	0.022	0.04	0.40	0.62	1.7	N.D.	16	>2420
9/20/2013 Base flow								N.D.	
Spring	0.006	0.020	0.03	0.38	0.50	4.7	N.D.	73	5040
Upstream	0.009	0.022	0.03	0.25	0.36	1.1	N.D.	81	9870
Downstream	0.013	0.022	0.05	0.44	0.53	1.1	N.D.	548	17230
9/24/2013 Base flow									
Spring	0.004	0.024	0.00	0.12	0.35	50.0	N.D.	9	>2420
Upstream	0.021	0.140	0.03	0.44	2.20	17.9	N.D.	39	1120
Downstream	0.007	0.028	0.01	0.51	0.58	1.5	N.D.	5	>2420
10/1/2013 Base flow									
Spring	0.001	0.162	0.00	0.11	0.41	89.2	N.D.	4	920.8
Upstream	0.011	0.038	0.02	0.24	0.34	2.2	N.D.	8	1300

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
Downstream	0.009	0.034	0.02	0.51	0.65	3.6	N.D.	2620	10810
10/9/2013 Base flow									
Spring	0.011	0.054	0.00	0.09	0.28	29.1	N.D.	3	1413.6
Upstream	0.016	0.034	0.00	0.50	0.73	7.1	N.D.	11	2419.6
Downstream	0.006	0.038	0.00	0.62	0.77	13.6	N.D.	28	3450.0
10/15/2013 Storm flow									
Spring	0.010	0.250	0.15	0.09	0.58	66.9	N.D.	1401	19863.0
Upstream	0.018	0.026	0.00	1.02	1.03	1.1	N.D.	759	>2419.6
Downstream	0.067	0.316	0.20	0.68	1.07	101.1	N.D.	1334	19863.0
10/22/2013 Base flow									
Spring	0.005	0.086	0.10	0.31	0.53	36.4	N.D.	1733	>2419.6
Upstream	0.014	0.034	0.00	0.35	0.32	0.3	N.D.	186	299.0
Downstream	0.012	0.020	0.04	0.72	0.76	0.7	N.D.	87	292.0
10/31/2013 Base flow									
Spring	0.003	0.404	0.14	0.32	1.02	400.9	N.D.	91	32550.0
Upstream	0.012	0.032	0.00	0.24	0.32	1.1	N.D.	66	1986.3
Downstream	0.012	0.024	0.03	0.44	0.45	1.4	N.D.	Leaked	Leaked
11/6/2013 Base flow									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
Spring	0.013	0.130	0.10	0.06	0.72	21.2	N.D.	8570	34480.0
Upstream	0.032	0.074	0.03	0.43	0.61	4.7	N.D.	4080	28510.0
Downstream	0.041	0.154	0.12	0.29	0.60	28.4	N.D.	3500	43520.0
11/12/2013 Base flow									
Spring	0.006	0.022	0.05	2.45	2.61	8.90	N.D.	48	2750.0
Upstream	0.011	0.010	0.00	0.16	0.22	1.00	N.D.	45	1986.3
Downstream	0.011	0.010	0.00	0.24	0.31	0.0	N.D.	24	>2419.2
11/19/2013 Base flow									
Spring	0.007	0.022	0.02	3.06	3.06	4.4	N.D.	579	9880.0
Upstream	0.010	0.026	0.00	0.12	0.22	0.7	N.D.	435	2400.0
Downstream	0.009	0.024	0.02	0.17	0.28	1.0	N.D.	194	4410.0
11/26/2013 Base flow									
Spring	0.007	0.018	0.00	1.69	1.70	4.5	N.D.	86	1553.1
Upstream	0.013	0.018	0.00	0.14	0.14	0.4	N.D.	77	1203.3
Downstream	0.013	0.016	0.00	0.23	0.24	1.2	N.D.	36	2419.2
12/3/2013 Base flow									
Spring	0.007	0.046	0.04	1.05	1.37	26.9	N.D.	25	1986.3
Upstream	0.007	0.012	0.00	0.15	0.25	0.5	N.D.	27	435.2

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
Downstream	0.006	0.012	0.00	0.23	0.28	0.5	N.D.	12	>2419.2
12/17/2013 After snow melt									
Spring	0.007	0.042	0.05	0.37	0.65	2.0	N.D.	248.1	2419.2
Upstream	0.010	0.036	0.06	0.18	0.27	1.2	N.D.	248.1	2419.2
Downstream	0.008	0.032	0.00	0.33	0.43	2.1	N.D.	148.3	>2419.2
PROCEEDING SAMPLES COLLECTED DURING SECOND QUARTER									
1/2/2014 Base flow									
Spring	0.006	0.024	0.05	3.35	3.24	0.5	N.D.	ND	ND
Upstream	0.009	0.022	0.01	0.22	0.25	0.7	N.D.	ND	ND
Downstream	0.012	0.036	0.00	0.49	0.54	0.8	N.D.	ND	ND
1/7/2014 Base flow									
Spring	0.008	0.024	0.00	2.36	2.32	1.3	N.D.	20.9	1413.6
Upstream	0.014	0.022	0.02	0.20	0.27	0.8	N.D.	66.3	307.6
Downstream	0.015	0.028	0.00	0.41	0.46	0.2	N.D.	18.3	325.5
1/14/2014 Base flow									
Spring	0.010	0.042	0.00	1.97	2.09	2.3	N.D.	24.3	1732.9
Upstream	0.008	0.028	0.01	0.16	0.25	0.3	N.D.	151.5	980.4
Downstream	0.008	0.026	0.05	0.31	0.39	0.5	N.D.	95.9	1299.7

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
1/21/2014 Base flow									
Spring	0.008	0.006	0.02	2.11	2.10	0.9	N.D.	5.2	613.1
Upstream	0.009	0.010	0.00	0.13	0.22	0.0	N.D.	55.7	290.9
Downstream	0.010	0.014	0.01	0.30	0.36	0.5	N.D.	131.3	410.6
1/29/2014 Base flow									
Spring	0.009	0.024	0.00	0.85	0.86	1.4	N.D.	3.1	325.5
Upstream	0.007	0.028	0.00	0.13	0.15	0.6	N.D.	10.9	248.1
Downstream	0.007	0.024	0.00	0.28	0.28	0.0	N.D.	<1	275.0
2/13/2014 Base flow									
Spring	0.009	0.024	0.00	0.65	0.73	5.1	N.D.	<1	461.1
Upstream	0.009	0.016	0.00	0.11	0.15	0.9	N.D.	68.9	238.2
Downstream	0.009	0.014	0.00	0.24	0.28	0.4	N.D.	9.8	290.9
2/19/2014 Base flow									
Spring	0.006	0.020	0.02	0.57	0.62	0.8	N.D.	1.0	365.4
Upstream	0.008	0.018	0.00	0.05	0.10	0.4	N.D.	111.9	325.5
Downstream	0.007	0.016	0.00	0.11	0.17	0.3	N.D.	8.5	272.3
2/27/14 Base flow									
Spring	0.007	0.106	0.06	0.59	0.82	70	N.D.	<1	307.6

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
Upstream	0.008	0.022	0.02	0.07	0.22	2.1	N.D.	29.5	209.8
Downstream	0.007	0.014	0.00	0.11	0.16	0.6	N.D.	2.00	547.5
3/10/2014 Base flow/After snow melt									
Spring	0.006	0.048	0.02	0.37	0.53	19.9	3.8	6.3	517.2
Upstream	0.005	0.026	0.06	0.09	0.12	0.9	1.4	52.1	275.5
Downstream	0.004	0.026	0.04	0.12	0.21	6.1	1.2	27.8	579.4
3/18/2014 Storm flow									
Spring	0.011	0.026	0.00	0.90	0.99	1.7	2.5	21.1	>2419.2
Upstream	0.010	0.038	0.08	0.19	0.24	2.1	1.2	50.4	435.2
Downstream	0.014	0.040	0.06	0.32	0.38	3.4	1.7	78.8	866.4
3/26/2014 Base flow									
Spring	0.010	0.026	0.01	1.00	1.13	3.0	1.4	8.4	980.4
Upstream	0.010	0.024	0.00	0.12	0.19	0.6	0.8	43.5	517.2
Downstream	0.011	0.026	0.00	0.25	0.30	1.2	0.7	21.8	866.4
3/29/2014 Storm flow									
Spring	0.006	0.044	0.00	0.29	0.51	3.3	8.1	ND	ND
Upstream	0.006	0.042	0.06	0.07	0.14	2.1	2.1	ND	ND
Downstream	0.008	0.038	0.00	0.13	0.19	2.5	2.2	ND	ND

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
PROCEEDING SAMPLES COLLECTED DURING THIRD QUARTER									
4/2/2014 Base flow									
Spring	0.011	0.020	0.00	0.60	0.67	0.6	2.1	3.10	307.6
Upstream	0.011	0.026	0.00	0.05	0.09	1.0	0.5	60.5	613.1
Downstream	0.010	0.024	0.00	0.11	0.14	0.8	0.6	29.5	1553.1
4/4/2014 Storm flow									
Spring	0.014	0.052	0.02	0.39	0.59	3.9	4.9	ND	ND
Upstream	0.012	0.056	0.05	0.11	0.19	3.3	2.3	ND	ND
Downstream	0.016	0.052	0.05	0.16	0.32	6.3	2.7	ND	ND
4/8/2014 Storm flow									
Spring	0.016	0.018	0.00	0.53	0.59	0.7	4.7	74.9	488.4
Upstream	0.012	0.026	0.02	0.09	0.13	0.8	1.4	110.6	1299.7
Downstream	0.014	0.024	0.03	0.17	0.23	2.2	1.5	155.3	1413.6
4/14/2014 Storm flow									
Spring	0.006	0.038	0.01	0.43	0.54	0.9	4.4	172.2	>2419.2
Upstream	0.005	0.034	0.04	0.10	0.17	3.7	2.1	387.3	3090.0
Downstream	0.007	0.050	0.08	0.14	0.25	8.7	3.1	613.1	5210.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
4/22/2014 Base flow									
Spring	0.013	0.020	0.00	0.59	0.66	1.7	0.9	11.0	>2419.2
Upstream	0.074	0.888	0.00	0.00	0.09	1.2	0.5	126.6	1203.3
Downstream	0.020	0.024	0.01	0.13	0.17	1.6	0.6	66.3	>2419.2
5/1/2014 Base flow									
Spring	0.007	0.012	0.00	0.51	0.57	1.4	1.0	52.1	1986.3
Upstream	0.006	0.018	0.00	0.07	0.09	1.9	1.0	96.0	3050.0
Downstream	0.007	0.008	0.05	0.12	0.11	1.5	0.9	62.4	3990.0
5/8/2014 Base flow									
Spring	0.009	0.020	0.00	0.39	0.48	11.1	1.0	8.6	5560.0
Upstream	0.013	0.020	0.06	0.09	0.09	1.2	0.9	57.3	5120.0
Downstream	0.008	0.028	0.03	0.16	0.55	4.7	1.0	19.9	14760.0
5/9/2014 Storm flow									
Spring	0.009	0.030	0.02	0.16	0.36	5.8	4.0	ND	ND
Upstream	0.008	0.030	0.00	0.07	0.10	1.5	0.7	ND	ND
Downstream	0.008	0.018	0.00	0.15	0.17	2.1	0.6	ND	ND

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
5/13/2014 Storm flow									
Spring	0.008	0.062	0.06	0.25	0.45	3.8	4.3	435.2	7280.0
Upstream	0.008	0.062	0.00	0.10	0.23	10.1	2.9	920.8	13130.0
Downstream	0.010	0.086	0.07	0.13	0.38	19.4	5.6	1553.1	29090.0
5/19/2014 Base flow									
Spring	0.007	0.018	0.00	0.64	0.70	3.7	0.8	27.5	>2419.2
Upstream	0.006	0.024	0.05	0.10	0.16	1.9	0.5	133.3	2419.2
Downstream	0.008	0.018	0.00	0.11	0.14	2.0	0.3	53.7	4220.0

N.D. is No Data. On March 10, 2014 Dissolved Organic Carbon measurement was initiated in all collected water samples.

Table 4. Water quality analyses at the culvert draining the subwatershed containing the production houses and manure holding ponds, the well adjacent to the ponds, and surface runoff from Field 1 (see Figure 13).

Date & time sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E_ coli	Total coliform
	---------- mg/L ----------							--- MPN/100 mL ---	
Culvert									
3/18/2014	0.009	0.028	0.05	0.64	0.63	1.0	0.7	19.3	365.4
3/26/2014	0.007	0.028	0.00	0.61	0.62	11.0	1.2	260.2	>2419.2
3/29/2014	0.004	0.042	0.00	0.69	0.81	3.3	4.9	ND	ND
4/2/2014	0.009	0.020	0.00	0.48	0.54	2.1	1.1	44.3	517.2
4/4/2014	0.026	0.262	0.46	0.85	2.36	908.8	6.5	ND	ND
4/8/2014	0.011	0.022	0.04	0.47	0.53	2.5	2.7	70.8	770.1
4/13/2014	0.003	0.016	0.00	0.46	0.49	4.7	1.8	8.5	195.6
4/13/2014	0.007	0.032	0.03	0.48	0.56	1.9	2.0	547.5	4320.0
4/22/2014	0.004	0.012	0.00	0.45	0.50	1.0	0.0	47.9	>2419.2
5/1/2014	0.005	0.010	0.00	0.45	0.50	1.5	0.6	90.5	4790.0
5/12/2014	0.010	0.290	0.61	0.94	2.33	847.6	4.7	ND	ND
5/13/2014	0.007	0.060	0.12	0.51	0.70	5.1	2.6	307.6	10760.0
5/19/2014	0.008	0.020	0.08	0.52	0.55	0.8	0.3	204.6	5940

Date & time sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E_ coli	Total coliform
House well									
4/2/2014	0.014	0.024	0.00	0.50	0.50	0.1	0.8	7.5	117.2
4/2/2014	0.014	0.020	0.04	0.50	0.49	0.3	0.7	ND	ND
4/22/2014	0.008	0.022	0.00	0.49	0.55	0.3	0.0	9.8	770.1
5/1/2014	0.012	0.012	0.08	0.47	0.52	0.7	0.5	<1	116.9
5/8/2014	0.008	0.010	0.18	0.44	0.68	0.3	1.4	<1	<1
5/13/2014	0.008	0.020	0.06	0.46	0.49	0.5	0.5	<1	18.9
5/19/2014	0.011	0.016	0.03	0.49	0.49	0.2	0.4	11.0	123.6
Field 1									
4/3/2014	0.181	0.638	0.25	0.11	2.08	207.0	14.7	ND	ND
5/8/2014	0.079	0.312	0.17	0.21	1.63	125.9	9.6	ND	ND
5/12/2014	0.190	0.366	0.10	0.13	1.33	42.1	10.2	ND	ND

N.D. is No Data. On March 10, 2014 Dissolved Organic Carbon measurement was initiated in all collected water samples.

Future Plan of Work

1. Complete installation of automatic water sampling equipment on Big Creek upstream of the C&H Farm. This is being done in partnership with USGS, who have installed a downstream real-time flow and nitrate monitoring, which is available on the web.
2. Conduct electrical resistivity analysis on application fields to determine the potential for subsurface areas of preferential flow pathways.
3. Continue to collect runoff, spring, and stream samples after each rainfall event from the autosamplers and manually collect baseflow samples every two weeks from the well, spring, and streams, for analysis of N, P, sediment, and bacteria (E. coli and total coliform from baseflow grab samples).
4. Collect water samples from the piezometers installed in Fields 5a and 12.
5. Install a subsurface flow collector trench immediately downslope of the manure holding ponds, which will routinely samples for analysis of N, P, sediment, and bacteria (E. coli and total coliform). In addition, an inventory of karst seeps or springs immediately down slope of the storage ponds will be conducted. These karst features represent natural emergence points where integration of flow occurs and will offer additional sampling points for detecting potential leakage.
6. Conduct dye-tracer tests on the C&H Farm in cooperation with USGS Geologists with experience and training in conducting dye-tracer tests.
7. Monitor flow, nutrients and sediment in Dry Creek entering Big Creek. See Figure 28 for location of Dry Creek.
8. Periodically determine plant uptake by collecting plant and hay samples for tissue analysis and determine yield (dry-matter mass for a pre-determined area).
9. Determine nutrient application rate by determining nutrient content of swine effluent before land application via manure application and determine volume of effluent being applied to known monitoring area.

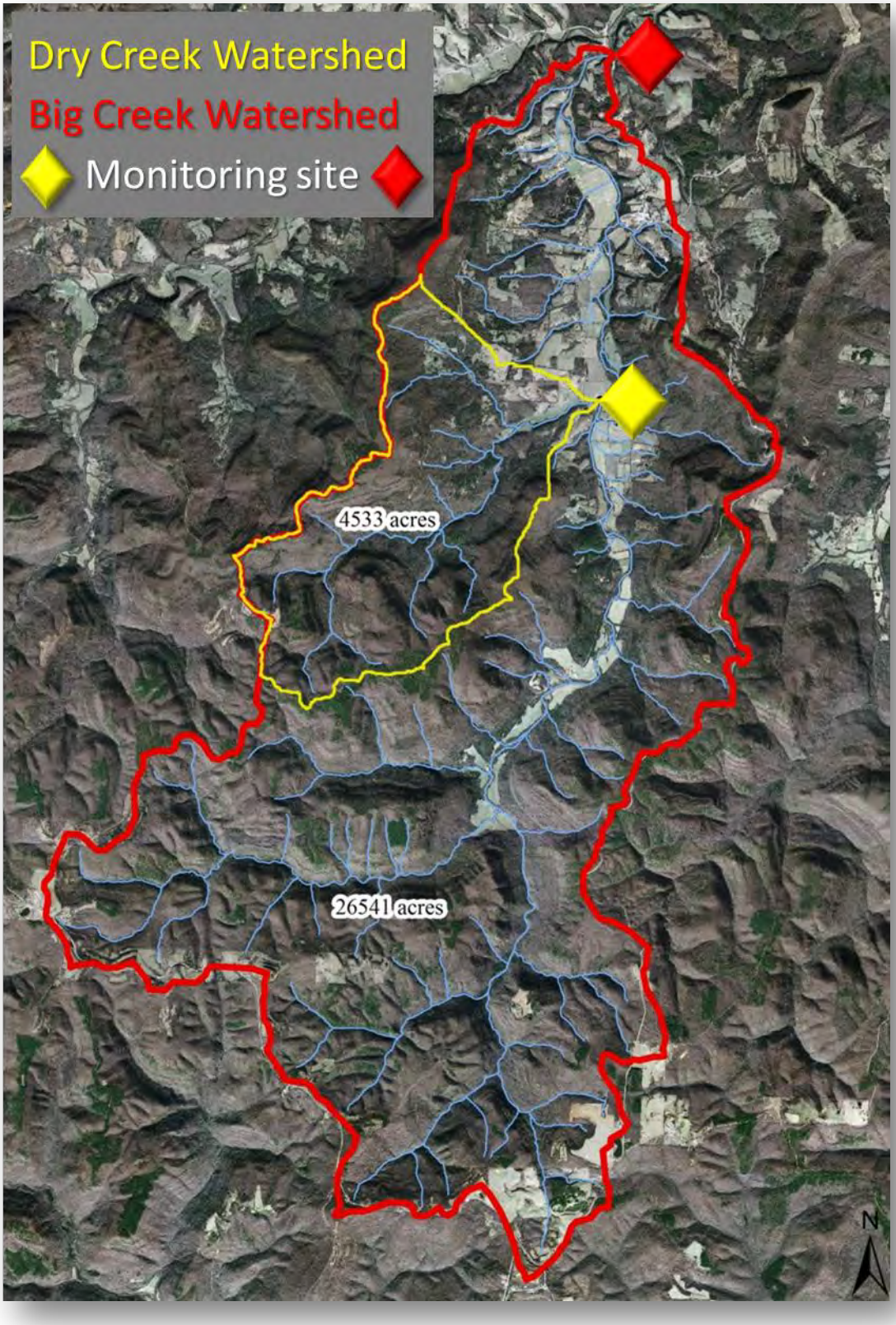


Figure 28. Location of Dry creek Watershed with the Big Creek Watershed.

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Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – July 1 to September 30, 2014

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

The mission of the **Division of Agriculture** is to advance the stewardship of natural resources and the environment, cultivate the improvement of agriculture and agribusiness, develop leadership skills and productive citizenship among youth and adults, enhance economic security and financial responsibility among the citizens of the state, ensure a safe, nutritious food supply, improve the quality of life in communities across Arkansas, and strengthen Arkansas families.

Dr. Mark J. Cochran
Vice President for Agriculture

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Executive Summary

This is the fourth Quarterly Report of the Big Creek Research and Extension Team that details the following progress made from July 1 through September 30, 2014.

1. Comments of the Expert Review Panel that took place in late spring were received and a response to their comments developed.
2. A Big Creek Summit was held on September 11, 2014, at the Pauline Whitaker Center, University of Arkansas. All involved in research and monitoring on the Big Creek were present including Dr. Van Brahana – retired Geosciences University of Arkansas, Faron Usrey – Park Service, Victor Roland – Geosciences University of Arkansas, USGS scientists, and BCRET Division of Agriculture members.
3. A trench was installed downslope of the manure holding ponds to monitor potential leakage from the holding ponds.
4. Sampling of Big Creek continued every week above and below the C&H Farm, a well adjacent to the production houses, a subwatershed draining the production area, surface runoff from Fields 1, 5a, and 12, and a spring below Field 1.
5. Continuous flow and storm sampling at the upstream and downstream sites continued during the quarter, in collaboration with USGS. The downstream site is providing real-time, on-line stream discharge, nitrate concentrations, water temperature, and rainfall data.
6. Hog barn wash-water contribution to manure volume was calculated as background information for the potential manure management options. A topographic elevation survey of the holding ponds and surrounding drainage area was conducted to determine the as-built volumes of the holding ponds and the precipitation catchment area of the ponds.

Big Creek Research Team

Faculty

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Rick Cartwright, Ph.D., Professor – Associate Director of Extension for Agriculture and Natural Resources

Mark Cochran, Ph.D., – Vice President, University of Arkansas System Division of Agriculture.

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Ed Gbur, Ph.D., Professor and Director, Agricultural Statistics Laboratory - Experimental design, linear and generalized linear mixed models, regression, agricultural applications of statistics.

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Phil Hays, Ph.D. Ground Water Specialist, U.S. Geological Survey and Research Professor with Geosciences Dept., University of Arkansas, application of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems

Tim Kresse, M.Sc., Water Quality Specialist, U.S. Geological Survey, natural geochemical evolution of groundwater and separating these processes from anthropogenic sources of contamination

Nathan McKinney, Ph.D., – Assistant Director, Agriculture Experiment Station

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Thad Scott, Ph.D., Assistant Professor - Water quality, transport of contaminants to and within water bodies

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Jun Zhu, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians

The Big Creek Research and Extension Team are ably supported by several excellent Program Technicians based in Little Rock and Fayetteville.

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Expert Panel Review of BCRET Project

Memoranda

Date: – May 19, 2014
From: – **Dr. Carl Bolster**, Agricultural Research Service, U.S. Department of Agriculture, Bowling Green, KY
– **Dr. Lee J. Florea, P.G.**, Department of Geological Sciences, Ball State University, Muncie, IN
– **Dr. Martin J. Shipitalo**, Agricultural Research Service, U.S. Department of Agriculture, Ames, IA
– **Mr. Mark Rice**, Department of Biological and Agricultural Engineering, North Carolina State University, Raleigh, NC
To: – **Dr. Mark J. Cochran**, Vice President for Agriculture, University of Arkansas, Little Rock, AR
Re: – Report from Expert Panel – C&H Farms Research Project

Dear Dr. Cochran,

It was our pleasure to meet you and spend a few days in Fayetteville at the end of April. We certainly hope that our visit was productive for your team and that the report below provides a constructive review of the research underway at C&H Farms and the surrounding environs of Mt. Judea in Newton County, AR. We are cognizant of the important and sensitive nature of this research to the University, the State, stakeholder agencies and organizations, and the citizens of Newton County including the owners of C&H Farms. Therefore, the scope of the Panel and the content of this report do not include opinion or endorsement for or against the operation of the farm, the permitting process, or the origin of funding for this research. Rather, this report includes the recommendations and opinions of the Panel with regard to the strengths and challenges of current and planned activities associated with this research project.

Scope of investigations

On April 28 to May 1, 2014 the four-member Panel met to review the current and planned monitoring program associated with the C&H Hog Farm operation in Mt. Judea, Arkansas. Panel members were selected for their expertise in surface hydrology and groundwater hydrogeology (Bolster), cave and karst science (Florea), soil use and management (Shipitalo), and swine animal and manure management (Rice). The Panel met with members of the Big Creek Research Team (herein referred to as the 'Team'), University of Arkansas Administration, the manager of C&H Farms, and spent one day touring the farm and the proposed and current monitoring locations.

The Panel spent April 29 in the field and visited key sites such as the swine waste ponds at the C&H facility, ephemeral and perennial surface waterways draining into Big Creek, and several karst features in the watershed including sinkholes and springs. Panel members also visited instrumented sites surrounding the facility that are currently part of the Team's

monitoring efforts. On the second day, Panel members met with members of the Team and Administration to go over aspects of the monitoring plan.

Summary of Findings

The complexity of the landscape and the farming operation presents a challenging task for the Team. However, the unfettered access of the Team to facilities and some of the application sites surrounding of Mt Judea in the Big Creek watershed is a strong benefit. Overall, the Panel was pleased with the collaborative nature of the Team, which included a wide range of experts suited to study the impacts of agriculture upon water quality. The Panel was also encouraged by the Team's openness to suggestions for improving the research and monitoring plan. The decision to hire a full-time technician to oversee the monitoring locations and the samples collected from those locations was appropriate and a good use of available resources. Both the Team and Panel, however, recognized the need for the addition of a karst hydrogeologist to the Team. The Panel was encouraged to learn that additional resources, both in equipment and personnel (including a scientist trained in karst hydrogeology), were being solicited from other agencies such as the U.S. Geological Survey. The Panel recognizes that this monitoring plan will require a substantial effort from the Team, and may place a considerable strain on untenured faculty and other scientists with significant commitments to other projects.

A key aspect of the Panel's charge was to identify limitations of the current research and monitoring plan and to provide input on possible solutions or augmentations within budget and time limitations. Even with the best monitoring system there can be considerable lag time between a change in management and system response. Thus, it is highly unlikely that a one-year study will provide sufficient information to conclusively determine the impact that the farming operations at C&H farms have on the water draining into the Big Creek. This is compounded by the fact that limited data on water quality are available prior to the onset of the farming operations. Additionally, within the Big Creek watershed there are a number of other ongoing land management and land use activities that can impact water quality. This includes other farming operations, domestic and wild livestock, and residential and municipal sewage systems. Securing resources, perhaps from multiple sources, to continue the monitoring efforts beyond the initial year should be a priority for the Team leaders. Finally, extreme events are often the driver of hydrologic responses to environmental stressors and we recommend that more effort be directed at sample collection during high-flow events.

Within this context, the Panel recognized three major potential threats to water quality associated with C&H Farms. These include: 1) leakage from the two onsite waste storage ponds, 2) contamination of surface and subsurface water due to land application of the wastes, and 3) potential long-term buildup of soil nutrient levels (primarily soil phosphorus) due to application in excess of crop needs and removal. These are each described below. Included are challenges the Panel identified along with recommended solutions.

Potential leakage from the waste storage ponds. Currently a single surface water monitoring station is positioned down gradient from the ponds that is capable of sampling intermittent flow events. This should be kept in place. In addition, water usage is being measured in the confinement buildings. The Panel recommends that a short-term, detailed water balance study be conducted to determine the actual seepage rate of the storage ponds. This more robust approach would include a measure of all liquid inputs to the ponds, withdrawals from the ponds, the liquid levels of the ponds and evaporative losses. The results would allow for the calculation of actual seepage rate (within certain bounds) from the storage ponds for comparison to design specifications and standards. In addition, a total water balance approach will identify other potential losses of liquid in excess of that which can be attributable to evaporation and planned withdrawals, either for land application or barn flushing.

Adjacent to the housing complex there is a single water supply well. Given the information provided on well design, depth, and construction, combined with the available information on nearby soil borings, it is unlikely that the water in this well will be adversely affected by leakage from the storage ponds. Nevertheless, the Panel recommends that water quality samples continue to be collected from this well on a routine basis. In addition, the Panel recommends that the detailed well driller's log be obtained and that a slug test, pump test, or both be conducted on this well to determine characteristics of the aquifer from which water is drawn.

Team members should conduct a detailed walking survey of the slope down gradient from the waste ponds to identify potential seeps and springs from perched aquifers. These have some potential for impact by leakage from the ponds. If perched aquifers are noted based on the driller's log or by the identification of hillside seeps, one or more shallow monitoring wells should be installed to the depth of the perched aquifer within as short a distance as feasible from the storage ponds. If springs or seeps are noted on the hillside, these should be monitored on a routine basis to establish baselines and trends in water quality.

Effects of Land Application. The current plan has two components: 1) automated sampling and gauging of Big Creek at two sites—one upstream from all permitted C&H Farm activities and a second site downstream from all permitted activities, and 2) sampling of surface runoff and soil water within three fields where land application of wastes are currently planned. The Panel recognizes that the selection of monitoring sites is dictated in part by accessibility and landowner permission and thus may be less than ideal. We suggest the following be conducted as soon as possible.

- An inventory of the entire reach of Big Creek between the upstream and downstream sampling points with georeferenced notes made on any significant changes in water flow due to tributaries or major springs. This inventory should include karst features located within the contributing area.
- A detailed land use map that identifies all land uses within the contributing area of the watershed. This should include surveys of farmers to gauge land management practices,

with particular emphasis on animal stocking practices, fertilization, and manure applications.

- A seepage survey to include stream profile measurements and estimations of discharge. The stream survey should be repeated under high (if feasible), medium, and low flow conditions to capture the potential variability in groundwater recharge and discharge to the riparian zone, valley alluvium, and karst features (if present).
- Develop rating curves between water level and discharge at both the upstream and downstream sites.
- Conduct traces with multiple dyes. The first set of traces should be qualitative to identify the potential connections between points of recharge and discharge. Once established, quantitative traces should be conducted with both conservative and non-conservative dyes to establish travel times and dispersion characteristics. Results of the traces, for example from the sinkhole in Field #1 to the spring downslope, may help revise the area for manure application.

During our tour of the watershed the Panel took particular note of a significant tributary known as Dry Creek located shortly downstream of the upstream Big Creek monitoring site. The Dry Creek watershed includes an estimated 1/3 of the proposed land area approved for manure application from C&H Farms. An automated sampling and gauging station should be installed as close to the confluence with Big Creek if landowner permission can be secured. Monitoring of this additional site should help reduce some of the confounding influences of non-C&H land management practices that may contribute to loadings at the larger downstream sampling location.

Currently, surface runoff flumes have been or are being installed in three fields designated for manure application. Given the geomorphology of these sites, the composition of the soils, and the current land management practices (e.g., permanent grass cover) surface runoff may not be a major contributor to water quality concerns under normal rainfall conditions. Nevertheless, the Panel recognizes the need to monitor surface runoff and recommends that more emphasis be placed on a sampling protocol to better capture flow-weighted samples during runoff events. The potential for movement of contaminants to groundwater at these sites is currently being assessed using piezometers and shallow monitoring wells. Additionally, ground penetrating radar (GPR) transects were made to characterize the subsurface conditions that could potentially contribute to preferential flow of water and contaminants in these fields. While GPR may provide useful information on shallow subsurface characteristics, this technique does not provide meaningful information on potentially deeper flow paths. The Panel recommends that more sophisticated geophysical surveys (such as terrain conductivity and electrical resistivity tomography) be conducted, if feasible, to more fully characterize the subsurface environment in these fields in lieu of further GPR studies. If these procedures document significant subsurface features that can affect water flow, subsurface investigations (i.e., drilling) should be conducted to confirm these observations. Depending on the results of these studies, relocation of existing piezometers and shallow monitoring wells or installation of additional equipment should be

considered so that the potential impact of these features on subsurface water quality can be assessed.

Nutrient buildup. Detailed soil sampling has been conducted on a grid basis to characterize available soil P levels in the monitored manure application fields. This has provided useful information and should be repeated post-manure application. If buildup of soil P levels is noted, the results of the manure solids and liquid separation trials that are being conducted as part of the project may offer an opportunity to better match waste applications to specific crop and soil fertility needs. In general, the manure solids will have a lower N:P ratio than the liquid fraction. Ideally, the dryer solid fraction could be applied to fields where soil P levels are low or transported out of the watershed altogether. In light of C&H Farm's use of additives to enhance the function of the waste storage ponds, a regular sampling of storage ponds is important to understand the effects of the additives and to determine variability in nutrient concentrations.

Additional Analyses

As part of the review, the Panel considered whether the existing sampling protocol undertaken by the Team would sufficiently answer their primary monitoring and research goals. Depending on results from initial sample collections, interpretations of those data by the Team, and available funding, we recommend the Team consider adopting some or all of the following:

Source tracking of nutrients and bacteria. While this is time consuming and can be prohibitively expensive to conduct on a routine basis, if elevated contaminant levels are noted at the downstream site relative to the upstream monitoring locations, source tracking using isotopic or PCR methods may provide additional information needed to establish whether activities associated with C&H are a contributing factor.

Supplemental chemical parameters. Studying watershed hydrology and geochemistry is regularly enhanced by combining a multi-parameter approach. For example, the use of multiple water quality parameters may provide additional information on flow paths, residence times, and sources that may otherwise be difficult to interpret on limited sources of data. Therefore, the Panel recommends that the Team consider, if practical, the following additional analytes:

- Principal ions
- Alkalinity
- Appropriate trace metals
- Environmental isotopes (including C/N ratios)
- Ammonia, Nitrite, and Nitrate fractions of total N
- Emerging contaminants (caffeine, hormones, antibiotics, etc.)

Storm event sampling. Wide-ranging studies of watershed processes and contaminant transport demonstrate the importance of storm events. In this particular investigation, the transport of waste offsite may be strongly correlated to periods of overland flow on application fields. While the Panel is encouraged to see instrumentation specifically designed to capture this

overland flow, it would be beneficial to capture more than a single composite sample, particularly for long lasting storms.

In summary, the Panel was impressed with the progress made thus far and was encouraged by the collaborative environment fostered by the Team leaders. Monitoring activities thus far are important, but perhaps not fully adequate in scope and duration to address the long-term potential for impacts to the quality of surface and groundwater resources. It is our hope that the above recommendations in this report may be of benefit to you and your team when developing future monitoring and research activities. We submit this report in the spirit of helpfulness, and thank you for providing us the opportunity to review the project.

Sincerely,

- Carl Bolster

- Lee Florea

- Mark Rice

- Martin Shipitalo

Panel members

cc: Andrew Sharpley
Nathan McKinney

Expert Panel Review Response

Response to the Expert Panel Review of the BCRET Project

We greatly appreciate the Review Panel's time and effort spent reviewing our Big Creek Research and Extension Team's Project at Mt. Judea. Your visit to the sites, meeting with Project personnel, and preparing a detailed report has been very helpful to our project. A response to the comments and suggestions raised in your report is given below detailing how the Team will address them.

A. **Potential Leakage from the Waste Storage Ponds:** We agree that the potential for leakage of manure from the storage ponds needs to be closely monitored. To address this we will install a trench downslope of the storage ponds that will intercept any subsurface flow of leakage moving along a restricting or less permeable layer. See Figure 1 for site plans. Initial soil coring reveals a natural cherty layer about 48 inches deep in the profile. Digging a trench below this depth will enable more precise characterization of this, and any other relevant low-permeability features. Once identified, a metal plate will be positioned on the profile just below the preferential flow layer to ensure water is intercepted and collected in a perforated pipe, taking flow to a downslope sampling point. Depending on site conditions, it is envisaged that this trench will be approximately 30' to 40' long and 6' deep. The perforated pipe will be embedded in pea-sized gravel and the top foot of the trench backfilled with soil. This trench collection system has been widely used to monitor shallow subsurface flows in karst systems and USGS have successfully installed one locally in the past to monitor leakage from a swine lagoon. We feel this approach is more technically rigorous to detect and collect seepage than installing single-point wells downslope of the waste storage ponds. Installation will be complete by the end of July. An inventory of karst seeps or springs immediately down slope of the storage ponds will be conducted. These karst features represent natural emergence points where integration of flow occurs and will offer additional sampling points for detecting potential leakage.

B. **Pond Water Balance:** The panel recommended conducting a short-term detailed water balance of the storage ponds. Given precision limits for the various direct and indirect measurements needed to estimate the seepage loses and the fact that the ADEQ's design criteria is 5000 gal/ac/day which is the same as 0.0013 in/day, we are concerned that a detailed water balance determination is not appropriate at this time. Rather the trench collection system will be used to test soil water for indications that it is seeping from the ponds. If these results indicate the need they and a rough water balance based on precipitation and pumping records will be used to reassess the feasibility of a detailed measured water balance for the storage ponds.

C. **Effects of Land Application:**

(i) We plan to conduct a water quality inventory along the reach of Big Creek between up and downstream sampling points this summer and fall with sondes continually determining water temperature, pH, dissolved oxygen, and turbidity. At the same time, USGS Hydrogeologists will conduct a visual survey for any obvious springs along the near stream areas of Big Creek.

(ii) While a detailed land use surveys to determine field management practices in the Big Creek Watershed is a laudable recommendation, it is outside the scope of our "charge." Voluntary

participation in such as survey by farmers in the watershed would likely be minimal given the public scrutiny of the project and Arkansas's Freedom of Information requirements. However, an aerial land-use survey will be conducted in the main watershed to determine the areas under pasture and forest.

(iii) Seepage survey: we plan to conduct such a survey, led by the USGS Hydrogeologists on the Team and recruited University of Arkansas Geology students.

(iv) Rating curves for both up and downstream monitoring and water sampling locations are in development. This has been contracted to USGS.

(v) Tracer studies with multiple dyes will be conducted on known sink holes on permitted monitoring fields (i.e., Fields 1, 5a, and 12) and on the losing reach of Big Creek, while this will identify surface and subsurface flow connectivity, it does not relate to current manure management practices, which broadcast slurry to pastures.

D. **Dry Creek Monitoring:** Plans are underway to monitor flow and collect base and stream flow samples where Dry Creek enters Big Creek. Installation should be completed by the end of July. Dry Creek contains approximately 1/3 of the fields permitted to receive manure that are more distant from Big Creek but drain into Dry Creek and ultimately to Big Creek.

E. **Electrical Resistivity Measurements:** We do plan to contract with experts to conduct electrical resistivity measurements that can identify subsurface flow pathways with minimal surface disturbance, more accurately than ground penetrating radar already conducted. This is planned for before and after a manure application; ideally in the fall or spring when forage height is minimal.

F. **Nutrient Buildup:** The detailed grid-soil sampling (0.25 acre grid) will be conducted annually in late fall or early winter for each monitored permitted field (i.e., Fields 1, 5a, and 12).

G. **Bacterial Source, Isotope or PCR Tracking:** We agree that these methods are time consuming and prohibitively expensive, as well as being research tools that might qualify but not quantify sources, and we will consider them, along with the measurement of antibiotics and hormones, if and when elevated contaminant levels are found at a specific location.

H. **Supplemental Chemical Parameter Measurement:** Will be considered on an as-needed basis and with funding availability. A Master's Student has been enlisted to conduct a survey of the biological and nutrient status of several waters in the Buffalo River Watershed, including Big Creek at the downstream sampling station.

I. **Storm-Event Sampling:** Is now occurring at all water quality monitoring sites; Big Creek up and downstream of the C&H Farm, surface runoff from Fields 1, 5a, and 12, culvert draining the subwatershed draining the production houses and manure storage ponds. We collaborated with USGS to continuously monitor nitrate concentrations in Big Creek downstream of the C&H Farm.

Figure 1. Plan of possible site of seepage monitoring trench.

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BCRET Summit

A meeting was held September 11th, 2014, at the Pauline Whitaker Center for everyone conducting monitoring and research in Big Creek and Buffalo River Watersheds. Those present included Dr. Van Brahana – retired Geosciences University of Arkansas; Victor Roland – Geosciences University of Arkansas; Faron Usrey – Park Service; USGS scientists Jaysson Funkhouser, Tim Kresse, Phil Hays, and Billy Justus; and several BCRET Division of Agriculture members.

The meeting agenda included;

11:00 Welcome and Introductions
11:05 Presentations by each group active in the Big Creek Watershed
11:10 BCRET update – Andrew Sharpley and team
11:35 Dye-tracer studies - Van Brahana
12:30 Park Service – Faron Usrey
12 50 Discussion of monitoring efforts presented
13:30 Stream biology – Thad Scott and Ashley Rodman
13:50 Microcosm studies - Victor Roland
14:10 Discussion of biological assessment studies
14:30 USGS efforts: Biology – Billy Justus (15 minutes)
14:45 USGS efforts: Hydrology – Tim Kresse (15 minutes)
15:00 Open discussion
16:00 Future plans and collaborative efforts
16:30 Adjourn

The meeting adhered to the above agenda and everyone had sufficient time to present the results of their ongoing effort in the Big Creek and Buffalo River Watersheds. In addition, there was ample discussion of the information presented and how the combined efforts of the researchers complimented to larger goal of identifying and measuring any impacts of the C&H Farm operation on area water quality. All attendees agreed that the meeting was productive and would be interested in being involved in subsequent research meetings.

Manure Holding Pond Interceptor Trench Installation

To determine potential leaching of liquid from the manure holding ponds, an interceptor trench 200 feet in length was constructed approximately 150 feet downslope of the holding ponds. Any leakage from the ponds would initially move vertically, but horizontal flow will be induced at any permeability contrast in the subsurface. The trench was designed to intercept horizontal flow that would be induced over a low-permeability restricting layer existing at a soil depth of 4 feet that was identified during site evaluation. The trench was excavated to about 10 feet below the base of the holding ponds. The trench

was designed to drain to outlets at both ends, with a minimum design gradient of 0.25 inch/foot maintained from the high midpoint of the trench to each of the two outlets to ensure unimpeded flow.

The base of the interceptor trench was lined with impermeable plastic sheeting to capture all flow moving through trench walls into the trench. A 4-inch perforated pipe was laid on top of the plastic sheet and the trench filled with washed gravel to a depth of 2-3 feet below the soil surface. The remaining trench was then backfilled with compacted soil and seed and hay placed on the surface to encourage surface vegetation regrowth. The design will capture any flow moving horizontally into the trench, and direct flow for collection and transmittal to the outlets where flow rate can be measured and samples can be collected for water-quality analyses.

The trench approach was selected over a three-dimensional network of shallow observation and sampling wells located below the holding ponds due to the greater probability of the trench intercepting any seepage from the ponds. The continuous interception provided by the trench offers a greater probability of capturing any subsurface seepage as compared to a three dimensional grid of discontinuous point observations. Thus, the trench reduces the probability of by-pass flow of any seepage down slope of the ponds. Water exiting the interceptor trench pipe outlets is currently sampled by hand. We plan to instrument both pipes with flow monitoring and sonde to collect continuous flow and water-quality data.

Figure 1. Trench location adjacent to the manure holding ponds at the C&H Farm, Mt. Judea, Newton County.

Similar interceptor trenches have been installed worldwide and information can be found in the following publications;

Hobza, C.M. 2006. ground-water quality near a swine waste lagoon in a mantled karst terrane in Northwestern Arkansas. Master's Thesis. Geology, University of Arkansas, Fayetteville, AR. 81 pages.

Pilgrim, D.H., and D.D. Huff. 1978. A field evaluation of subsurface and surface runoff: I. Tracer studies. Journal of Hydrology, 38:29-318.

Pilgrim, D.H., and D.D. Huff. 1978. A field evaluation of subsurface and surface runoff: II. Runoff processes. Journal of Hydrology, 38:319-341.

Smettem, K.R.J., D.J. Chittleborough, B.G. Rishards, and F.W. Leaney. 1991. The influence of macropores on runoff generation from a hillslope soil with a contrasting textural class. Journal of Hydrology, 122:235-252.

Trudgill, S.T., A.M. Pickles, K.R.J. Smettem, and R.W. Crabtree. 1983. Soil water residence time and solute uptake: I. Dye tracing and rainfall events. Journal of Hydrology, 60:257-279.

Wagner, D. 2005. Applications of δ15N, δ18O of nitrate to waste storage effectiveness in mantled karst terrain, Northwestern Arkansas. Master's Thesis. Geology, University of Arkansas, Fayetteville, AR. 109 pages.

Weyman, D.R. 1974. Runoff processes, contributing area and streamflow in a small upland catchment. *In*: K.J. Gregory and D.E. Walling (Editors), Fluvial Processes in Instrumented Watersheds. British Institute of Geography, London, Spec. Publ., 6:33-43. London, United Kingdom.

Figure 2. Trench construction and interceptor pipe installation adjacent to the manure holding ponds at the C&H Farm, Mt. Judea, Newton County.

Water Sampling and Analyses

Sampling Locations

Since July 1 and reported in the 3rd Quarterly Report, installation of a trench below the manure holding pond was completed (Site 8) and samples of trench water discharge collected for analysis. Water quality monitoring sites are shown in Figure 3 and are;

Site 1. Edge-of-field monitoring on Field 1 permitted to receive slurry.

Site 2. Edge-of-field monitoring on Field 5a.

Site 3. Edge-of-field monitoring on Field 12 permitted to receive slurry.

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities.

Site 5. Spring below Field 1.

Site 6. Big Creek upstream of the C&H Farm operation.

Site 7. Big Creak downstream of the C&H Farm operation.

Site 8. Manure holding pond trench – Figures 1 and 2.

Sampling Protocols and Analyses

The following protocols were used to collect, prepare, and analyze all water samples;

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted and samples were placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
6. Analyses included Dissolved Phosphorus (EPA 365.2), Total Phosphorus (APHA 4500-P), Ammonia (EPA 351.2), Nitrate (EPA 300.0), Total Nitrogen (APHA 4500-N), Total Suspended Solids (EPA 160.2), E. coli (APHA 9223, B) and Total Coliforms (APHA 9223, B). APHA is American Public Health Association from the Wadeable Streams Assessment, Water Chemistry Laboratory Manual http://www.epa.gov/owow/monitoring/wsa/WRS_lab_manual.pdf
7. The minimum detection limits (MDLs) for each chemical and biological constituent measured are listed in Table 1.

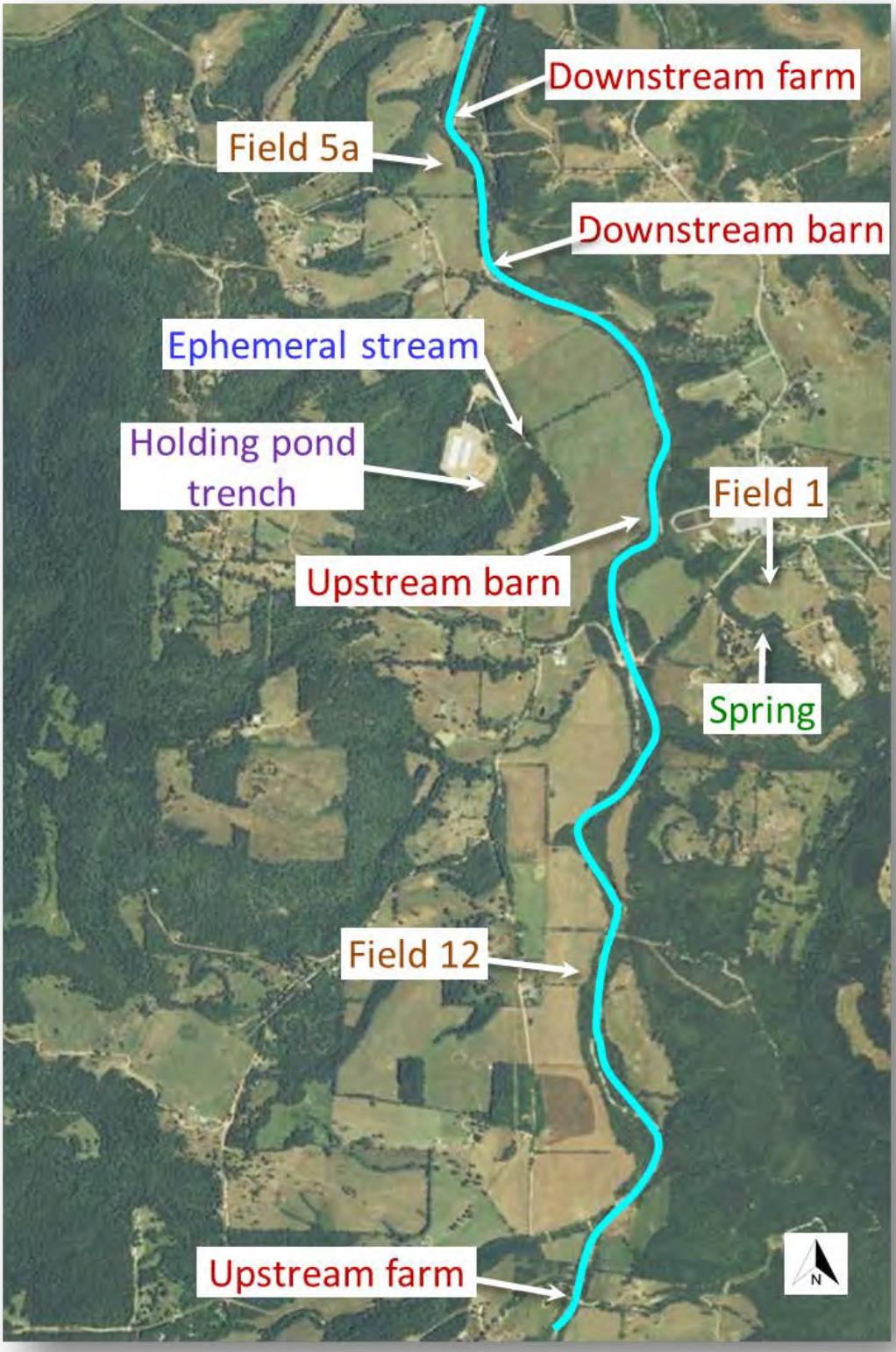

Figure 3. Location of water quality sampling sites on Big Creek and the C&H Farm.

The chemical composition of water samples collected prior to June 30, 2014, is listed in Tables 2, 3, and 4.

Table 1. Minimum detection limits (MDLs) for each chemical and biological constituent measured.

Constituent	Minimum detection limit
Dissolved P, mg L^{-1}	0.002
Total P, mg L^{-1}	0.012
Nitrate-N, mg L^{-1}	0.004
Ammonium-N, mg L^{-1}	0.027
Total N, mg L^{-1}	0.006
Total suspended solids, mg L^{-1}	6.58
Dissolved organic carbon, mg L^{-1}	0.18
E. coli, MPN 100 mL^{-1}	1
Total coliform, MPN 100 mL^{-1}	1

USGS Stations

Big Creek Continuous Flow

We are collaborating with USGS, Big Creek at the downstream site of prior water sample collection was instrumented with continuous flow gaging equipment and a nitrate sensor, which provides real-time flow, water temperature, water nitrate and precipitation data. These data are available on-line at the following site. Flow and nitrate for from the USGS downstream site is given in Figures 4 and 5.

USGS 07055790 Big Creek near Mt. Judea, AR

http://nwis.waterdata.usgs.gov/ar/nwis/uv/?site_no=07055790&agency_cd=USGS

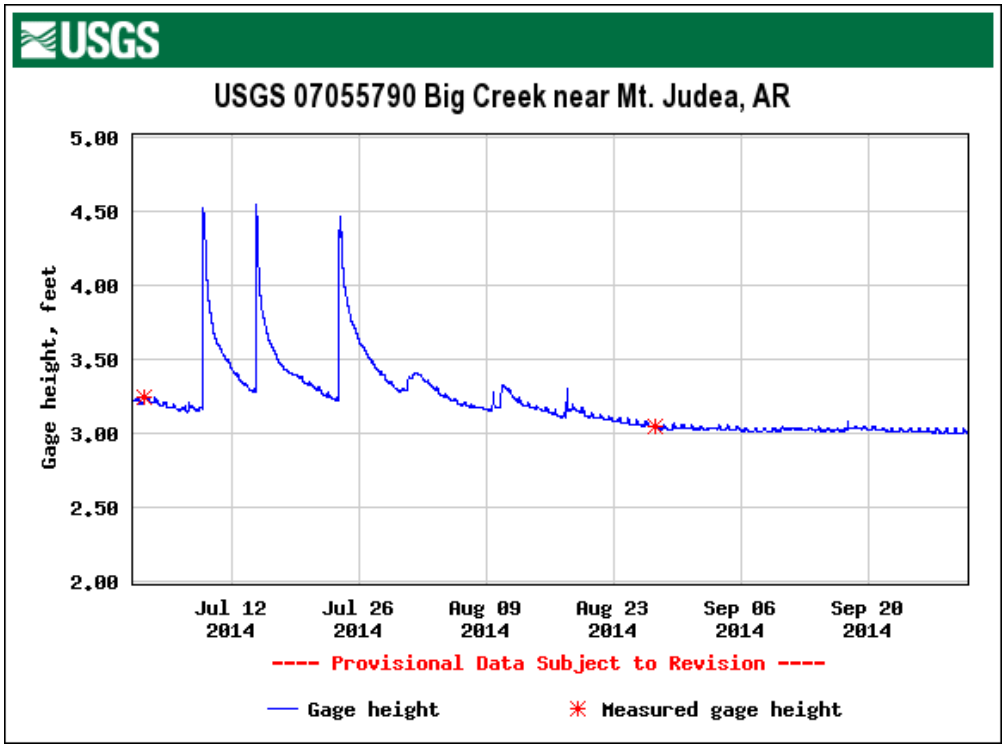

Figure 4. Big Creek flow at the monitoring site downstream of the C&H Farm during the 4th quarter.

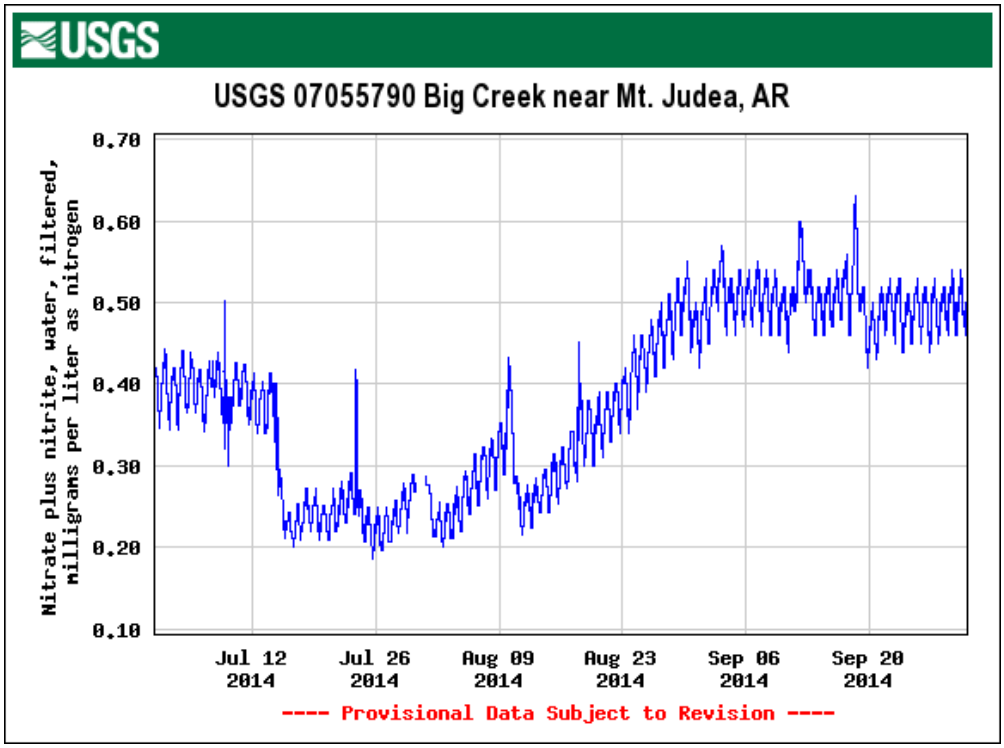

Figure 5. Nitrate concentration in Big Creek at the monitoring site downstream of the C&H Farm during the 4th quarter.

Table 2. Water quality analyses at each sample site. Coliform units are Most Probable Number (MPN) per 100 mL of water.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
			---------- mg/L ----------							-- MPN/100 mL --	
5/1/2014	**5/1/2014**	**Base flow**									
10:09	13:05	Spring	0.007	0.012	0.00	0.505	0.57	1.4	1.0	52.1	1986.3
10:29	13:05	Upstream farm	0.006	0.018	0.00	0.070	0.09	1.9	1.0	96.0	3050.0
10:19	13:05	Upstream barn	0.007	0.014	0.04	0.096	0.10	2.2	0.4	73.8	4310.0
9:58	13:05	Downstream farm	0.007	0.008	0.05	0.119	0.11	1.5	0.9	62.4	3990.0
10:49	13:05	House well	0.012	0.012	0.08	0.467	0.52	0.7	0.5	<1	116.9
10:44	13:05	Culvert	0.005	0.010	0.00	0.448	0.50	1.5	0.6	90.5	4790.0
5/8/2014	**5/8/2014**	**Base flow**									
13:00	15:32	Spring	0.009	0.020	0.00	0.386	0.48	11.1	1.0	8.6	5560.0
12:45	15:32	Upstream farm	0.013	0.020	0.06	0.087	0.09	1.2	0.9	57.3	5120.0
12:53	15:32	Upstream barn	0.008	0.016	0.01	0.121	0.14	1.4	0.9	34.1	5760.0
13:13	15:32	Downstream farm	0.008	0.028	0.03	0.163	0.55	4.7	1.0	19.9	14760.0
12:34	15:32	House well	0.008	0.010	0.18	0.440	0.68	0.3	1.4	<1	<1

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
5/9/2014	**5/9/2014**	**Storm flow**									
10:05	13:54	Spring	0.009	0.030	0.02	0.161	0.36	5.8	4.0	N.D.	N.D.
10:42	13:54	Upstream farm	0.008	0.030	0.00	0.072	0.10	1.5	0.7	N.D.	N.D.
11:22	13:54	Upstream barn	0.008	0.020	0.06	0.102	0.10	2.0	0.7	N.D.	N.D.
9:52	13:54	Downstream farm	0.008	0.018	0.00	0.152	0.17	2.1	0.6	N.D.	N.D.
5/8/2014, 13:54	13:54	Field 1	0.079	0.312	0.17	0.209	1.63	125.9	9.6	N.D.	N.D.
5/13/2014	**5/13/2014**	**Storm flow**									
9:33	13:15	Spring	0.008	0.062	0.06	0.249	0.45	3.8	4.3	435.2	7280.0
10:38	13:15	Upstream farm	0.008	0.062	0.00	0.096	0.23	10.1	2.9	920.8	13130.0
10:05	13:15	Upstream barn	0.008	0.074	0.06	0.113	0.30	11.8	5.7	1046.2	15290.0
9:22	13:15	Downstream farm	0.010	0.086	0.07	0.133	0.38	19.4	5.6	1553.1	29090.0
10:13	13:15	House well	0.008	0.020	0.06	0.458	0.49	0.5	0.5	<1	18.9
10:20	13:15	Culvert	0.007	0.060	0.12	0.509	0.70	5.1	2.6	307.6	10760.0
5/12/2014, 16:26	13:15	Field 1	0.190	0.366	0.10	0.126	1.33	42.1	10.2	N.D.	N.D.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
5/19/2014	**5/19/2014**	**Base flow**									
13:17	15:38	Spring	0.007	0.018	0.00	0.639	0.70	3.7	0.8	27.5	2419.2
12:11	15:38	Upstream farm	0.006	0.024	0.05	0.103	0.16	1.9	0.5	133.3	2419.2
13:10	15:38	Upstream barn	0.008	0.020	0.00	0.000	0.10	1.5	0.5	95.9	4710.0
13:30	15:38	Downstream farm	0.008	0.018	0.00	0.111	0.14	2.0	0.3	53.7	4220.0
12:46	15:38	House well	0.011	0.016	0.03	0.489	0.49	0.2	0.4	11.0	123.6
12:41	15:38	Culvert	0.008	0.020	0.08	0.522	0.55	0.8	0.3	204.6	5940
5/28/2014	**5/28/2014**	**Storm flow**									
9:34	14:00	Spring	0.010	0.036	0.00	0.353	0.58	7.3	2.8	1986.3	16740.0
11:06	14:00	Upstream farm	0.007	0.022	0.00	0.124	0.10	2.1	0.7	290.9	15760.0
10:13	14:00	Upstream barn	0.007	0.020	0.03	0.154	0.14	1.9	0.7	198.9	12660.0
9:16	14:00	Downstream farm	0.008	0.020	0.03	0.221	0.21	1.9	0.7	209.8	8390.0
10:35	14:00	House well	0.009	0.012	0.06	0.495	0.51	0.1	0.3	<1	<1
10:28	14:00	Culvert	0.011	0.020	0.10	0.799	0.85	1.7	0.2	517.2	14830.0
9:55	14:00	Field 1	0.235	0.310	N.D.	N.D.	N.D.	56.1	164.7	N.D.	N.D.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
6/5/2014	**6/5/2014**	**Base flow**									
13:03	15:37	Spring	0.022	0.030	0.08	0.350	0.46	4.5	0.9	33.2	4280.0
12:50	15:37	Upstream farm	0.012	0.022	0.01	0.136	0.14	1.2	1.0	307.6	18500.0
13:16	15:37	Downstream farm	0.012	0.026	0.05	0.219	0.28	4.3	0.8	201.4	13330.0
11:37	15:37	House well	0.008	0.028	0.12	0.444	0.59	0.0	1.4	<1	<1
6/9/2014	**6/9/2014**	**Storm flow**									
9:06	13:02	Spring	0.009	0.048	0.15	0.163	0.39	7.2	5.15	770.1	173290.0
10:22	13:02	Upstream farm	0.006	0.030	0.00	0.176	0.19	3.3	1.95	410.6	2419.2
9:34	13:02	Upstream barn	0.006	0.034	0.00	0.213	0.31	3.9	2.66	1119.9	29870.0
8:51	13:02	Downstream farm	0.006	0.026	0.02	0.256	0.26	4.3	1.33	517.2	11690.0
9:54	13:02	House well	0.005	0.016	0.14	0.501	0.57	0.2	0.90	<1	<1
6/19/2014	**6/19/2014**	**Base flow**									
9:10	13:27	Spring	0.008	0.024	0.06	0.320	0.43	3.7	0.20	28.8	2419.2
9:55	13:27	Upstream farm	0.008	0.028	0.09	0.154	0.22	0.3	0.3	36.4	3790.0
9:24	13:27	Upstream barn	0.009	0.026	0.10	0.180	0.25	0.1	0.40	49.6	5120.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
8:55	13:27	Downstream farm	0.010	0.020	0.03	0.246	0.32	0.9	0.33	61.3	4960.0
9:32	13:27	House well	0.009	0.028	0.06	0.442	0.57	0.0	0.33	<1	<1
6/24/2014	**6/24/2014**	**Storm flow**									
9:46	14:56	Spring	0.007	0.046	0.04	0.201	0.38	4.8	5.14	10810.0	275.5
12:17	14:56	Upstream farm	0.014	0.056	0.03	0.219	0.27	4.3	2.63	28510.0	980.4
10:17	14:56	Upstream barn	0.010	0.052	0.04	0.228	0.30	30.1	2.45	17270.0	1046.2
9:27	14:56	Downstream farm	0.009	0.068	0.05	0.245	0.35	7.2	3.81	24950.0	1046.2
10:47	14:56	House well	0.006	0.036	0.03	0.504	0.53	0.2	0.61	<1	<1
6/22/14, 8:02	14:56	Culvert, ISCO	0.005	0.090	0.68	4.562	7.16	2096	4.09	N.D.	N.D.
6/20/14, 14:31	14:56	Field 1	0.228	0.498	0.18	0.114	2.39	23.2	20.15	N.D.	N.D.
6/27/2014	**6/27/2014**	**Storm flow**									
10:03	14:25	Spring	0.012	0.010	0.00	0.378	0.51	3.3	3.86	N.D.	N.D.
6/26/14, 4:52	14:25	Upstream farm, ISCO	0.007	0.014	0.01	0.117	0.14	5.1	3.34	N.D.	N.D.
10:10	14:25	Upstream barn	0.017	0.026	0.02	0.248	0.29	3.5	0.54	N.D.	N.D.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:17	14:25	Downstream farm	0.017	0.022	0.01	0.379	0.42	5.5	1.26	N.D.	N.D.
11:00	14:25	Culvert	0.017	0.022	0.00	0.550	0.60	1.7	0.83	N.D.	N.D.
6/25/14, 14:29	14:25	Field 1	1.166	1.374	0.10	0.333	1.18	12.3	7.80	N.D.	N.D.
6/25/14, 15:29	14:25	Field 5a	0.506	0.656	0.06	0.000	0.53	39.7	5.82	N.D.	N.D.
7/7/2014	**7/7/2014**	**Storm flow**									
9:28	15:15	Spring	0.009	0.132	0.33	0.352	0.66	18.7	2.97	10190.0	111990.0
11:00	15:15	Upstream farm	0.009	0.040	0.00	0.266	0.28	3.9	1.08	1732.9	69100.0
9:38	15:15	Upstream barn	0.013	0.040	0.00	0.322	0.33	3.7	0.67	2419.2	48840.0
9:12	15:15	Downstream farm	0.010	0.034	0.00	0.398	0.40	3.5	0.67	649.8	15760.0
9:51	15:15	House well	0.007	0.020	0.11	0.483	0.57	0.2	0.50	<1	<1
7/8/2014	**7/10/2014**	**Storm flow**									
17:10	**8:38**	Culvert, ISCO	0.023	0.054	0.37	0.759	2.89	1252.1	6.96	N.D.	N.D.
7/15/2014	**7/15/2014**	**Base flow**									
9:33	14:38	Spring	0.005	0.014	0.01	0.353	0.43	2.7	1.39	129.6	2810.0
10:20	14:38	Upstream	0.010	0.046	0.04	0.215	0.30	5.2	1.73	686.7	26130.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
		farm									
10:10	14:38	Upstream barn	0.013	0.048	0.04	0.245	0.34	7.8	1.98	1119.9	26130.0
11:32	14:38	Downstream farm	0.009	0.050	0.03	0.270	0.40	9.1	1.92	816.4	27550.0
10:46	14:38	House well	0.009	0.012	0.08	0.476	0.60	0.4	0.70	<1	<1
7/18/2014	**7/18/2014**	**Storm flow**									
12:34	15:00	Spring	0.012	0.022	0.07	0.410	0.49	1.9	0.83	N.D.	N.D.
7/15/14, 18:52	15:00	Upstream farm, ISCO	0.006	0.032	0.04	0.004	0.20	4.4	1.83	N.D.	N.D.
12:13	15:00	Upstream farm	0.012	0.028	0.00	0.200	0.19	1.5	0.66	N.D.	N.D.
12:42	15:00	Upstream barn	0.013	0.028	0.03	0.249	0.25	2.1	0.68	N.D.	N.D.
10:45	15:00	Downstream farm	0.014	0.030	0.09	0.292	0.30	2.6	0.77	N.D.	N.D.
7/16/14, 12:18	15:00	Culvert, ISCO	0.006	0.032	0.06	0.601	0.67	16.8	0.56	N.D.	N.D.
7/23/2014	**7/23/2014**	**Base flow**									
10:27	13:11	Spring	0.015	0.024	0.05	0.342	0.37	2.5	1.42	14.6	1413.6
12:21	13:11	Upstream farm	0.021	0.020	0.05	0.103	0.11	1.3	1.13	142.1	2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:53	13:11	Upstream barn	0.018	0.026	0.04	0.217	0.21	1.8	1.08	344.8	5540.0
10:09	13:11	Downstream farm	0.019	0.032	0.09	0.280	0.31	3.7	1.12	95.9	6010.0
11:19	13:11	House well	0.013	0.016	0.26	0.469	0.67	0.2	0.70	<1	<1
7/25/2014	**7/25/2014**	**Storm flow**									
7/23/14, 15:41	15:59	Upstream farm, ISCO	0.081	0.476	0.09	0.004	0.86	447.1	5.55	N.D.	N.D.
11:33	15:59	Upstream farm	0.010	0.036	0.05	0.087	0.11	2.6	1.21	N.D.	N.D.
10:39	15:59	Upstream barn	0.012	0.034	0.04	0.134	0.19	2.7	1.31	N.D.	N.D.
9:55	15:59	Downstream farm	0.013	0.040	0.00	0.196	0.29	5.9	1.30	N.D.	N.D.
7/23/14, 14:42	15:59	Culvert, ISCO	0.016	1.018	0.98	0.875	2.69	2642.0	5.09	N.D.	N.D.
7/23/14, 15:06	15:59	Field 1	0.648	0.794	0.16	0.388	1.65	5.6	8.84	N.D.	N.D.
7/23/14, 16:09	15:59	Field 5a	0.625	0.754	0.09	0.004	0.61	9.0	5.81	N.D.	N.D.
7/31/2014	**7/31/2014**	**Storm flow**									
10:56	13:32	Upstream farm	0.015	0.022	0.00	0.116	0.13	1.2	0.76	275.5	6370.0
9:32	13:32	Downstream farm	0.018	0.030	0.00	0.250	0.30	3.3	0.77	224.7	23590.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:38	13:32	Culvert	0.017	0.042	0.20	1.204	1.23	4.9	1.03	1732.9	30760.0
8/12/2014	**8/12/2014**	**Base flow**									
10:09	13:23	Spring	0.009	0.032	0.03	0.217	0.26	7.0	0.56	40.4	2419.2
10:52	13:23	Upstream farm	0.012	0.026	0.00	0.108	0.13	1.7	0.30	98.8	1986.3
10:21	13:23	Upstream barn	0.015	0.024	0.01	0.162	0.18	1.5	0.28	83.0	2419.2
9:54	13:23	Downstream farm	0.012	0.036	0.04	0.232	0.23	8.3	0.40	125.0	9870.0
10:37	13:23	House well	0.009	0.020	0.20	0.418	0.62	0.5	0.35	<1	<1
8/20/2014	**8/20/2014**	**Base flow**									
10:28	14:05	Spring	0.010	0.036	0.00	0.285	0.45	7.5	1.09	307.6	40830.0
11:23	14:05	Upstream farm	0.014	0.040	0.00	0.214	0.32	8.3	0.52	88.4	3000.0
10:39	14:05	Upstream barn	0.015	0.030	0.00	0.229	0.22	3.5	0.32	12.1	2310.0
10:14	14:05	Downstream farm	0.011	0.032	0.01	0.319	0.37	3.4	0.44	69.7	7380.0
10:53	14:05	House well	0.010	0.020	0.15	0.412	0.61	0.3	0.28	<1	<1
8/22/2014	**8/25/2014**	**Base flow**									
14:06	9:25	Trench, South	0.007	0.008	0.00	0.523	0.69	5.7	1.79	N.D.	N.D.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
8/26/2014	**8/26/2014**	**Base flow**									
11:38	14:23	Spring	0.007	0.078	0.05	0.256	0.42	38.6	0.35	51.2	4650.0
12:08	14:23	Upstream farm	0.005	0.064	0.09	0.075	0.42	6.5	1.21	3.1	4370.0
11:14	14:23	Downstream farm	0.013	0.018	0.01	0.398	0.46	1.4	0.22	19.7	5120.0
11:56	14:23	House well	0.008	0.022	0.26	0.378	0.66	0.4	0.18	<1	<1

N.D. is No Data.

Table 3. Water quality analyses at the spring and in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application fields.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
5/8/2014 Base flow									
Spring	0.009	0.020	0.00	0.386	0.48	11.1	1.0	8.6	5560.0
Upstream	0.013	0.020	0.06	0.087	0.09	1.2	0.9	57.3	5120.0
Downstream	0.008	0.028	0.03	0.163	0.55	4.7	1.0	19.9	14760.0
5/9/2014 Storm flow									
Spring	0.009	0.030	0.02	0.161	0.36	5.8	4.0	N.D.	N.D.
Upstream	0.008	0.030	0.00	0.072	0.10	1.5	0.7	N.D.	N.D.
Downstream	0.008	0.018	0.00	0.152	0.17	2.1	0.6	N.D.	N.D.
5/13/2014 Storm flow									
Spring	0.008	0.062	0.06	0.249	0.45	3.8	4.3	435.2	7280.0
Upstream	0.008	0.062	0.00	0.096	0.23	10.1	2.9	920.8	13130.0
Downstream	0.010	0.086	0.07	0.133	0.38	19.4	5.6	1553.1	29090.0
5/28/2014 Storm flow									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Spring	0.010	0.036	0.00	0.353	0.58	7.3	2.8	1986.3	16740.0
Upstream	0.007	0.022	0.00	0.124	0.10	2.1	0.7	290.9	15760.0
Downstream	0.008	0.020	0.03	0.221	0.21	1.9	0.7	209.8	8390.0
6/5/2014 Base flow									
Spring	0.022	0.030	0.08	0.350	0.46	4.5	0.9	33.2	4280.0
Upstream	0.012	0.022	0.01	0.136	0.14	1.2	1.0	307.6	18500.0
Downstream	0.012	0.026	0.05	0.219	0.28	4.3	0.8	201.4	13330.0
6/9/2014 Storm flow									
Spring	0.009	0.048	0.15	0.163	0.39	7.2	5.15	770.1	173290.0
Upstream	0.006	0.030	0.00	0.176	0.19	3.3	1.95	410.6	2419.2
Downstream	0.006	0.026	0.02	0.256	0.26	4.3	1.33	517.2	11690.0
6/19/2014 Base flow									
Spring	0.008	0.024	0.06	0.320	0.43	3.7	0.20	28.8	2419.2
Upstream	0.008	0.028	0.09	0.154	0.22	0.3	0.3	36.4	3790.0
Downstream	0.010	0.020	0.03	0.246	0.32	0.9	0.33	61.3	4960.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
6/24/2014 Storm flow									
Spring	0.007	0.046	0.04	0.201	0.38	4.8	5.14	10810.0	275.5
Upstream	0.014	0.056	0.03	0.219	0.27	4.3	2.63	28510.0	980.4
Downstream	0.009	0.068	0.05	0.245	0.35	7.2	3.81	24950.0	1046.2
6/27/2014 Storm flow									
Spring	0.012	0.010	0.00	0.378	0.51	3.3	3.86	N.D.	N.D.
Upstream	0.007	0.014	0.01	0.117	0.14	5.1	3.34	N.D.	N.D.
Downstream	0.017	0.022	0.01	0.379	0.42	5.5	1.26	N.D.	N.D.
7/7/2014 Storm flow									
Spring	0.009	0.132	0.33	0.352	0.66	18.7	2.97	10190.0	111990.0
Upstream	0.009	0.040	0.00	0.266	0.28	3.9	1.08	1732.9	69100.0
Downstream	0.010	0.034	0.00	0.398	0.40	3.5	0.67	649.8	15760.0
7/15/2014 Base flow									
Spring	0.005	0.014	0.01	0.353	0.43	2.7	1.39	129.6	2810.0
Upstream	0.010	0.046	0.04	0.215	0.30	5.2	1.73	686.7	26130.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.009	0.050	0.03	0.270	0.40	9.1	1.92	816.4	27550.0
7/18/2014 Storm flow									
Spring	0.012	0.022	0.07	0.410	0.49	1.9	0.83	N.D.	N.D.
Upstream, ISCO	0.006	0.032	0.04	0.000	0.20	4.4	1.83	N.D.	N.D.
Upstream	0.012	0.028	0.00	0.200	0.19	1.5	0.66	N.D.	N.D.
Downstream	0.014	0.030	0.09	0.292	0.30	2.6	0.77	N.D.	N.D.
7/23/2014 Base flow									
Spring	0.015	0.024	0.05	0.342	0.37	2.5	1.42	14.6	1413.6
Upstream	0.021	0.020	0.05	0.103	0.11	1.3	1.13	142.1	2419.2
Downstream	0.019	0.032	0.09	0.280	0.31	3.7	1.12	95.9	6010.0
7/25/2014 Storm flow									
Upstream farm, ISCO	0.081	0.476	0.09	0.000	0.86	447.1	5.55	N.D.	N.D.
Upstream	0.010	0.036	0.05	0.087	0.11	2.6	1.21	N.D.	N.D.
Downstream	0.013	0.040	0.00	0.196	0.29	5.9	1.30	N.D.	N.D.
7/31/2014 Storm flow									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.015	0.022	0.00	0.116	0.13	1.2	0.76	275.5	6370.0
Downstream	0.018	0.030	0.00	0.250	0.30	3.3	0.77	224.7	23590.0
8/12/2014 Base flow									
Spring	0.009	0.032	0.03	0.217	0.26	7.0	0.56	40.4	2419.2
Upstream	0.012	0.026	0.00	0.108	0.13	1.7	0.30	98.8	1986.3
Downstream	0.012	0.036	0.04	0.232	0.23	8.3	0.40	125.0	9870
8/20/2014 Base flow									
Spring	0.010	0.036	0.00	0.285	0.45	7.5	1.09	307.6	40830.0
Upstream	0.014	0.040	0.00	0.214	0.32	8.3	0.52	88.4	3000.0
Downstream	0.011	0.032	0.01	0.319	0.37	3.4	0.44	69.7	7380.0
8/26/2014 Base flow									
Spring	0.007	0.078	0.05	0.256	0.42	38.6	0.35	51.2	4650.0
Upstream	0.005	0.064	0.09	0.075	0.42	6.5	1.21	3.1	4370.0
Downstream	0.013	0.018	0.01	0.398	0.46	1.4	0.22	19.7	5120.0

N.D. is No Data.

Table 4. Water quality analyses at the culvert draining the subwatershed containing the production houses and manure holding ponds, the well adjacent to the ponds, and surface runoff from Field 1 (see Figure 3).

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	---------- mg/L ----------							--- MPN/100 mL ---	
Culvert									
5/1/2014	0.005	0.010	0.00	0.448	0.50	1.5	0.6	90.5	4790.0
5/12/2014	0.010	0.290	0.61	0.939	2.33	847.6	4.7	N.D.	N.D.
5/13/2014	0.007	0.060	0.12	0.509	0.70	5.1	2.6	307.6	10760.0
5/19/2014	0.008	0.020	0.08	0.522	0.55	0.8	0.3	204.6	5940
5/28/2014	0.011	0.020	0.10	0.799	0.85	1.7	0.2	517.2	14830.0
6/22/2014	0.005	0.090	0.68	4.562	7.16	2096.3	4.09	N.D.	N.D.
6/27/2014	0.017	0.022	0.00	0.550	0.60	1.7	0.83	N.D.	N.D.
7/8/2014	0.023	0.054	0.37	0.759	2.89	1252.1	6.96	N.D.	N.D.
7/16/2014	0.006	0.032	0.06	0.601	0.67	16.8	0.56	N.D.	N.D.
7/23/2014	0.016	1.018	0.98	0.875	2.69	2642.0	5.09	N.D.	N.D.
7/31/2014	0.017	0.042	0.20	1.204	1.23	4.9	1.03	1732.9	30760.0
House well									

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/1/2014	0.012	0.012	0.08	0.467	0.52	0.7	0.5	<1	116.9
5/8/2014	0.008	0.010	0.18	0.440	0.68	0.3	1.4	<1	<1
5/13/2014	0.008	0.020	0.06	0.458	0.49	0.5	0.5	<1	18.9
5/19/2014	0.011	0.016	0.03	0.489	0.49	0.2	0.4	11.0	123.6
5/28/2014	0.009	0.012	0.06	0.495	0.51	0.1	0.3	<1	<1
6/5/2014	0.008	0.028	0.12	0.444	0.59	0.0	1.4	<1	<1
6/9/2014	0.005	0.016	0.14	0.501	0.57	0.2	0.90	<1	<1
6/19/2014	0.009	0.028	0.06	0.442	0.57	0.0	0.33	<1	<1
6/24/2014	0.006	0.036	0.03	0.504	0.53	0.2	0.61	<1	<1
7/7/2014	0.007	0.020	0.11	0.483	0.57	0.2	0.50	<1	<1
7/15/2014	0.009	0.012	0.08	0.476	0.60	0.4	0.70	<1	<1
7/23/2014	0.013	0.016	0.26	0.469	0.67	0.2	0.70	<1	<1
8/12/2014	0.009	0.020	0.20	0.418	0.62	0.5	0.35	<1	<1
8/20/2014	0.010	0.020	0.15	0.412	0.61	0.3	0.28	<1	<1
8/26/2014	0.008	0.022	0.26	0.378	0.66	0.4	0.18	<1	<1

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Field 1									
5/8/2014	0.079	0.312	0.17	0.209	1.63	125.9	9.6	N.D.	N.D.
5/12/2014	0.190	0.366	0.10	0.126	1.33	42.1	10.2	N.D.	N.D.
5/28/2014	0.235	0.310	N.D.	N.D.	N.D.	56.1	164.7	N.D.	N.D.
6/20/2014	0.228	0.498	0.18	0.114	2.39	23.2	20.15	N.D.	N.D.
6/25/2014	1.166	1.374	0.10	0.333	1.18	12.3	7.80	N.D.	N.D.
7/23/2014	0.648	0.794	0.16	0.388	1.65	5.6	8.84	N.D.	N.D.
Field 5a									
6/25/2014	0.506	0.656	0.06	0.004	0.53	39.7	5.82	N.D.	N.D.
7/23/2014	0.625	0.754	0.09	0.004	0.61	9.0	5.81	N.D.	N.D.
Interceptor Trench (South)									
8/22/2014	0.007	0.008	0.00	0.523	0.69	5.7	1.79	N.D.	N.D.

N.D. is No Data. E. coli and total coliform were not measured on surface runoff samples collected by ISCO samplers when sample holding time exceeded the required 8-hour threshold.

The mean, minimum, maximum, geometric mean, and standard deviations of concentrations of P, N, suspended sediment, dissolved organic C, E. coli, and total coliform measured in Big Creek above and below the C&H Farm presented in Table 5. Concentrations presented in all Tables are those measured at the site and do not include an estimate of flow. Thus, it is dangerous to compare concentrations among sites, especially those measuring different flow pathways for example, streams, culvert, springs, wells, and surface runoff from fields. Such comparisons are only valid on a mass flow basis. When flow is obtained from equipment at each site, concentration data will be converted to mass loading or flow-weighted values that allow a more informed interpretation of site data. Until this conversion is completed and flow considered, conclusions and interpretations should not be made on differences among site concentrations.

Table 5. Minimum, maximum, average, Geometric mean and standard deviation of concentrations of analytes measured in Big Creek above and below the C&H Farm, Newton County during the monitoring period. There were a total of 52 samples collected at each site.

Location & metric	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	---------- mg/L ----------							MPN/100 mL	
Upstream of farm									
Minimum	0.005	0.010	0.01	0.004	0.09	0.3	0.3	3	210
Maximum	0.074	0.074	0.09	1.024	2.20	17.9	3.3	28510	69100
Average	0.012	0.030	0.03	0.179	0.28	2.7	1.3	936	5622
Geomean	0.010	0.027	0.03	0.137	0.21	1.7	1.1	111	1884
St. Dev.	0.010	0.014	0.02	0.156	0.32	3.1	0.8	4256	11617
Downstream of farm									
Minimum	0.004	0.008	0.01	0.108	0.11	0.2	0.2	1	272
Maximum	0.067	0.316	0.20	0.723	1.07	101.1	5.6	24950	43520
Average	0.012	0.037	0.04	0.283	0.37	5.9	1.3	917	7376
Geomean	0.011	0.028	0.03	0.250	0.33	2.5	1.0	90	3180
St. Dev.	0.009	0.045	0.03	0.147	0.18	14.3	1.2	3773	9348

Hourly Rainfall at the Manure Holding Lagoons

Rainfall at the manure holding lagoons was measured at hourly intervals and while all information is available, only the daily rainfall amounts are presented in Figure 6.

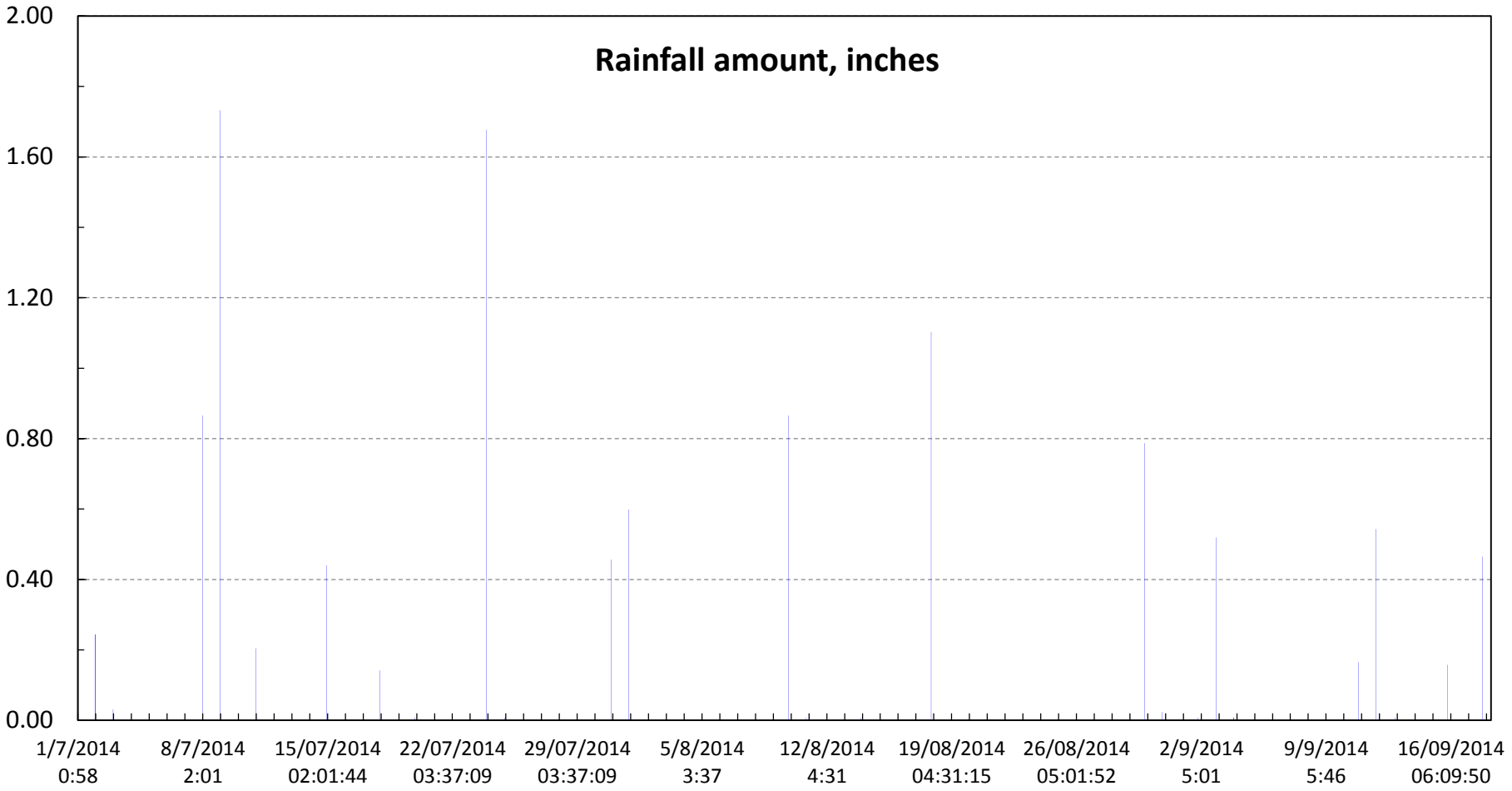

Figure 6. Rainfall amount in inches at the holding pond at the CH Farm for July 1 through September 18, 2014.

Manure Management Options

The volume of manure produced by a livestock is largely determined by the average animal population characteristics, fresh water additions, spilled drinking water, and pen wash-down water. Any precipitation directly into manure storages or via surface runoff will also increase manure volume.

Wash-water volume determination

Discussions with C&H management revealed that the farm used "wet/dry" feeders so that any animal drinking water spillage would fall into feed troughs to be consumed with the feed. As a result, there is effectively no spilled drinking water adding to manure volume. Estimates for pen wash-down water were provided in the form of the number of pressure washers, the flow rates in gallons per minute, and the average time spent washing each day. As a more direct determination of pen wash-water addition to the manure was desired, two standard water meters were installed to measure all water used by two pressure washers used in the barns (Figure 7). Pictures of the meters were taken and submitted to provide date and meter readings, from which accurate daily and cumulative wash-water volumes were calculated. From March 20 to September 9, 2014 a total of 161,722 gallons of water was used to wash the pens, with the water then draining into the manure pits. The average daily water use over these 174 days was 929 gallons/day (Table 6; Figures 8 and 9).

Table 6 Pen wash water meter readings and water volumes.

Reading Date	Days	Meter 1			Meter 2			Total	
		Reading	Cumulative	Daily average	Reading	Cumulative	Daily average	Cumulative	Daily average
		---------- gallons ----------							
3/20/2014		126.5			80.2				
9/10/2014	174	96,609.6	96,483.1	555	65,319.3	65,239.1	374.9	161,722	929

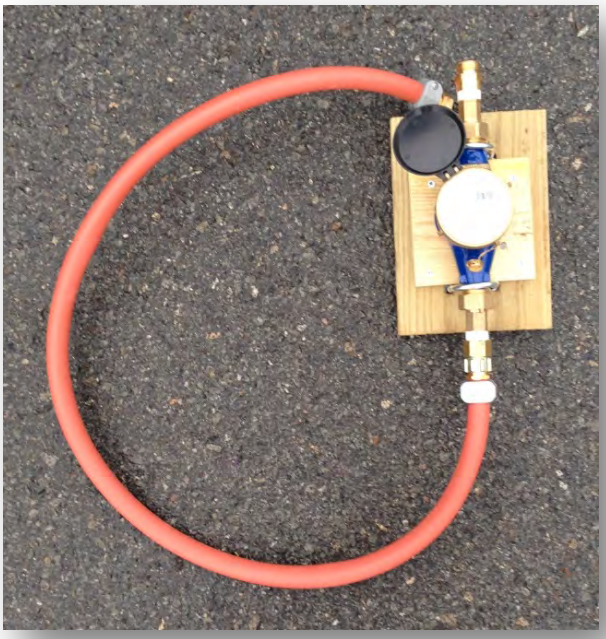

Figure 7. Standard water meter with hose adapters and mounting base installed to measure water use during pressure washing to clean animal pens.

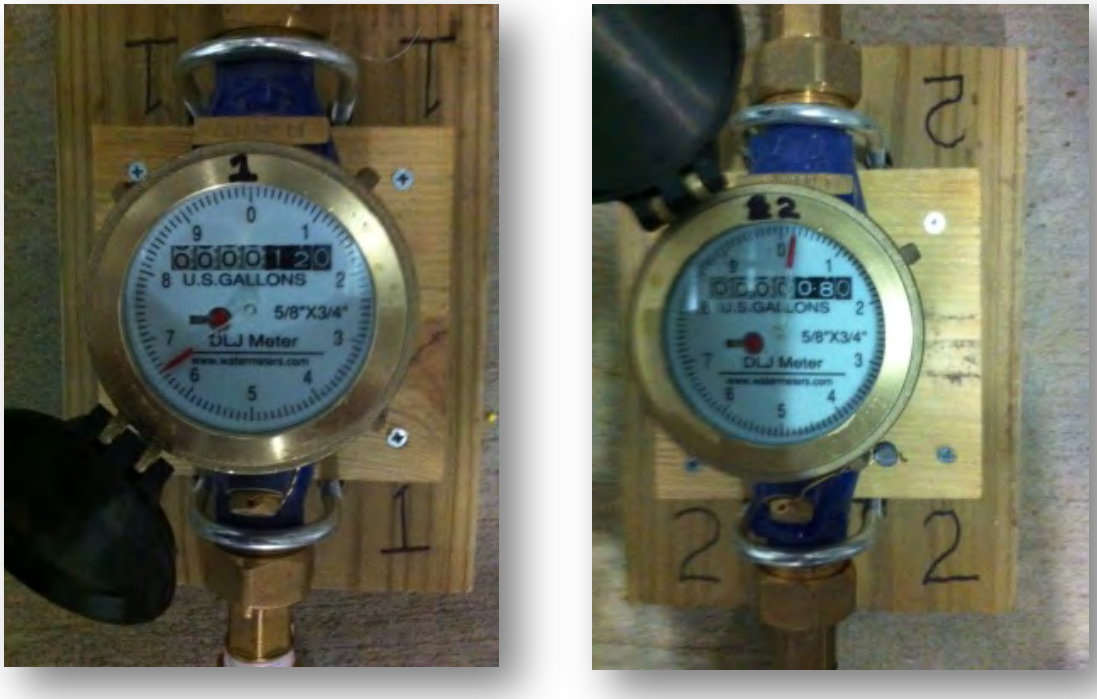

Figure 8. Two water meters purchased and installed on March 20th, 2014 to measure pen wash down water additions to manure volume. Initial meters readings were 126.6 and 80.2 gallons for meter 1 and 2.

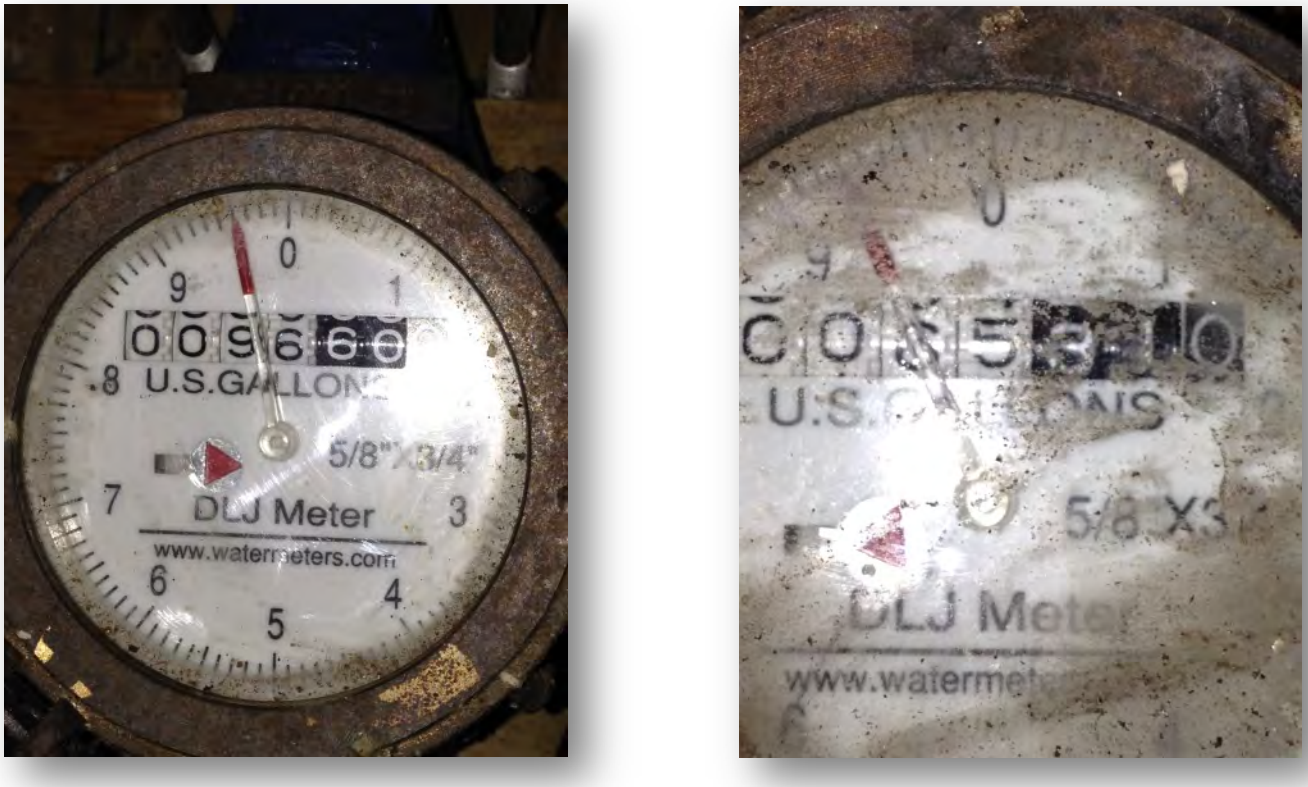

Figure 9. Two water meters purchased and installed on March 20th, 2014 to measure pen wash down water additions to manure volume. Meters readings were 96,609.6 and 65,319.3 gallons for meter 1 and 2 on September 10th, 2014.

Topographic Elevation Survey of Holding Ponds

To quantify potential precipitation additions to the volume of manure in the holding ponds, a topographic elevation survey of land adjacent to the ponds was conducted using total station survey equipment. A second elevation survey of land surrounding the holding ponds was conducted to determine the area of land draining to the ponds (Figure 10). Visual inspections and photographs provided additional inputs. This information is being used to build a Graphical Information System (GIS) surface model that will provide both the precipitation capture area of the holding ponds and storage volume at various holding-pond depths. This information and historical rainfall information will be included in the information used to estimate potential precipitation additions to the manure volume.

Figure 10. General area included in the topographic elevation survey delineated by yellow boundary line and holding pond 1 (smaller) and holding pond 2 (larger) delineated by red boundary lines.

Future Plan of Work

1. Conduct electrical resistivity analysis on application fields to determine the potential for subsurface areas of preferential flow pathways.
2. Continue to collect surface runoff, spring, and stream samples after each rainfall event from the autosamplers and manually collect baseflow samples every two weeks from the well, spring, and streams, for analysis of N, P, sediment, and bacteria (E. coli and total coliform from baseflow grab samples).
3. Collect water samples from the piezometers installed in Fields 5a and 12.
4. Install equipment to monitor flow, nutrients and sediment in Dry Creek entering Big Creek, after land owner permission and MOUs are obtained.
5. Continue to periodically determine plant uptake by collecting plant and hay samples for tissue analysis and determine yield (dry-matter mass for a pre-determined area).
6. Develop a Memorandum of Understanding with Oklahoma State University to conduct an Electrical Resistivity assessment of water movement below Fields 5a and 12 in the fall / early winter of 2014.
7. Finalize determination of holding pond volumes, precipitation capture area of holding ponds and surrounding area. Precipitation inputs, average daily wash-down water, and manure holding pond volumes will be used to estimate annual manure and nutrient production values. These values, coupled with chemical treatment trial results, will form the basis for investigating manure management alternatives.

DIVISION OF AGRICULTURE
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University of Arkansas System

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Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – October 1 to December 31, 2014

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

The mission of the **Division of Agriculture** is to advance the stewardship of natural resources and the environment, cultivate the improvement of agriculture and agribusiness, develop leadership skills and productive citizenship among youth and adults, enhance economic security and financial responsibility among the citizens of the state, ensure a safe, nutritious food supply, improve the quality of life in communities across Arkansas, and strengthen Arkansas families.

Dr. Mark J. Cochran
Vice President for Agriculture

Executive Summary

This is the fourth Quarterly Report of 2014 for the Big Creek Research and Extension Team that details the following progress made from October 1 through December 31, 2014.

1. Continued to collect weekly baseflow and periodic storm flow water samples from Big Creek above and below the C&H Farm, along with water from the spring, culvert, surface runoff sites on Fields 1, 5a, and 12, interceptor trench below the slurry holding ponds, and house well for chemical analysis.
2. As recommended by the External Review Panel, the electrical resistivity imaging (ERI) analysis of Fields 5a and 12 was completed by Dr. Hallihan, School of Geology, Oklahoma State University in late December, 2014.
3. Installed sampling site at the mouth of Dry Creek where it enters Big Creek as suggested by the External Review Panel. Before the site became operational, it was vandalized and will be replaced in the near future.
4. Measured bacteria concentrations in Big Creek were high both above (20,140 and 173,290 MPN/100 mL as E.coli and total coliform, respectively) and below the C&H Farm (1,203 and 20,120 MPN/100 mL as E.coli and total coliform, respectively) during storm flow grab sampling on 10/13/2014, as well as trench flow below the holding ponds. However, no consistent or prolonged trends in nutrients or bacteria concentrations were evident at or among any of the monitoring locations. In fact, based on all the data collected since we started monitoring in September 2013, geometric mean bacterial levels tend to be greater under storm than base flow conditions.

	Base flow		Storm flow	
	E. coli	Total coliform	E. coli	Total coliform
	---------- MPN/100 mL ----------			
Upstream	55	1,631	502	6,248
Downstream	52	2,633	334	6,458

A longer period of monitoring is needed for a more reliable assessment of farm impact on Big Creek water quality.

5. As inputs for the adaptive and potential alternative manure management options, determination of the contribution of barn wash-water to manure slurry volume was continued. A topographic elevation survey of the holding ponds and surrounding areas was performed to determine the as-built volumes and precipitation catchment area of each pond. A set of chemical manure treatment trials were performed with the resulting manure samples submitted for analysis.

Big Creek Research Team

Faculty

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Rick Cartwright, Ph.D., Professor – Associate Director of Extension for Agriculture and Natural Resources

Mark Cochran, Ph.D., – Vice President, University of Arkansas System Division of Agriculture.

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Ed Gbur, Ph.D., Professor and Director, Agricultural Statistics Laboratory - Experimental design, linear and generalized linear mixed models, regression, agricultural applications of statistics.

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Phil Hays, Ph.D. Ground Water Specialist, U.S. Geological Survey and Research Professor with Geosciences Dept., University of Arkansas, application of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems

Tim Kresse, M.Sc., Water Quality Specialist, U.S. Geological Survey, natural geochemical evolution of groundwater and separating these processes from anthropogenic sources of contamination

Nathan McKinney, Ph.D., – Assistant Director, Agriculture Experiment Station

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Thad Scott, Ph.D., Assistant Professor - Water quality, transport of contaminants to and within water bodies

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Jun Zhu, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians

The Big Creek Research and Extension Team are ably supported by several excellent Program Technicians based in Little Rock and Fayetteville.

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Land Use Analysis for the Big Creek Watershed

Land use of the watershed drainage area was determined for several segments of the Big Creek Watershed (Tables 1 and 2). This was accomplished using data from the USDA-NRCS Geospatial Data Gateway for Newton Co., AR http://datagateway.nrcs.usda.gov/; national land cover dataset by State for 2006; cropland data layer by State for 2006; and hydrography data layer for streams and HUC 12 watershed boundaries for 2007 to present. The following drainage areas were delineated; Big Creek (Figure 1), Big Creek upstream of the C&H (Figure 2), downstream of the C&H Farm to the Buffalo River (Figure 3), the monitored land area encompassing fields permitted to receive manure slurry (Figure 4), and Dry Creek Watershed (Figure 5).

Overall, land use of the area of the monitored watershed encompassing the C&H Farm (18% pasture and 78% forest) was similar to the land area downstream of the C&H Farm to the Buffalo River (17% pasture and 80% forest) (Table 2). Upstream of the C&H Farm there was less pasture (5%) and more forest (92%) (Table 2).

Table 1. Land use classification of the monitored watershed, upstream of C&H, downstream of C&H and Dry Creek Watersheds. [1]

	Upstream of C&H (Figure 2)		Downstream of C&H (Figure 3)		Monitored watershed (Figure 4)		Dry Creek watershed (Figure 5)	
Land use/Land cover	**Area (acres)**	**% of total area**	**Area (acres)**	**% of total area**	**Area (acres)**	**% of total area**	**Area (acres)**	**% of total area**
Grassland/Pasture	1,389	8.0	5,431	17.0	1,561	17.8	231	5.1
Forest								
Deciduous forest	15,110	86.5	24,297	75.9	6,570	75.1	4,036	89.0
Evergreen forest	514	2.9	1,094	3.4	250	2.9	145	3.2
Mixed forest	4	0.0	54	0.2	11	0.1	2	0.03
Shrubland	5	0.0	2	0.0	- - [2]	- -	- -	- -
Woody wetlands	0.4	0.0	0.7	0.00	0.7	0.0	- -	- -
Urban								
Developed/Open space	435	2.5	1,038	3.2	327	3.7	119	2.6
Developed/Low intensity	13.	0.1	77	0.2	23	0.3	0.7	0.01
Developed/Medium intensity	0.2	0.0	2	0.0	4	0.1	- -	- -
Developed/High intensity	- -	- -	- -	- -	1	0.1	- -	- -
Open water	- -	- -	0.9	0.0	- -	- -	- -	- -
TOTAL	**17,471**		**31,997**		**8,750**		**4,534**	

[1] Obtained the following data from the USDA:NRCS Geospatial Data Gateway for Newton Co., AR http://datagateway.nrcs.usda.gov/.
National land cover dataset by State, 2006.
Cropland data layer by State, 2006.
Hydrography (streams and HUC 12 watershed boundaries), 2007-present.

[2] None measured.

Table 2. Area as pasture forest and urban for the monitored watershed, upstream of C&H, downstream of C&H and Dry Creek Watersheds.

Land use/Land cover	Upstream of C&H		Downstream of C&H		Monitored watershed		Dry Creek watershed	
	Area (acres)	% of total area	Area (acres)	% of total area	Area (acres)	% of total area	Area (acres)	% of total area
Pasture	1389	7.95	5431	16.97	1561	17.84	231	5.10
Forest	15628	89.45	25446	79.52	6830	78.09	4182	92.25
Urban	448	2.57	1118	3.49	355	4.06	120	2.64
Other	5	0.03	4	0.01	1	0.01	231	5.10

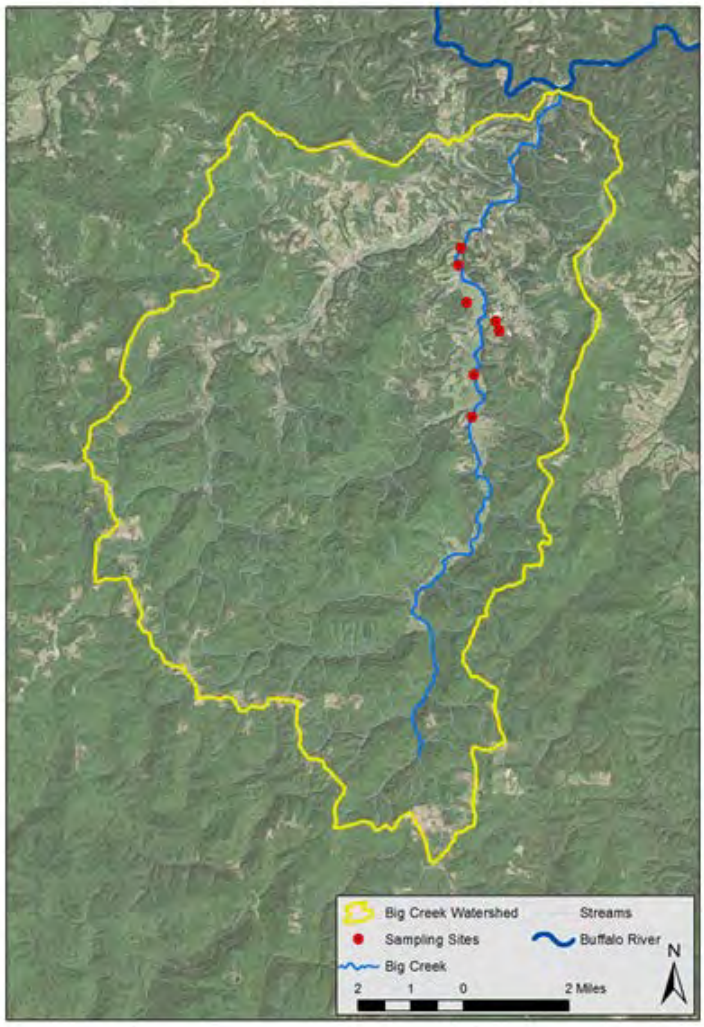

Figure 1. Big Creek Watershed with sampling sites.

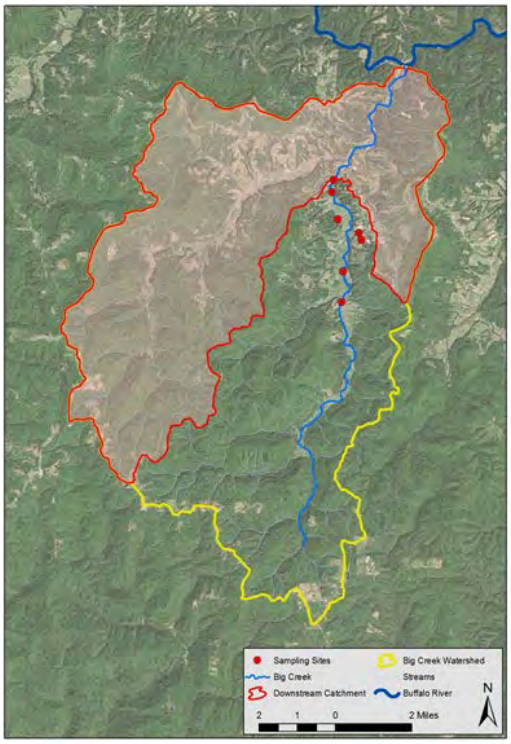

Figure 2. Delineation of the watershed downstream of the C&H to the Buffalo River.

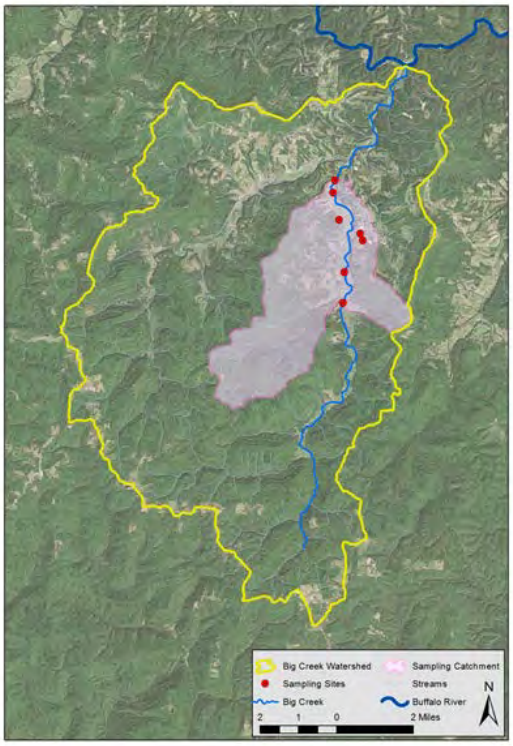

Figure 4. Delineation of the monitored watershed between upstream and downstream of the C&H Farm.

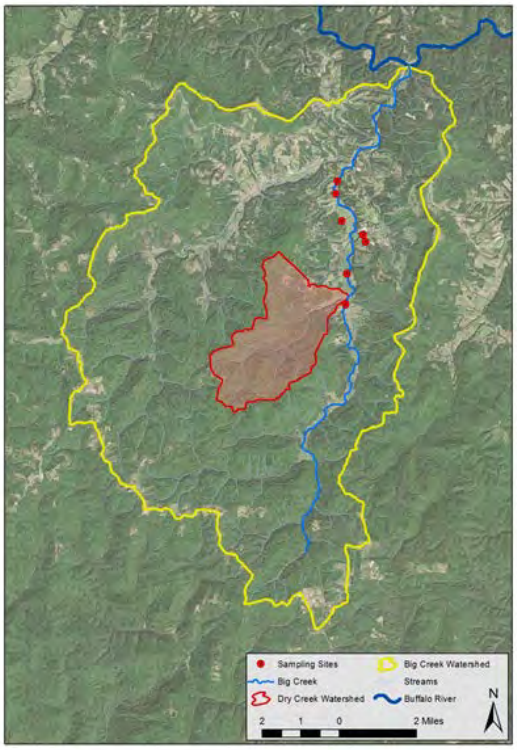

Figure 3. Dry Creek watershed.

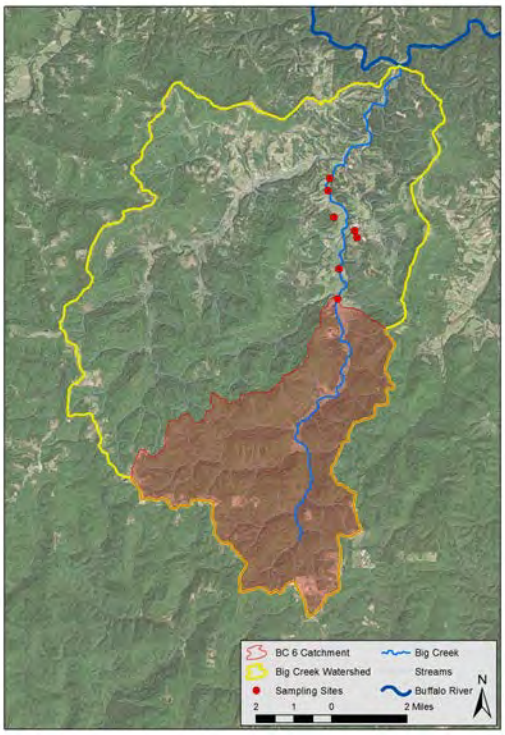

Figure 5. Watershed delineation for the upstream C&H sampling site.

Water Sampling and Analyses

Sampling Locations

Water quality monitoring sites are shown in Figure 6 and are;

Site 1. Edge-of-field monitoring on Field 1 permitted to receive slurry.

Site 2. Edge-of-field monitoring on Field 5a.

Site 3. Edge-of-field monitoring on Field 12 permitted to receive slurry.

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities.

Site 5. Spring below Field 1.

Site 6. Big Creek upstream of the C&H Farm operation.

Site 7. Big Creak downstream of the C&H Farm operation.

Site 8. Manure holding pond trench. The site was visited weekly and trench water sampled when flowing. The trenches flow periodically and flow measurement equipment will be installed during the first quarter of 2015.

Sampling Protocols and Analyses

The following protocols were used to collect, prepare, and analyze all water samples:

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted and samples were placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
6. Analyses included Dissolved Phosphorus (EPA 365.2), Total Phosphorus (APHA 4500-P), Ammonia (EPA 351.2), Nitrate (EPA 300.0), Total Nitrogen (APHA 4500-N), Total Suspended Solids (EPA 160.2), E. coli (APHA 9223, B) and Total Coliforms (APHA 9223, B). APHA is American Public Health Association from the Wadeable Streams Assessment, Water Chemistry Laboratory Manual http://www.epa.gov/owow/monitoring/wsa/WRS_lab_manual.pdf
7. The minimum detection limits (MDLs) for each chemical and biological constituent measured are listed in Table 3.
8. Chemical and biological analyses of samples collected in the 4th Quarter of 2014 are presented in Tables 4, 5, and 6.

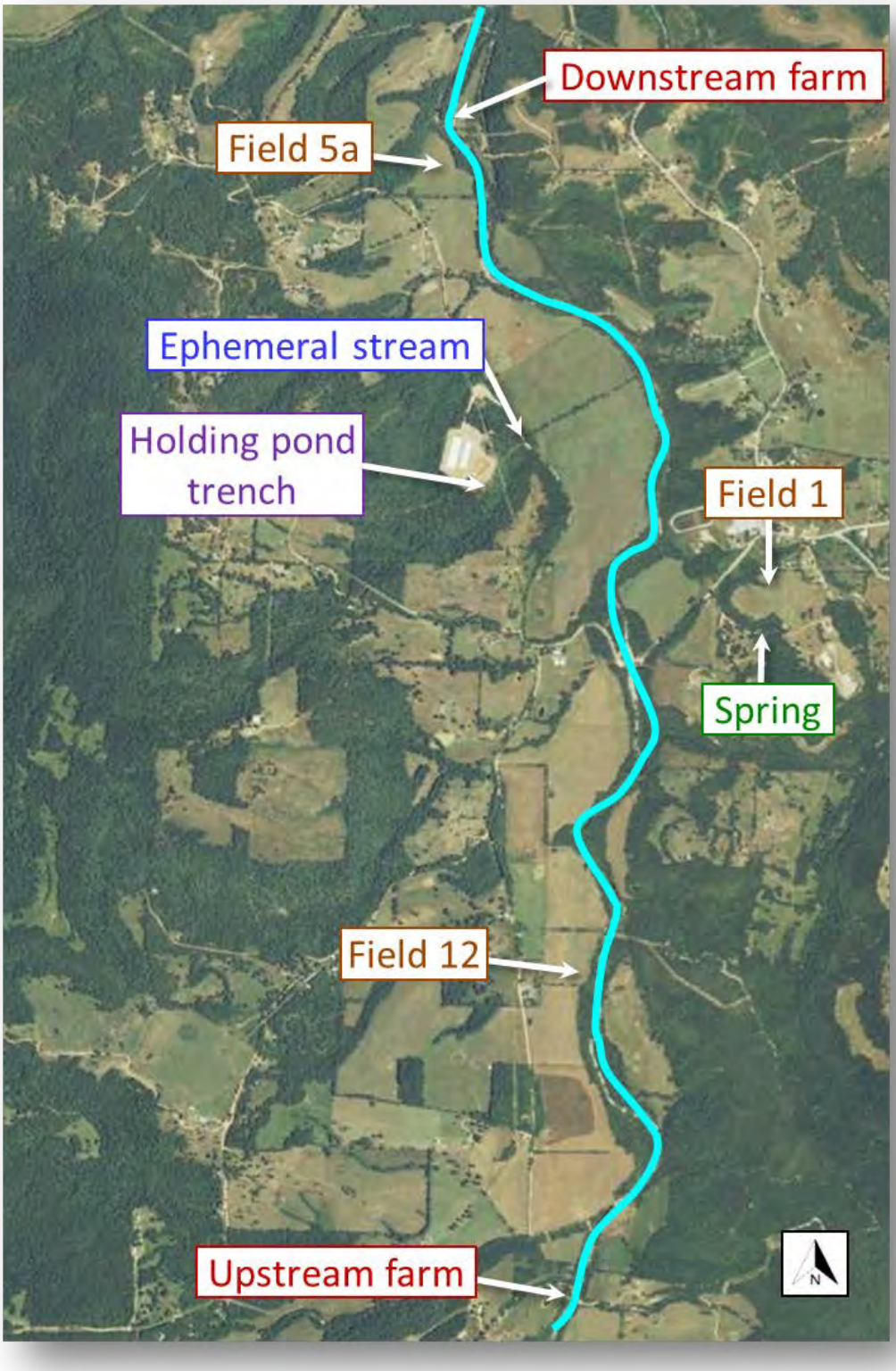

Figure 6. Location of water quality sampling sites on Big Creek and the C&H Farm.

Table 3. Minimum detection limits (MDLs) for each chemical and biological constituent measured.

Constituent	Minimum detection limit
Dissolved P, mg L^{-1}	0.002
Total P, mg L^{-1}	0.012
Ammonium-N, mg L^{-1}	0.03
Nitrate-N, mg L^{-1}	0.004
Total N, mg L^{-1}	0.006
Total suspended solids, mg L^{-1}	6.58
Dissolved organic carbon, mg L^{-1}	0.18
E. coli, MPN 100 mL^{-1}	1
Total coliform, MPN 100 mL^{-1}	1

USGS Stations

Big Creek Continuous Flow

We are collaborating with USGS, Big Creek at the downstream site of prior water sample collection, which was instrumented with continuous flow gaging equipment and a nitrate sensor, which provides real-time flow, water temperature, water nitrate and precipitation data. These data are available on line at the USGS website below. Flow and nitrate for from the USGS downstream site for the last quarter is given in Figures 7 and 8.

USGS 07055790 Big Creek near Mt. Judea, AR

http://nwis.waterdata.usgs.gov/ar/nwis/uv/?site_no=07055790&agency_cd=USGS

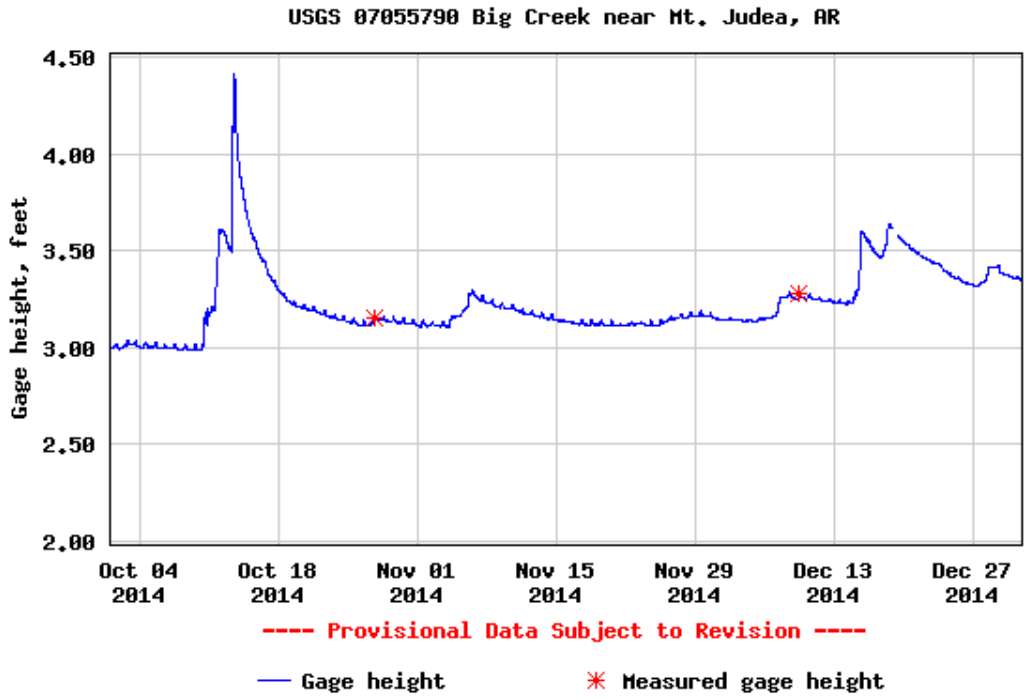

Figure 7. Big Creek flow at the monitoring site downstream of the C&H Farm during the 4th quarter of 2014.

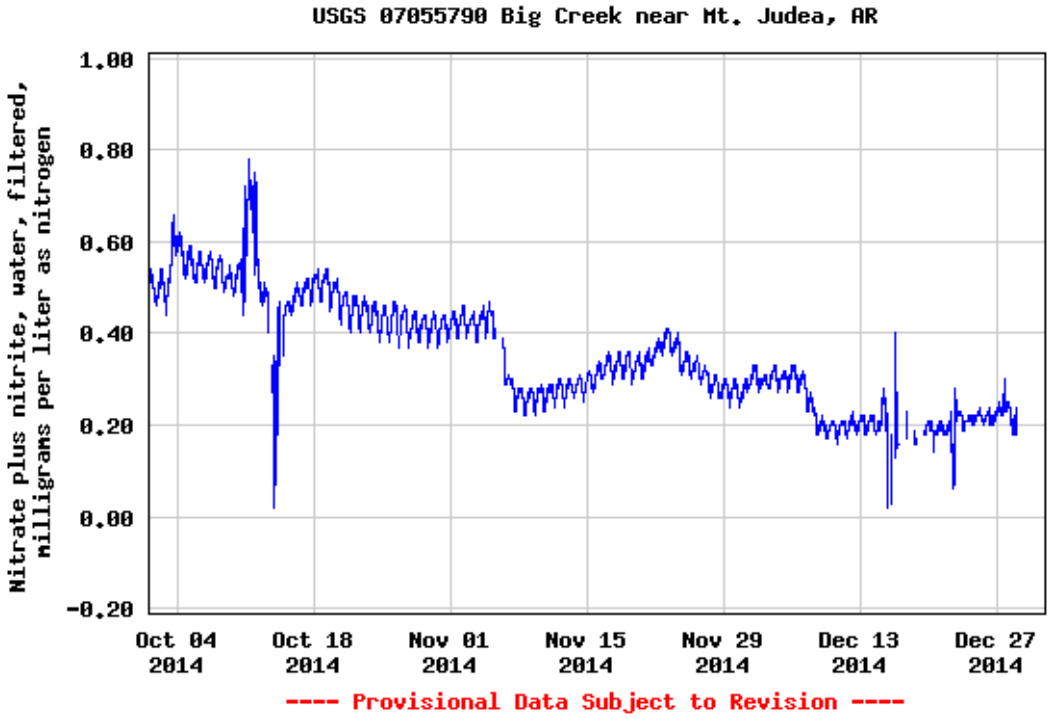

Figure 8. Nitrate concentration in Big Creek at the monitoring site downstream of the C&H Farm during the 4th quarter of 2014.

Table 4. Water quality analyses at each sample site. Coliform units are Most Probable Number (MPN) per 100 mL of water for the 4th Quarter of 2014.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
			mg/L							MPN/100 mL	
8/12/2014	**8/12/2014**	**Base flow**									
10:09	13:23	Spring	0.009	0.032	0.03	0.217	0.26	7.0	0.56	40.4	2419
10:52	13:23	Upstream farm	0.012	0.026	<0.03	0.108	0.13	1.7	0.30	98.8	1986
9:54	13:23	Downstream farm	0.012	0.036	0.04	0.232	0.23	8.3	0.40	125.0	9870
10:37	13:23	House well	0.009	0.020	0.20	0.418	0.62	0.5	0.35	<1	<1
8/20/2014	**8/20/2014**	**Base flow**									
10:28	14:05	Spring	0.010	0.036	<0.03	0.285	0.45	7.5	1.09	307.6	40830
11:23	14:05	Upstream farm	0.014	0.040	<0.03	0.214	0.32	8.3	0.52	88.4	3000
10:14	14:05	Downstream farm	0.011	0.032	0.01	0.319	0.37	3.4	0.44	69.7	7380
10:53	14:05	House well	0.010	0.020	0.15	0.412	0.61	0.3	0.28	<1	<1
8/22/2014	**8/25/2014**	**Base flow**									
14:06	9:25	Trench, South	0.007	0.008	<0.03	0.523	0.69	5.7	1.79	N.D.	N.D.
8/26/2014	**8/26/2014**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:38	14:23	Spring	0.007	0.078	0.05	0.256	0.42	38.6	0.35	51.2	4650
12:08	14:23	Upstream farm	0.005	0.064	0.09	0.075	0.42	6.5	1.21	3.1	4370
11:14	14:23	Downstream farm	0.013	0.018	0.01	0.398	0.46	1.4	0.22	19.7	5120
11:56	14:23	House well	0.008	0.022	0.26	0.378	0.66	0.4	0.18	<1	<1
9/3/2014	**9/3/2014**	**Storm flow**									
10:24	13:28	Spring	0.008	0.022	<0.03	0.227	0.37	10.9	0.61	1870.0	21430
11:15	13:28	Upstream farm	0.010	0.030	0.04	0.303	0.52	5.3	0.67	270	8570
9:39	13:28	Downstream farm	0.015	0.018	<0.03	0.500	0.60	3.5	0.09	65.7	4040
10:40	13:28	House well	0.011	0.008	0.17	0.475	0.68	2.9	0.02	56.3	59.1
11:36	13:28	Trench 1	0.004	0.003	0.04	0.937	1.22	3.7	0.68	N.D.	N.D.
9/11/2014	**9/11/2014**	**Storm flow**									
11:48	15:20	Spring	0.004	0.012	<0.03	0.564	0.65	1.3	0.16	35.4	7440
12:56	15:20	Upstream farm	0.001	0.040	0.06	0.198	0.53	6.2	2.28	2419.2	81640
11:31	15:20	Downstream farm	0.010	0.024	0.04	0.476	0.52	1.5	0.24	980.4	15970
12:43	15:20	House well	0.006	0.010	0.00	0.495	0.52	0.3	<0.18	<1.0	<1

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:35	15:20	Trench 1	0.001	0.018	0.03	1.580	1.86	1.0	0.54	1.0	57940
12:29	15:20	Trench 2	<0.002	0.010	0.03	2.033	2.31	3.2	0.70	81.3	27550
9/18/2014	**9/18/2014**	**Storm flow**									
10:42	13:42	Spring	0.007	0.200	0.17	0.170	0.6	54.7	3.12	12590.0	81640
11:25	13:42	Upstream farm	0.006	0.024	0.02	0.555	0.66	3.7	0.69	365.4	11720
9:54	13:42	Downstream farm	0.013	0.028	0.02	0.523	0.61	2.1	0.33	579.4	11530
11:06	13:42	House well	0.009	0.014	0.01	0.494	0.52	<6.6	<0.18	35.0	6940
9/23/2014	**9/23/2014**	**Base flow**									
1:05	15:28	Spring	0.001	0.024	<0.03	0.253	0.37	6.7	0.93	201.4	2750
12:45	15:28	Upstream farm	0.003	0.022	0.02	0.152	0.27	3.5	0.82	9.7	2419
10:59	15:28	Downstream farm	0.010	0.026	0.02	0.442	0.53	2.7	0.50	47.1	2620
12:27	15:28	House well	0.006	0.018	<0.03	0.494	0.53	0.5	0.33	8.5	866
9/30/2014	**9/30/2014**	**Base flow**									
10:56	14:36	Spring	0.002	0.138	<0.03	0.256	0.63	81.8	0.53	135.4	13960
12:20	14:36	Upstream farm	0.002	0.032	0.01	0.172	0.46	6.1	1.09	5.2	4320

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
9:57	14:36	Downstream farm	0.011	0.032	0.01	0.444	0.57	1.9	0.45	85.7	2560
11:10	14:36	House well	0.007	0.012	<0.03	0.501	0.56	0.3	0.17	2.0	43.5
10/8/2014	**10/8/2014**	**Base flow**									
10:24	14:46	Spring	0.001	0.050	<0.03	0.218	0.41	22.1	0.64	88.4	7330
12:11	14:46	Upstream farm	0.003	0.052	0.04	0.125	0.53	8.7	1.61	24.6	4260
9:31	14:46	Downstream farm	0.009	0.028	0.03	0.474	0.57	2.1	0.45	56.3	5630
11:01	14:46	House well	0.006	0.018	0.03	0.486	0.54	1.1	0.19	1.0	69.1
10/13/2014	**10/13/2014**	**Storm flow ISCO**									
10:07	13:45	Upstream farm	<0.005	0.072	0.03	0.124	0.46	20.8	3.36	N.D.	N.D.
9:21	13:45	Downstream farm	0.110	0.450	0.23	0.257	1.03	171.2	4.77	N.D.	N.D.
11:33	13:45	Culvert	0.004	0.068	0.08	0.996	1.37	11.2	3.28	N.D.	N.D.
9:55	13:45	Field 1	0.529	0.746	0.98	0.698	2.89	65.7	9.46	N.D.	N.D.
10:48	13:45	Field 5a	0.707	0.926	0.36	0.068	0.91	38.1	5.34	N.D.	N.D.
10/13/2014	**10/13/2014**	**Storm flow grab**									
9:38	13:45	Spring	0.005	0.126	0.12	0.083	0.62	46.5	6.55	19350	198630

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:11	13:45	Upstream farm	0.069	0.200	0.10	0.147	0.55	28.4	4.59	20140	173290
9:31	13:45	Downstream farm	0.015	0.058	0.05	0.379	0.51	7.0	2.30	1203.3	20120
11:00	13:45	House well	0.005	0.016	<0.03	0.496	0.56	0.3	0.23	28.1	2750
11:15	13:45	Trench 1	<0.002	0.024	<0.03	1.251	1.46	71.4	0.83	15650.0	61310
11:10	13:45	Trench 2	0.001	0.116	0.33	1.714	2.73	11.1	4.14	920.8	241920
10/22/2014	**10/22/2014**	**Base flow**									
10:24	15:23	Spring	0.006	0.058	<0.03	0.402	0.59	26.1	0.87	1046.2	5210
11:56	15:23	Upstream farm	0.010	0.026	<0.03	0.123	0.15	0.6	0.61	67.6	2430
10:09	15:23	Downstream farm	0.011	0.028	<0.03	0.380	0.47	2.0	0.59	200.0	4350
11:11	15:23	House well	0.007	0.016	<0.03	0.497	0.5	0.2	0.24	5.2	81
10/30/2014	**10/30/2014**	**Base flow**									
11:30	15:16	Spring	<0.002	0.048	0.04	0.360	0.58	23.5	0.61	110.0	3950
9:53	15:16	Upstream farm	0.005	0.016	<0.03	0.114	0.12	0.5	0.44	31.8	2419
11:47	15:16	Downstream farm	0.006	0.016	<0.03	0.368	0.42	1.8	0.42	20.1	2330
11/5/2014	**11/5/2014**	**Storm flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
9:29	15:26	Spring	0.013	0.088	0.11	0.145	0.50	13.4	3.91	579.4	11530
11:31	15:26	Upstream farm	0.018	0.032	<0.03	0.103	0.18	0.7	1.22	214.3	5040
9:10	15:26	Downstream farm	0.014	0.023	<0.03	0.353	0.48	2.1	0.78	153.9	4190
10:25	15:26	Trench 1	0.004	0.012	0.02	1.54	1.67	0.9	0.37	N.D.	N.D.
10:14	15:26	Trench 2	0.004	0.032	0.03	3.375	3.65	33.1	0.87	N.D.	N.D.
11/12/2014	**11/12/2014**	**Base flow**									
10:22	15:30	Spring	0.011	0.024	<0.03	0.095	0.16	<6.6	0.50	65	3310
10:38	15:30	Upstream farm	0.012	0.036	<0.03	0.065	0.10	0.5	0.40	57.3	3130
9:27	15:30	Downstream farm	0.012	0.026	<0.03	0.217	0.31	1.2	0.39	14.6	4350
11/24/2014	**11/24/2014**	**Storm flow**									
9:39	12:55	Spring	0.007	0.014	<0.03	0.271	0.48	4.1	4.71	40.2	2419
10:34	12:55	Upstream farm	0.013	0.013	<0.03	0.097	0.11	0.7	2.15	72.7	2419
9:23	12:55	Downstream farm	0.014	0.016	<0.03	0.297	0.38	1.5	2.11	14.8	2419
9:53	12:55	House well	0.010	0.010	<0.03	0.452	0.57	1.9	2.81	<1.0	5.2
12/4/2014	**12/4/2014**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:49	15:25	Spring	0.007	0.024	<0.03	0.317	0.50	2.3	5.57	5.2	1120
11:10	15:25	Upstream farm	0.011	0.022	<0.03	0.103	0.13	0.7	2.94	45.7	1850
10:35	15:25	Downstream farm	0.013	0.024	<0.03	0.264	0.33	1.5	2.98	7.4	2990
12/9/2014	**12/9/2014**	**Storm flow**									
10:00	14:00	Spring	0.008	0.024	<0.03	0.295	0.48	2.3	4.26	18.9	1203
10:33	14:00	Upstream farm	0.011	0.024	0.01	0.057	0.09	0.5	1.60	36.4	1986
9:38	14:00	Downstream farm	0.013	0.022	<0.03	0.179	0.23	1.1	1.42	35	2650

N.D. is No Data.

Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

Table 5. Water quality analyses at the spring and in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application fields for the 4th Quarter of 2014.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
8/12/2014 Base flow									
Spring	0.009	0.032	0.03	0.217	0.26	7.0	0.56	40.4	2419
Upstream	0.012	0.026	<0.03	0.108	0.13	1.7	0.30	98.8	1986
Downstream	0.012	0.036	0.04	0.232	0.23	8.3	0.40	125.0	9870
8/20/2014 Base flow									
Spring	0.010	0.036	<0.03	0.285	0.45	7.5	1.09	307.6	40830
Upstream	0.014	0.040	<0.03	0.214	0.32	8.3	0.52	88.4	3000
Downstream	0.011	0.032	0.01	0.319	0.37	3.4	0.44	69.7	7380
8/26/2014 Base flow									
Spring	0.007	0.078	0.05	0.256	0.42	38.6	0.35	51.2	4650
Upstream	0.005	0.064	0.09	0.075	0.42	6.5	1.21	3.1	4370
Downstream	0.013	0.018	0.01	0.398	0.46	1.4	0.22	19.7	5120
9/3/2014 Storm flow									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Spring	0.008	0.022	<0.03	0.227	0.37	10.9	0.61	1870.0	21430
Upstream	0.010	0.030	0.04	0.303	0.52	5.3	0.67	270.0	8570
Downstream	0.015	0.018	<0.03	0.500	0.6	3.5	0.09	65.7	4040
9/11/2014	**Storm flow**								
Spring	0.004	0.012	<0.03	0.564	0.65	1.3	0.16	35.4	7440
Upstream	0.001	0.040	0.06	0.198	0.53	6.2	2.28	2419.2	81640
Downstream	0.010	0.024	0.04	0.476	0.52	1.5	0.24	980.4	15970
9/18/2014	**Storm flow**								
Spring	0.007	0.200	0.17	0.170	0.60	54.7	3.12	12590.0	81640
Upstream	0.006	0.024	0.02	0.555	0.66	3.7	0.69	365.4	11720
Downstream	0.013	0.028	0.02	0.523	0.61	2.1	0.33	579.4	11530
9/23/2014	**Base flow**								
Spring	0.001	0.024	<0.03	0.253	0.37	6.7	0.93	201.4	2750
Upstream	0.003	0.022	0.02	0.152	0.27	3.5	0.82	9.7	2419
Downstream	0.010	0.026	0.02	0.442	0.53	2.7	0.50	47.1	2620

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
9/30/2014	**Base flow**								
Spring	0.002	0.138	<0.03	0.256	0.63	81.8	0.53	135.4	13960
Upstream	0.002	0.032	0.01	0.172	0.46	6.1	1.09	5.2	4320
Downstream	0.011	0.032	0.01	0.444	0.57	1.9	0.45	85.7	2560
10/8/2014	**Base flow**								
Spring	0.001	0.050	<0.03	0.218	0.41	22.1	0.64	88.4	7330
Upstream	0.003	0.052	0.04	0.125	0.53	8.7	1.61	24.6	4260
Downstream	0.009	0.028	0.03	0.474	0.57	2.1	0.45	56.3	5630
10/13/2014	**Storm flow ISCO**								
Upstream	<0.005	0.072	0.03	0.124	0.46	20.8	3.36	N.D.	N.D.
Downstream	0.110	0.450	0.23	0.257	1.03	171.2	4.77	N.D.	N.D.
10/13/2014	**Storm flow grab**								
Spring	0.005	0.126	0.12	0.083	0.62	46.5	6.55	19350.0	198630
Upstream	0.069	0.200	0.10	0.147	0.55	28.4	4.59	20140.0	173290
Downstream	0.015	0.058	0.05	0.379	0.51	7.0	2.30	1203.3	20120

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
10/22/2014	**Base flow**								
Spring	0.006	0.058	<0.03	0.402	0.59	26.1	0.87	1046.2	5210
Upstream	0.010	0.026	<0.03	0.123	0.15	0.6	0.61	67.6	2430
Downstream	0.011	0.028	<0.03	0.380	0.47	2.0	0.59	200.0	4350
10/30/2014	**Base flow**								
Spring	<0.002	0.048	0.04	0.360	0.58	23.5	0.61	110.0	3950
Upstream	0.005	0.016	<0.03	0.114	0.12	0.5	0.44	31.8	2419
Downstream	0.006	0.016	<0.03	0.368	0.42	1.8	0.42	20.1	2330
11/5/2014	**Storm flow**								
Spring	0.013	0.088	0.11	0.145	0.50	13.4	3.91	579.4	11530
Upstream	0.018	0.032	<0.03	0.103	0.18	0.7	1.22	214.3	5040
Downstream	0.014	0.023	<0.03	0.353	0.48	2.1	0.78	153.9	4190
11/12/2014	**Base flow**								
Spring	0.011	0.024	<0.03	0.095	0.16	<6.6	0.50	65	3310
Upstream	0.012	0.036	<0.03	0.065	0.10	0.5	0.40	57.3	3130

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.012	0.026	<0.03	0.217	0.31	1.2	0.39	14.6	4350
11/24/2014	**Storm flow**								
Spring	0.007	0.014	<0.03	0.271	0.48	4.1	4.71	40.2	2419
Upstream	0.013	0.013	<0.03	0.097	0.11	0.7	2.15	72.7	2419
Downstream	0.014	0.016	<0.03	0.297	0.38	1.5	2.11	14.8	2419
12/4/2014	**Base flow**								
Spring	0.007	0.024	<0.03	0.317	0.50	2.3	5.57	5.2	1120
Upstream	0.011	0.022	<0.03	0.103	0.13	0.7	2.94	45.7	1850
Downstream	0.013	0.024	<0.03	0.264	0.33	1.5	2.98	7.4	2990
12/9/2014	**Storm flow**								
Spring	0.008	0.024	<0.03	0.295	0.48	2.3	4.26	18.9	1203
Upstream	0.011	0.024	0.01	0.057	0.09	0.5	1.60	36.4	1986
Downstream	0.013	0.022	<0.03	0.179	0.23	1.1	1.42	35	2650

N.D. is No Data.

Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

Table 6. Water quality analyses at the culvert draining the subwatershed containing the production houses and manure holding ponds, the well adjacent to the ponds, and surface runoff from Field 1 for the 4th Quarter of 2014.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	---------- mg/L ----------							--- MPN/100 mL ---	
Culvert									
10/13/2014	0.004	0.068	0.08	0.996	1.37	11.2	3.28	N.D.	N.D.
House well									
8/12/2014	0.009	0.020	0.20	0.418	0.62	0.5	0.35	<1	<1
8/20/2014	0.010	0.020	0.15	0.412	0.61	0.3	0.28	<1	<1
8/26/2014	0.008	0.022	0.26	0.378	0.66	0.4	0.18	<1	<1
9/3/2014	0.011	0.008	0.17	0.475	0.68	2.9	0.02	56.3	59.1
9/11/2014	0.006	0.010	<0.03	0.495	0.52	0.3	<0.18	<1.0	<1
9/18/2014	0.009	0.014	0.01	0.494	0.52	<6.6	<0.18	35.0	6,940
9/23/2014	0.006	0.018	<0.03	0.494	0.53	0.5	0.33	8.5	866
9/30/2014	0.007	0.012	<0.03	0.501	0.56	0.3	0.17	2.0	43.5
10/8/2014	0.006	0.018	0.03	0.486	0.54	1.1	0.19	1.0	69.1
10/13/2014	0.005	0.016	<0.03	0.496	0.56	0.3	0.23	28.1	2,750

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
10/22/2014	0.007	0.016	<0.03	0.497	0.5	0.2	0.24	5.2	81.3
11/24/2014	0.010	0.010	<0.03	0.452	0.57	1.9	2.81	<1.0	5.2
8/22/2014	0.007	0.008	<0.03	0.523	0.69	5.7	1.79	N.D.	N.D.
Interceptor Trench 1 (South)									
9/3/2014	0.004	0.003	0.04	0.937	1.22	3.7	0.68	N.D.	N.D.
9/11/2014	0.001	0.018	0.03	1.580	1.86	1.0	0.54	1.0	57,940
10/13/2014	<0.002	0.024	<0.03	1.251	1.46	71.4	0.83	15,650.0	61,310
11/5/2014	0.004	0.012	0.02	1.54	1.67	0.9	0.37	N.D.	N.D.
Interceptor Trench 2 (North)									
9/11/2014	<0.002	0.010	0.03	2.033	2.31	3.2	0.70	81.3	27,550
10/13/2014	0.001	0.116	0.33	1.714	2.73	11.1	4.14	920.8	241,920
11/5/2014	0.004	0.032	0.03	3.375	3.65	33.1	0.87	N.D.	N.D.
Field 1 Surface runoff									
10/13/2014	0.529	0.746	0.98	0.698	2.89	65.7	9.46	N.D.	N.D.
Field 5a Surface runoff									

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
10/13/2014	0.707	0.926	0.36	0.068	0.91	38.1	5.34	N.D.	N.D.

N.D. is No Data.

Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

E. coli and total coliform were not measured on surface runoff samples collected by ISCO samplers when sample holding time exceeded the required 8-hour threshold.

Statistical Analysis

Statistical analysis of the limited amount of data collected so far in Big Creek above and below the C&H Farm (one year with 52 samples at each location over a range of flow conditions). Based on the water chemistry before December 30, 2013, it appears that;

- Total nitrogen concentrations were low (<0.6 mg/L on average) relative to more developed watersheds across the Ozark and Boston Mountains,
- Nitrate- nitrogen concentrations increased slightly (0.1 mg/L) downstream from the application fields, whereas total nitrogen concentrations did not change relative to upstream of the C&H Farm operation,
- The slight increase in nitrate is probably reflective of the land use continuum and historic management, and
- Based on the analysis of samples collected to date, other water-quality parameters did not change significantly ($p<0.05$ level) at our monitoring sites upstream to downstream of the C&H Farm operation.

Based on water chemistry before and after December 30, 2014, it appears that;

- Nitrogen concentrations decreased upstream and downstream reflecting seasonal variability, which is typical in streams draining the Ozark and Boston Mountains,
- Phosphorus concentrations and coliform numbers did not change over time upstream or downstream of the C&H Farm operation, but continued monitoring is needed to understand how land application of the manure might possibly influence water chemistry.

Coliform Numbers in Big Creek Above and Below C&H Farm:

- Based on the analysis of Big Creek water samples collected before December 30, 2013, there was no significant ($p<0.05$) change in E. coli and total coliform numbers at our monitoring sites upstream to downstream of the C&H Farm operation.
- Based on the analysis of Big Creek water samples collected before and after December 30, 2014, E. coli and total coliform numbers have not changed over time, but continued monitoring is needed to understand how land application of the manure might possibly influence water chemistry.
- E. coli concentrations were high in trench flow samples on October 13th, 2014 and total coliform concentration on the same date and September 11th, 2014, although other parameters such as dissolved P and nitrate were not elevated on October 13 relative to dates before or after. The site was visited weekly and trench water sampled when flowing. While these appear to be isolated high levels at the moment and may result from construction contamination flushing, we will continue to sample the trench water as well as monitoring pond influx and level. However, the elevated numbers have prompted the determination of other water quality parameters such as chloride, electrical conductivity and total dissolved solids to help interpret these numbers. Also, to eliminate the possibility of external contamination of the trench water samples, we are

installing equipment to protect trench flow at the point at which samples are taken from external contamination.

To put the measured bacteria concentrations into a State water quality standard perspective, the criteria set by Arkansas Department of Environmental Quality (ADEQ) are given. Water quality standards for *E. coli* are established by the state in ADEQ Regulation 2 (see Table 7). The *E. coli* numbers must remain below a threshold in a specified number of total samples collected. The exact upper limit that is allowed depends on the designation of the waterbody and time of year (primary or secondary contact season). *Primary contact recreation* is a designation given to a waterbody where full body contact occurs and occurs from May 1 through September 30.

ADEQ also designates any stream with a watershed (e.g. drainage basin in the landscape) exceeding 10 square miles and those with smaller watersheds on individual cases (i.e. after site verification) for primary contact recreation. *Secondary contact recreation* designates waterbodies where activities such as boating, fishing, and wading take place and occurs from October 1 through April 30.

Table 7. Upper limits for Escherichia coli counts defined in Regulation 2 of the Arkansas Department of Environmental Quality (ADEQ) as specified by contact season and waterbody designation for both single samples and geometric mean.

Contact season	Water designation	Limit of *E. coli* (MPN/100mL)	
		Single sample[1]	Geometric mean[2]
Primary (May 1-Sept. 30)	Extraordinary Resource Water Ecologically Sensitive Waterbody Natural & Scenic Waterways, Lakes, & Reservoirs	298	126
	All other water	410	NA[3]
Secondary (Oct. 1-April 30)	Extraordinary Resource Water Ecologically Sensitive Waterbody Natural & Scenic Waterways, Lakes, & Reservoirs	1490	630
	All other water	2050	NA

[1] No more than 25% of samples from no less than 8 samples per contact season may exceed the limit.

[2] Geometric mean is calculated from at least 5 samples collected within 30 days at evenly spaced time intervals during that 30-day period.

[3] Not applicable.

Electrical Resistivity Imaging Analysis

Electrical resistivity imaging (ERI) analysis provides a good method to understand the distribution of fluids and rock properties in the subsurface environment especially in the presence of fractures or karst features. The method allows an electrical image to be created with a resolution of half the distance between electrodes, which typically provides a meter-scale dataset that can be utilized to evaluate heterogeneity and fluid distribution. Improvements in sensitivity generated by the Halihan/Fenstemaker method allow greater differentiation of these signatures. In a field setting, this will result in a two-dimensional mapping of subsurface electrical properties for each dataset, which will be used to interpret groundwater movement in a complex mantled karst with applied manures.

As part of cooperative research, Oklahoma State University (OSU) designed and conducted ERI experiments and will integrate ERI data with well and other site data to provide an understanding of the subsurface distribution of flowpaths at a background and manure study site. Dr. Todd Halihan and his graduate research assistant (OSU) travelled to the sites to conduct the imaging and data collection. University of Arkansas (UA) provided 2-3 field assistants to aid in collecting data and clearing brush. Aestus, LLC was utilized to provide 3-D visualization of the field data utilizing RockWorks™. Data analysis and reporting will be performed in conjunction with research team members at UA and Aestus, LLC.

The work was conducted in late December, 2014 and data quality is anticipated to be high due to the geologic setting lacking metallic infrastructure. The resistivity structure of the site will be evaluated with OSU working with UA and Aestus to ensure proper integration of the ERI acquisition location and scale with the UA well and soil sampling protocols. More detailed information on the ERI methods and analyses is given in Appendix 1.

The results of the work will be reported to UA, and published in appropriate journal locations. The work is intended to be applied to understanding best management practices for conducting land application of agricultural waste in karstic settings. Data acquired during the ERI analysis of Fields 5a and 12 will be processed and analyzed by OSU researchers during the first quarter of 2015 and results will be made available in the next Quarterly Report, due April 15, 2015.

Manure Management Inputs Determination Efforts

The volume of manure produced by a livestock is largely determined by the average animal population characteristics, freshwater additions (if any), spilled drinking water (if any), and pen wash down water. In addition, any precipitation directly into manure storages or via surface runoff will increase manure volume.

Wash-water volume determination

Discussions with C&H management revealed that the farm used “wet/dry” feeders so that any animal drinking water spillage would fall into the feed troughs and consumed with the feed. As a result, there will be effectively no spilled drinking water adding to manure slurry volume. Estimates for pen wash down water were provided in the form of the number of pressure washers, the flow rates in

gallons per minute, and the average time spent washing each day. As a more direct determination of pen wash water additions to the manure was desired, two standard water meters were purchased and installed to measure all the water used by two pressure washers used in the barns (Figure 9).

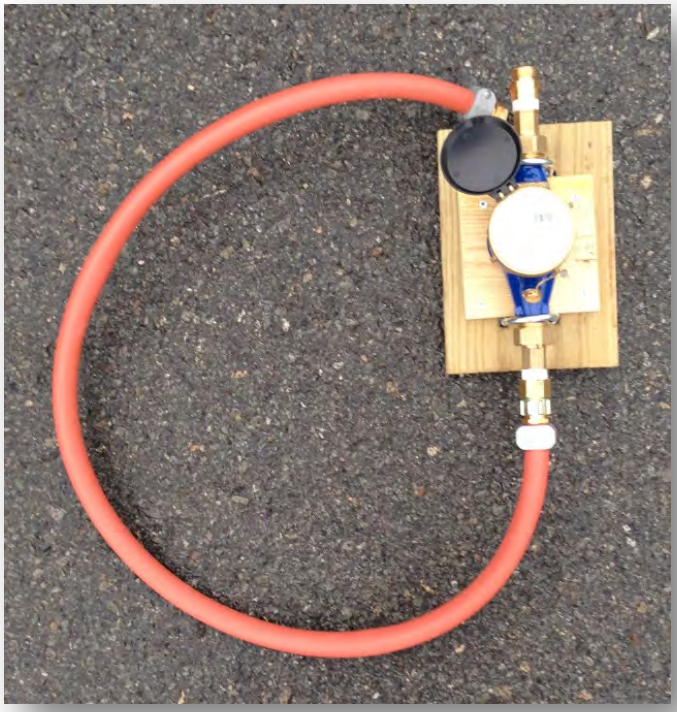

Figure 9. Standard water meter with hose adapters and mounting base installed to measure water use during pressure washing to clean animal pens.

Periodically, pictures of the meters were submitted providing readings and the date of the readings to document cumulative and daily wash-water volumes added to the manure slurry volume. From March 20, 2014 to September 9, 2014 a total of 161,722 gallons of water was used to wash the pens with the water then draining into the manure pits. The average daily water use over these 174 days was 929 gallons/day. (Table 8 and Figures 10 and 11).

Table 8. Pen wash-water meter readings and water volumes in gallons.

Date	Days	Meter 1			Meter 2			Total	
		Reading	Cumulative	Daily average	Reading	Cumulative	Daily average	Cumulative	Daily average
		---------- Gallons ----------							
3/20/2014		126.5			80.2				
9/10/2014	174	96,610	96,483	554	65,319	65,239	375	161,722	929

Figure 10. Two water meters purchased and installed on March 20th, 2014 to measure pen wash down water additions to manure volume. Initial meters readings were 126.6 and 80.2 gallons for meter 1 and 2.

Figure 11. Two water meters purchased and installed on March 20th, 2014 to measure pen wash down water additions to manure volume. Meters readings were 96,609.6 and 65,319.3 gallons for meter 1 and 2 on September 10th, 2014.

Topographic Elevation Survey of Holding Ponds

To quantify potential precipitation additions to the manure volume, a topographic elevation survey of the catchments for the holding ponds was conducted utilizing total station survey equipment. This survey measured the elevation at various locations around the holding ponds, as well as points on the interior slopes and bottoms of the ponds. The survey was followed by a second survey utilizing a traditional transit and "Philidelphia rod," which measured elevation at various points on the outside the ponds to document drainage patterns away from the ponds. In addition, visual inspections and photographs were made to provide additional inputs. All this information was utilized to build a Graphical Information System (GIS) surface model that provides both precipitation capture area of the holding ponds and storage volumes of holding ponds (Table 9 and Figure 12). This pond information and historical rainfall information are being used to estimate potential precipitation additions to manure slurry volume.

Table 9. Summary information for the topographic survey surface modeling area and volume.

Pond	Area	Total volume [1]	Available storage [2]
	ft^2	gallon	gallon
Pond 1	16,999 [3]	743,011	616,395
Pond 2	34,618 [3]	1,977,675	1,723,009
Sum of Pond 1 & 2	51,617	2,720,686	2,339,403
Drainage area into ponds [4]	59,457	Not applicable	Not applicable

[1] Area of the top of the pond's 1 ft deep freeboard zone.
[2] Area in which water would drain into the ponds during a precipitation event.
[3] Total volume from the bottom of the pond to the top of the freeboard.
[4] Available storage is the total volume minus a 6 inch bottom layer assumed as unpumpable and the top 1 ft freeboard layer.

Figure 12. Yellow outer boundary denotes the drainage area (59,457 ft^2) into the holding ponds. The red inner boundary denotes area of the top of the free board for holding Pond 1 (16,999 ft^2) and Pond 2 (34,618 ft^2).

Chemical Manure Treatment Trials

A guiding concept of the chemical treatment trials is the goal of sustainable preferential separation of the manure into a P-rich portion for transport to more distant locations for utilization, and phosphorus-poor portion for closer utilization. In addition, due to the fact that P is a finite resource, it is desirable to retain P in manure for beneficial use, where P is needed for optimal crop production. For this reason, we investigated the effectiveness of calcium (Ca) binding with manure P enhanced by natural settling of manure solids. In principal, after addition of Ca to manure various Ca phosphate compounds are formed, which settle out with manure solids. Depending on the chemical and physical properties of the settled solids, the necessary mechanical and structural components of a manure separation system could be designed to meet the transportation needs and hopefully economic constraints of the farm enterprise. More detail of the manure treatment trials is given in Appendix 2.

Future Plan of Work

1. Analyze and interpret the ERI results for Fields 5a and 12 to determine the potential for subsurface areas of preferential flow pathways.
2. Continue to collect surface runoff, spring, and stream samples after each rainfall event from the autosamplers and manually collect baseflow samples weekly from the house well (when it is turned back on after the risk of freezing), spring, and streams. All samples will be analyzed for N, P, sediment, and bacteria within the confines of holding time requirements.
3. Collect water samples from the piezometers installed in Fields 5a and 12.
4. Re-install equipment to monitor flow, nutrients and sediment in Dry Creek entering Big Creek.
5. Repeat grid-soil sampling of Fields 1, 5a, and 12.
6. Continue to periodically determine plant uptake by collecting plant and hay samples for tissue analysis and determine yield (dry-matter mass for a pre-determined area).
7. Install equipment to measure the liquid flow from the production houses and determine pond height. In combination with weather data and interceptor trench monitoring, this will provide another indication of whether the holding ponds are leaking.
8. Precipitation inputs, average daily wash-down water, and manure holding pond volumes will be used to estimate annual manure and nutrient production values. These values, coupled with chemical treatment trial results, will form the basis for investigating manure management alternatives.

Appendix 1 – Electrical Resistivity Imaging Analysis Methods

Electrical Resistivity Imaging of Mantled Karst in the Buffalo River Basin, Arkansas

Todd Halihan, Professor, Boone Pickens School of Geology, Oklahoma State University

Electrical resistivity imaging (ERI) provides a good method to understand the distribution of fluids and rock properties in the subsurface environment especially in the presence of fractures or karst features (Bolyard, 2007, Smith et al., 2008, Gary et al., 2009, Halihan et al., 2009). The method allows an electrical image to be created with a resolution of half the distance between electrodes, which typically provides a meter-scale dataset that can be utilized to evaluate heterogeneity and fluid distribution. Improvements in sensitivity generated by the Halihan/Fenstemaker method (OSU, 2004) allow greater differentiation of these signatures (Miller et al, in press). In a field setting, this will result in a two-dimensional mapping of subsurface electrical properties for each dataset.

For these experiments, the electrical imaging will be conducted on a one time basis to evaluate rock properties, but can also be repeated on a pre- and post-infiltration basis to generate images of changes in the electrical properties (Albano et al., 2010, Halihan et al., 2011). These transient datasets will allow an understanding of changes in fluid electrical properties as the infiltrating fluid and associated reactions will be the only subsurface change. The datasets will be used to interpret groundwater movement in a complex mantled karst with applied agricultural waste.

As part of cooperative research, Oklahoma State University (OSU) will design and conduct ERI imaging experiments and integrate ERI data with well data and other site data to provide an understanding of the subsurface distribution of flowpaths at a background and waste application study sites. Dr. Todd Halihan and his graduate research assistant (OSU) will travel to the sites to assist in experimental setup of the imaging and collecting initial data. University of Arkansas (UA) will provide 2-3 field assistants to aid in collecting data and clearing brush as needed. Aestus, LLC will be utilized to provide 3-D visualization of the field data utilizing RockWorks™. Data analysis and reporting will be performed in conjunction with research team members at UA and Aestus, LLC. The work is anticipated to begin 1 October 2014 and conclude 30 September 2015.

Potential hurdles for the research are field logistics and constraints due to site access and stream access. For this site, data quality is anticipated to be high due to the geologic setting lacking metallic infrastructure. The resistivity structure of the site will be evaluated with OSU working with UA and Aestus to ensure proper integration of the ERI acquisition location and scale with the UA well and soil sampling protocols.

The results of the work will be reported to UA, and published in appropriate journal locations. The work is intended to be applied to understanding best management practices for conducting land application of agricultural waste in karstic settings.

1.0 Scope of Work

ERI data will be collected at two sites near Mount Judea, Arkansas (Figure 1). A total of 18 ERI lines are planned to be acquired and visualized in 3-D. Current planning involves acquiring data along 10 transect lines at the northern site (MJN; Site 1) (Figures 1 and 2), and 8 transect lines at the southern site (MJS; Site 2) (Figures 1 and 3). A dozen lines will be acquired at a ~1.5 meter resolution (3 meter electrode spacing), providing datasets that are ~165 meters long horizontally with a depth of imaging of approximately 33 meters. An additional six higher resolution transect lines are planned at a ~0.5 meter resolution (1 meter electrode spacing) to provide higher resolution imaging of pathways observed during the acquisition of the coarser data for each site. It is anticipated that two field acquisition efforts will be required to ensure proper data acquisition and integration. The locations of lines may need to be shifted as field conditions dictate, relative to land access or thick vegetation.

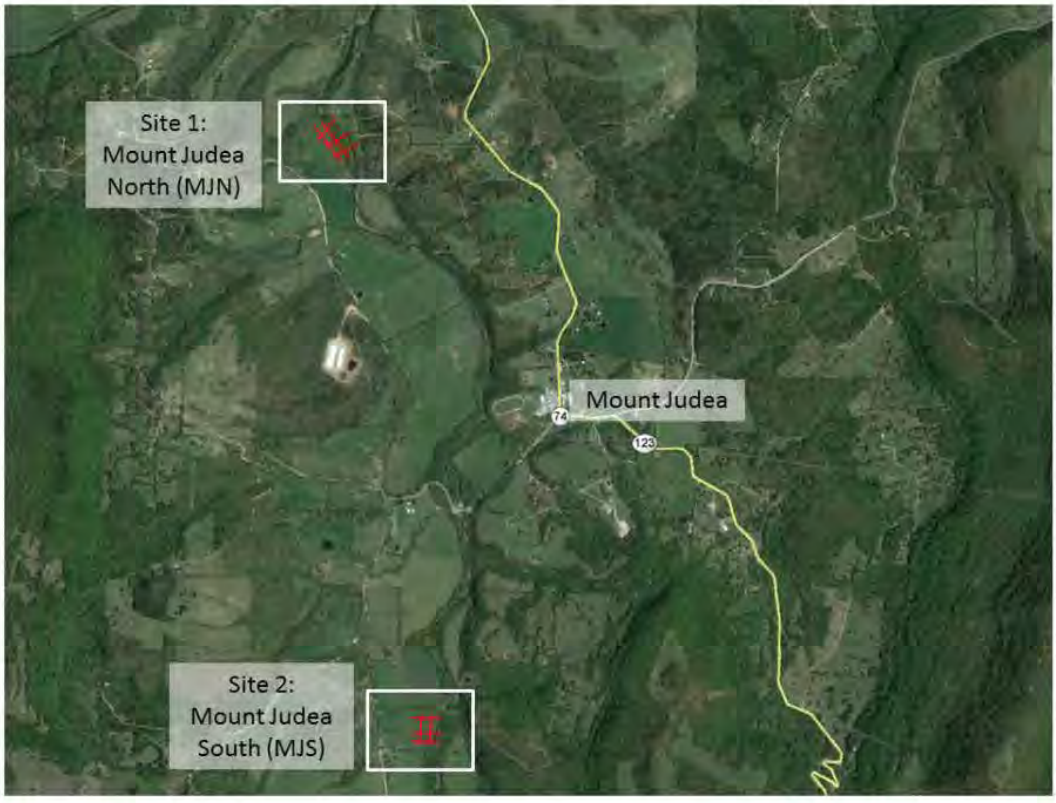

Figure 1. Location of sites for ERI imaging near Mount Judea, Arkansas.

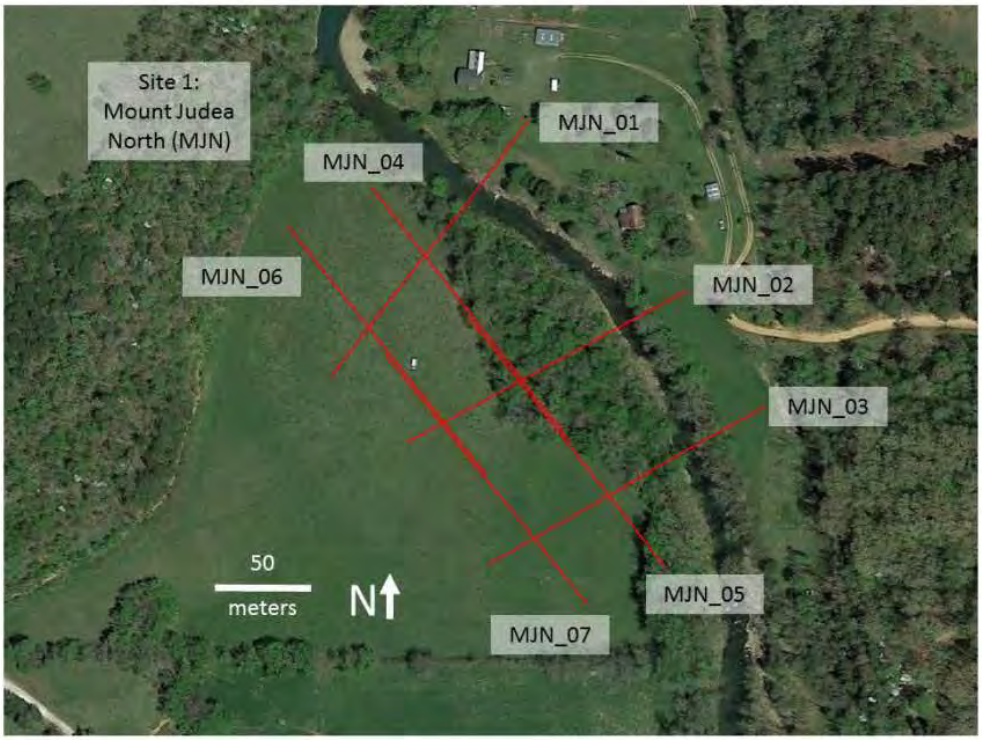

Figure 1. Location of ERI lines at northern (downgradient) site MJN. Seven 165 meter long lines illustrated. 3 additional high resolution lines (placement not shown) will be acquired after evaluating initial data.

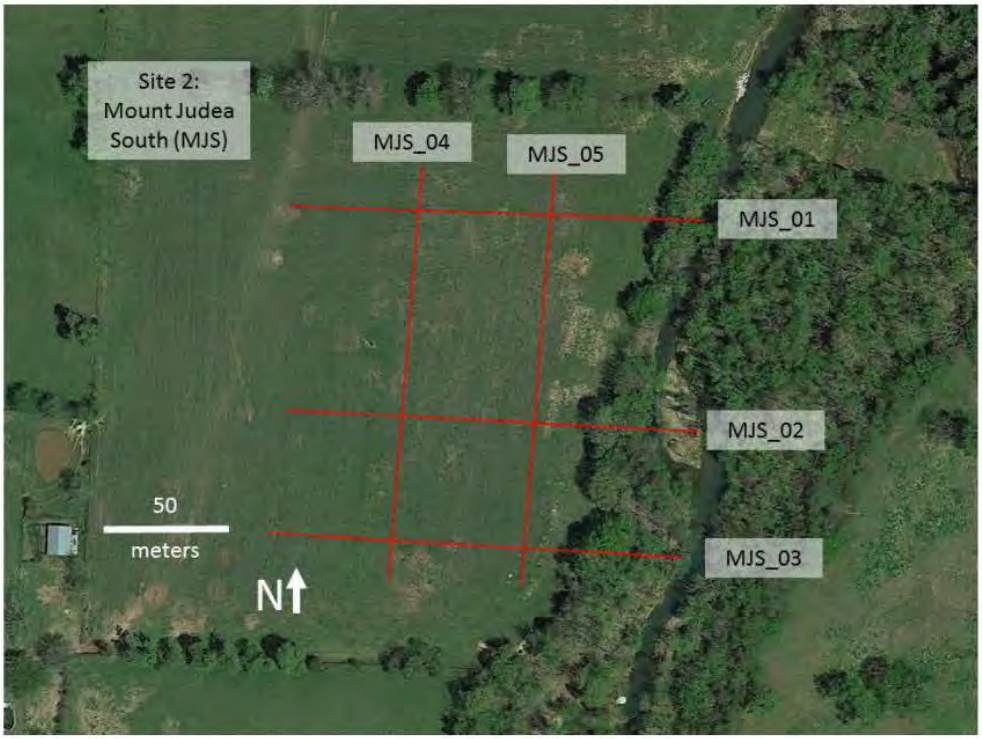

Figure 2. Location of ERI lines at southern (upgradient) site MJS. Five 165 meter long lines illustrated. 3 additional high resolution lines (placement not shown) will be acquired after evaluating initial data.

1.0.1 Assumptions for OSU

The work plan assumes the following for OSU:

1. OSU will utilize their own resistivity instrumentation for acquisition of ERI data.
2. OSU will utilize their own GPS instrumentation for acquisition of 3-D survey data.
3. ERI data can be obtained on the sites as they are largely natural settings.
4. GPS can be obtained on the sites as they are largely cleared fields.
5. OSU will work with Aestus, LLC to visualize the data. Note that Dr. Halihan has a managed conflict of interest between OSU and Aestus, LLC.

1.0.2 Assumptions for UA

The work plan assumes the following for UA:

1. UA will provide 2-3 field assistants on site to assist with acquiring ERI and survey data.
2. UA will work with land owners to obtain legal access for the OSU field team and answer questions regarding the field work.
3. UA will provide well data to OSU to include in the visualization model of the site data.

3.0 References

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Appendix 2 – Summary of Chemical Manure Treatment Trials

Two sources of Ca for the trials were Ca hydroxide ($Ca(OH)_2$) and agricultural lime ($CaCO_3$). The Ca hydroxide was added to manure slurry in either a liquid slurry form (30% by weight) or as a dry powder. The agricultural lime was added in the dry fine granular form, which is routinely land applied to adjust soil pH. Liquid slurry Ca hydroxide was applied to manure slurry on a volumetric (mL/mL) basis at 0, ½, 1, and 2 times the target treatment rate. The target treatment rate was determined by mixing various amounts of Ca hydroxide slurry to 500 mL of manure in clear containers. After allowing time for settling, a visual inspection was used to set the target treatment rate as 5%, (50 mL/1000 mL) (Figure 13). The dry Ca addition rates were at equivalent elemental Ca rates as the liquid Ca treatments (Table 10).

Figure 13. Calcium hydroxide slurry treatment test results. Bottle labels represent 0, 1, 2, 3, 4, 6, 8, and 10% Ca treatments. Based on both the clarity of the top liquid and settled solids a target rate of 5% was select for the chemical amendment trial.

Table 10. Chemical treatment rates based a 5% (mL/mL) target mixture rate of Ca hydroxide to manure slurry and 17 liters of manure slurry.

Chemical and form	Treatment rate			
	O x Target rate	½ x Target rate	1 x Target rate	2 x Target rate
Ca Hydroxide, 30% (gm/gm) slurry	0 mL	425 mL	850 mL	1700 mL
Ca Hydroxide, dry powder	O gm	154 gm	307 gm	614 gm
Ca Carbonate, dry fine granular	O gm	207 gm	415 gm	830 gm

As any chemical treatment system would likely treat the manure as it discharges from the barns and before it enters holding Pond 1, a manure collection and mixing system was designed for this chemical trial (Figure 14). On the day of the trial (September 4th, 2014), a pump was used to capture a portion of the manure discharged from the barns into holding Pond 1 as one of the manure pits was being drained. The captured manure was pumped into a 360 gallon tank via two mixing nozzles to ensure uniform mixing of the manure slurry in the tank.

Once this tank was filled, a discharge valve was opened to drain a portion of the collected manure into holding Pond 1. By adjusting the discharge valve and pump throttle, the manure flow rate into and out of the tank were balanced resulting in the tank manure volume remaining fixed (Figure 14). This balanced-flow process continued until the manure pit in the barn had been drained and a composite sample of all the manure slurry from the drained pit was collected. After manure was collected was completed, valves were closed so that the pump continually mixed manure slurry in the tank (Figure 14).

Figure 14. Manure collection and mixing system. Discharge valve for pulling manure for treatment is above the front corner of the tank base.

Manure was drained from the tank into 5 gallon buckets in 17 liter volumes as needed for the chemical treatments. Before any settling could occur, the mixture was poured into a second bucket lined with a filter bag and a subsample collected for analysis. This process was repeated until three replicates of each chemical/rate combination in Table 10 had been prepared.

At this time the each filter bag was lifted from its bucket and allowed to drain for 3 minutes. Then samples of the concentrated manure slurry in the filter bag and the leachate from the bucket were sampled for analysis.

After the manure from the filter bags were sampled, tripods were used to suspend them above their bucket (Figure 15). The combination of buckets and tripods were placed under a cover, which allowed for full air movement while protecting them from rainfall and damage from animals. After 5

days (September 9th, 2014), the filter bags were dry enough that they were placed on tables to reduce the potential for wind damage and rewetting of the bags (Figure 16). On September 15th, 2014, a total of 10 days after treatment, the manure slurry mixture in the filter bags and leachate in the 5 gallon buckets was mixed and sampled for analysis.

Figure 15. Filter bags containing separated manure slurry suspended above their respective buckets of leachate.

Figure 16. Leachate buckets and filter bags after the separated solids were dry enough for placement on tables for additional drying.

A total of 93 samples were collected the day the manure slurry was treated, with an additional 62 samples collected after treatment for 10 days. The chemical analyses have been completed and the results have begun to be analyzed for the next phase of the manure treatment trial. Initial information from the first trial and descriptive codes of the manure slurry samples are given in Tables 11 and 12.

Table 11. Descriptive code format for chemically treated manure samples.

Treatment		
	Ca source/Rate/Material sampled/ Day sample collected/Replicate	
Example	LS 1 M 1 A	
Interpretation	Lime Slurry, 1 x target rate, mixed, day of treatment, first replicate	
Ca Source		
LS	Lime Surry on 30% wt. basis	
HL	Hydrated lime dry powder	
AL	Ag Lime Dry granules	
CS	Control sample	
Rate		
0	Control no additive	
0.5	1/2 x Target Rate	
1	1 x Target Rate	
2	2 x Target Rate	
Material Sampled		
M	Mixed after Ca addition prior to filtering	
L	Leachate after filtration	
P	Precipitate after filtration	
Day Sample Collected		
1	Sampled day of treatment	
2	Sampled after days of storage	
Replication		**Control Sample Details**
A	1st Replicate	Control Sample collected prior to LS samples
B	2nd Replicate	Control Sample collected prior to HS samples
C	3rd Replicate	Control Sample collected prior to AL samples
D	4th Replicate	Control Sample collected after AL samples

Table 12. Analysis results summary form chemically treated manure samples.

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Ca	Water extractable P
	%		mg/kg						
1CS0LA	0.96	7.56	1476	803	BDL	325	1335	176	152
1CS0LB	0.89	7.62	1289	730	BDL	318	1358	207	141
1CS0LC	1.08	7.60	1467	737	BDL	428	1323	299	144
1CS0LD	0.94	7.61	1486	743	BDL	315	1272	246	102
1CS0L Average	**0.97**	**7.60**	**1429**	**753**		**346**	**1322**	**232**	**135**
1LS½LA	0.91	10.32	1252	570	BDL	101	1320	299	19
1LS½LB	1.06	12.70	833	497	BDL	45	1258	872	9
1LS½LC	0.92	10.09	1145	583	BDL	115	1305	356	20
1LS½L Average	**0.96**	**11.04**	**1077**	**550**		**87**	**1294**	**509**	**16**
1LS1LA	0.96	12.66	891	398	BDL	22	1222	592	9
1LS1LB	1.00	12.67	980	507	BDL	34	1201	709	9
1LS1LC	0.89	12.68	1011	474	BDL	35	1270	690	11
1LS1L Average	**0.95**	**12.67**	**961**	**460**		**30**	**1231**	**664**	**9**
1LS2LA	1.07	12.72	938	457	BDL	27	1200	942	6

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Ca	Water extractable P
1LS2LB	1.20	12.75	916	440	BDL	27	1217	999	5
1LS2LC	1.06	12.72	858	491	BDL	25	1207	938	6
1LS2L Average	**1.11**	**12.73**	**904**	**463**		**26**	**1208**	**959**	**6**
1HL½LA	0.93	9.09	1213	711	BDL	187	1327	422	51
1HL½LB	0.94	8.90	1246	707	BDL	220	1351	405	57
1HL½LC	0.98	8.87	1294	721	BDL	259	1344	432	58
1HL½L Average	**0.95**	**8.95**	**1251**	**713**		**222**	**1341**	**419**	**56**
1HL1LA	0.93	9.19	1290	683	BDL	185	1329	406	56
1HL1LB	0.91	9.38	1249	683	BDL	141	1320	392	41
1HL1LC	0.91	9.57	1245	689	BDL	135	1281	464	36
1HL1L Average	**0.92**	**9.38**	**1261**	**685**		**154**	**1310**	**421**	**44**
1HL2LA	0.89	12.24	1133	511	BDL	58	1294	409	17
1HL2LB	0.99	12.60	1149	529	BDL	53	1323	559	12
1HL2LC	0.99	12.55	1155	522	BDL	56	1282	503	13
1HL2L Average	**0.96**	**12.46**	**1145**	**521**		**56**	**1300**	**490**	**14**
1AL½LA	0.91	7.56	1323	693	BDL	270	1264	210	153

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Ca	Water extractable P
1AL½LB	0.90	7.62	1335	719	BDL	291	1310	250	92
1AL½LC	0.93	7.60	1351	766	BDL	308	1346	270	71
1AL½L Average	**0.91**	**7.59**	**1336**	**726**		**290**	**1307**	**243**	**105**
1AL1LA	1.07	7.58	1361	736	BDL	352	1316	615	84
1AL1LB	0.90	7.61	1319	776	BDL	271	1291	270	75
1AL1LC	0.97	7.58	1350	764	BDL	292	1336	351	82
1AL1L Average	**0.98**	**7.59**	**1343**	**759**		**305**	**1315**	**412**	**80**
1AL2LA	0.98	7.61	1319	759	BDL	290	1313	494	78
1AL2LB	1.19	7.62	1372	758	BDL	350	1312	920	89
1AL2LC	1.08	7.63	1334	732	BDL	312	1300	682	84
1AL2L Average	**1.08**	**7.62**	**1342**	**750**		**317**	**1308**	**699**	**84**
1CS0PA	2.50	7.45	2037	851	BDL	1090	1431	926	226
1CS0PB	2.67	7.45	1940	803	BDL	1166	1393	1086	213
1CS0PC	4.53	7.33	2709	782	BDL	2068	1368	1974	300
1CS0PD	3.86	7.28	2689	810	BDL	1763	1327	1717	258
1CS0P Average	**3.39**	**7.38**	**2344**	**812**		**1522**	**1380**	**1426**	**249**

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Ca	Water extractable P
1LS½PA	8.00	12.48	2358	610	0.35	2355	1430	15573	21
1LS½PB	10.10	12.49	2611	653	BDL	2787	1345	17487	22
1LS½PC	8.05	12.51	2447	612	BDL	2371	1416	14752	21
1LS½P Average	**8.71**	**12.49**	**2472**	**625**	**0.35**	**2505**	**1397**	**15937**	**21**
1LS1PA	11.54	12.72	2739	705	BDL	2138	1299	23213	11
1LS1PB	11.62	12.71	2719	683	0.35	2167	1280	23904	14
1LS1PC	13.76	12.70	3208	762	0.50	2754	1339	29446	17
1LS1P Average	**12.31**	**12.71**	**2889**	**716**	**0.43**	**2353**	**1306**	**25521**	**14**
1LS2PA	12.66	12.75	2184	653	BDL	1731	1262	34284	4
1LS2PB	11.25	12.74	1975	580	BDL	1487	1245	30856	2
1LS2PC	10.42	12.74	1972	617	BDL	1411	1251	28106	2
1LS2P Average	**11.45**	**12.74**	**2044**	**617**		**1543**	**1253**	**31082**	**3**
1HL½PA	14.43	12.67	3020	838	BDL	3098	1350	29408	16
1HL½PB	13.37	12.65	3011	777	BDL	2574	1222	24630	14
1HL½PC	10.05	12.68	2606	798	BDL	2282	1329	19686	14
1HL½P Average	**12.62**	**12.67**	**2879**	**804**		**2651**	**1300**	**24575**	**15**

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Ca	Water extractable P
1HL1PA	11.19	12.74	2668	741	BDL	2611	1323	23139	15
1HL1PB	15.05	12.76	2704	860	BDL	2638	1276	33244	7
1HL1PC	16.61	12.75	2726	783	0.67	2731	1245	39822	5
1HL1P Average	**14.28**	**12.75**	**2699**	**795**	**0.67**	**2660**	**1281**	**32068**	**9**
1HL2PA	20.51	12.78	2301	648	BDL	2086	1173	52339	3
1HL2PB	21.31	12.80	2343	654	BDL	1999	1158	54756	3
1HL2PC	18.94	12.80	2336	736	BDL	1884	1192	47195	3
1HL2P Average	**20.25**	**12.79**	**2327**	**679**		**1990**	**1174**	**51430**	**3**
1AL½PA	9.39	7.16	3207	855	BDL	2950	1308	15912	531
1AL½PB	7.33	7.32	2991	874	BDL	2273	1258	11874	402
1AL½PC	9.17	7.26	2972	874	BDL	2681	1266	13791	509
1AL½P Average	**8.63**	**7.25**	**3056**	**868**		**2635**	**1277**	**13859**	**481**
1AL1PA	7.25	7.34	2674	824	BDL	1922	1274	13517	370
1AL1PB	11.62	7.17	3085	874	BDL	2588	1194	26354	530
1AL1PC	8.00	7.18*	2718	847	BDL	2233	1343	15489	413
1AL1P Average	**8.95**	**7.23**	**2826**	**848**			**1270**	**18454**	**438**

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Ca	Water extractable P
1AL2PA	19.63	7.20	2600	787	BDL	2330	1233	36401	626
1AL2PB	14.88	7.23	3014	823	BDL	2444	1252	38626	533
1AL2PC	19.84	7.28	3284	817	BDL	2551	1160	47155	657
1AL2P Average	**18.12**	**7.24**	**2966**	**809**		**2442**	**1215**	**40727**	**605**
2CS0LA	1.11	7.97	991	483	BDL	499	1536	246	127
2CS0LB	1.21	8.00	874	420	BDL	516	1515	845	147
2CS0LC	1.09	8.11	881	406	BDL	476	1555	220	147
2CS0LD	1.09	8.06	969	462	BDL	509	1538	263	125
2CS0L Average	**1.12**	**8.04**	**929**	**443**		**500**	**1536**	**393**	**137**
2LS½LA	1.00	8.52	335	65	BDL	178	1527	755	27
2LS½LB	1.03	8.77	341	66	BDL	184	1416	739	25
2LS½LC	1.16	8.34	440	94	BDL	288	1450	1182	38
2LS½L Average	**1.06**	**8.54**	**372**	**75**		**217**	**1465**	**892**	**30**
2LS1LA	1.07	12.54	190	17	BDL	92	1541	1172	10
2LS1LB	0.95	12.55	207	43	0.45	62	1435	848	10
2LS1LC	0.93	12.46	193	35	BDL	58	1408	755	10

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Ca	Water extractable P
2LS1L Average	**0.98**	**12.52**	**197**	**32**	**0.45**	**71**	**1461**	**925**	**10**
2LS2LA	2.02	12.71	196	44	BDL	120	1429	3193	4
2LS2LB	1.71	12.72	161	36	BDL	67	1453	2158	4
2LS2LC	2.00	12.70	212	47	BDL	111	1367	3190	5
2LS2L Average	**1.91**	**12.71**	**190**	**42**		**99**	**1416**	**2847**	**5**
2HL½LA	0.54	8.24	420	198	BDL	128	879	277	37
2HL½LB	0.60	8.17	453	217	0.55	148	920	268	38
2HL½LC	0.65	8.04	519	215	BDL	233	1118	440	42
2HL½L Average	**0.60**	**8.15**	**464**	**210**	**0.55**	**170**	**972**	**328**	**39**
2HL1LA	1.18*	8.31	601	207	BDL	316	1524	897	45
2HL1LB	1.16	8.37	562	208	BDL	299	1546	1147	40
2HL1LC	1.26	8.30	553	196	BDL	300	1581	1198	46
2HL1L Average	**1.20**	**8.33**	**572**	**204**		**305**	**1551**	**1081**	**44**
2HL2LA	1.07	9.60	216	42	0.45	183	1292	1500	18
2HL2LB	1.30	12.21	242	21	BDL	132	1539	1063	13
2HL2LC	1.41	12.42	329	62	BDL	204	1511	1721	11

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Ca	Water extractable P
2HL2L Average	**1.26**	**11.41**	**262**	**42**	**0.45**	**173**	**1447**	**1428**	**14**
2AL½LA	1.18*	7.95	1002	495	BDL	491	1485	822	162
2AL½LB	1.21	8.02	933	420	BDL	500	1494	815	158
2AL½LC	0.67	7.86	644	377	BDL	280	1054	88	115
2AL½L Average	**1.02**	**7.94**	**860**	**431**		**423**	**1345**	**575**	**145**
2AL1LA	1.34	8.10	948	475	BDL	490	1595	1268	151
2AL1LB	1.34	8.01	954	447	0.36	492	1542	1332	151
2AL1LC	1.33	8.01	956	436	BDL	514	1565	1382	140
2AL1L Average	**1.34**	**8.04**	**952**	**453**	**0.36**	**499**	**1567**	**1327**	**147**
2AL2LA	1.44	8.10	931	454	BDL	431	1528	1826	147
2AL2LB	1.34	8.13	951	452	BDL	436	1510	1835	145
2AL2LC	1.30	8.09	874	444	BDL	416	1536	1688	141
2AL2L Average	**1.36**	**8.11**	**918**	**450**		**428**	**1525**	**1783**	**144**
2CS0PA	27.70	8.80	9652	1153	BDL	12692	3053	14069	1059
2CS0PB	26.73	8.86	12258	1151	BDL	14631	3542	16162	977
2CS0PC	25.00	8.08	8605	760	BDL	12413	3975	13003	1222

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Ca	Water extractable P
2CS0PD	30.69	8.96	12838	1266	BDL	15026	3694	15962	1246
2CS0P Average	**27.53**	**8.68**	**10838**	**1083**		**13690**	**3566**	**14799**	**1126**
2LS½PA	28.61	9.24	4051	254	BDL	9551	2491	65309	196
2LS½PB	23.83	8.31	3988	82	3.05	9929	2628	67821	227
2LS½PC	31.64	8.90	4140	172	BDL	9770	2769	65084	184
2LS½P Average	**28.03**	**8.82**	**4060**	**169**	**3.05**	**9750**	**2629**	**66071**	**203**
2LS1PA	34.58	12.60	4072	178	BDL	9053	2767	104067	35
2LS1PB	32.26	12.64	4137	157	5.39	7509	2104	88832	26
2LS1PC	30.78	12.63	3934	155	2.19	7633	2116	85937	32
2LS1P Average	**32.54**	**12.62**	**4047**	**164**	**3.79**	**8065**	**2329**	**92945**	**31**
2LS2PA	34.18*	12.70	1316	138	BDL	5520	1872	128405	20
2LS2PB	33.78	12.66	3234	146	BDL	5521	1920	125661	21
2LS2PC	33.53	12.65	2500	174	BDL	5511	1740	117627	21
2LS2P Average	**33.83**	**12.67**	**2350**	**153**		**5517**	**1844**	**123898**	**21**
2HL½PA	31.84	12.46	4857	317	2.19	10120	2856	80281	57
2HL½PB	31.75	12.62	4519	419	2.31	10691	2898	69858	51

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Ca	Water extractable P
2HL½PC	34.16	12.61	4148	420	4.53	11973	4206	80854	23
2HL½P Average	**32.58**	**12.56**	**4508**	**385**	**3.01**	**10928**	**3320**	**76998**	**43**
2HL1PA	41.55	12.68	3803	142	BDL	7187	1737	133242	12
2HL1PB	36.82	12.69	3255	136	BDL	7229	2240	119635	17
2HL1PC	38.34	12.67	3177	131	BDL	6208	2059	138827	21
2HL1P Average	**38.91**	**12.68**	**3412**	**137**		**6875**	**2012**	**130568**	**17**
2HL2PA	36.12	12.65	2657	118	BDL	7463	1987	128798	11
2HL2PB	39.26	12.70	2942	111	BDL	5563	1915	144154	9
2HL2PC	39.30	12.68	2498	100	BDL	5666	2154	148989	13
2HL2P Average	**38.23**	**12.68**	**2699**	**110**		**6231**	**2019**	**140647**	**11**
2AL½PA	47.66	8.60	9825	1071	BDL	10570	2718	113632	1436
2AL½PB	60.96	8.55	7554	807	BDL	10985	2850	147508	1909
2AL½PC	52.86	8.62	8470	1071	BDL	11909	2785	120942	1739
2AL½P Average	**53.83**	**8.59**	**8617**	**983**		**11155**	**2785**	**127360**	**1695**
2AL1PA	72.86	8.66	3962	813	BDL	11283	3212	139127	1929
2AL1PB	54.15	8.24	9354	818	BDL	8525	2180	170099	1658

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Ca	Water extractable P
2AL1PC	59.20	8.90	5333	705	BDL	13064	3249	127705	1644
2AL1P Average	**62.07**	**8.60**	**6216**	**779**		**10957**	**2880**	**145644**	**1744**
2AL2PA	69.06	8.68	4961	802	BDL	9912	2544	155240	1765
2AL2PB	71.56	8.84	3226	497	BDL	3432	947	213582	1514
2AL2PC	69.92	8.73	5631	674	BDL	6936	1762	185573	1656
2AL2P Average	**70.18**	**8.75**	**4606**	**658**		**6760**	**1751**	**184798**	**1645**

BDL is the Below Detection Limit of nitrate-N in slurry materials.

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Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – January 1 to March 31, 2015

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

The mission of the **Division of Agriculture** is to advance the stewardship of natural resources and the environment, cultivate the improvement of agriculture and agribusiness, develop leadership skills and productive citizenship among youth and adults, enhance economic security and financial responsibility among the citizens of the state, ensure a safe, nutritious food supply, improve the quality of life in communities across Arkansas, and strengthen Arkansas families.

Dr. Mark J. Cochran
Vice President for Agriculture

Executive Summary

This is the first Quarterly Report of 2015 for the Big Creek Research and Extension Team that details the following progress made from January 1 through March 31, 2015.

1. Continued collection weekly baseflow and periodic storm flow water samples from Big Creek above and below the C&H Farm, along with water from the spring, culvert, surface runoff sites on Fields 1, 5a, and 12, interceptor trench below the slurry holding ponds, and house well for chemical analysis. Occasional inclement weather and freezing conditions limited access to sites and collection of water samples.
2. All sites are fully functional after being brought off-line during the extreme cold winter weather conditions; where the likelihood of freezing will cause costly damage to autosampler pumping equipment.

Big Creek Research Team

Faculty

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Brian Breaker, M.Sc., Hydrologic Technician, stream flow and constituent collection, analysis, and statistical evaluation of trends.

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Rick Cartwright, Ph.D., Professor – Associate Director of Extension for Agriculture and Natural Resources

Mark Cochran, Ph.D., – Vice President, University of Arkansas System Division of Agriculture.

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Ed Gbur, Ph.D., Professor and Director, Agricultural Statistics Laboratory - Experimental design, linear and generalized linear mixed models, regression, agricultural applications of statistics.

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Phil Hays, Ph.D. Ground Water Specialist, U.S. Geological Survey and Research Professor with Geosciences Dept., University of Arkansas, application of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems

Tim Kresse, M.Sc., Water Quality Specialist, U.S. Geological Survey, natural geochemical evolution of groundwater and separating these processes from anthropogenic sources of contamination

Nathan McKinney, Ph.D., – Assistant Director, Agriculture Experiment Station

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Thad Scott, Ph.D., Associate Professor - Water quality, transport of contaminants to and within water bodies

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Jun Zhu, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians

The Big Creek Research and Extension Team are ably supported by several excellent Program Technicians based in Little Rock and Fayetteville.

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Water Sampling and Analyses

Sampling Locations

Water quality monitoring sites are shown in Figure 6 and are;

Site 1. Edge-of-field monitoring on Field 1 permitted to receive slurry.

Site 2. Edge-of-field monitoring on Field 5a.

Site 3. Edge-of-field monitoring on Field 12 permitted to receive slurry.

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities.

Site 5. Spring below Field 1.

Site 6. Big Creek upstream of the C&H Farm operation.

Site 7. Big Creak downstream of the C&H Farm operation.

Site 8. Manure holding pond trench. The site was visited weekly and trench water sampled when flowing. The trenches flow periodically and flow measurement equipment will be installed during the first quarter of 2015.

Sampling Protocols and Analyses

The following protocols were used to collect, prepare, and analyze all water samples:

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted and samples were placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
6. Analyses included Dissolved Phosphorus (EPA 365.2), Total Phosphorus (APHA 4500-P), Ammonia (EPA 351.2), Nitrate (EPA 300.0), Total Nitrogen (APHA 4500-N), Total Suspended Solids (EPA 160.2), E. coli (APHA 9223, B) and Total Coliforms (APHA 9223, B). APHA is American Public Health Association from the Wadeable Streams Assessment, Water Chemistry Laboratory Manual http://www.epa.gov/owow/monitoring/wsa/WRS_lab_manual.pdf
7. The minimum detection limits (MDLs) for each chemical and biological constituent measured are listed in Table 3.
8. Chemical and biological analyses of samples collected in the 4th Quarter of 2014 are presented in Tables 4, 5, and 6.

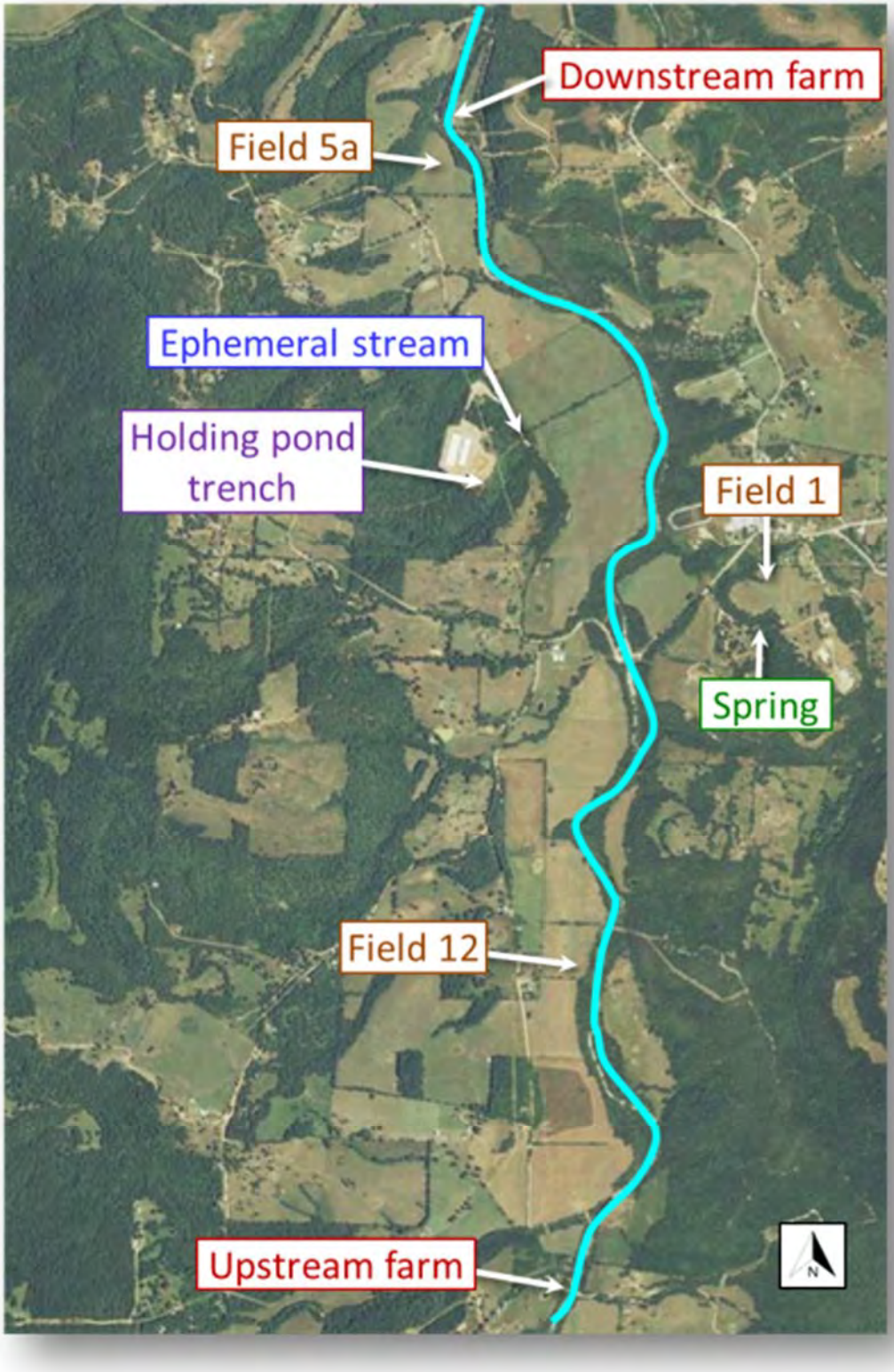

Figure 1. Location of water quality sampling sites on Big Creek and the C&H Farm.

Table 1. Minimum detection limits (MDLs) for each chemical and biological constituent measured.

Constituent	Minimum detection limit
Dissolved P, mg L^{-1}	0.002
Total P, mg L^{-1}	0.012
Ammonia-N, mg L^{-1}	0.03
Nitrate-N, mg L^{-1}	0.004
Total N, mg L^{-1}	0.006
Total suspended solids, mg L^{-1}	6.58
Dissolved organic carbon, mg L^{-1}	0.18
E. coli, MPN 100 mL^{-1}	1
Total coliform, MPN 100 mL^{-1}	1

USGS Stations

Big Creek Continuous Flow

We are collaborating with USGS, Big Creek at the downstream site of prior water sample collection, which was instrumented with continuous flow gaging equipment and a nitrate sensor, which provides real-time flow, water temperature, water nitrate and precipitation data. These data are available on line at the USGS website below. Flow, Creek temperature, precipitation, and nitrate for from the USGS downstream site for the last quarter is given in Figures 2, 3, 4, and 5.

USGS 07055790 Big Creek near Mt. Judea, AR

http://nwis.waterdata.usgs.gov/ar/nwis/uv/?site_no=07055790&agency_cd=USGS

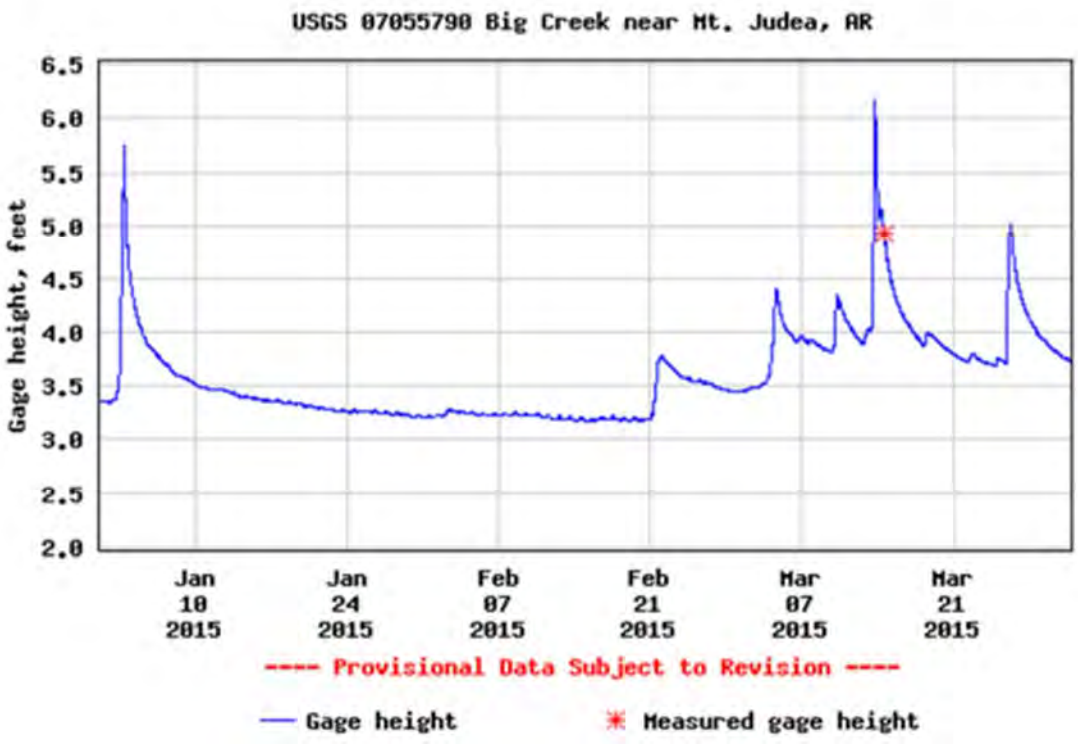

Figure 2. Flow at the Big Creek monitoring site downstream of the C&H Farm during the 1st quarter of 2015.

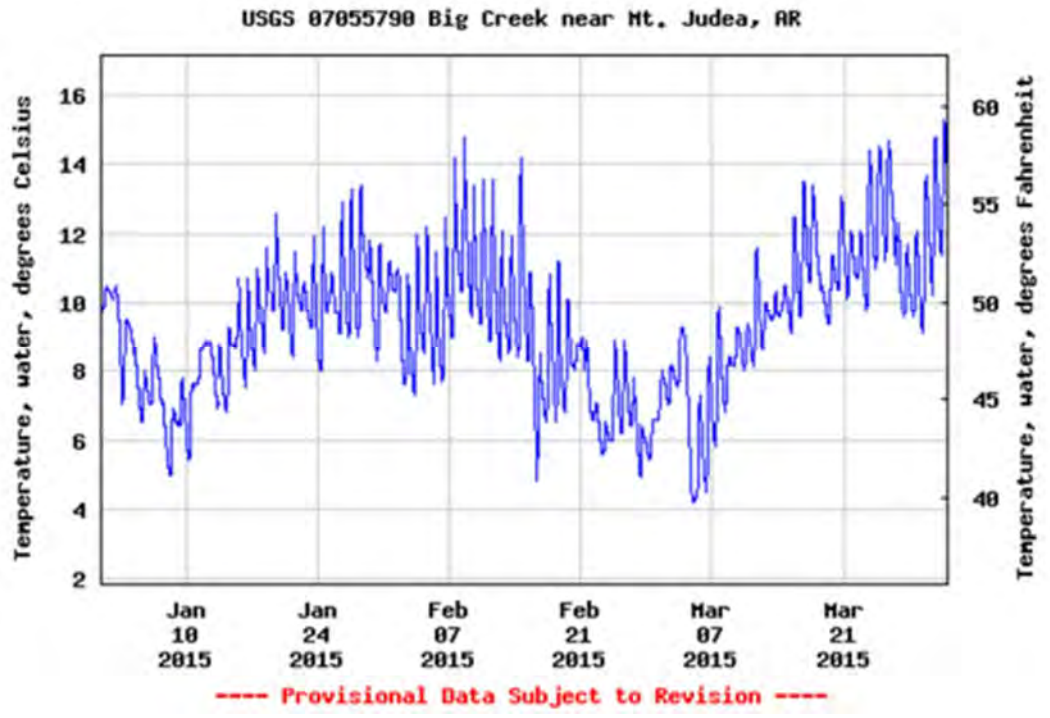

Figure 3. Water temperature at the Big Creek monitoring site downstream of the C&H Farm during the 1st quarter of 2015.

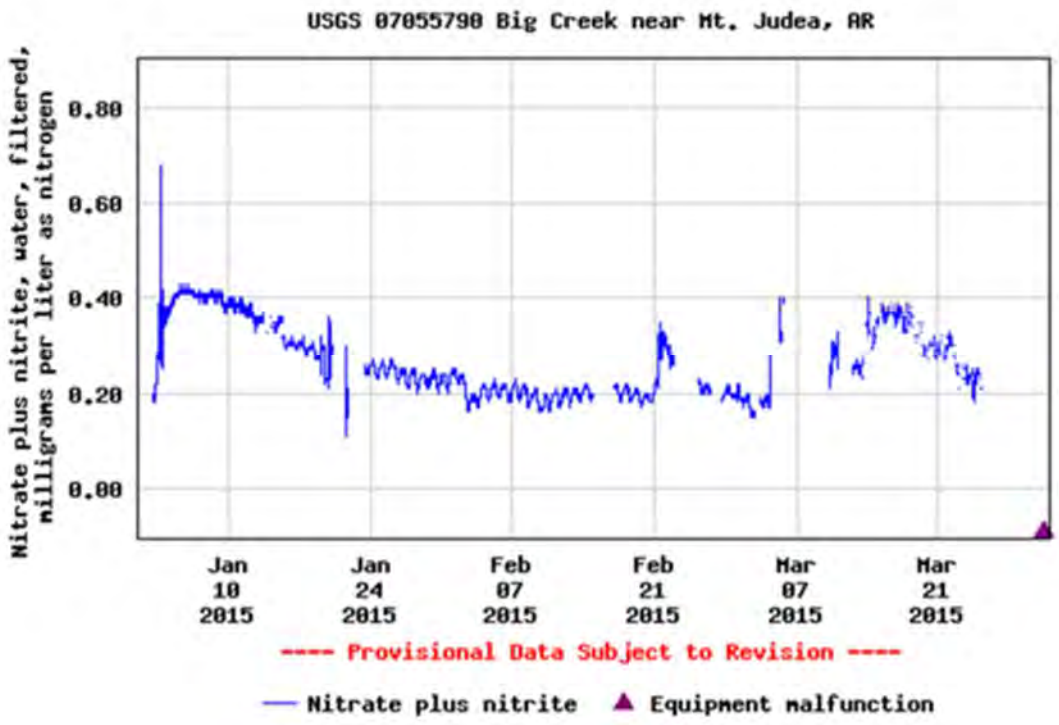

Figure 4. Precipitation at the Big Creek monitoring site downstream of the C&H Farm during the 1st quarter of 2015.

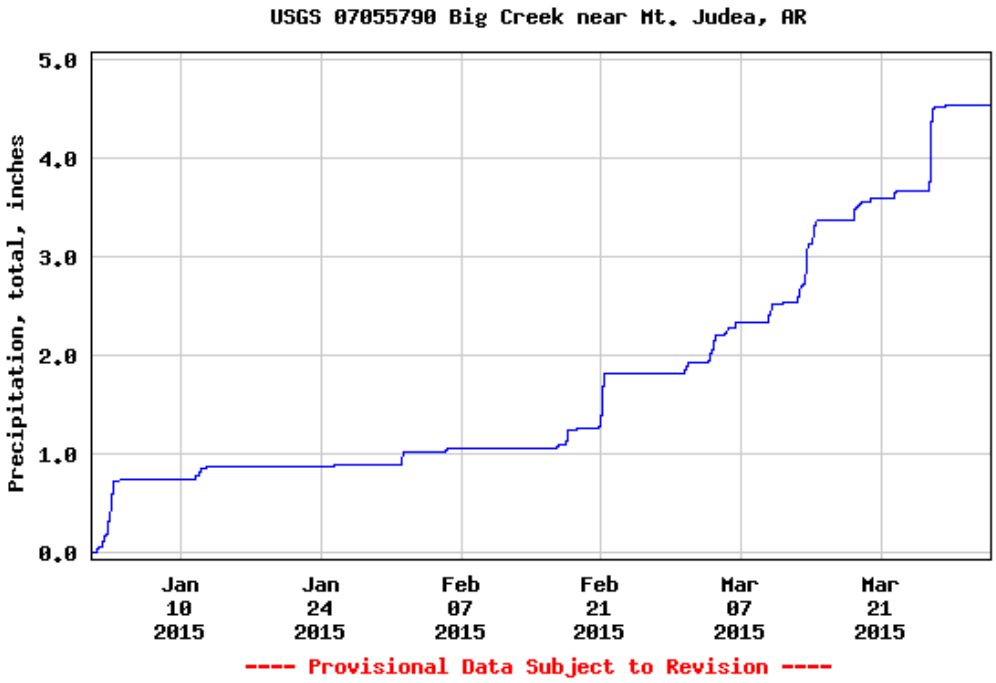

Figure 5. Nitrate concentration at the Big Creek monitoring site downstream of the C&H Farm during the 1st quarter of 2015.

Table 2. Water quality analyses at each sample site. Coliform units are Most Probable Number (MPN) per 100 mL of water for the 1st Quarter of 2015.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
			mg/L							MPN/100 mL	
12/4/2014	**12/4/2014**	**Base flow**									
10:49	15:25	Spring	0.007	0.024	<0.03	0.317	0.50	2.3	5.57	5.2	1120
11:10	15:25	Upstream farm	0.011	0.022	<0.03	0.103	0.13	0.7	2.94	45.7	1850
10:35	15:25	Downstream farm	0.013	0.024	<0.03	0.264	0.33	1.5	2.98	7.4	2990
11:05	15:25	Dry Creek	0.012	0.030	<0.03	0.167	0.21	0.7	2.30	27.8	1553.1
12/9/2014	**12/9/2014**	**Storm flow**									
10:00	14:00	Spring	0.008	0.024	<0.03	0.295	0.48	2.3	4.26	18.9	1203
10:33	14:00	Upstream farm	0.011	0.024	<0.03	0.057	0.09	0.5	1.60	36.4	1986
9:38	14:00	Downstream farm	0.013	0.022	<0.03	0.179	0.23	1.1	1.42	35	2650
12/15/2014	**12/15/2014**	**Storm flow**									
12:17	10:15	Spring	0.016	0.110	0.09	0.070	0.58	5.9	9.21	N.S.	N.S.
12:28	10:15	Upstream farm	0.026	0.070	0.06	0.067	0.26	21.6	3.17	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:09	10:15	Downstream farm	0.013	0.044	0.04	0.162	0.33	4.3	1.87	N.S.	N.S.
12:31	10:15	Dry Creek	0.011	0.030	0.03	0.071	0.15	1.4	1.01	N.S.	N.S.
12:44	10:15	Culvert	0.021	0.040	0.04	1.161	1.11	8.2	1.11	N.S.	N.S.
12/22/2014	**12/22/2014**	**Base flow**									
11:15	14:35	Spring	0.012	0.024	<0.03	0.459	0.70	1.1	2.93	28.5	1299.7
12:05	14:35	Upstream farm	0.010	0.028	0.06	0.096	0.12	0.9	1.05	155.3	1046.2
11:00	14:35	Downstream farm	0.011	0.052	<0.03	0.175	0.24	1.5	1.14	55.6	980.0
12:11	14:35	Dry Creek	0.014	0.036	<0.03	0.132	0.18	0.5	1.10	100.0	860.0
11:33	14:35	Culvert	0.011	0.026	<0.03	0.416	0.58	6.3	1.54	770.1	3550.0
11:45	14:35	Trench	0.005	0.018	<0.03	0.881	0.83	6.1	1.09	<1.0	630.0
1/8/2015	**1/8/2015**	**Base flow**									
11:05	15:05	Spring	0.010	0.014	<0.03	0.376	0.56	2.0	3.80	14.8	686.7
11:25	15:05	Upstream farm	0.009	0.022	<0.03	0.187	0.21	2.3	1.41	30.9	547.5
10:53	15:05	Downstream farm	0.011	0.024	<0.03	0.376	0.39	2.5	1.22	42.6	980.4
11:40	15:05	Culvert	0.008	0.022	<0.03	0.448	0.59	2.4	1.73	25.6	1203.3

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:00	15:05	Trench	0.005	0.022	<0.03	0.769	0.75	4.7	0.88	<1.0	13130.0
1/14/2015	**1/14/2015**	**Base flow**									
1:30	15:20	Spring	0.010	0.028	<0.03	0.473	0.66	1.1	10.20	21.6	613.1
11:45	15:20	Upstream farm	0.012	0.032	<0.03	0.135	0.19	1.1	3.02	88.2	727.0
11:15	15:20	Downstream farm	0.011	0.020	<0.03	0.388	0.34	1.0	2.03	25.6	613.1
12:00	15:20	Culvert	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6
12:40	15:20	Trench	0.005	0.012	<0.03	0.658	0.63	0.5	0.45	<1.0	727.0
1/21/2015	**1/21/2015**	**Base flow**									
11:15	15:28	Spring	0.009	0.020	<0.03	0.552	0.69	1.5	2.29	9.8	461.1
11:52	15:28	Upstream farm	0.008	0.018	<0.03	0.089	0.12	1.1	0.95	70.3	579.4
11:05	15:28	Downstream farm	0.010	0.026	0.06	0.197	0.30	1.1	1.60	37.4	613.1
11:25	15:28	Culvert	0.005	0.016	<0.03	0.370	0.46	1.0	2.34	155.3	2419.2
1/29/2015	**1/29/2015**	**Base flow**									
40:40	15:28	Spring	0.010	0.018	0.03	0.886	0.74	2.3	4.27	<1.0	2850.0
11:45	15:28	Upstream farm	0.006	0.060	<0.03	0.065	0.21	47.8	1.71	727.0	1413.6

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
13:20	15:28	Downstream farm	0.009	0.020	0.04	0.168	0.27	1.3	1.50	19.9	1046.2
2/3/2015	**2/3/2015**	**Base flow**									
11:05	15:40	Spring	0.008	0.018	<0.03	0.191	0.77	3.8	7.64	<1.0	461.1
11:40	15:40	Upstream farm	0.006	0.022	<0.03	0.051	0.28	1.1	2.69	4.1	1203.3
10:50	15:40	Downstream farm	0.009	0.018	<0.03	0.140	0.29	4.1	2.66	<1.0	547.5
2/10/2015	**2/10/2015**	**Base flow**									
10:38	15:08	Spring	0.010	0.010	<0.03	0.544	0.64	1.9	0.76	2.0	686.7
11:05	15:08	Upstream farm	0.009	0.012	<0.03	0.056	0.09	0.7	1.04	1119.1	2419.2
10:25	15:08	Downstream farm	0.011	0.012	<0.03	0.143	0.23	1.0	1.15	7.4	1553.1
2/26/2015	**2/26/2015**	**Base flow**									
10:45	15:30	Spring	0.009	0.042	<0.03	0.237	0.38	5.0	3.97	37.3	2419.2
11:36	15:30	Upstream farm	0.006	0.024	<0.03	0.100	0.13	0.6	1.20	47.9	686.7
10:34	15:30	Downstream farm	0.008	0.026	<0.03	0.200	0.25	0.8	1.17	48.7	866.4
10:55	15:30	Culvert	0.006	0.022	<0.03	0.530	0.57	1.3	1.38	16.1	4790.0
11:15	15:30	Trench	0.004	0.028	<0.03	0.712	0.76	46.0	0.60	<1.0	41063.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
3/3/2015	**3/3/2015**	**Base flow**									
11:07	15:33	Spring	0.008	0.052	<0.03	0.124	0.35	N.D.	4.90	N.S.	N.S.
11:50	15:33	Upstream farm	0.006	0.026	<0.03	0.048	0.11	N.D.	1.50	N.S.	N.S.
10:50	15:33	Downstream farm	0.007	0.028	<0.03	0.138	0.23	N.D.	1.50	N.S.	N.S.
11:18	15:33	Culvert	0.006	0.020	<0.03	0.477	0.52	N.D.	1.84	N.S.	N.S.
11:30	15:33	Trench	0.003	0.024	<0.03	0.867	0.89	N.D.	0.95	N.S.	N.S.

N.S. is No Sample.

Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

Table 3. Water quality analyses at the spring and in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application fields for the 1st Quarter of 2015.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
12/4/2014									
Spring	0.007	0.024	<0.03	0.317	0.50	2.3	5.57	5.2	1120
Upstream	0.011	0.022	<0.03	0.103	0.13	0.7	2.94	45.7	1850
Downstream	0.013	0.024	<0.03	0.264	0.33	1.5	2.98	7.4	2990
12/92014									
Spring	0.008	0.024	<0.03	0.295	0.48	2.3	4.26	18.9	1203
Upstream	0.011	0.024	<0.03	0.057	0.09	0.5	1.60	36.4	1986
Downstream	0.013	0.022	<0.03	0.179	0.23	1.1	1.42	35	2650
12/22/2014									
Spring	0.012	0.024	<0.03	0.459	0.70	1.1	2.93	28.5	1299.7
Upstream	0.010	0.028	0.06	0.096	0.12	0.9	1.05	155.3	1046.2
Downstream	0.011	0.052	<0.03	0.175	0.24	1.5	1.14	55.6	980.0
1/8/2015									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Spring	0.010	0.014	<0.03	0.376	0.56	2.0	3.80	14.8	686.7
Upstream	0.009	0.022	<0.03	0.187	0.21	2.3	1.41	30.9	547.5
Downstream	0.011	0.024	<0.03	0.376	0.39	2.5	1.22	42.6	980.4
1/14/2015									
Spring	0.010	0.028	<0.03	0.473	0.66	1.1	10.20	21.6	613.1
Upstream	0.012	0.032	<0.03	0.135	0.19	1.1	3.02	88.2	727.0
Downstream	0.011	0.020	<0.03	0.388	0.34	1.0	2.03	25.6	613.1
1/21/2015									
Spring	0.009	0.020	<0.03	0.552	0.69	1.5	2.29	9.8	461.1
Upstream	0.008	0.018	<0.03	0.089	0.12	1.1	0.95	70.3	579.4
Downstream	0.010	0.026	0.06	0.197	0.30	1.1	1.60	37.4	613.1
1/29/2015									
Spring	0.010	0.018	0.03	0.886	0.74	2.3	4.27	1.0	2850.0
Upstream	0.006	0.060	<0.03	0.065	0.21	47.8	1.71	727.0	1413.6
Downstream	0.009	0.020	0.04	0.168	0.27	1.3	1.50	19.9	1046.2

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
2/3/2015									
Spring	0.008	0.018	<0.03	0.191	0.77	3.8	7.64	1.0	461.1
Upstream	0.006	0.022	<0.03	0.051	0.28	1.1	2.69	4.1	1203.3
Downstream	0.009	0.018	<0.03	0.140	0.29	4.1	2.66	1.0	547.5
2/10/2015									
Spring	0.010	0.010	<0.03	0.544	0.64	1.9	0.76	2.0	686.7
Upstream	0.009	0.012	<0.03	0.056	0.09	0.7	1.04	1119.1	2419.2
Downstream	0.011	0.012	<0.03	0.143	0.23	1.0	1.15	7.4	1553.1
2/26/2015									
Spring	0.009	0.042	<0.03	0.237	0.38	5.0	3.97	37.3	2419.2
Upstream	0.006	0.024	<0.03	0.100	0.13	0.6	1.20	47.9	686.7
Downstream	0.008	0.026	<0.03	0.200	0.25	0.8	1.17	48.7	866.4
3/3/2015									
Spring	0.008	0.052	<0.03	0.124	0.35	N.D.	4.90	N.S.	N.S.
Upstream	0.006	0.026	<0.03	0.048	0.11	N.D.	1.50	N.S.	N.S.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.007	0.028	<0.03	0.138	0.23	N.D.	1.50	N.S.	N.S.

N.S. is No Sample.

Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

Table 4. Water quality analyses at the culvert draining the subwatershed containing the production houses and manure holding ponds, the well adjacent to the ponds, and surface runoff from Field 1 for the 1st Quarter of 2015.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	---------- mg/L ----------							--- MPN/100 mL ---	
Culvert									
12/15/2014	0.021	0.040	0.04	1.161	1.11	8.2	1.11	N.S.	N.S.
12/22/2014	0.011	0.026	<0.03	0.416	0.58	6.3	1.54	770.1	3550.0
1/8/2015	0.008	0.022	<0.03	0.448	0.59	2.4	1.73	25.6	1203.3
1/15/2015	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6
1/21/2015	0.005	0.016	<0.03	0.370	0.46	1.0	2.34	155.3	2419.2
2/26/2015	0.006	0.022	<0.03	0.530	0.57	1.3	1.38	16.1	4790.0
3/3/2015	0.006	0.020	<0.03	0.477	0.52	ND	1.84	N.S.	N.S.
Interceptor Trench 1 (South)									
12/22/2014	0.005	0.018	<0.03	0.881	0.83	6.1	1.09	1.0	630.0
1/8/2015	0.005	0.022	<0.03	0.769	0.75	4.7	0.88	1.0	13130.0
1/14/2015	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6
2/26/2015	0.004	0.028	<0.03	0.712	0.76	46.0	0.60	1.0	41063.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/3/2015	0.003	0.024	<0.03	0.867	0.89	N.D.	0.95	N.S.	N.S.
Dry Creek									
12/4/2014	0.012	0.030	<0.03	0.167	0.21	0.7	2.30	27.8	1553.1
12/15/2014	0.011	0.030	0.03	0.071	0.15	1.4	1.01	N.S.	N.S.
12/22/2014	0.014	0.036	<0.03	0.132	0.18	0.5	1.10	100.0	860.0

N.S. is No Sample.

N.D. is No Data

E. coli and total coliform were not measured on surface runoff samples collected by ISCO samplers when sample holding time exceeded the required 8-hour threshold.

Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

Nutrient and Bacteria Concentration in Big Creek over the Monitoring Period

The concentration of dissolved P, total P, nitrate-N, total N, E. coli, and total coliform measured in Big Creek above and below the C&H Farm from the beginning of our monitoring project (September 12, 2013), are presented graphically to show variations in concentration with time. In addition, the difference between down and upstream concentrations for the same sampling date are presented. These measurements were taken during base flow and storm flow, more routinely after installation of ISCO samplers was completed in March 2014. On all these graphs, storm flow samples are distinguished with yellow fill, from base flow samples that have solid color fills. See Figures 6, 7, 8, 9, 10, 11, 12, and 13.

From the monitoring samples collected to date there does not appear to be any consistent effect of flow on all nutrient forms except total P or on bacterial concentrations of E. coli and total coliform. For total P, higher concentrations both up and downstream of the Farm were generally associated with higher storm flows (Figure 7). This is consistent with the fact that storm flows have greater energy of flow than base flow and will mobilize and transport particulates and associated P, which can originate from field runoff, stream bank erosion, and Creek bed sediment resuspension.

The slurry application schedule for the C&H Farm is given in Table 5 and in Table 6, the total amount applied to each field between December 2013 and October 2014 is presented. The location of the fields on the Farm is shown in Figure 14. For visual representation of any trends that might be evident, the manure applications, dissolved P, nitrate and E. coli concentrations are plotted with time of year in Figure 15.

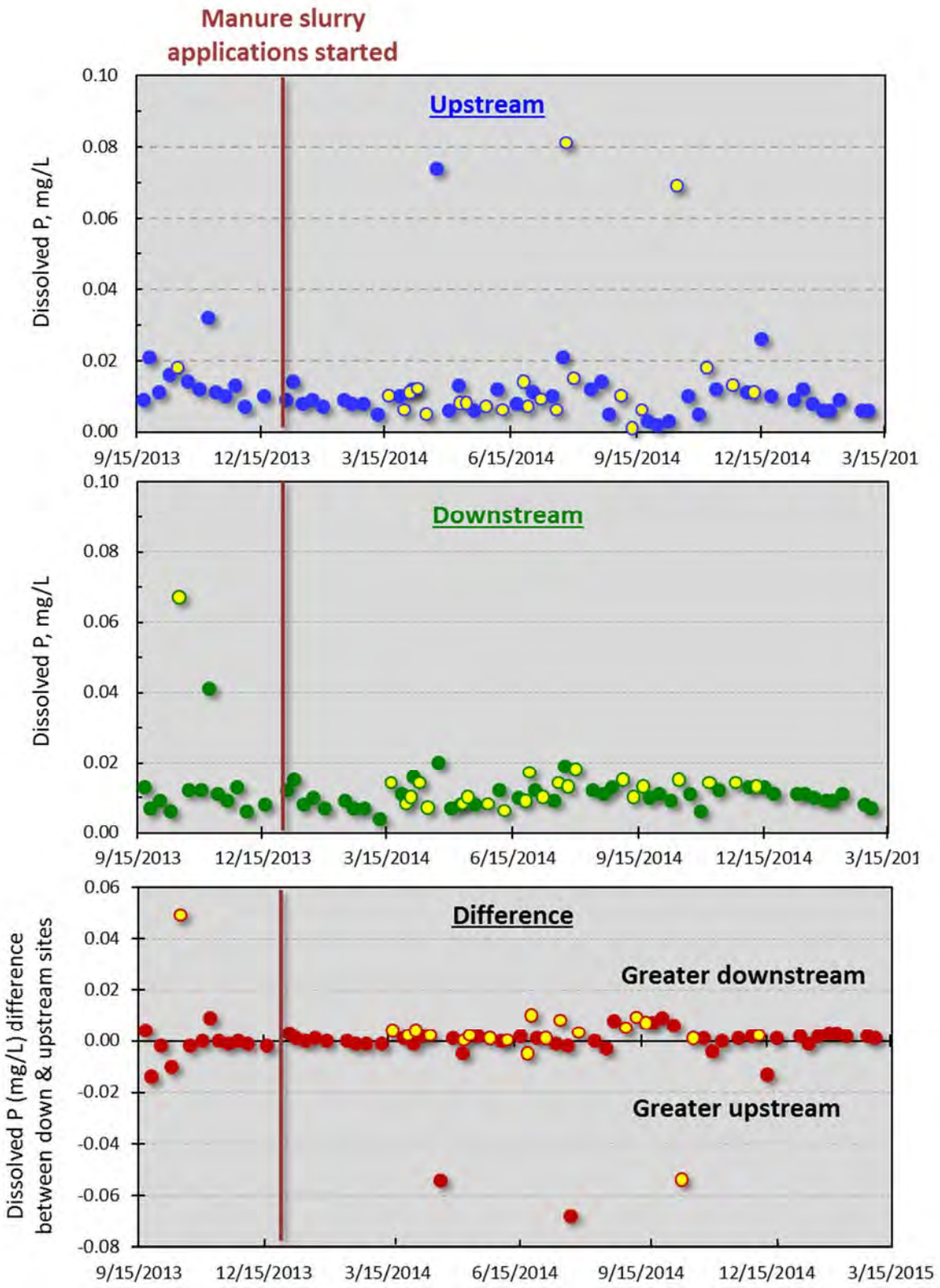

Figure 6. Dissolved P concentrations in Big Creek down and upstream of the C&H Farm, along with the difference, during the monitoring period to date. Yellow filled points are samples taken during storm flow, solid points during base flow.

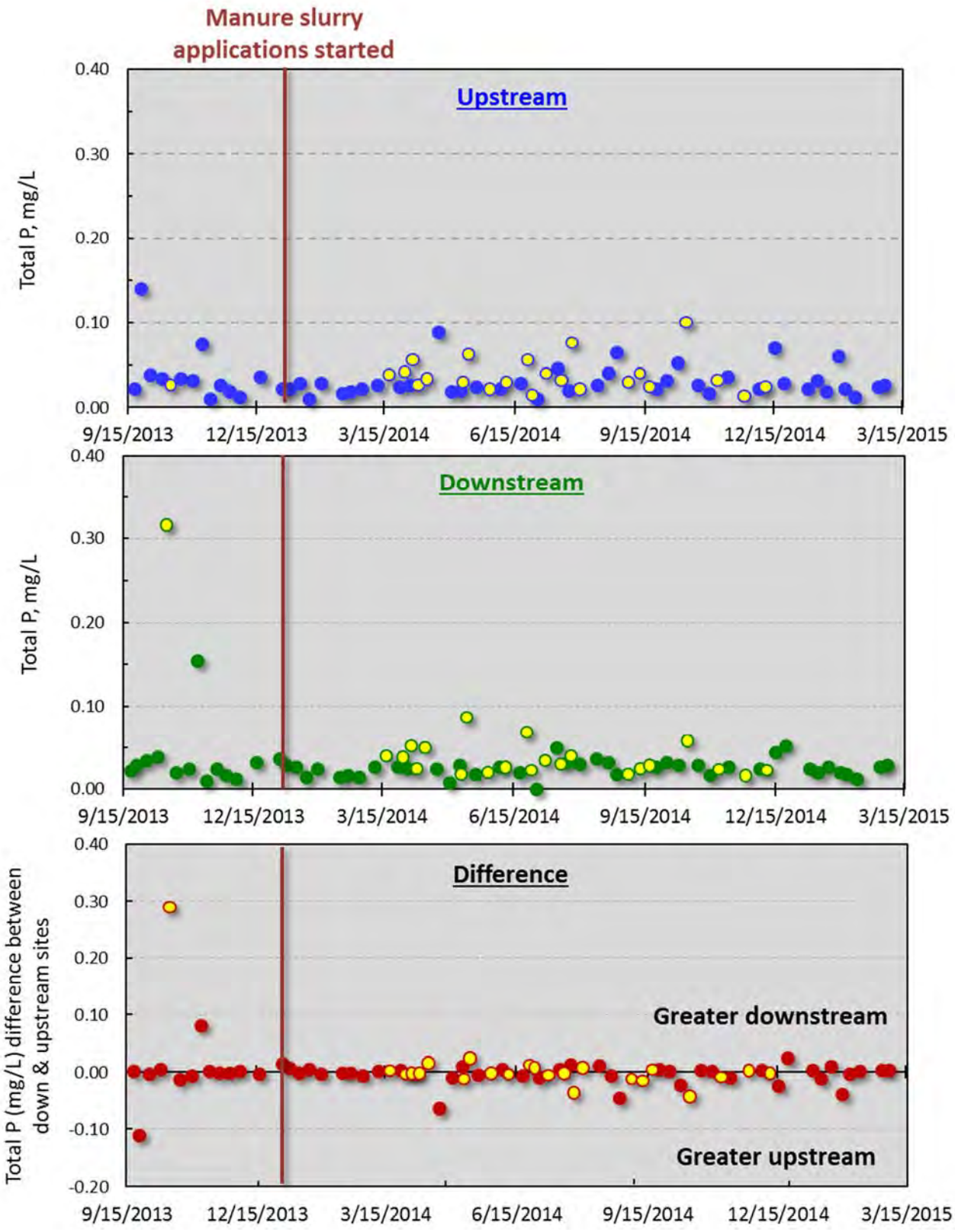

Figure 7. Total P concentrations in Big Creek down and upstream of the C&H Farm, along with the difference, during the monitoring period to date. Yellow filled points are samples taken during storm flow, solid points during base flow.

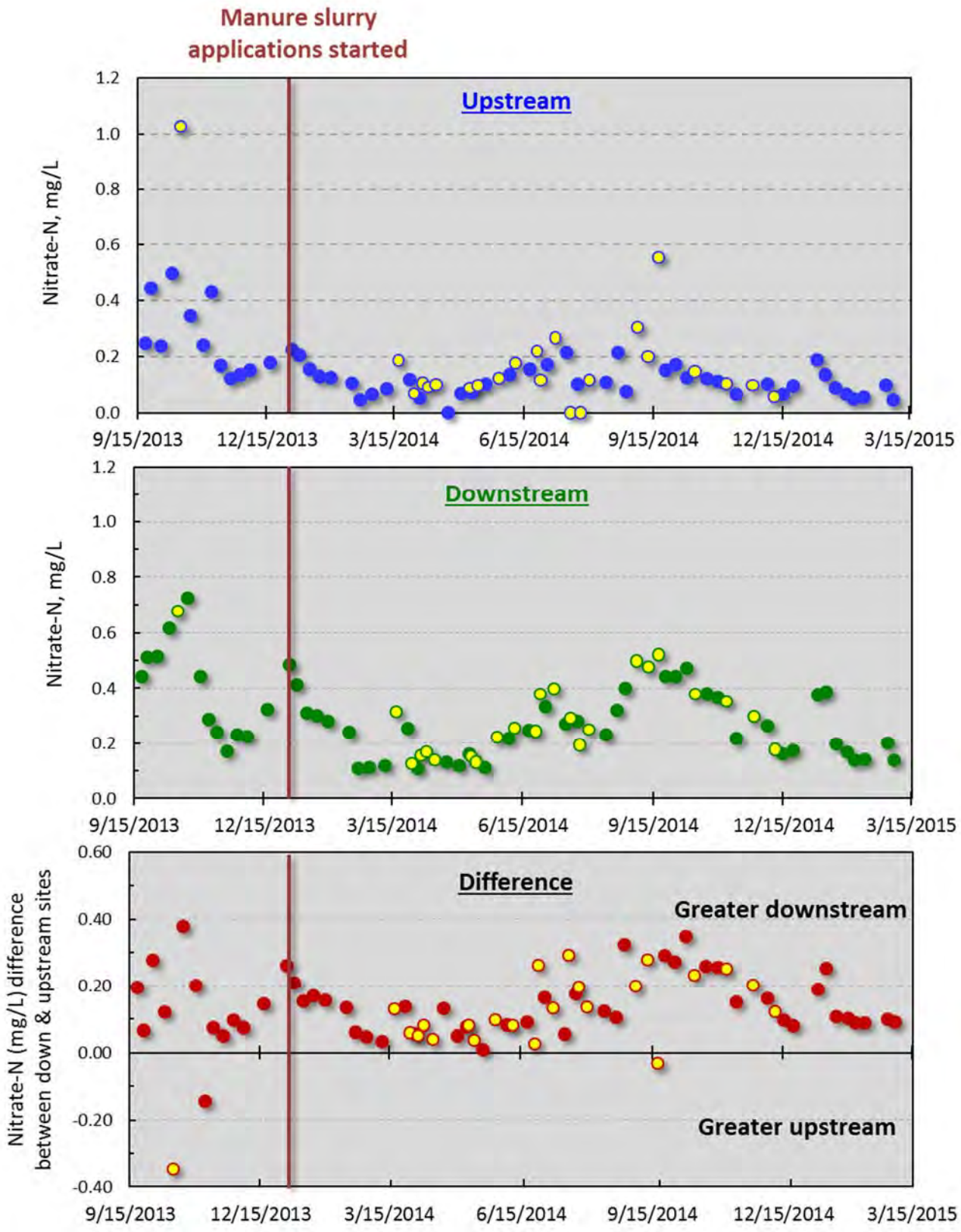

Figure 8. Nitrate-N concentrations in Big Creek down and upstream of the C&H Farm, along with the difference, during the monitoring period to date. Yellow filled points are samples taken during storm flow, solid points during base flow.

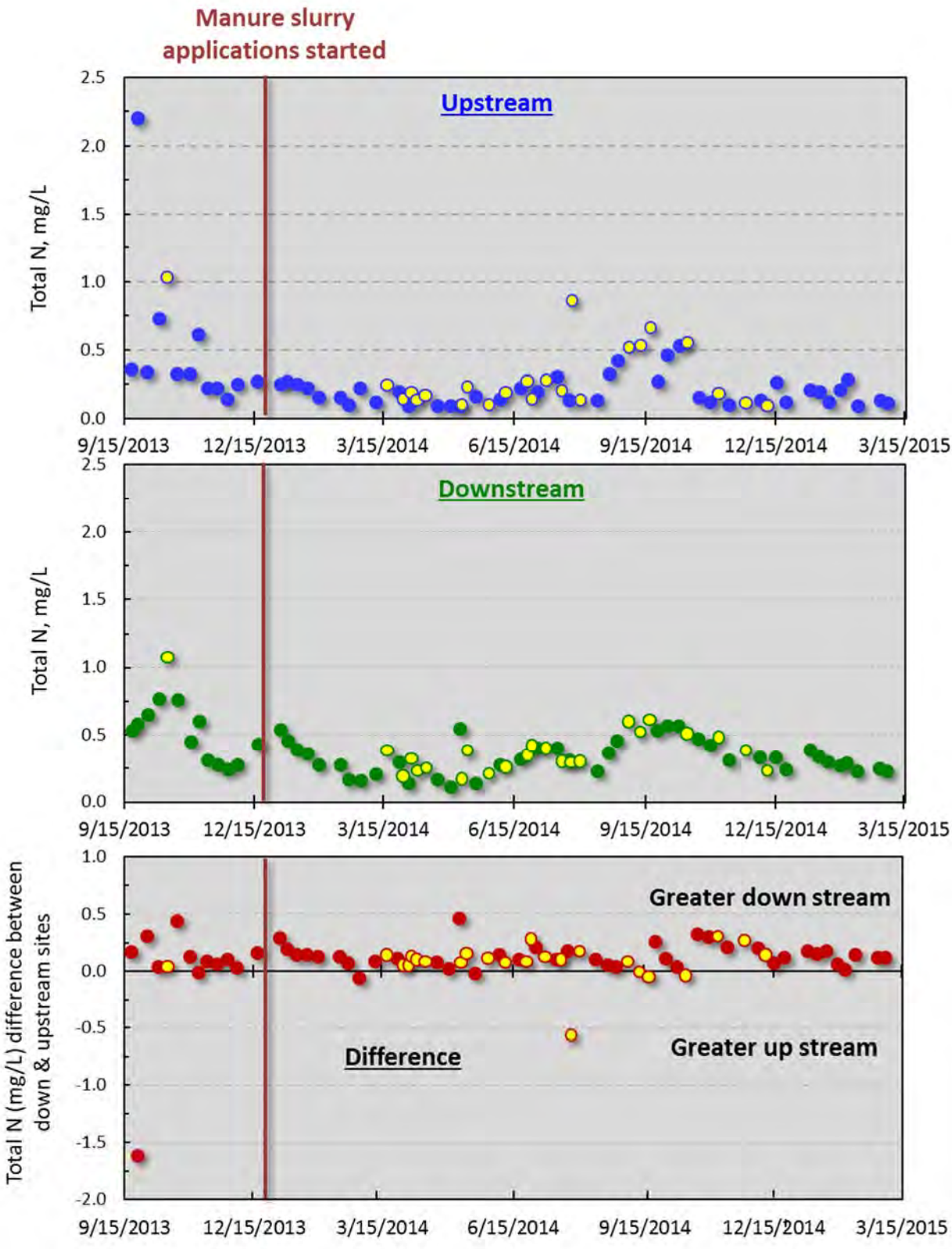

Figure 9. Total N concentrations in Big Creek down and upstream of the C&H Farm, along with the difference, during the monitoring period to date. Yellow filled points are samples taken during storm flow, solid points during base flow.

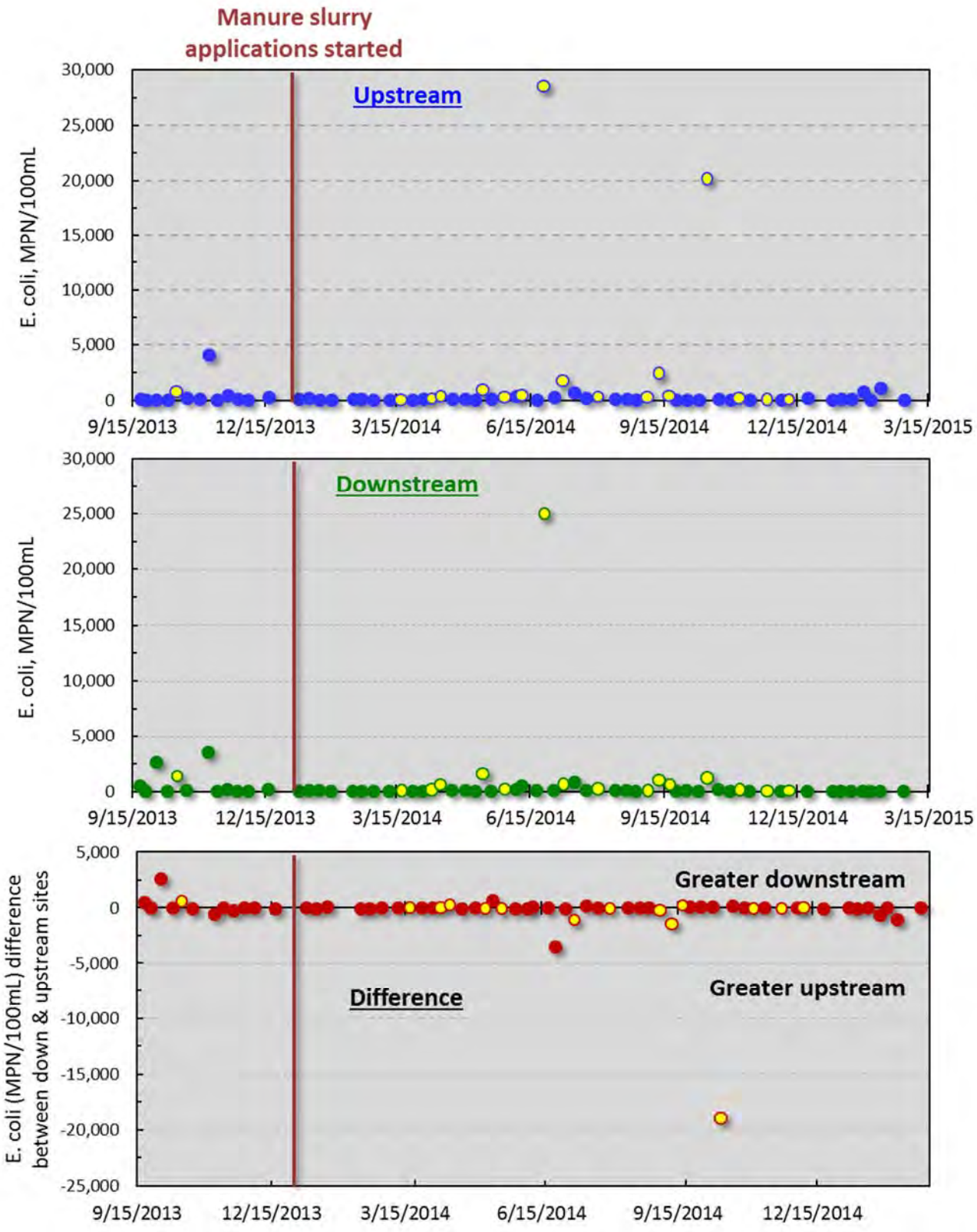

Figure 10. E. coli concentrations in Big Creek down and upstream of the C&H Farm, along with the difference, during the monitoring period to date. Yellow filled points are samples taken during storm flow, solid points during base flow.

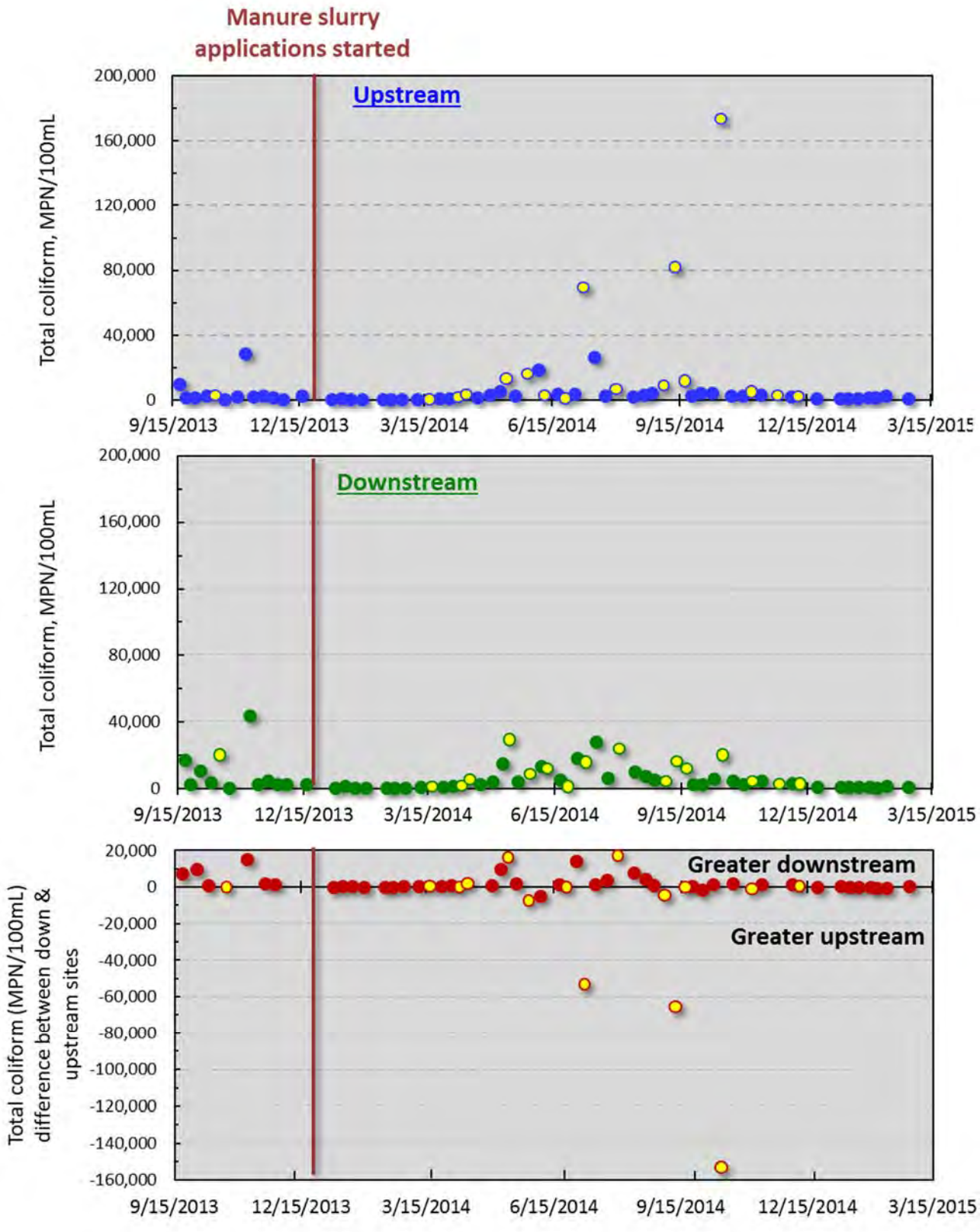

Figure 11. Total coliform concentrations in Big Creek down and upstream of the C&H Farm, along with the difference, during the monitoring period to date. Yellow filled points are samples taken during storm flow, solid points during base flow.

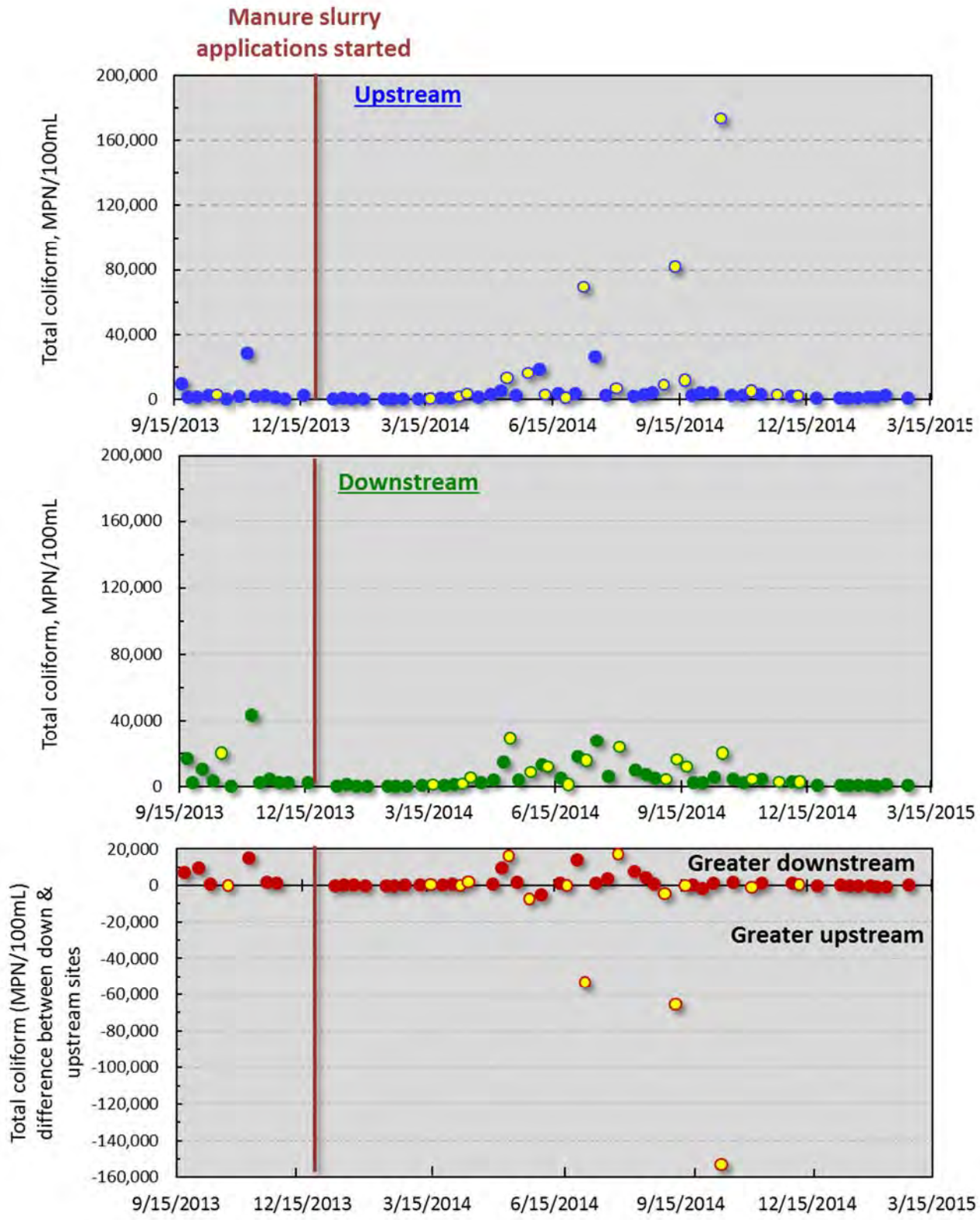

Figure 12. Expanded axis E. coli concentrations in Big Creek down and upstream of the C&H Farm, along with the difference, during the monitoring period to date. Yellow filled points are samples taken during storm flow, solid points during base flow.

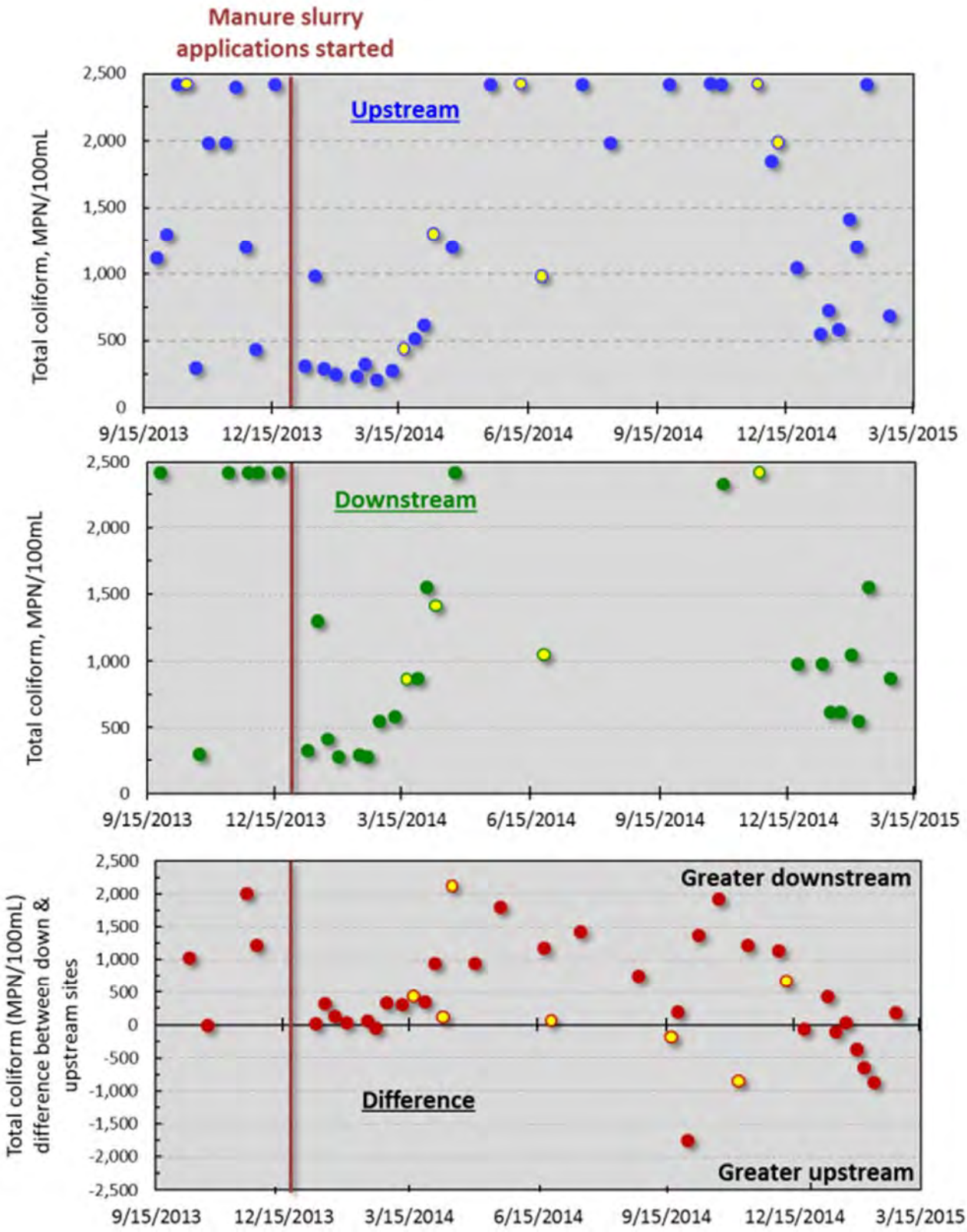

Figure 13. Expanded axis total coliform concentrations in Big Creek down and upstream of the C&H Farm, along with the difference, during the monitoring period to date. Yellow filled points are samples taken during storm flow, solid points during base flow.

Table 5. The timing and rate of slurry applied to each field up to 1-15-2015 by the C&H Farm.

Date applied	Field #	Volume applied	Area applied	Average rate applied
		gallons	acres	gallons/acre
12/27/2013	15	3,000	1	3000
12/30/2013	15	6,000	2	3000
12/31/2013	15	24,000	9	2667
1/16/2014	15	18,000	7	2571
1/16/2014	17	6,000	2	3000
1/19/2014	3	18,000	6	3000
1/20/2014	15	36,000	13	2769
1/25/2014	3	38,500	6	6417
3/11/2014	13	33,000	11	3000
3/14/2014	13	57,500	19	3026
3/21/2014	13	87,000	29	3000
3/22/2014	14	45,000	15	3000
3/24/2014	11	51,000	17	3000
3/31/2014	15	42,000	14	3000
4/1/2014	1	18,000	6	3000
4/1/2014	4	3,000	1	3000
4/1/2014	15	45,000	15	3000
4/1/2014	17	30,000	10	3000
4/1/2014	17	3,000	10	300
4/18/2014	10	60,000	15	4000
4/18/2014	17	30,000	5	6000
4/22/14	10	18,000	6	3000
4/22/14	12	48,000	9.9	4848
4/22/14	17	21,000	7	3000

Date applied	Field #	Volume applied	Area applied	Average rate applied
4/25/14	17	36,000	12	3000
6/05/14	4	12,000	4	3000
6/05/14	10	51,000	14	3643
4/06/14	1	28,000	7	4000
4/06/14	2	22,600	6	3767
4/06/14	4	13,800	3.5	3943
6/16/14	15	25,400	9	2822
6/17/14	15	16,800	6	2800
6/18/14	7	133,000	29	4586
6/18/14	15	16,800	6	2800
6/19/14	15	11,200	4	2800
6/19/14	16	56,000	9	6222
6/30/14	7	67,200	15	4480
1/07/14	17	25,000	9	2778
3/07/14	7	87,000	19	4579
6/07/14	9	72,800	25	2912
6/07/14	17	22,400	8	2800
7/14/14	17	16,800	6	2800
7/21/14	10	67,200	15	4480
7/22/14	10	53,000	14	3786
7/22/14	17	11,800	4	2950
7/28/14	8	25,000	9	2778
7/28/14	15	8,200	3	2733
5/08/14	3	61,600	15	4107
5/08/14	9	31,000	10	3100

Date applied	Field #	Volume applied	Area applied	Average rate applied
8/13/14	13	44,800	14	3200
9/23/14	13	58,000	19	3053
9/24/14	13	27,500	9	3056
7/14/10	15	90,000	29	3103
10/17/14	15	57,500	20	2875
10/18/14	15	34,500	12	2875
10/19/14	17	18,000	6	3000
10/20/14	17	46,000	16	2875
10/21/14	13	28,750	9	3194
10/21/14	17	28,750	10	2875
10/22/14	13	12,000	4	3000
10/24/14	13	14,200	5	2840
10/25/14	7	109,000	60	1817
10/26/14	13	62,800	22	2855
10/30/14	13	28,000	10	2800
10/30/14	14	28,000	8	3500

Table 6. Total amount of slurry applied to each field between 12-15-2013 and 1-15-2015 by the C&H Farm.

Field number	Field area	Application area	Number of apps	Volume	Average rate applied	Average inches applied
		acres		gallons	gallons/acre	inches
1	28.5	13.0	2	46,000	3,538	0.13
2	16.5	6.0	1	22,600	3,767	0.14
3	16.8	27.0	3	118,100	4,374	0.16
4	12.0	8.5	3	28,800	3,388	0.12
7	80.1	123.0	4	396,200	3,221	0.12
8	15.7	9.0	1	25,000	2,778	0.10
9	47.7	35.0	2	103,800	2,966	0.11
10	36.8	64.0	5	249,200	3,894	0.14
11	20.7	17.0	1	51,000	3,000	0.11
12	28.7	9.9	1	48,000	4,848	0.18
13	66.9	151.0	11	453,550	3,004	0.11
14	18.0	23.0	2	73,000	3,174	0.12
15	66.3	150.0	15	434,400	2,896	0.11
16	79.6	9.0	1	56,000	6,222	0.23
17	88.7	105.0	13	294,750	2,807	0.10

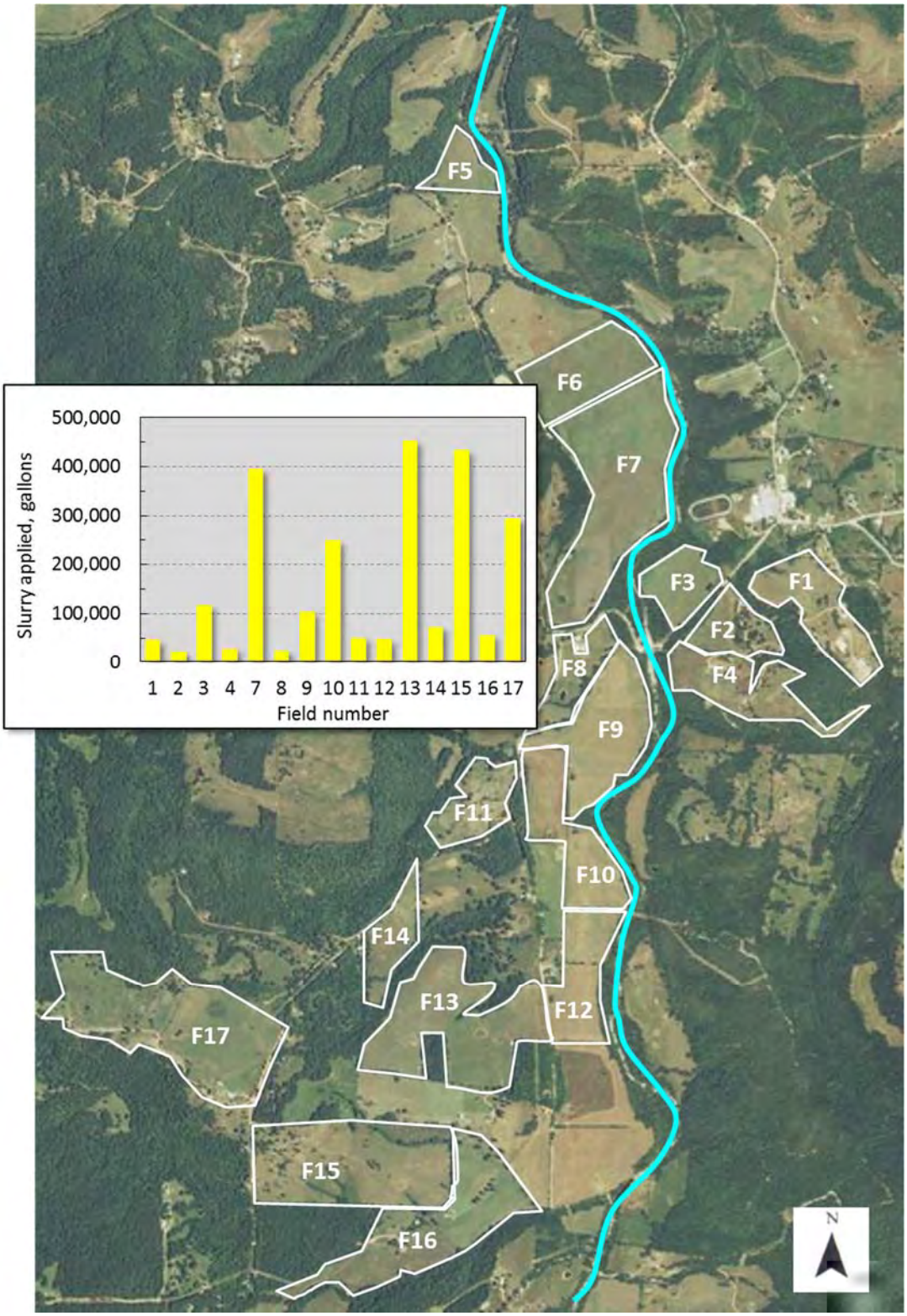

Figure 14. Location of application fields and amount of slurry aplied between 12-27-2013 and 10-30-2014.

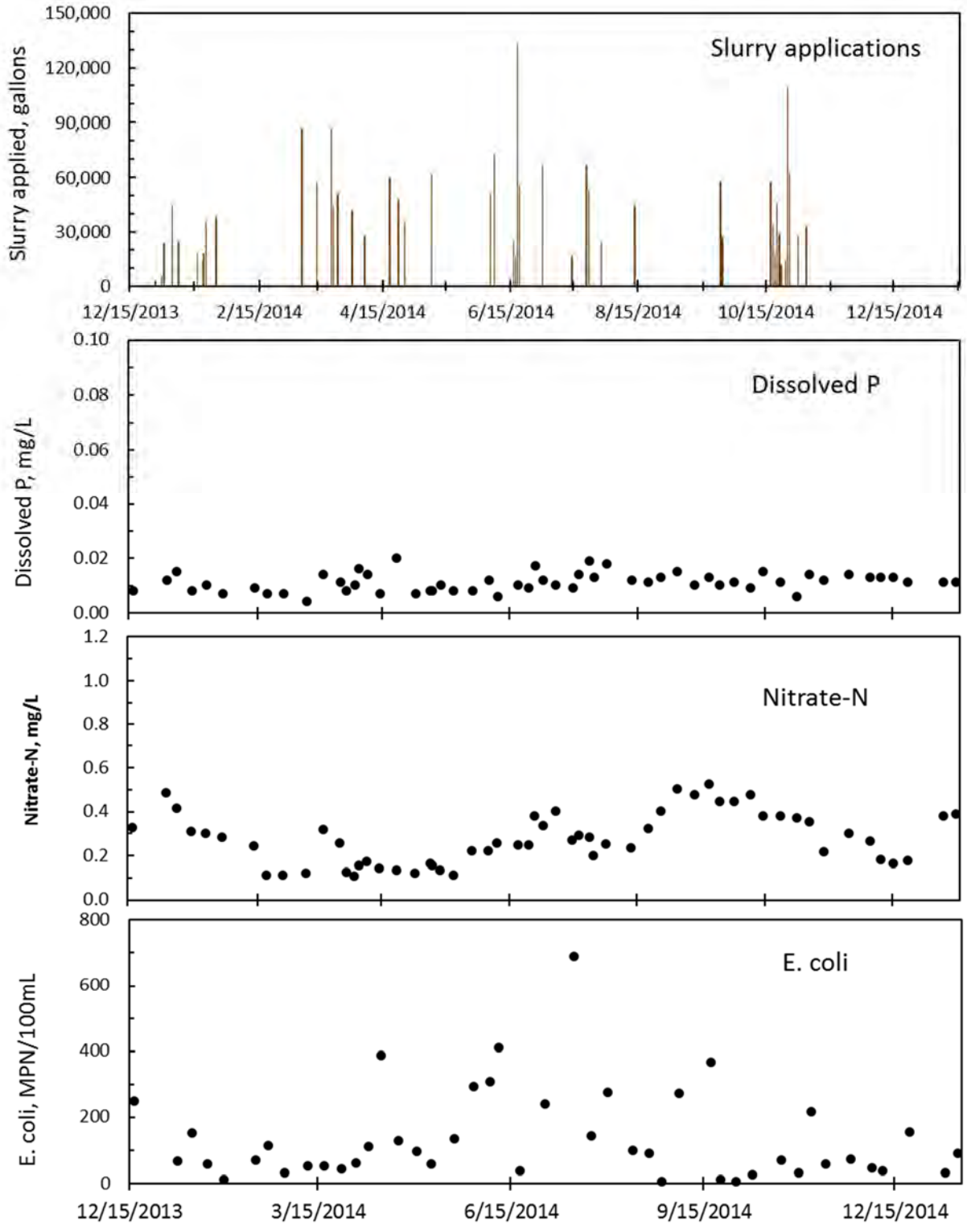

Figure 15. Slurry application timing and concentrations of nutrients and E. coli downstream of the C&H Farm over the monitoring period December 15, 2013 through January 15, 2015.

Bacteria Concentration Trends in Subwatersheds of the Buffalo River Watershed

USGS personnel collated information that had been collected at different USGS gauging stations in the Buffalo River Watershed over the last two decades, in order to put into perspective the concentrations currently being measured in Big Creek above and below the C&H Farm (Figure 16). These concentrations for E. coli and fecal coliform are presented for Buffalo River near Boxley (USGS site 07055646; Figures 17 and 18), Crooked Creek at Pyatt (USGS site 07055600; Figures 19), Bear Creek near Silver Hill (USGS site 07056515; Figures 20 and 21), Calf Creek near Silver Hill (USGS site 07055893; Figure 22), and Buffalo River near St. Joe (USGS site 07056000; Figures 23 and 24). Corresponding bacteria data from this monitoring project at Big Creek below the C&H Farm near Mt. Judea (USGS site 070555790; Figures 25 and 26) and Big Creek above the C&H Farm near Mt. Judea (Figures 27 and 28), are presented.

While bacterial concentrations from several sub-watersheds of the Buffalo River Watershed are presented here, it needs to be noted that these independent monitoring studies were established for differing reasons and with differing sampling protocols. Thus, it is statistically inappropriate to compare actual concentrations for the USGS historic data with the Big Creek BCRET concentrations. In order to make such comparisons the same sampling protocols would be needed to ensure that the same number and frequency of samples were taken under both base and storm flow conditions. The importance of similar sampling objectives and timing are evident from linear relations between bacteria, turbidity, and suspended sediment noted by various researchers (http://msaag.org/wp-content/uploads/2013/05/5_Irvine_et_al.pdf http://ks.water.usgs.gov/pubs/reports/vgc.fisc.html). If other sites primarily were collected under base-flow conditions or contained fewer samples as related to other sites, then higher bacteria counts could be missed. Sites that have more samples, and especially numerous samples collected during storm events would encompass a larger variability and contain samples with higher bacteria counts.

For bacteria data

The presence in water of E. coli, and often enterococci, is direct evidence of fecal contamination from warm-blooded animals (Myers and others, 2014). Their presence indicates the possible presence of pathogens (Dufour, 1977; Wade et al., 2003). Densities of other indicator bacteria (total coliforms, fecal coliforms, and fecal streptococci) can be, but are not necessarily, associated with fecal contamination. Despite this limitation, total coliforms are used to indicate ground-water susceptibility to fecal contamination (Myers and others, 2014). Fecal coliforms also are used to assess the sanitary quality of shellfish-growing waters and, in some States, for attainment of recreational-water-quality standards (Myers and others, 2014).

The areal and temporal distribution of bacteria in surface water can be as variable as the distribution of suspended sediment because bacteria commonly are associated with solid particles (Myers et al., 2014). USGS bacteria samples are collected following the methods used to collect surface-

water samples for suspended sediment analysis which is outlined in the USGS National Field Manual for the Collection of Water-Quality Data (NFM 4.1 and table 7.1–4).

For this Project, BCRET personnel prepared an informational sheet on E. coli in flowing waters, which is available on the Project's website at http://www.bigcreekresearch.org/. The document is also attached as Appendix A to this Report.

For box plots

The box plots represent the general distribution of measured data and the medina value. Such a box plot is conceptualized in Figure 16. In a box plot, the two 'hinges' are versions of the first and third quartile. The 'whiskers' extend to roughly the 95th and 5th percentile of values within the box plot. The upper whisker extends from the hinge to the highest value that is within 1.5 x IQR of the hinge, where IQR is the inter-quartile range, or distance between the first and third quartiles. The lower whisker extends from the hinge to the lowest value within 1.5 x IQR of the hinge. Data beyond the end of the whiskers are outliers and plotted as points (as specified by Tukey, 1977).

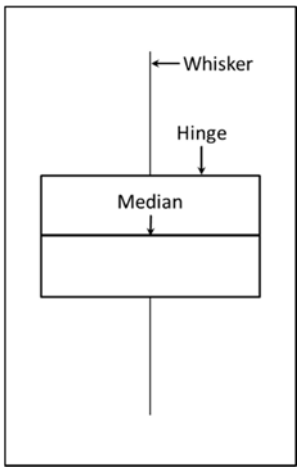

Figure 16. Components of a "box plot."

References

Dufour, A.P. 1977. Escherichia coli—the fecal coliform. Pages 48-58. *In* Hoadley, A.W., and Dutka, B.J., (eds.), Bacterial indicators/health hazards associated with water. American Society for Testing and Materials, Philadelphia, PA.

Myers, D.N., D.M. Stoeckel, R.N. Bushon, D.S. Francy, and A.M.G. Brady. 2014. Fecal indicator bacteria (ver. 2.1). U.S. Geological Survey Techniques of Water-Resources Investigations. Book 9, Chapter A7, Section 7.1. Accessed Mar 1, 2015 from http://pubs.water.usgs.gov/twri9A/

Tukey, J. W. 1977. Exploratory Data Analysis. Section 2C.

Wade, T.J., N. Pai, J.N.S. Eisenberg, and J.M. Colford Jr. 2003. Do U.S. Environmental Protection Agency water quality guidelines for recreational waters prevent gastrointestinal illness? A systematic review and meta-analysis. Environmental Health Perspectives. Volume 111, Issue 8, Pages 1102 to 1109.

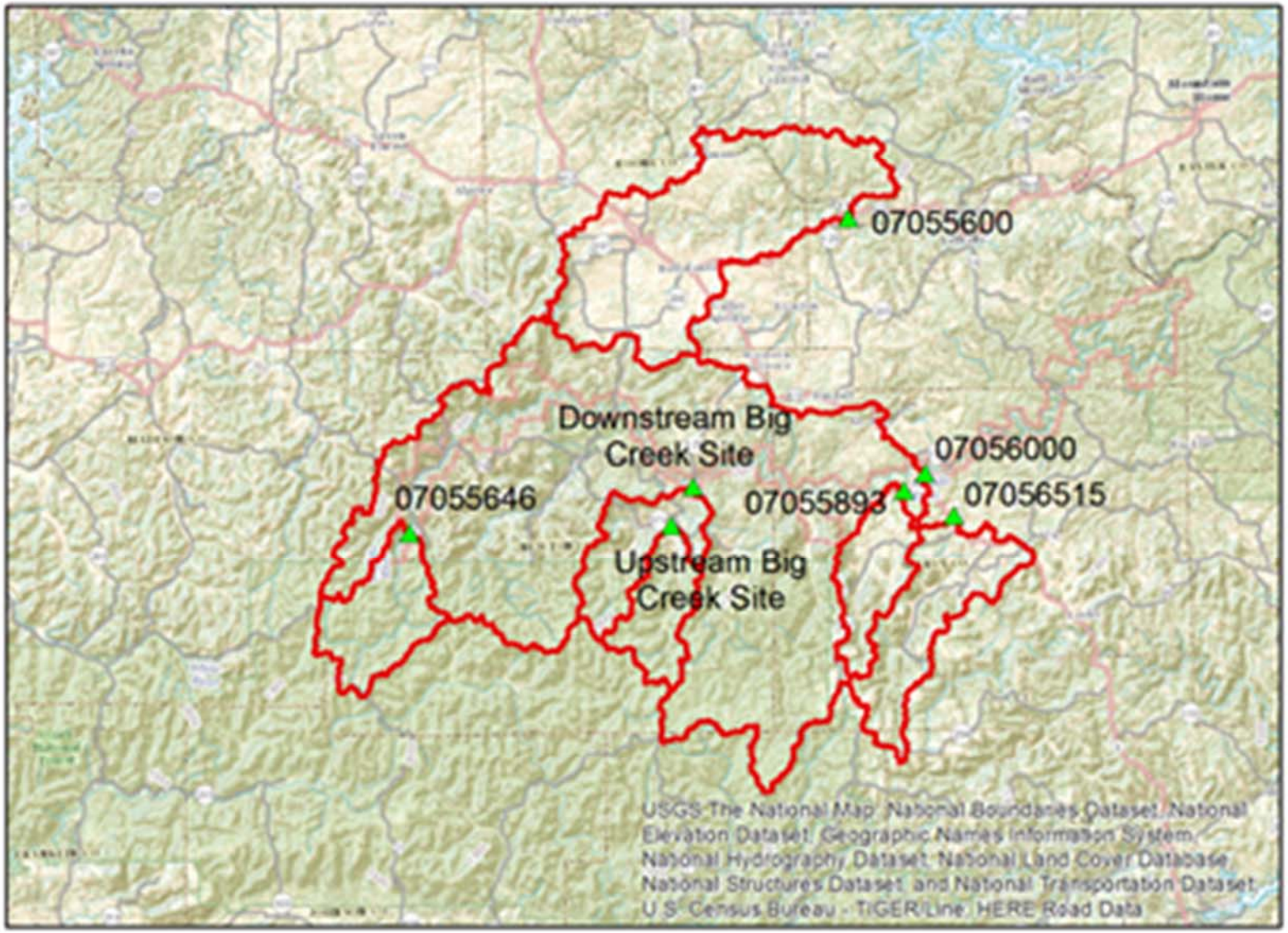

Figure 17. Location of USGS sampling sites for historic bacteria in the Buffalo River Watershed.

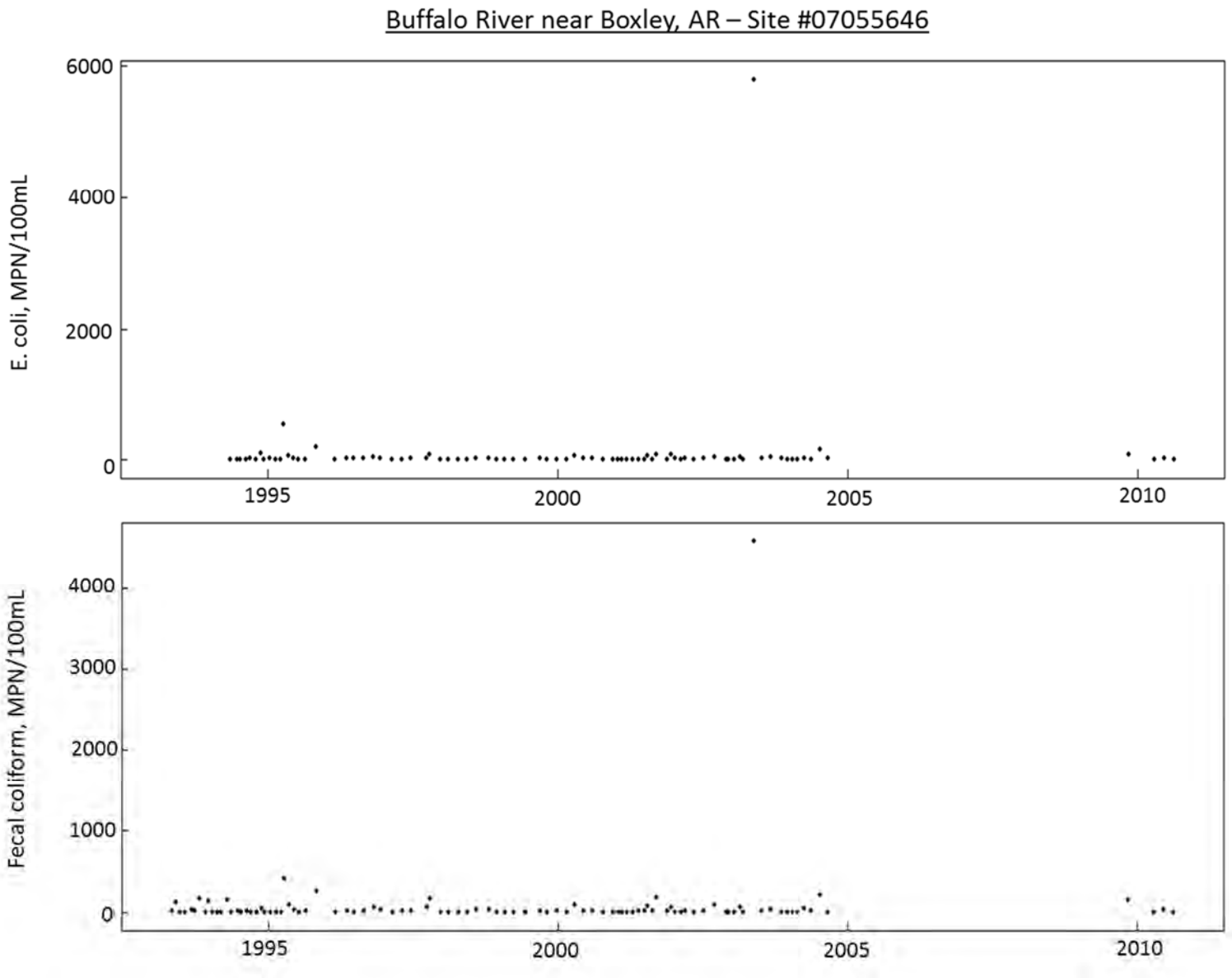

Figure 18. E. coli and fecal coliform concentrations between 1992 and 2011 in the Buffalo River near Boxley, AR (USGS site 07055646).

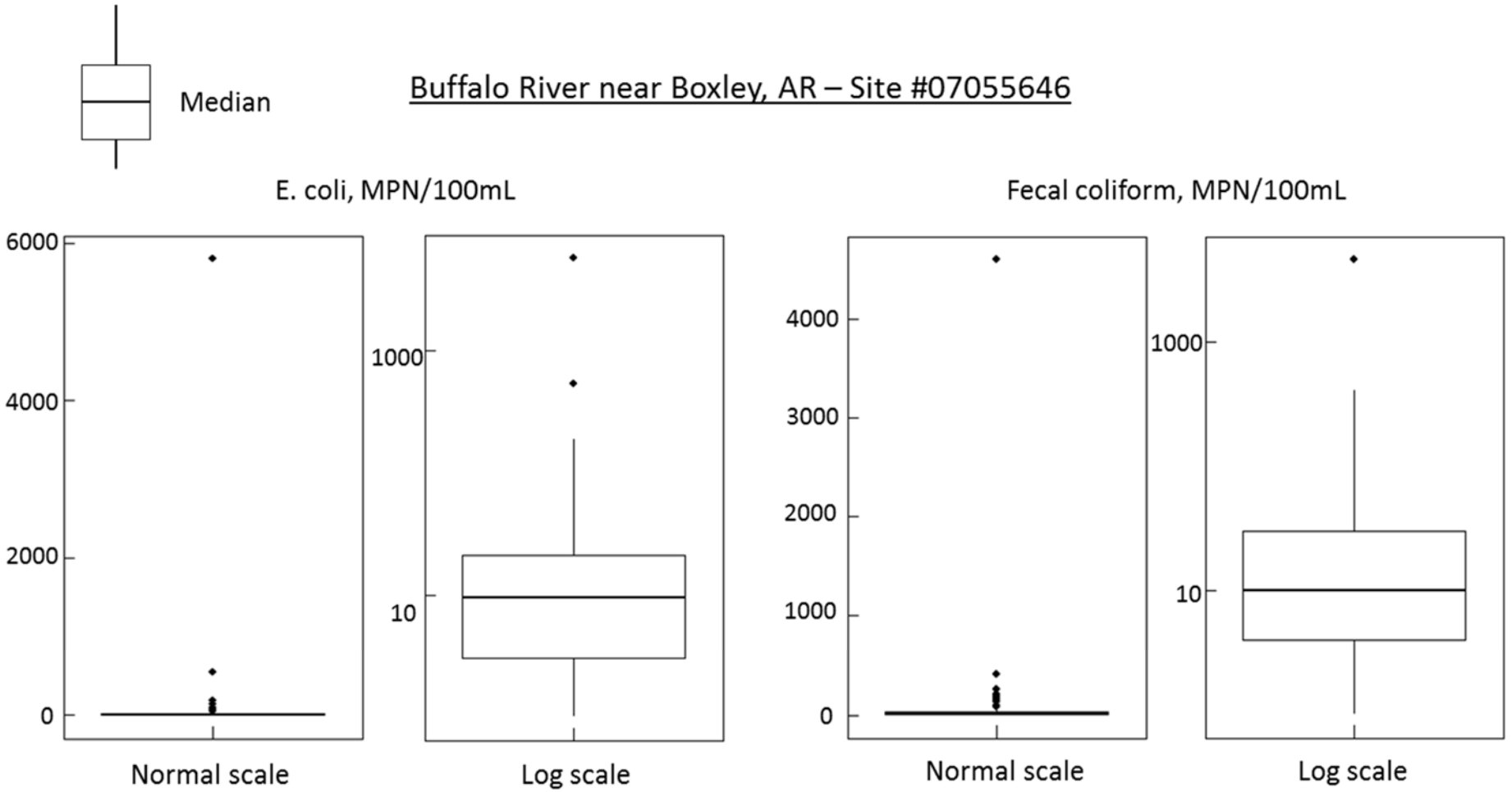

Figure 19. Range in E. coli and fecal coliform concentrations between 1992 and 2011 in the Buffalo River near Boxley, AR (USGS site 07055646).

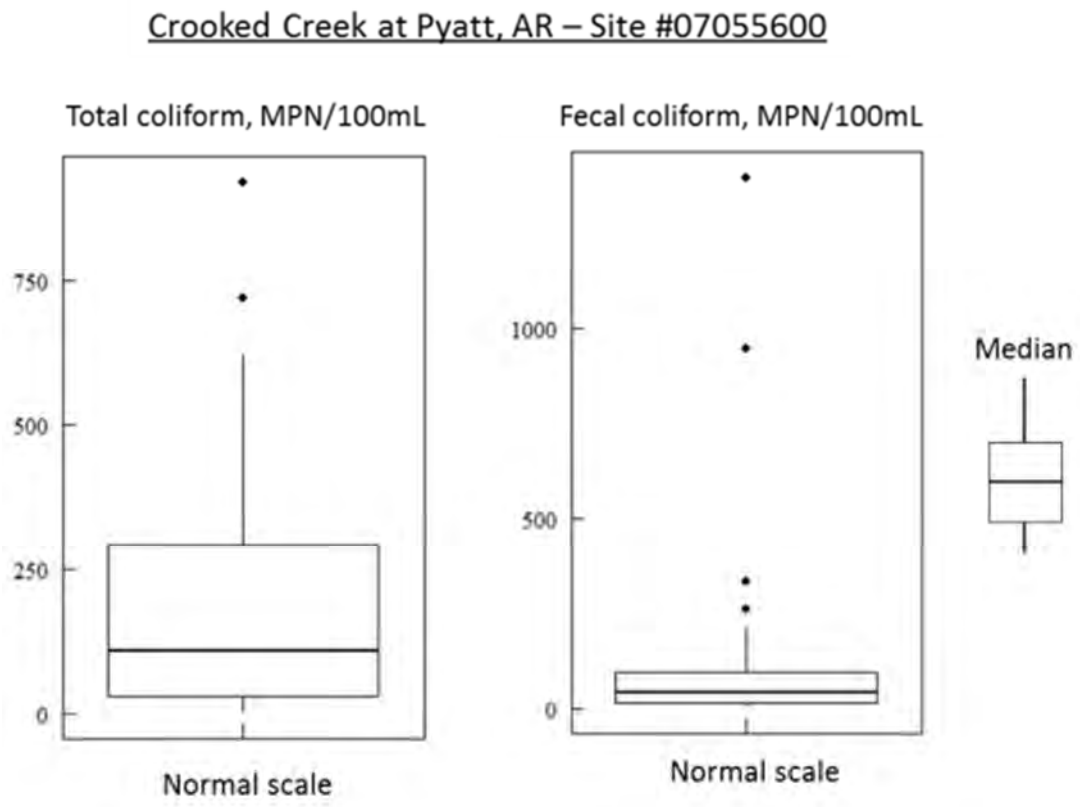

Figure 20. Range in E. coli and fecal coliform concentrations between 1992 and 2011 in Crooked Creek at Pyatt, AR (USGS site 07055600).

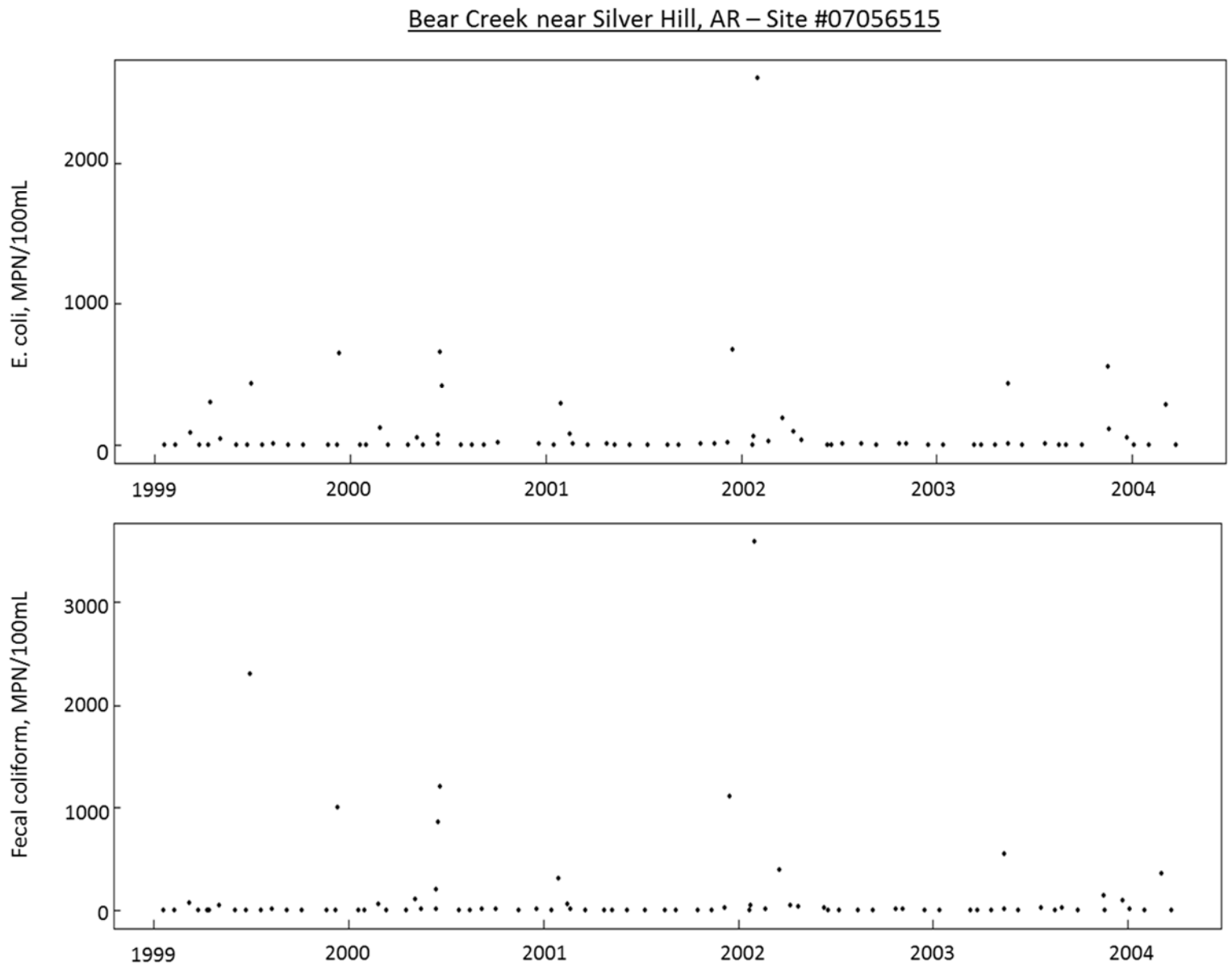

Figure 21. E. coli and fecal coliform concentrations between 1998 and 2004 in the Bear Creek near Silver Hill, AR (USGS site 07056515).

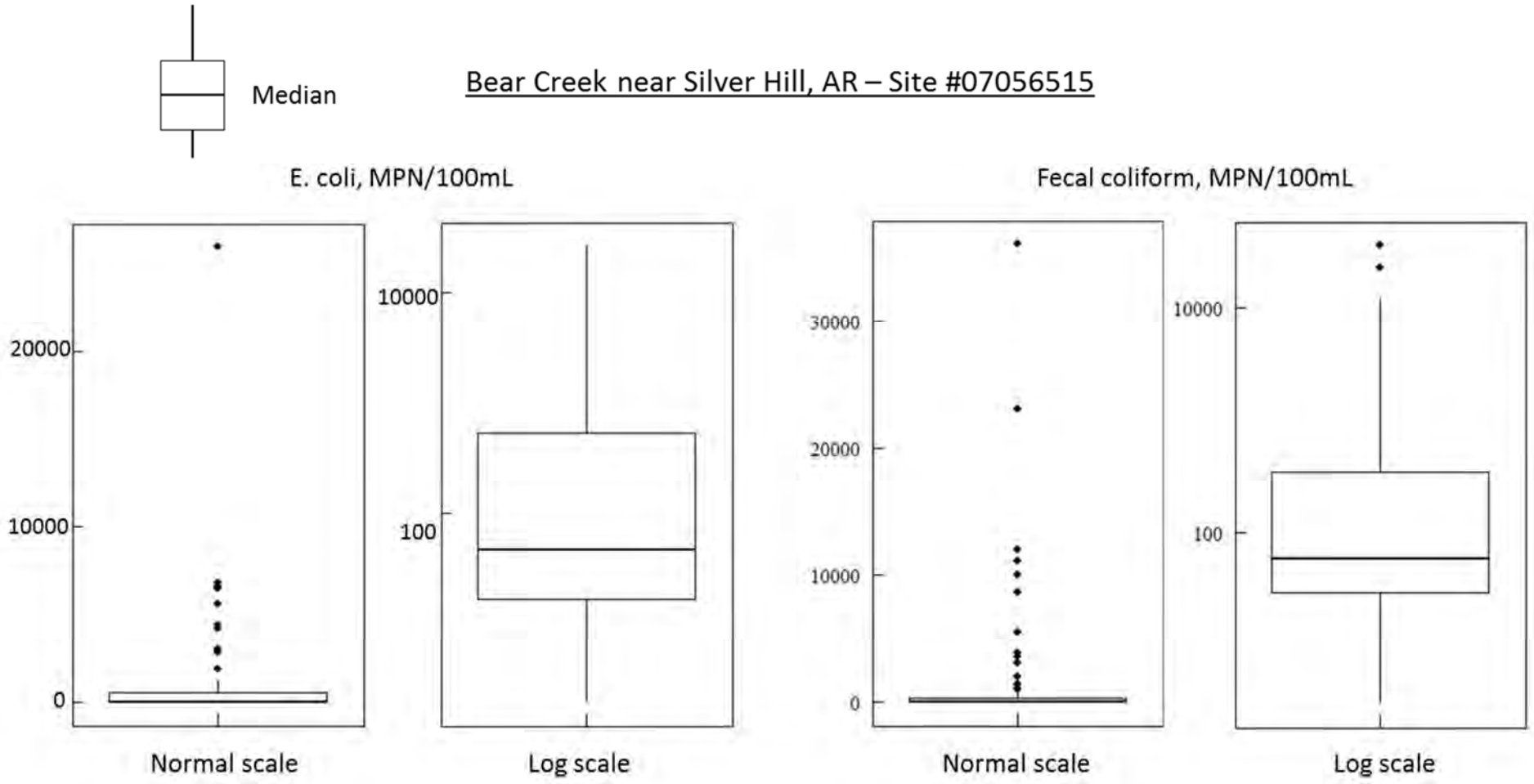

Figure 22. Range in E. coli and fecal coliform concentrations between 1998 and 2004 in the Bear Creek near Silver Hill, AR (USGS site 07056515).

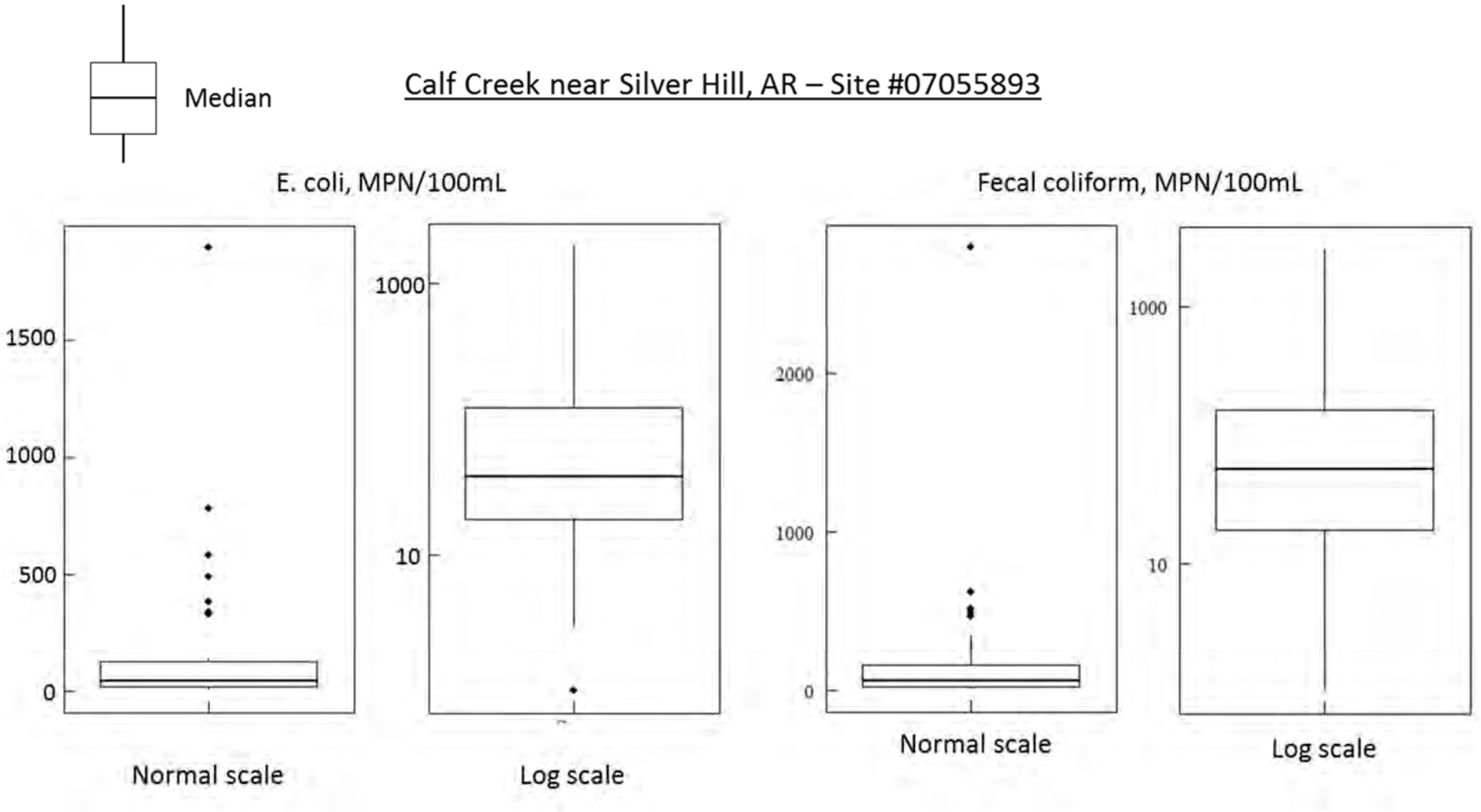

Figure 23. Range in E. coli and fecal coliform concentrations between 1998 and 2004 in the Calf Creek near Silver Hill, AR (USGS site 07056893).

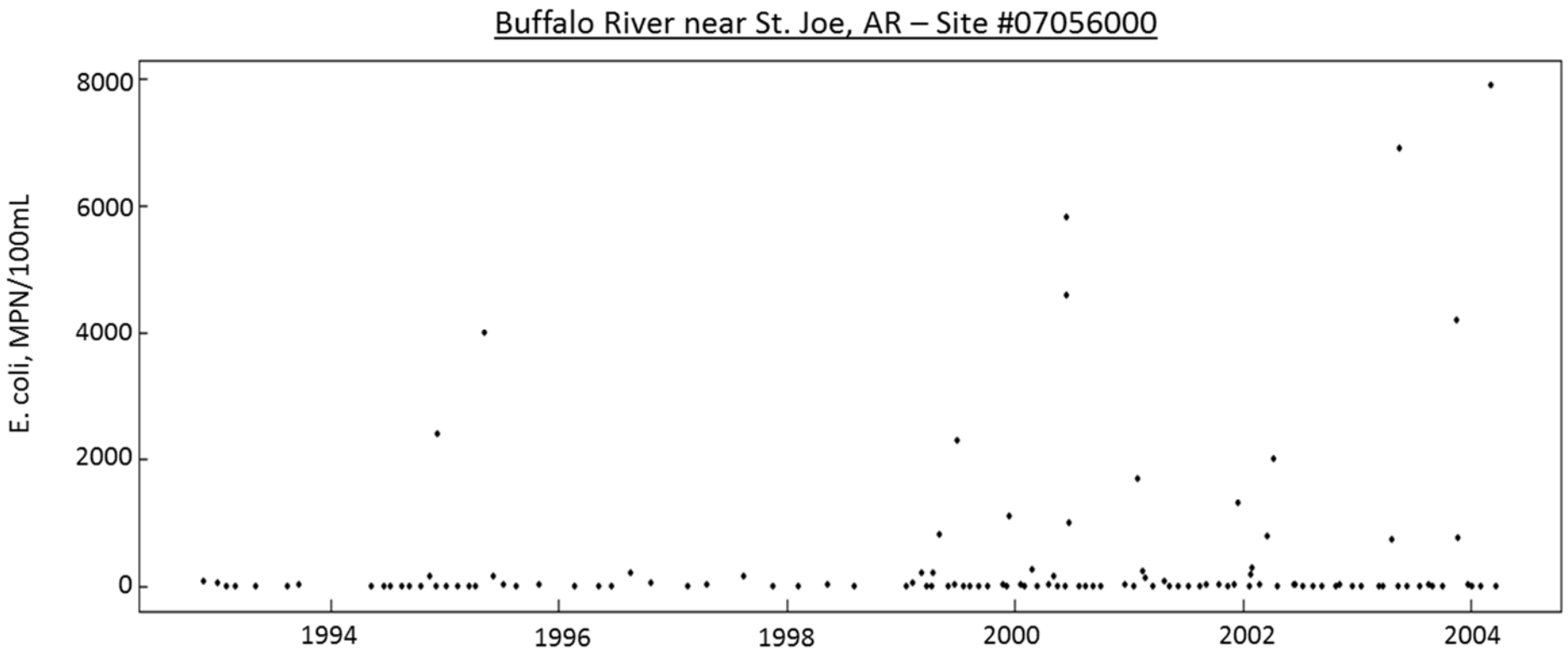

Figure 24. E. coli and fecal coliform concentrations between 1993 and 2004 in the Buffalo River near St. Joe, AR (USGS site 07056000).

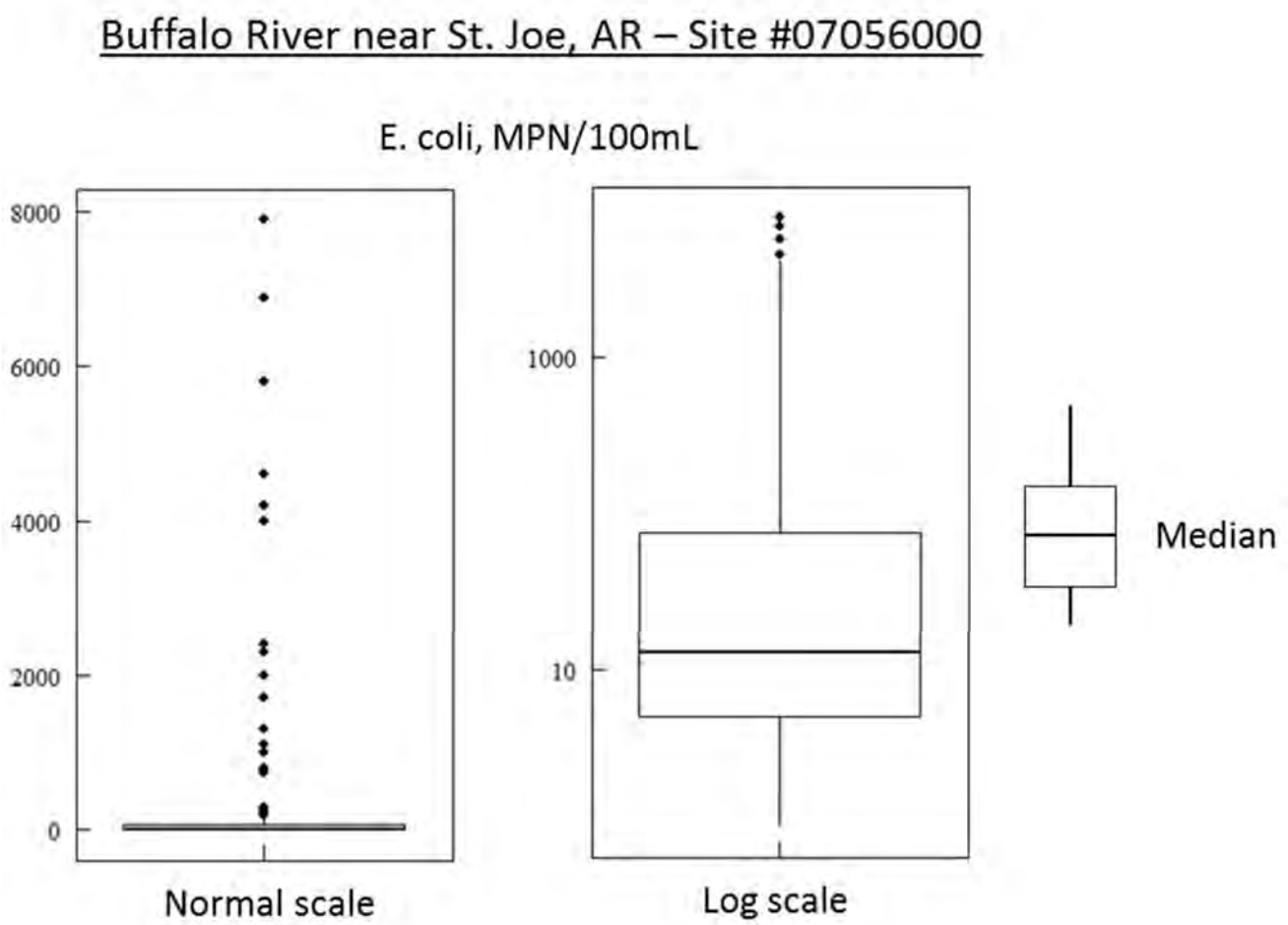

Figure 25. Range in E. coli and fecal coliform concentrations between 1993 and 2004 in the Buffalo River near St. Joe, AR (USGS site 07056000).

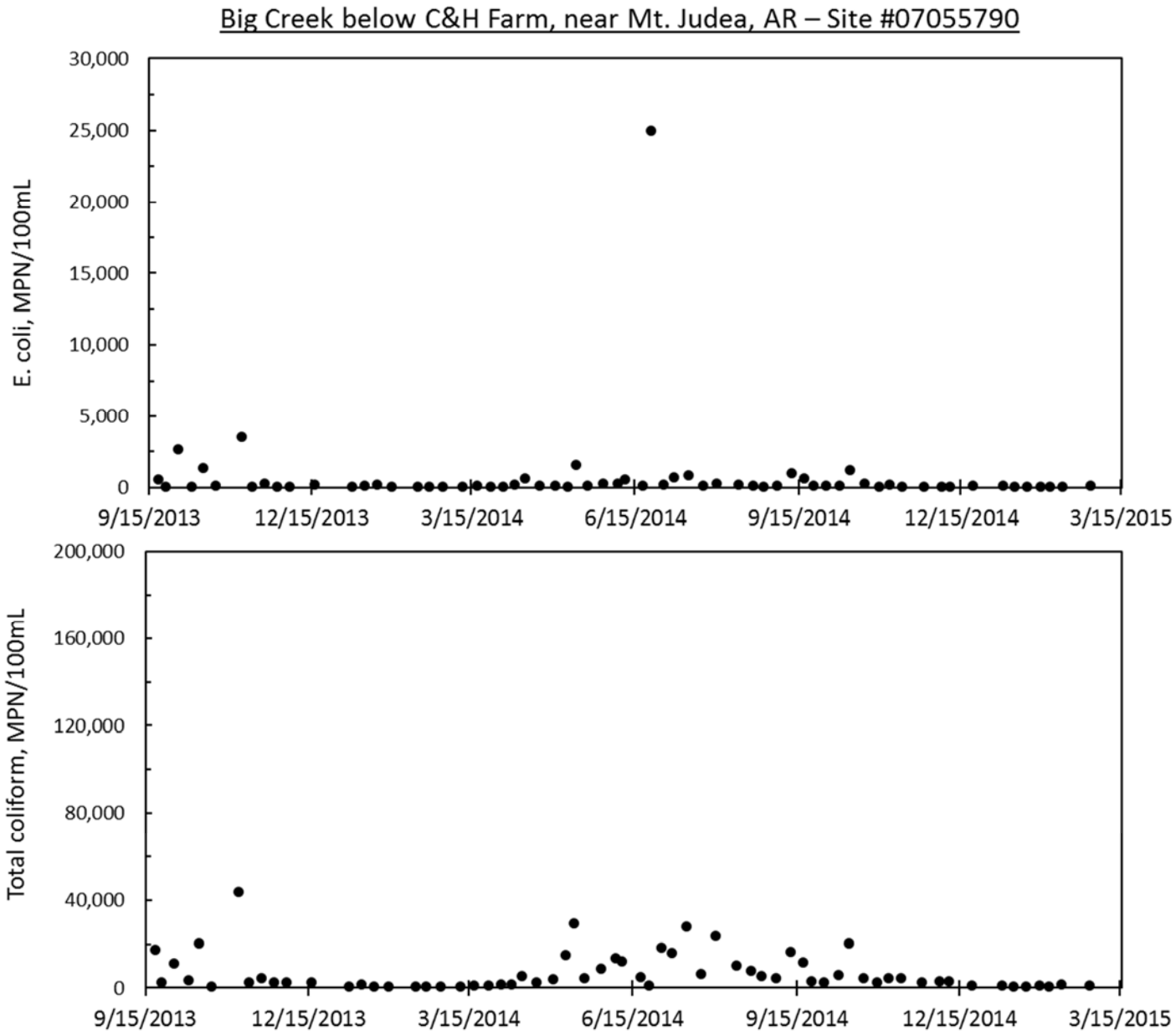
Big Creek below C&H Farm, near Mt. Judea, AR – Site #07055790
E. coli, MPN/100mL
30,000
25,000
20,000
15,000
10,000
5,000
0
9/15/2013
12/15/2013
3/15/2014
6/15/2014
9/15/2014
12/15/2014
3/15/2015
Total coliform, MPN/100mL
200,000
160,000
120,000
80,000
40,000
0
9/15/2013
12/15/2013
3/15/2014
6/15/2014
9/15/2014
12/15/2014
3/15/2015

Figure 26. E. coli and fecal coliform concentrations between 1993 and 2004 in Big Creek below the C&H Farm near Mt. Judea, AR (USGS site 07055790).

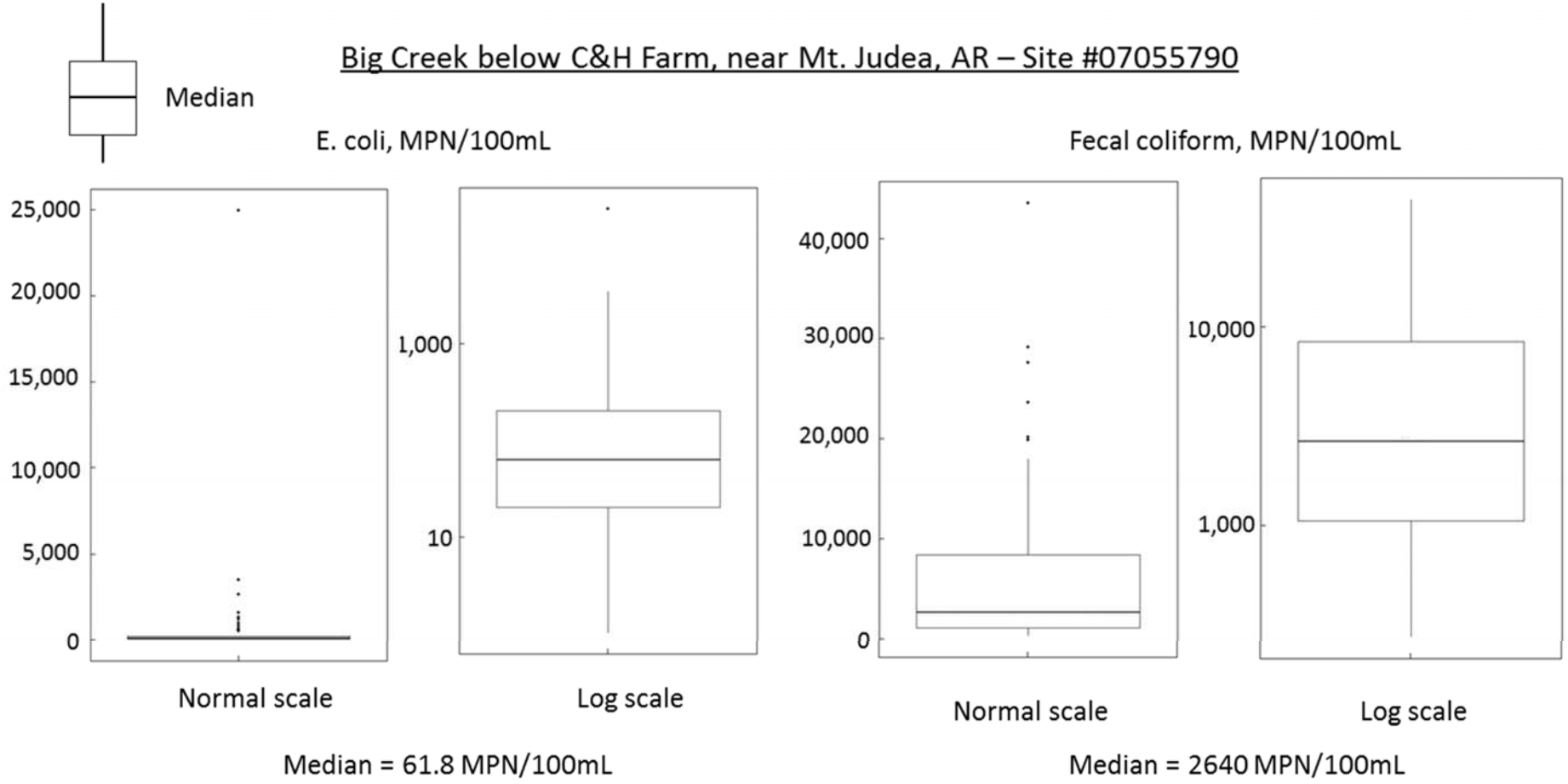

Figure 27. Range in E. coli and fecal coliform concentrations between 1993 and 2004 in Big Creek below the C&H Farm near Mt. Judea, AR (USGS site 07055790).

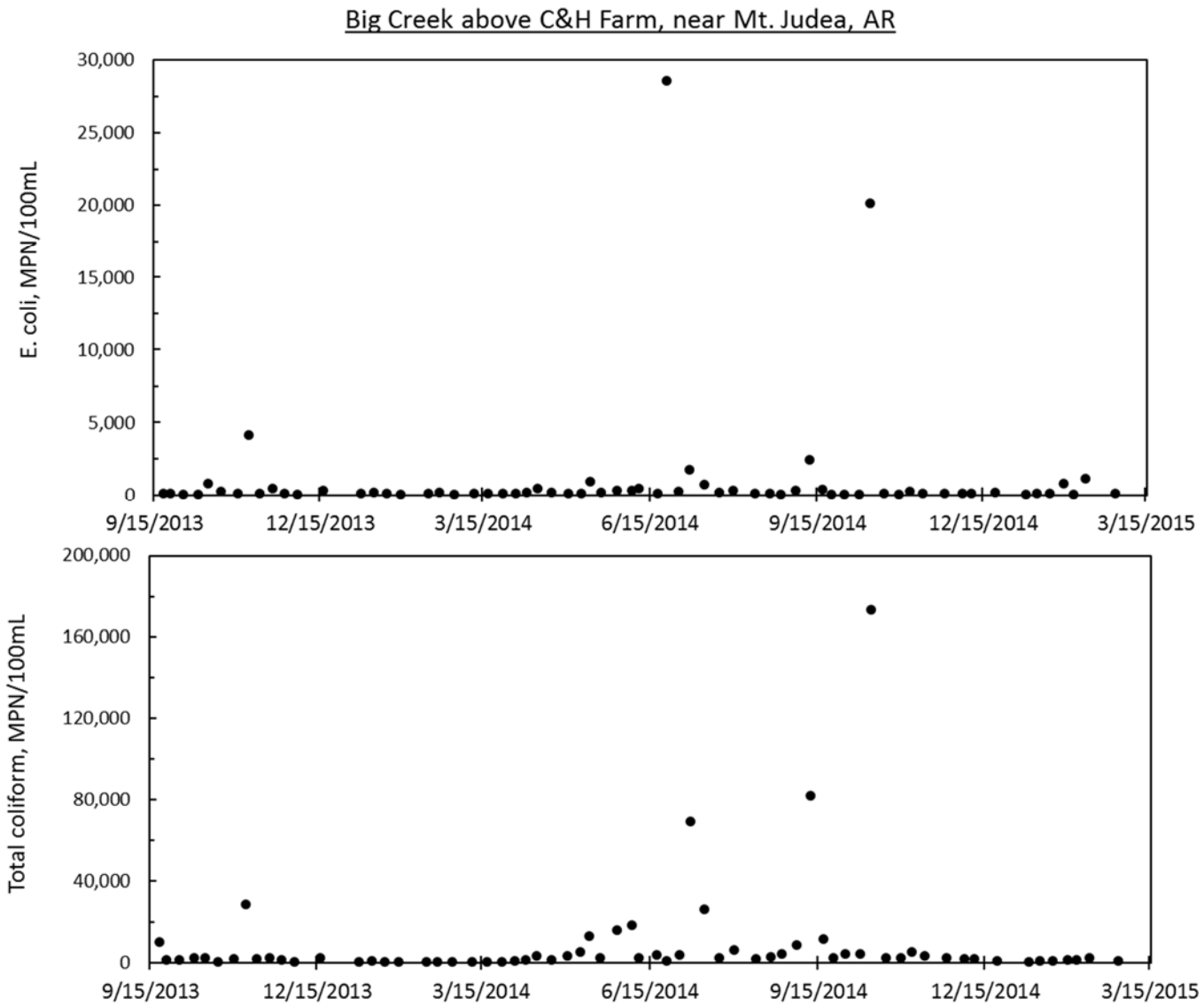

Figure 28. E. coli and fecal coliform concentrations between 1993 and 2004 in Big Creek above the C&H Farm near Mt. Judea, AR.

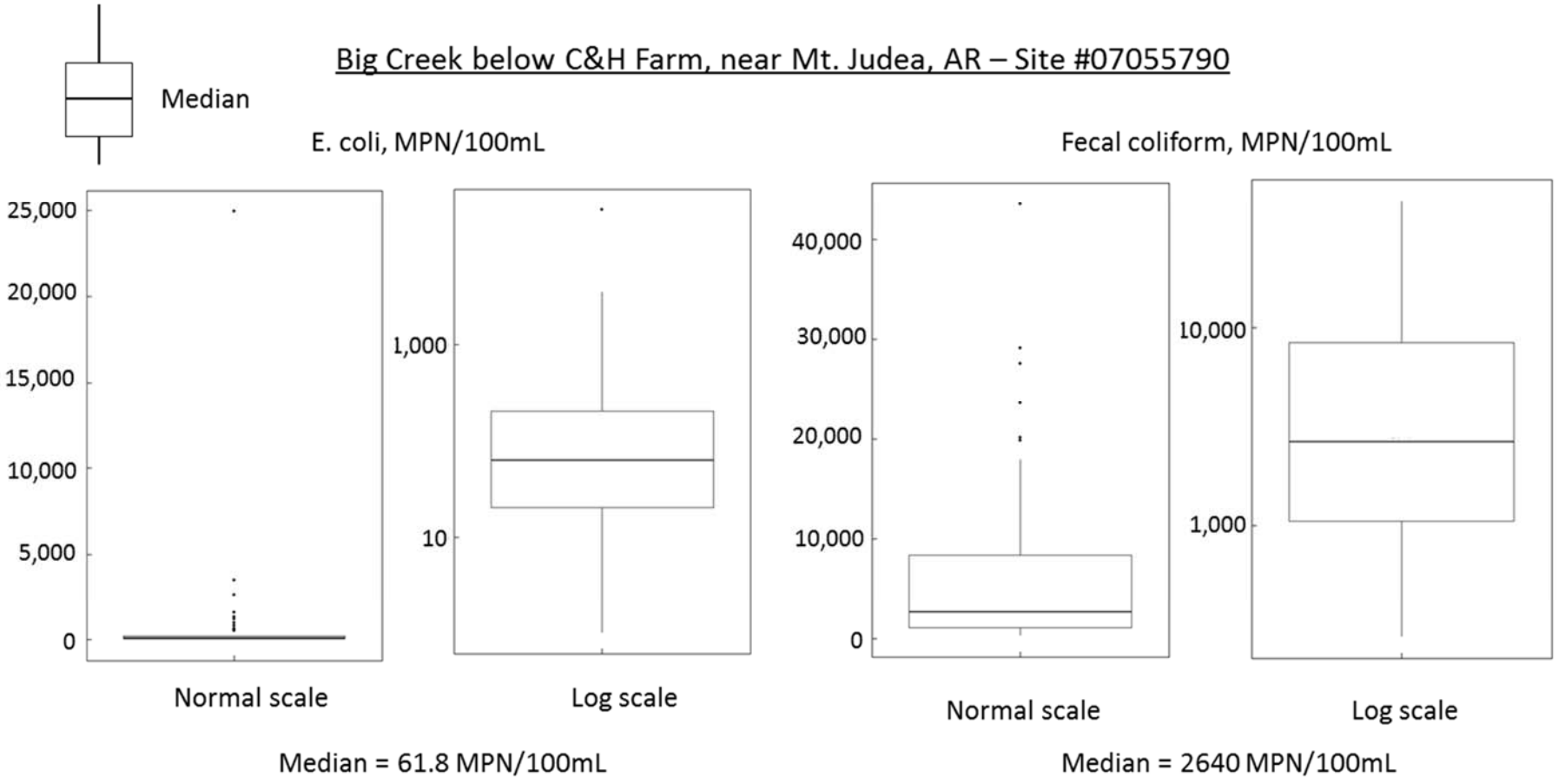

Figure 29. Range in E. coli and fecal coliform concentrations between 1993 and 2004 in Big Creek above the C&H Farm near Mt. Judea, AR.

Future Plan of Work

1. Continue to collect surface runoff, spring, and stream samples after each rainfall event from the autosamplers and manually collect baseflow samples weekly from the house well (when it is turned back on after the risk of freezing), spring, and streams. All samples will be analyzed for N, P, sediment, and bacteria within the confines of holding time requirements.
2. With the help of USGS team members, continue to develop a data base of nutrient and bacteria concentrations in sub-watersheds of the Buffalo River Watershed.
3. Complete the grid soil-sampling of Fields 1, 5a, and 12.
4. Continue to periodically determine plant uptake by collecting plant and hay samples for tissue analysis and determine yield (dry-matter mass for a pre-determined area).
5. Install equipment to measure the liquid flow from the production houses and determine pond height. In combination with weather data and interceptor trench monitoring, this will provide another indication of whether the holding ponds are leaking.
6. Precipitation inputs, average daily wash-down water, and manure holding pond volumes will be used to estimate annual manure and nutrient production values. These values, coupled with chemical treatment trial results, will form the basis for investigating manure management alternatives.

APPENDIX A: *E. COLI* IN FLOWING WATERS

Mary Savin and BCRET members

I. Why is *Escherichia coli* (*E. coli)* being monitored? What is the concern?

Fecal pollution (from excrement of humans or animals) in the environment is of concern for many reasons, not least of which is human health risks and disease control. Other concerns related to fecal pollution of our natural waters include potential changes in the nutrient status of water, introduction of antibiotic resistance and chemical contaminants, changes in the ecological condition of waters, and degradation of natural resources on which rural economies depend.

People are concerned that the land application of swine effluent (pig excrement) will increase *Escherichia coli* in Big Creek and consequently, the Buffalo River, the first National Scenic River in the U.S. This document aims to provide better understanding of:

1) what is involved in *E. coli* monitoring;
2) what the numbers mean;
3) some limitations in interpreting values; and
4) provide a context for further research that may be needed to better interpret the *E. coli* numbers being measured in flowing waters such as Big Creek and Buffalo River.

II. What is *E. coli*? Why and how is it used as an indicator?

E. coli is a species of bacteria from the coliform group - bacteria that are rod-shaped, gram negative, non-spore forming facultative anaerobes, commonly found in the feces of humans and warm blooded animals. *E. coli* occurs in human intestines - many strains with no ill effects, although certain *E. coli* cause serious human illnesses. Thus, while many *E. coli* do not harm us, there are important variants that do. There are also other species of bacteria, viruses, and other small organisms that cause disease, which if present in fecal sources polluting our waters, can make humans sick. Depending on whether *E. coli* survive as long in the environment as these other pathogens, *E. coli* may or may not adequately warn us about a disease causing agent in our waters. To date, *E. coli* is the most reliable test we have, although other indicators and tests are being investigated.

E. coli cannot be seen in streams by the human eye. Thus, it is important to determine if there is a problem of elevated *E. coli* numbers by careful water sampling and using U.S. Environmental Protection Agency (EPA) standardized methods. *E. coli* is counted in water because of the extensive studies and relationships established between the presence of *E. coli* and the number of human illnesses occurring from contact with the water (e.g. swimming) containing the bacteria. From these relationships, there have been upper limits established for bacterial numbers that correspond to the acceptable risk of people getting sick from exposure to water containing them.

Water quality standards for *E. coli* are established by the state in Arkansas Department of Environmental Quality (ADEQ) Regulation 2 (see Table 1). The *E. coli* numbers must remain below a

threshold in a specified number of total samples collected. The exact upper limit that is allowed depends on the designation of the waterbody and time of year (primary or secondary contact season). *Primary*

Table A 1.

Table 7. Upper limits for Escherichia coli counts defined in Regulation 2 of the Arkansas Department of Environmental Quality (ADEQ) as specified by contact season and waterbody designation for both single samples and geometric mean.

Contact season	Water designation	Limit of *E. coli* (MPN/100mL)	
		Single sample[1]	Geometric mean[2]
Primary (May 1-Sept. 30)	Extraordinary Resource Water Ecologically Sensitive Waterbody Natural & Scenic Waterway Lakes Reservoirs	298	126
	All other water	410	NA[3]
Secondary (Oct. 1-April 30)	Extraordinary Resource Water Ecologically Sensitive Waterbody Natural & Scenic Waterway Lakes Reservoirs	1490	630
	All other water	2050	NA

[1] No more than 25% of samples from no less than 8 samples per contact season may exceed the limit

[2]Geometric mean is calculated from at least 5 samples collected within 30 days at evenly spaced time intervals during that 30-day period

[3]Not applicable

contact recreation is a designation given to a waterbody where full body contact occurs and occurs from May 1 through September 30. The ADEQ also designates any stream with a watershed (e.g. drainage basin in the landscape) exceeding 10 square miles and those with smaller watersheds on individual cases (i.e. after site verification) for primary contact recreation. *Secondary contact recreation* designates waterbodies where activities such as boating, fishing, and wading take place and occurs from October 1 through April 30.

E. coli is measured in samples of water collected strictly following EPA guidelines. The measurement of *E. coli* starts within 8 hours of collection. This method provides an estimate of *E. coli* presence in the sampled water that is the most probable number (MPN) of *E. coli*. Using an EPA method provides numbers that are theoretically comparable to other labs using the same method. The MPN

depends on growing bacteria in the laboratory in "culture" and is an approach used routinely in microbiology. This measurement is subject to high variability because of the nature of environmental bacteria; thus, variability in the data in *E. coli* counts from streams is not unusual. For this reason, it is important to establish background levels of *E. coli* in any water resulting from various wildlife, human (e.g., septic tanks, sewers), and agricultural (e.g. pig, chicken, cattle) sources.

E. coli thresholds are lower in late spring through summer (primary contact season) when more people are expected to be in contact with streams and lakes. More stringent limits also apply to Extraordinary Resource Waters (e.g., Buffalo River), Ecologically Sensitive Waterbodies, and Natural Scenic Waterways. During the primary contact season (May 1- Sept. 30), we do not want *E. coli* to exceed 298 MPN/100 mL, and during secondary contact season (Oct. 1 – Apr. 30) *E. coli* counts should not exceed 1490 MPN/100 mL in single samples.

III. How does the *E. coli* measurement "fit" into the context of the landscape?

While monitoring one bacterial species to assess the biological quality of water may seem simple, determining the actual ecological condition of a system is complicated. Measurement of *E. coli* is an indicator for potential fecal pollution and potential pathogen problems, but by itself, does not identify the source(s) of the bacteria.

E. coli is present in intestines (and feces) and is not supposed to grow in the environment; thus, the presence and abundance should indicate pollution and be directly related to human and animal sources. However, because *E. coli* is in many different animals (e.g. human, wildlife, agricultural) and because of the different pathways that bacteria may travel throughout the environment before ending up in water where we can measure it, the presence of *E. coli* does not identify the source of pollution.

IV. Why is *E. coli* monitoring important and why is it complicated?

There are many of factors that affect whether *E. coli* survives in the environment, for how long, and whether it moves to other locations. *E. coli* is adapted to living in intestines. After deposition from an animal, cells have to survive rapidly changing environmental conditions (e.g. temperature and moisture), exposure to harmful UV rays in sunlight, outcompete other organisms, and avoid predators. All these factors make it difficult to estimate how long *E. coli* will survive in lagoon, soil, and river environments. However, there is evidence that *E. coli* can persist in soil and sediments.

V. What are the numbers?

E. coli is measured weekly in Big Creek upstream and downstream of the C&H Farm, Mt. Judea, Newton County, Arkansas. Water sample collection for *E. coli* analysis began Sept 12, 2013, prior to manure from C&H Farm application to fields, either in fields adjacent to or distant from Big Creek. Manure application began in 2014 to fields distant from Big Creek, and then adjacent to Big Creek in March 2014. So far in the period following manure applications by C&H Farms (Jan 2 through May 19, 2014), no trends in *E. coli* with time or between sampling locations are apparent (Table 2).

The Table 2 data are detailed in the Big Creek Research and Extension Team Quarterly Reports and demonstrate the week-to-week variability in *E. coli* at upstream and downstream sites. The *E. coli* counts

are expected to continue to be variable. Clearly, it is important to quantify the variability in *E. coli* concentrations long-term in order to determine if changes occur as a result of C&H operation.

The MPN is expected to increase with increases in flow, and the recent installation of a USGS gauge to measure flow will allow for the determination of the relationship between measured flow in the stream and *E. coli* concentrations. Because of the dangers during high flows, most contact recreation is expected during base flow, and thus sampling during base flow may provide more meaningful data.

Table 8. Geometric mean of E. coli (and range of sample MPN) before (Sept 12 - Dec 17, 2013) and after manure applications began on the C&H Farm (Jan 2 - May 19, 2014).

C&H location	Before any manure application	After manure application
	Sept. 12 - Dec. 17, 2013	Jan. 2 - May 19, 2014
	(MPN/100mL)	
Upstream	82 (6 – 4080)	83 (ND[a] – 921)
Downstream	111 (5 – 3500)	39 (ND – 1553)

[a]Not detected.

Regulation

Arkansas Pollution Control and Ecology Commission # 014.00-002 2014. Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas as revised, effective March 24, 2014. Arkansas Department of Environmental Quality (ADEQ). Available at http://www.adeq.state.ar.us/regs/files/reg02_final_140324.pdf. Last accessed 20 Aug 2014.

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Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – April 1 to June 30, 2015

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

The mission of the **Division of Agriculture** is to advance the stewardship of natural resources and the environment, cultivate the improvement of agriculture and agribusiness, develop leadership skills and productive citizenship among youth and adults, enhance economic security and financial responsibility among the citizens of the state, ensure a safe, nutritious food supply, improve the quality of life in communities across Arkansas, and strengthen Arkansas families.

Dr. Mark J. Cochran
Vice President for Agriculture

Executive Summary

This is the second Quarterly Report of 2015 for the Big Creek Research and Extension Team that details the following progress made from April 1 through June 30, 2015.

1. Continued collection weekly baseflow and periodic storm flow water samples from Big Creek above and below the C&H Farm, along with water from the spring, ephemeral stream, surface runoff sites on Fields 1, 5a, and 12, interceptor trench below the slurry holding ponds, and house well for chemical analysis.

2. We started monitoring the nutrient and bacterial concentrations in Left Fork as it enters Big Creek in early June. At the same time USGS installed a station that currently measures stage height, the same as at our downstream site on Big Creek. This will allow the comparison of nutrient and bacteria flows from a watershed similar to Big Creek, but without a hog operation. The Left Fork watershed (16 % pasture and 79% forest) has similar land use classification to Big Creek watershed (18 % pasture and 80% forest), except for the presence of the hog operation.

3. At the beginning of 2015, we initiated the measurement of pH, alkalinity, chloride, electrical conductivity, and total dissolved solids in water samples collected at the upstream, downstream, spring, house well, and trench sites. This information will in the long term, allow us to better define the sources of water at these sampling sites. The data collected to date are presented in this report, with median values from January 8, 2015 to May 25, 2015 given below.

Median pH, alkalinity, chloride, conductivity, and total dissolved solids at several Big Creek monitoring sites.

Location	pH	Alkalinity	Chloride	Conductivity	Total dissolved solids
		mg/L	mg/L	µS/cm	mg/L
Upstream	7.740	40.0	1.732	109.7	67.6
Downstream	7.75	64.0	2.023	150.4	89.1
Spring			1.853	513.5	283.7
House well			5.018	453.0	237.3
Trench 1			1.945	248.9	129.6
Trench 2			0.934	164.9	140.8

4. A final report detailing findings of the Electrical Resistivity Imaging (ERI) analysis conducted on application fields was not available at the time this Quarterly Report was due. The ERI report will be released as soon as it is available to us.

Big Creek Research Team

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Brian Breaker, M.Sc., Hydrologic Technician, stream flow and constituent collection, analysis, and statistical evaluation of trends.

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Rick Cartwright, Ph.D., Professor – Associate Director of Extension for Agriculture and Natural Resources

Mark Cochran, Ph.D., – Vice President, University of Arkansas System Division of Agriculture.

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Ed Gbur, Ph.D., Professor and Director, Agricultural Statistics Laboratory - Experimental design, linear and generalized linear mixed models, regression, agricultural applications of statistics.

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Phil Hays, Ph.D. Ground Water Specialist, U.S. Geological Survey and Research Professor with Geosciences Dept., University of Arkansas, application of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems

Tim Kresse, M.Sc., Water Quality Specialist, U.S. Geological Survey, natural geochemical evolution of groundwater and separating these processes from anthropogenic sources of contamination

Nathan McKinney, Ph.D., – Assistant Director, Agriculture Experiment Station

Morteza Mozaffari, Ph.D. – Director, Univ. of Arkansas Soil Testing and Research Laboratory, Marianna.

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Thad Scott, Ph.D., Associate Professor - Water quality, transport of contaminants to and within water bodies

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Jun Zhu, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians - The Big Creek Research and Extension Team are ably supported by several excellent Program Technicians based in Little Rock and Fayetteville.

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Watershed Land Use Analysis

Land use of the watershed drainage area was determined for several segments of the Big Creek Watershed (Tables 1 and 2). This was determined using data from the USDA-NRCS Geospatial Data Gateway for Newton Co., AR http://datagateway.nrcs.usda.gov/; national land cover dataset by State for 2006; cropland data layer by State for 2006; and hydrography data layer for streams and HUC 12 watershed boundaries for 2007 to present. The following drainage areas were delineated; Big Creek (Figure 1), Big Creek upstream of the C&H (Figure 2), downstream of the C&H Farm to the Buffalo River (Figure 3), the monitored land area encompassing fields permitted to receive manure slurry (Figure 4), Dry Creek Watershed (Figure 5), and the newly monitored Left Fork Watershed (Figure 6).

Monitoring flow and water quality of Left Fork, as it enters Big Creek, was initiated in May 2015 by both USGS and the BCRET Project. The quality of water in Left Fork will be used as a baseline to compare with water quality at the site downstream of the C&H Farm, as the Left Fork Watershed does not contain any concentrated animal feeding operations. Left Fork enters Big Greek just below the BCRET downstream monitoring station.

Overall, land use of the area of the monitored watershed encompassing the C&H Farm (18% pasture and 78% forest) was similar to the land area downstream of the C&H Farm to the Buffalo River (17% pasture and 80% forest) (Table 2). Upstream of the C&H Farm there was less pasture (5%) and more forest (92%) (Table 2). Land use in the monitored portion of the Big Creek watershed (17% pasture and 80% forest) was also similar to the land use in the newly instrumented Left Fork watershed (16% pasture and 79% forest) (Table 2), which is planned to serve as a baseline of chemical and biological composition representative of waters draining a watershed without an animal feeding operation.

Table 1. Land use classification of the monitored watershed, upstream of C&H, downstream of C&H and Dry Creek Watersheds. 1

	Big Creek watershed (Figure 1)		Upstream of C&H (Figure 2)		Downstream of C&H (Figure 3)		Monitored watershed (Figure 4)		Dry Creek watershed (Figure 5)		Left Fork watershed (Figure 6)	
Land use/Land cover			**Area (acres)**	**% of total area**	**Area (acres)**	**% of total area**	**Area (acres)**	**% of total area**	**Area (acres)**	**% of total area**	**Area (acres)**	**% of total area**
Forest												
Deciduous forest	45,977	79.0	15,110	86.5	24,297	75.9	6,570	75.1	4,036	89.0	17,324	73.1
Evergreen forest	1,858	3.2	514	2.9	1,094	3.4	250	2.9	145	3.2	1,406	5.9
Mixed forest	69	0.1	4	0.0	54	0.2	11	0.1	2	0.03	440	1.9
Shrub land	9	0	5	0.0	2	0.0	- - [2]	- -	- -	- -	2.73	0.0
Woody wetlands	2	0	0.4	0.0	0.7	0.00	0.7	0.0	- -	- -	3	0.0
Pasture												
Grassland/ Pasture	8,381	14.4	1,389	8.0	5,431	17.0	1,561	17.9	231	5.1	3,833	16.2
Urban												
Developed/ Open space	1,800	3.1	435	2.5	1,038	3.2	327	3.7	119	2.6	675	2.8
Developed/Low intensity	113	0.2	13.	0.1	77	0.3	23	0.3	0.7	0.01	30	0.1
TOTAL	**58,209**		**17,470**		**31,994**		**8,745**		**4,534**		**23,714**	

[1] Obtained the following data from the USDA:NRCS Geospatial Data Gateway for Newton Co., AR http://datagateway.nrcs.usda.gov/; National land cover dataset by State, 2006; Cropland data layer by State, 2006; and Hydrography (streams and HUC 12 watershed boundaries), 2007-present.

[2] None measured.

Table 2. Area as pasture forest and urban for upstream of C&H, downstream of C&H, the monitored watershed, Left Fork watershed, and Dry Creek watershed.

Land use/Land cover	Upstream of C&H		Monitored watershed		Downstream of C&H		Left Fork watershed		Big Creek watershed	
	Area (acres)	% of total area	Area (acres)	% of total area	Area (acres)	% of total area	Area (acres)	% of total area	Area (acres)	% of total area
Forest	15,633	89.4	6,834	78.1	25,448	79.5	19,176	80.9	47,915	82.3
Pasture	1,389	8.0	1,561	17.9	5,431	17.0	3,833	16.2	8,381	14.4
Urban	448	2.6	350	4.0	1,115	3.5	705	2.9	1,913	3.3

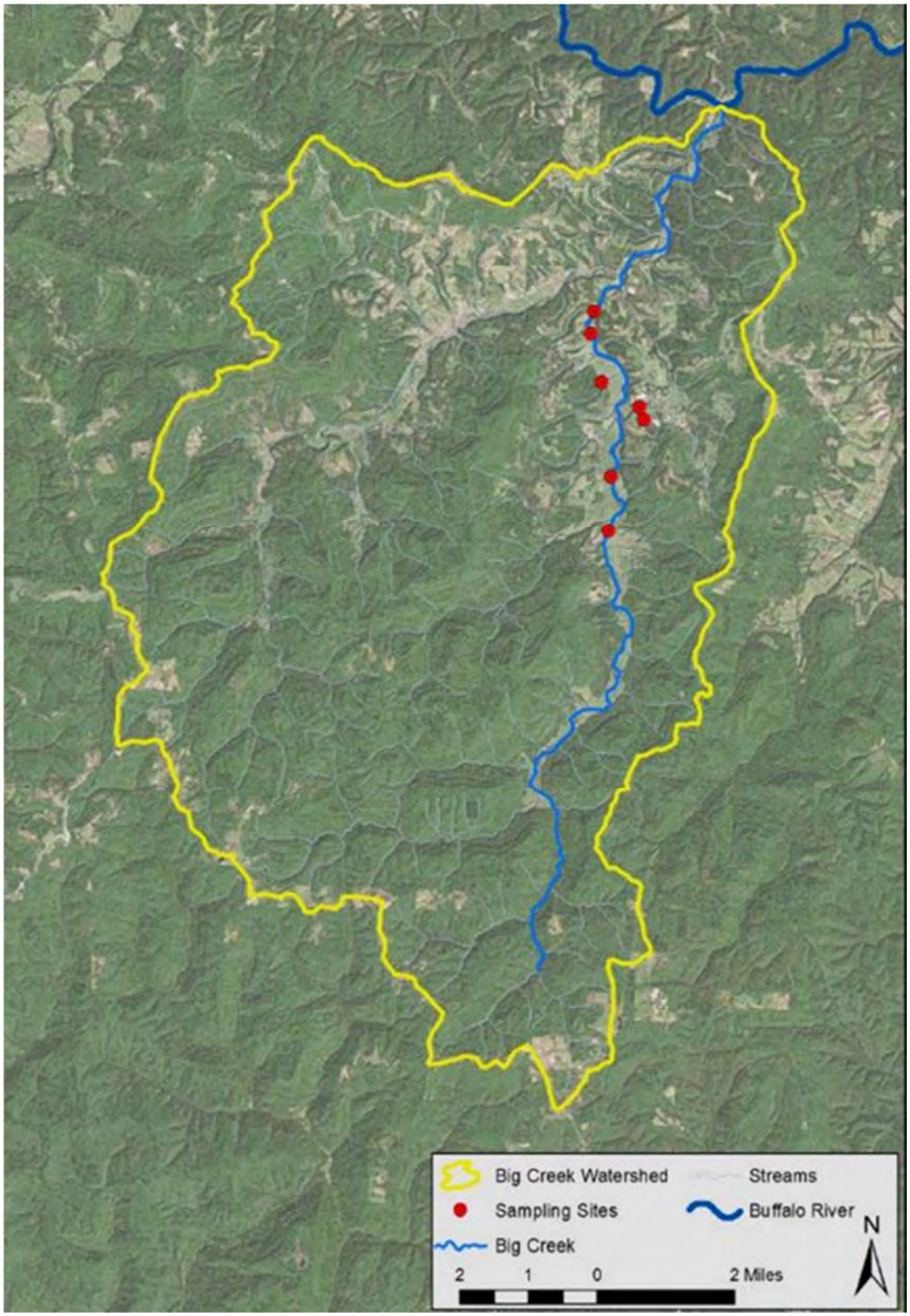

Figure 1. Big Creek Watershed.

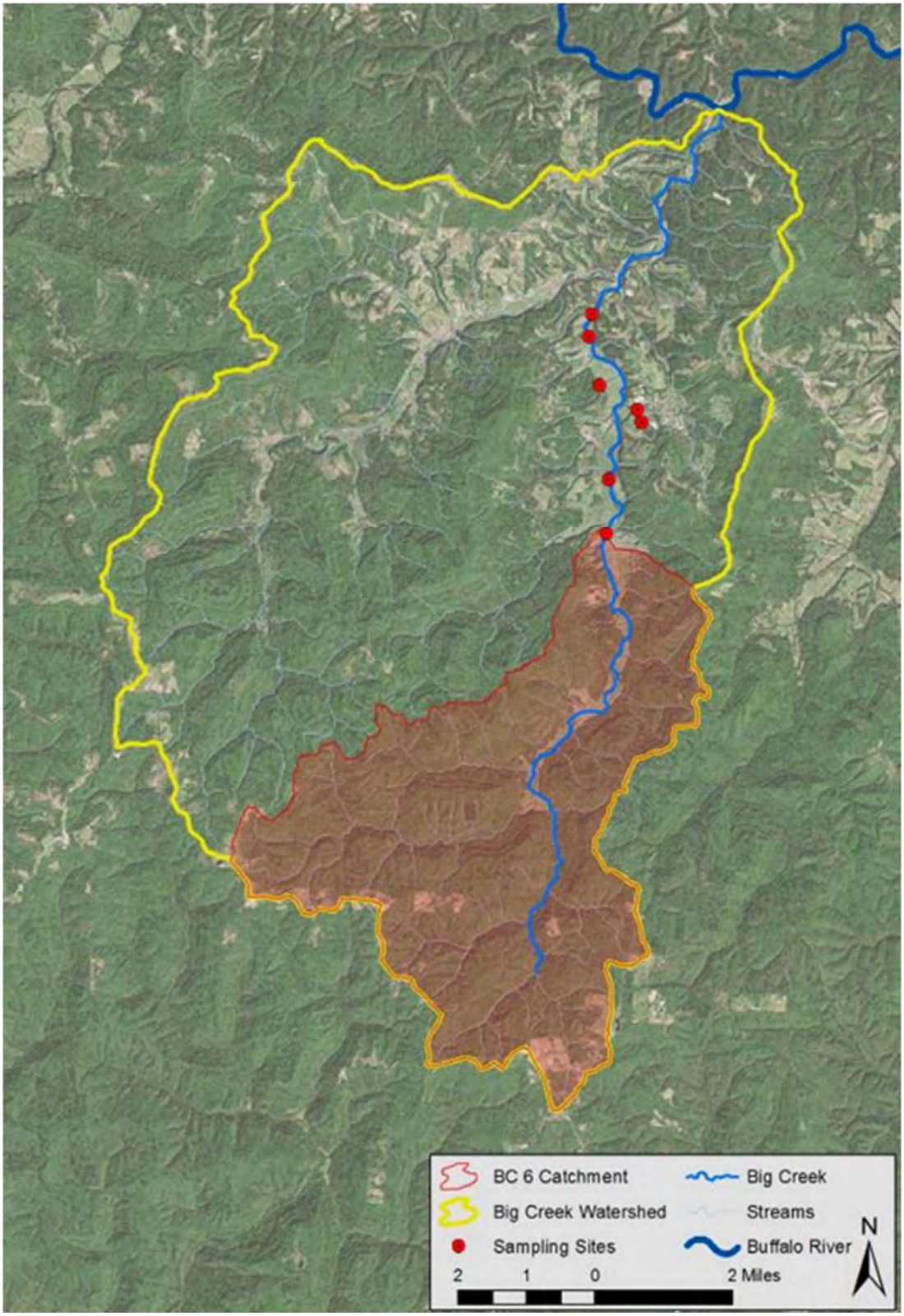

Figure 2. Big Creek Watershed up stream of the C&H Farm.

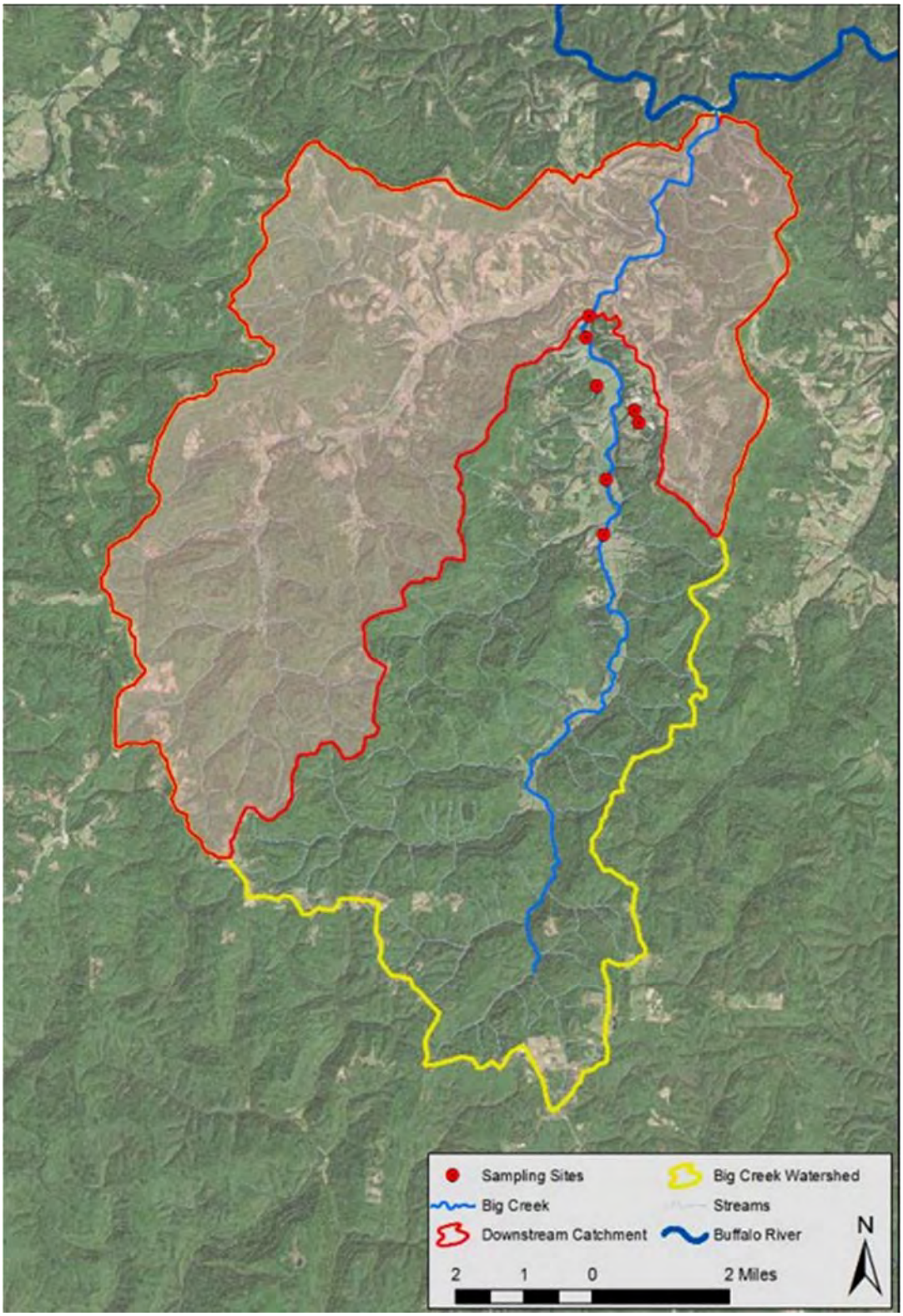

Figure 3. Big Creek Watershed below the downstream monitoring site on C&H Farm.

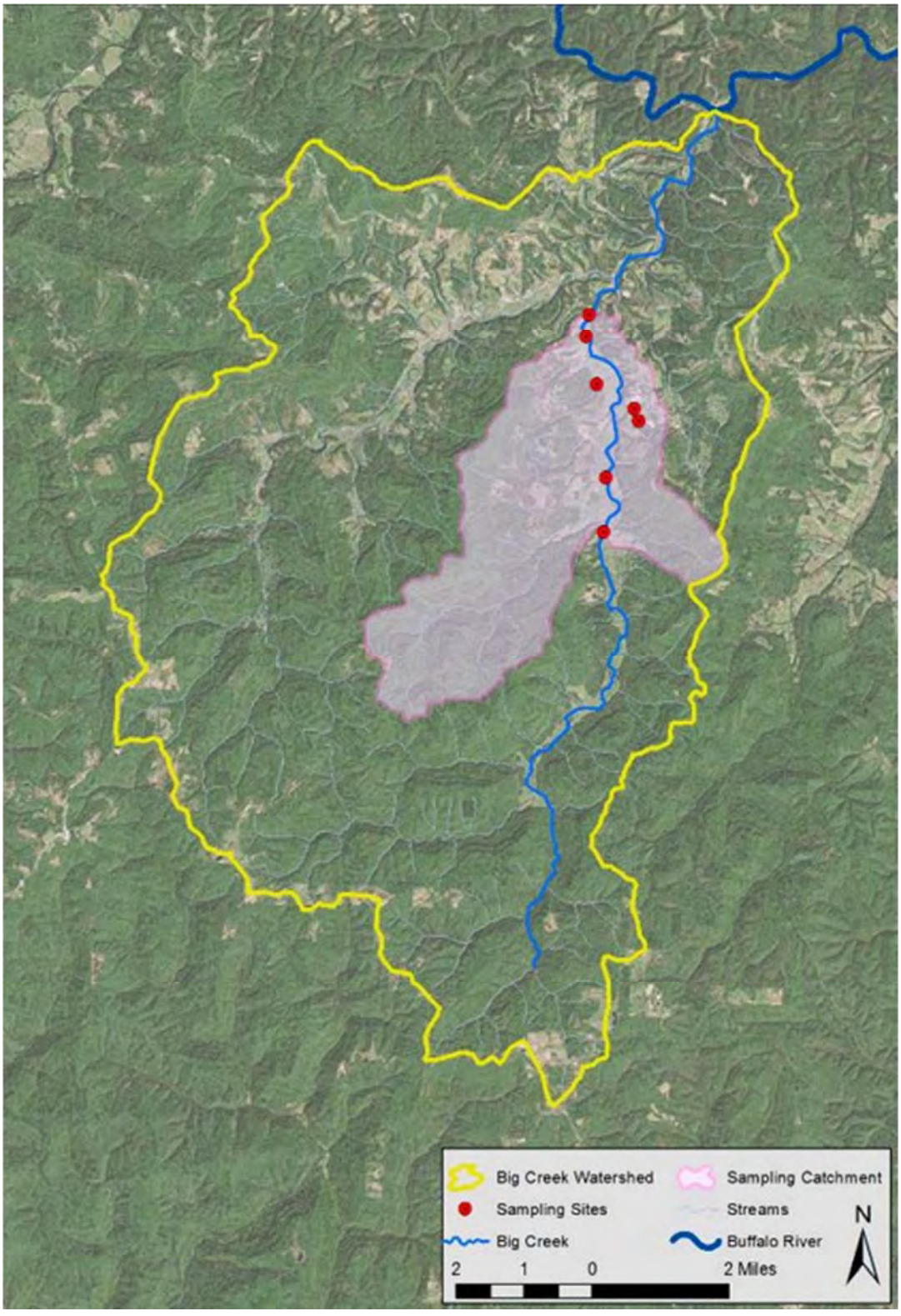

Figure 4. The watershed created by BRCET up and downstream sampling sites at C&H Farm. The C&H permitted fields' watershed.

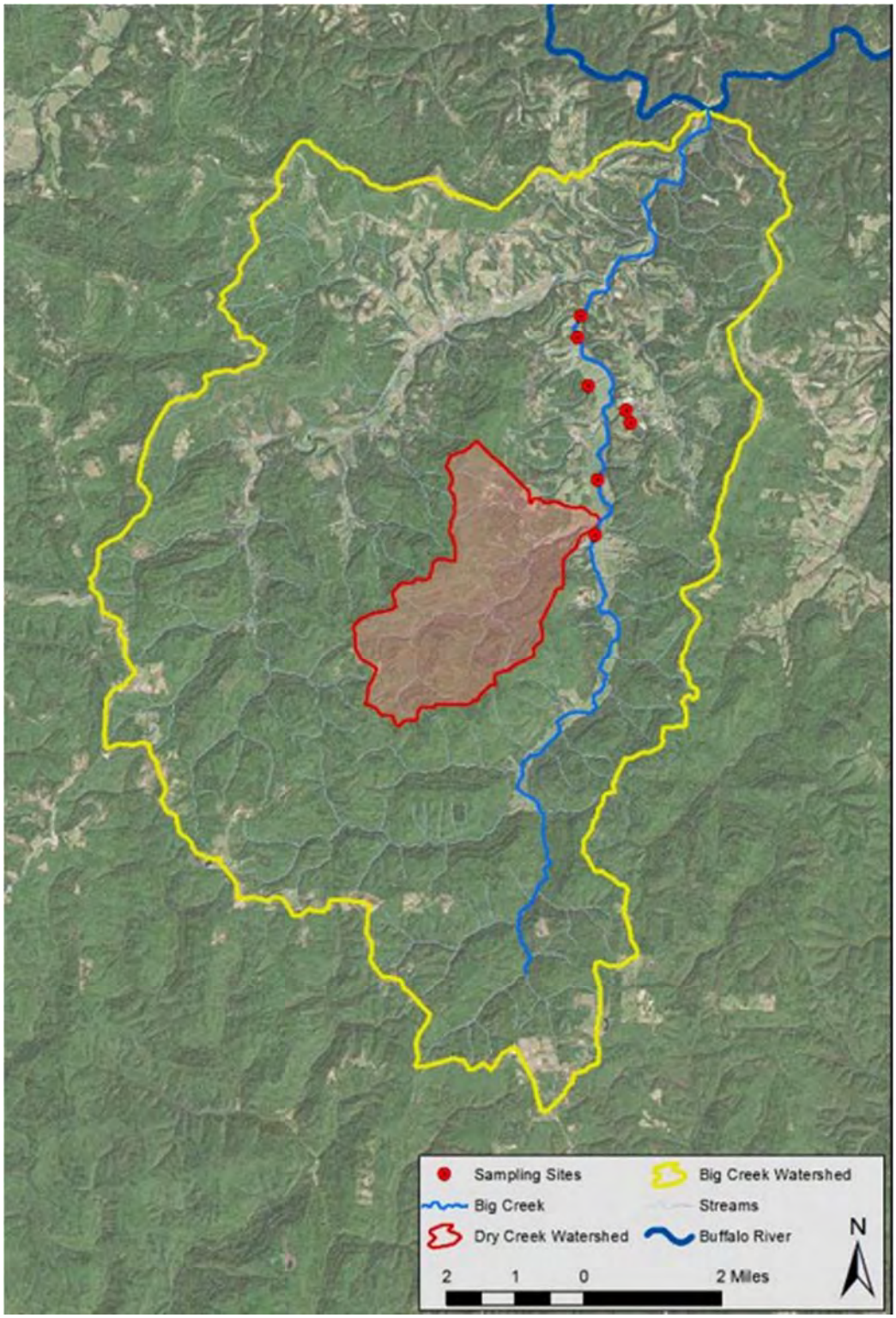

Figure 5. Dry Creek Watershed.

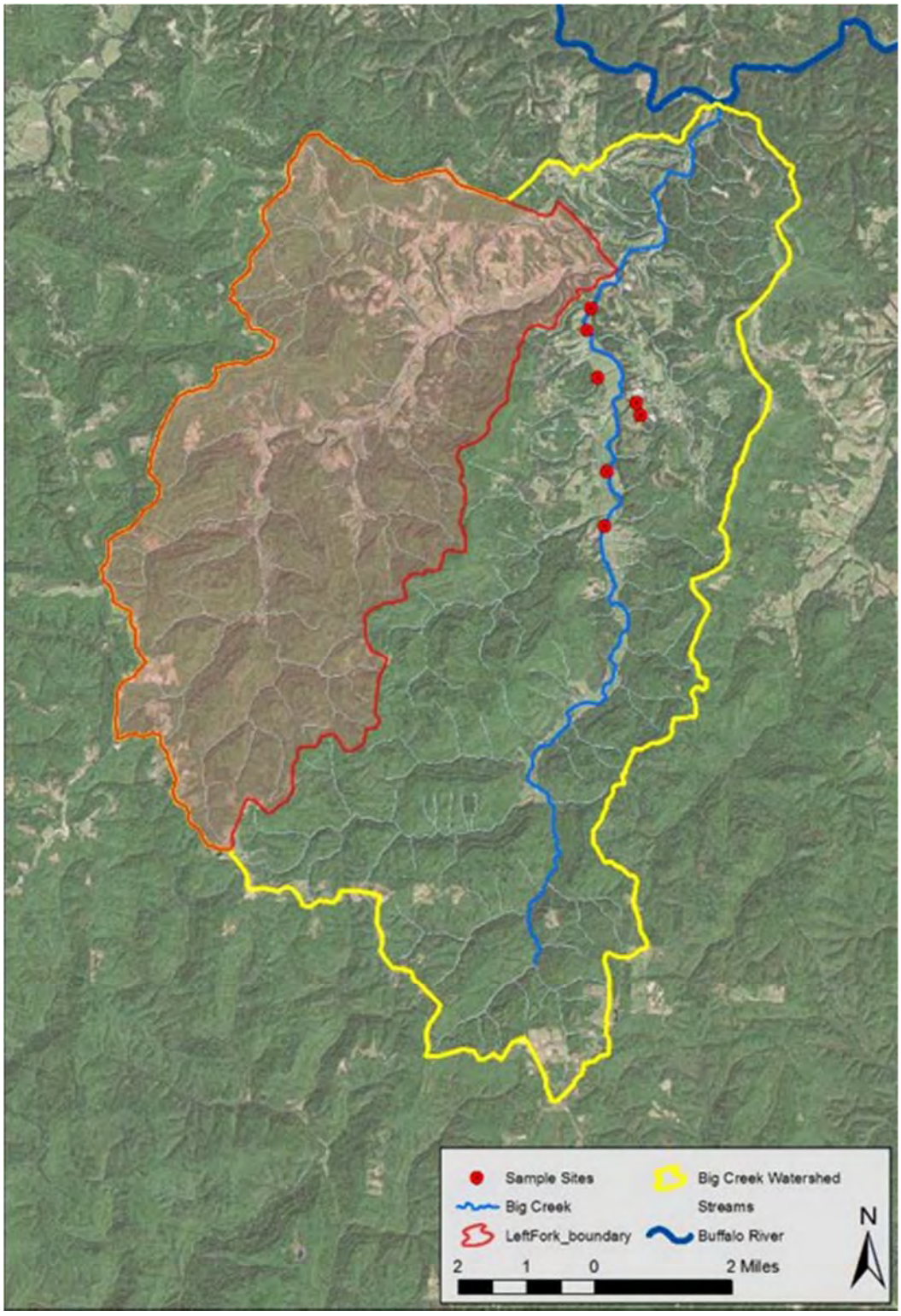

Figure 6. Left Fork Watershed.

Grid-Soil Sampling

Grid-soil sampling was completed on Field 5a in January, 2015. Samples were collected to a depth of 24 inches and sent to the University of Arkansas Soil Testing and Research Laboratory, Marianna, AR.

Table 3. Mehlich-3 extractable soil phosphorus, potassium, and calcium and pH of soils collected from Field 5a, January, 2015.

Soil depth, inches	pH	Phosphorus	Potassium	Calcium
Mean, mg/kg				
0 – 4	5.59	45	60	1289
4 – 8	5.7	30	54	1230
8 – 12	5.8	31	68	1383
12 – 18	5.9	42	81	1605
18 – 24	5.9	43	86	1638
Median, mg/kg				
0 – 4	5.45	42	53	955
4 – 8	5.6	24.0	54.5	962.5
8 – 12	5.9	24.5	67.0	1217.0
12 – 18	6.0	29.5	79.0	1384.0
18 – 24	6.1	25.5	87.0	1700.0
Minimum, mg/kg				
0 – 4	4.50	17	25	167
4 – 8	4.7	9.0	21.0	206.0
8 – 12	4.7	7.0	37.0	411.0
12 – 18	4.7	7.0	46.0	491.0
18 – 24	4.6	5.0	40.0	400.0
Maximum, mg/kg				
0 – 4	7.00	91	176	3404
4 – 8	6.8	72.0	89.0	3397.0
8 – 12	7.0	97.0	105.0	3976.0
12 – 18	6.8	300.0	124.0	2752.0
18 – 24	7.3	262.0	135.0	3228.0

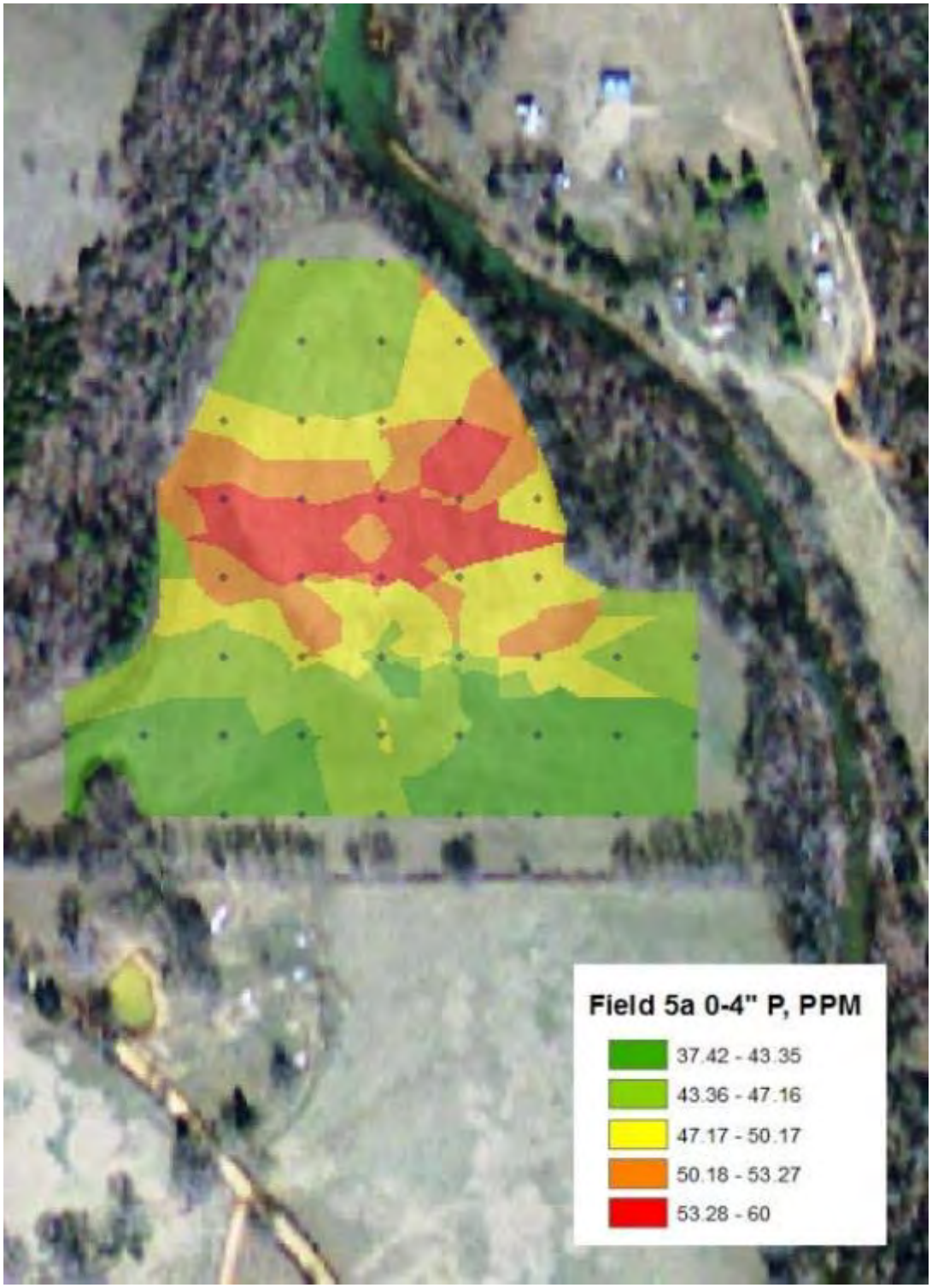

Figure 7. Spatial distribution of soil test P with depth for Field 5a.

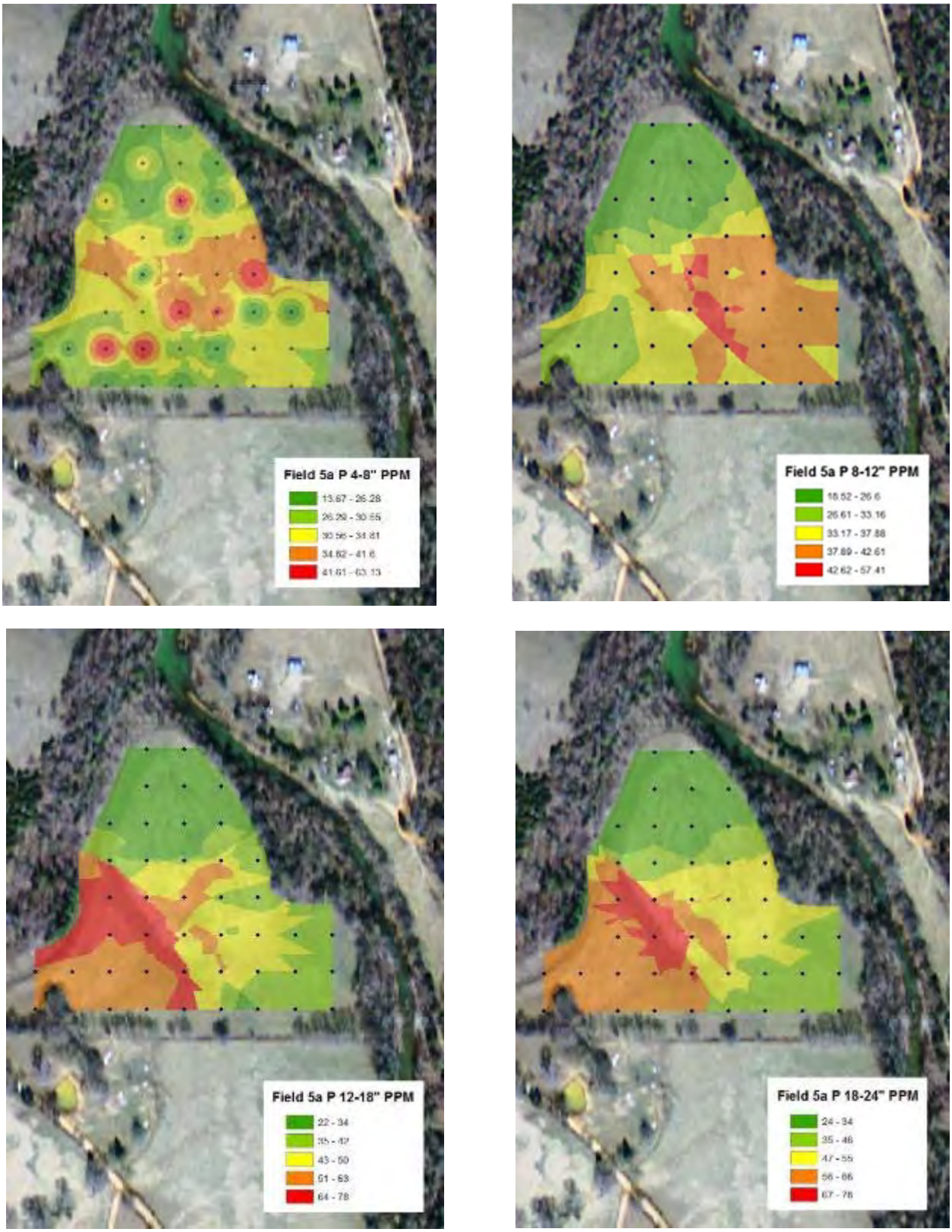

Figure 8. Spatial distribution of soil test P with depth for Field 5a.

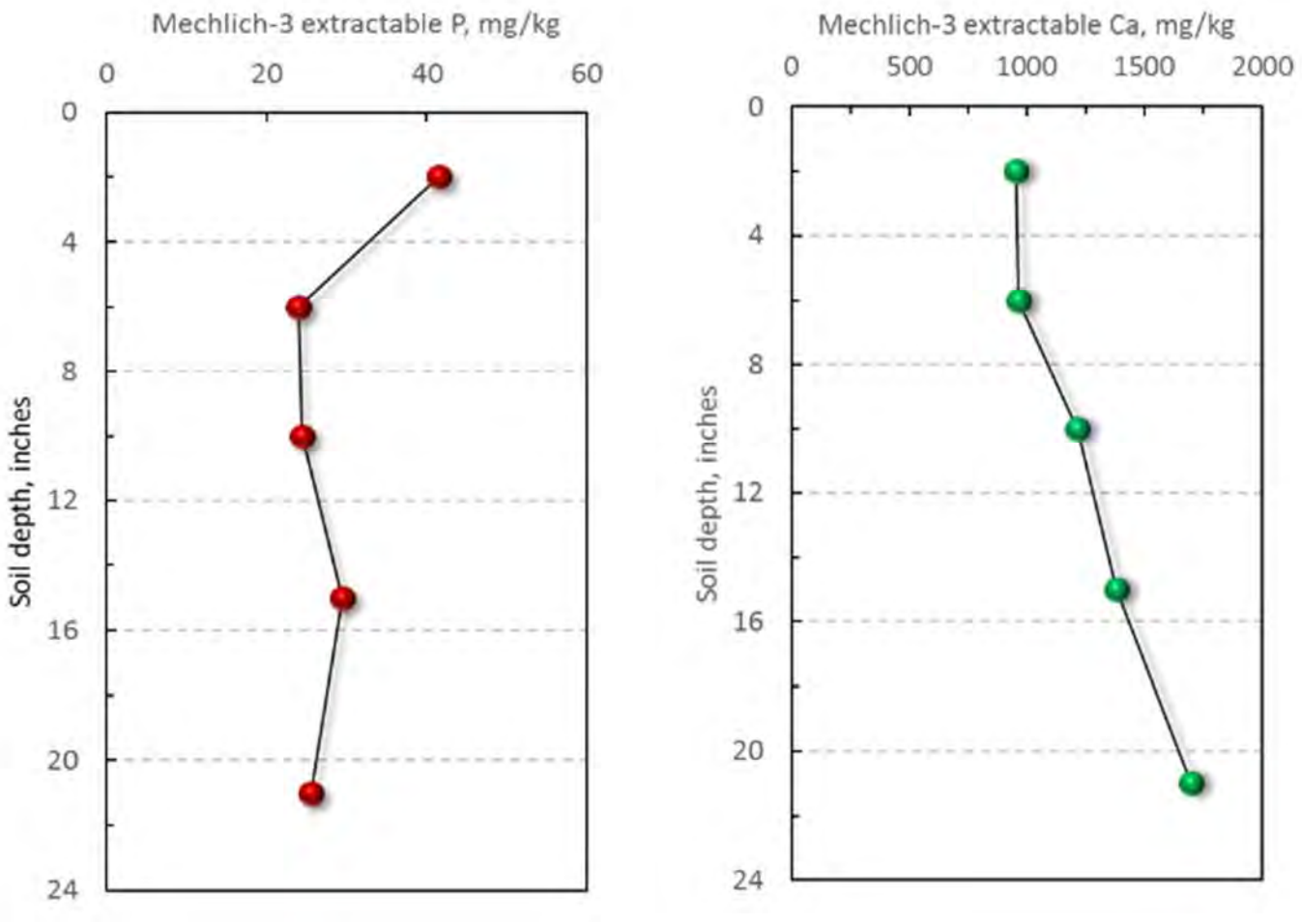

Figure 9. Relationship between median soil test P and Ca for Field 5a with depth.

The concentration of Soil test P at the surface of the soil is slightly greater than at depth. This is consistent with soils under pasture that have received fertilizer and in this case poultry litter in the past. However, the median soil test P concentration is just below the optimum (50 mg/kg) recommended by the State for warm season grass forage production. The increase in Ca concentration with depth, represent weathering processes occurring in a limestone setting, where lower concentrations in the upper soil profile representing uptake by plants, in addition to weathering and downward leaching of Ca.

Similar trends were observed for Field 12, for samples collected in 2014. For Field 1, which was at a higher elevation compared to the stream channel, samples could not be collected beyond 12 inches.

The grid-soil sampling of Fields 1, 5a, and 12 will be repeated in the fall of 2015. Nutrient concentrations will be compared with data from prior grid samplings to determine if any soil fertility changes are occurring these fields with time of farm operation.

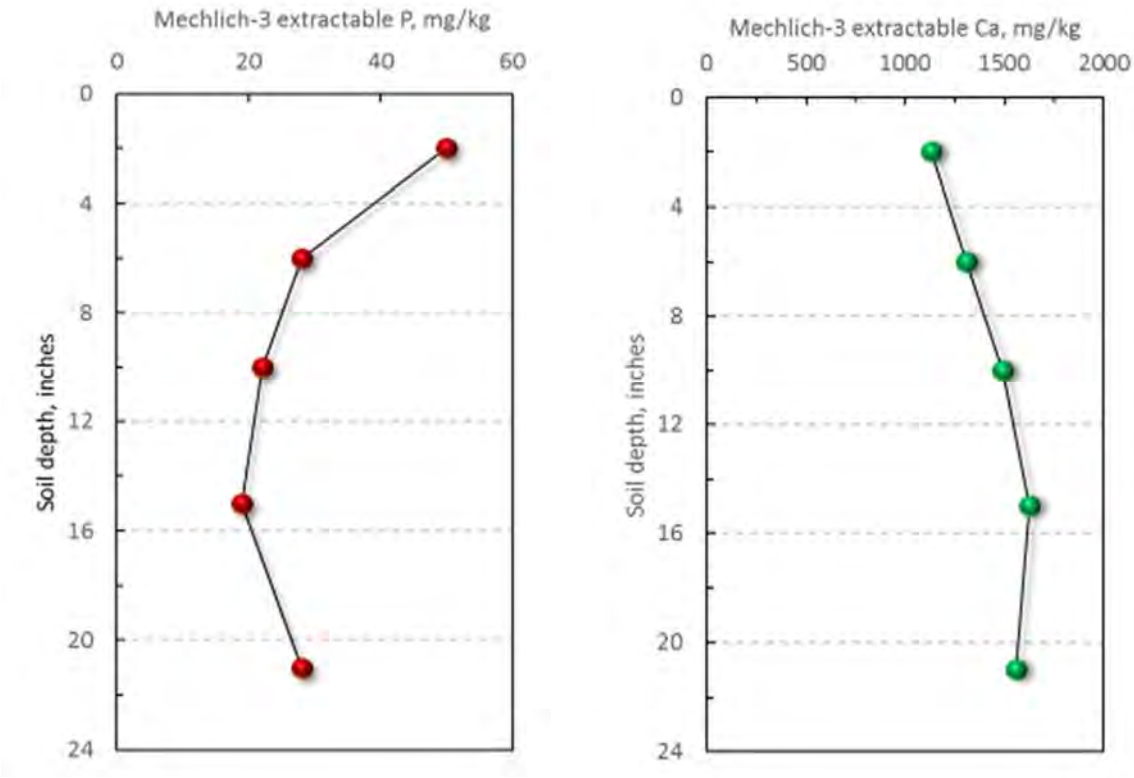

Figure 10. Relationship between median soil test P and Ca for Field 12 with depth.

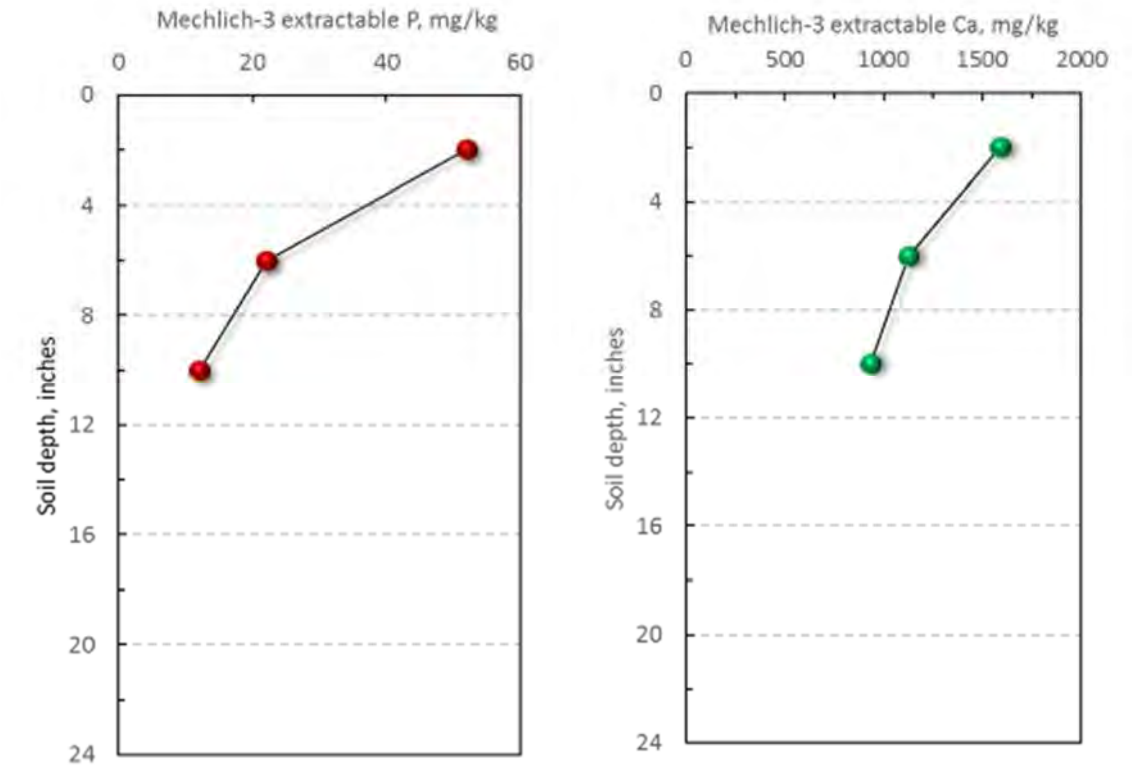

Figure 11. Relationship between median soil test P and Ca for Field 1 with depth.

Water Sampling and Analytical Methods

Sampling Locations

Water quality monitoring sites are shown in Figure 12 and are;

Site 1. Edge-of-field monitoring on Field 1 permitted to receive slurry.

Site 2. Edge-of-field monitoring on Field 5a.

Site 3. Edge-of-field monitoring on Field 12 permitted to receive slurry.

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities.

Site 5. Spring below Field 1.

Site 6. Big Creek upstream of the C&H Farm operation.

Site 7. Big Creak downstream of the C&H Farm operation.

Site 8. Manure holding pond trench. The site was visited weekly and trench water sampled when flowing.

Sampling Protocols and Analyses

The following protocols were used to collect, prepare, and analyze all water samples:

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface, where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted, and samples placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
6. Analyses included Alkalinity (APHA 2320-B), Ammonia (EPA 351.2), Chloride (EPA 300.0), Dissolved Phosphorus (EPA 365.2), E. coli (APHA 9223-B), Electrical Conductivity (EPA 120.1), Nitrate (EPA 300.0), pH (EPA 150.1), Total Coliforms (APHA 9223-B), Total Dissolved Solids (EPA 160.1), Total Nitrogen (APHA 4500-P J), Total Phosphorus (APHA 4500-P J), and Total Suspended Solids (EPA 160.2). APHA is American Public Health Association from the Wadeable Streams Assessment, Water Chemistry Laboratory Manual http://www.epa.gov/owow/monitoring/wsa/WRS_lab_manual.pdf
7. The minimum detection limits (MDLs) for each chemical and biological constituent measured are listed in Table 4.
8. Chemical and biological analyses of samples collected from the beginning of 2015 to the end of May, 2015 are presented in Tables 5, 6, and 7.

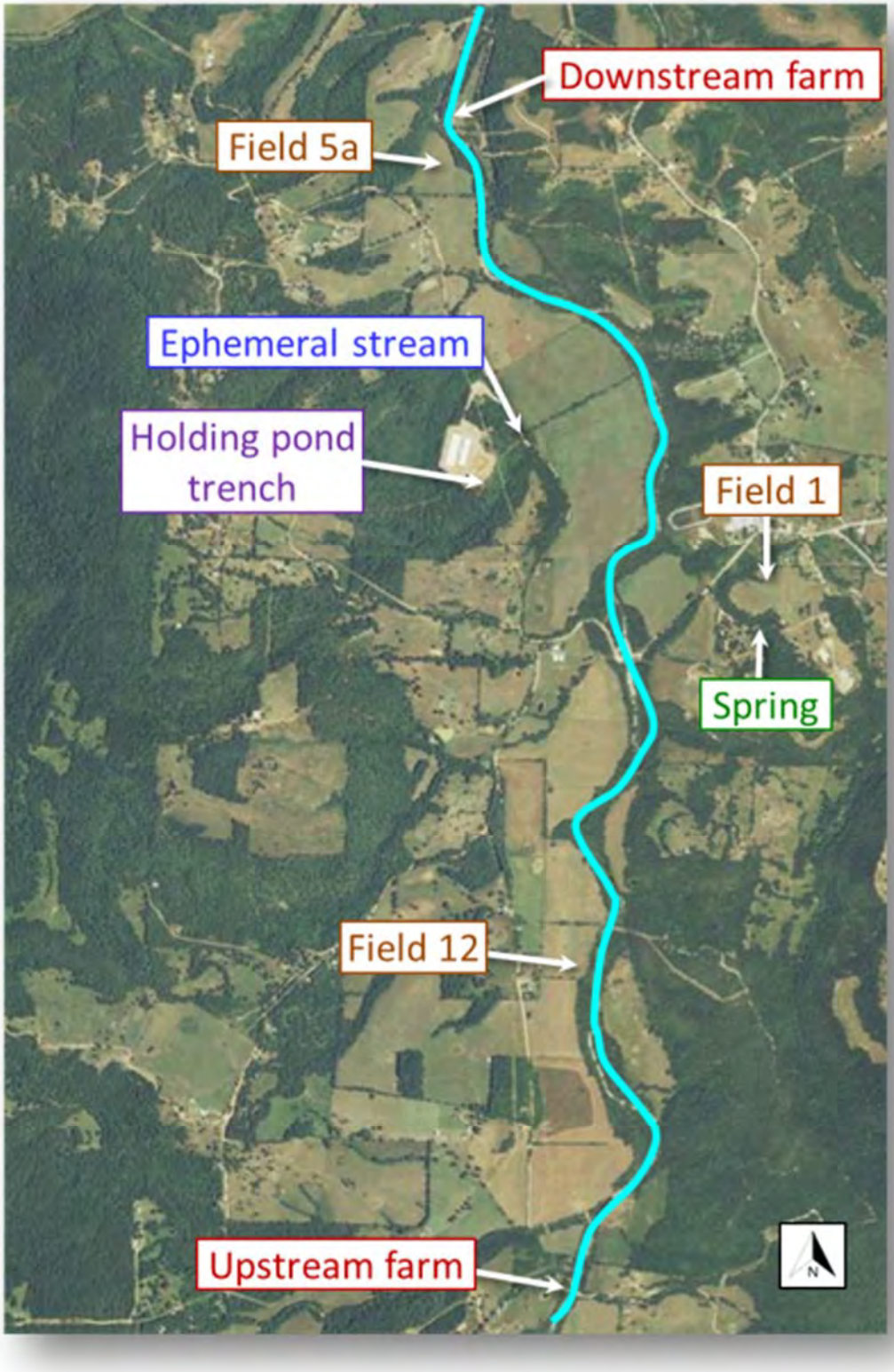

Figure 12. Location of water quality sampling sites on Big Creek and the C&H Farm.

Table 4. Minimum detection limits (MDLs) for each chemical and biological constituent measured.

Constituent	Minimum detection limit
Alkalinity, mg/L as $CaCO_3$	2
Chloride, mg/L	0.093
Dissolved P, mg/L	0.002
Conductivity, uS/cm	1
Ammonium-N, mg/L	0.03
Dissolved organic carbon, mg/L	0.18
E. coli, MPN/100 mL	1
Nitrate-N, mg/L	0.004
pH	0.1
Total coliform, MPN/100 mL	1
Total dissolved solids, mg/L	15.22
Total N, mg/L	0.006
Total P, mg/L	0.012
Total suspended solids, mg/L	6.58

USGS Stations

Big Creek Continuous Flow

We are collaborating with USGS at Big Creek near Mt. Judea (USGS 705579; downstream of the C&H Farm operation) and at Left Fork Big Creek near Vendor (USGS 07055792), to collect base and storm water flows for N, P, and bacteria analysis. The USGS Big Creek site is instrumented with continuous flow gaging equipment and a nitrate sensor, which provides real-time flow, water temperature, nitrate and precipitation data. These data are available on line at the USGS website below. Gage height, water temperature, precipitation, and continuous nitrate concentrations for the USGS downstream site for the last quarter are shown in Figures 13, 14, 15, and 16.

USGS 07055790 Big Creek near Mt. Judea, AR

http://nwis.waterdata.usgs.gov/ar/nwis/uv/?site_no=07055790&agency_cd=USGS

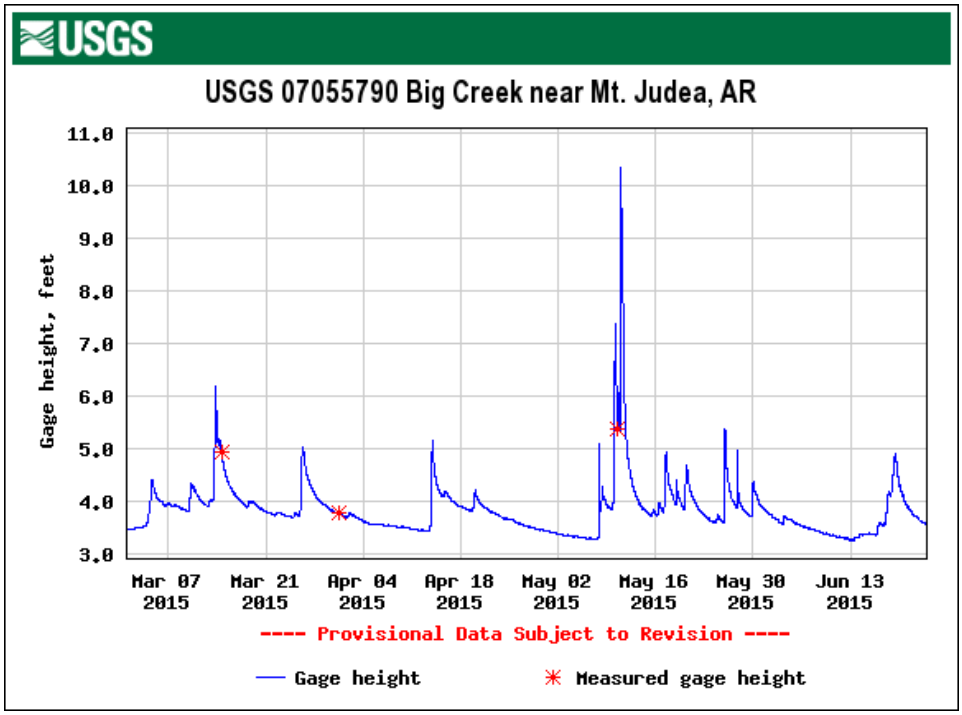

Figure 13. Flow at the Big Creek monitoring site downstream of the C&H Farm during the 2nd quarter of 2015.

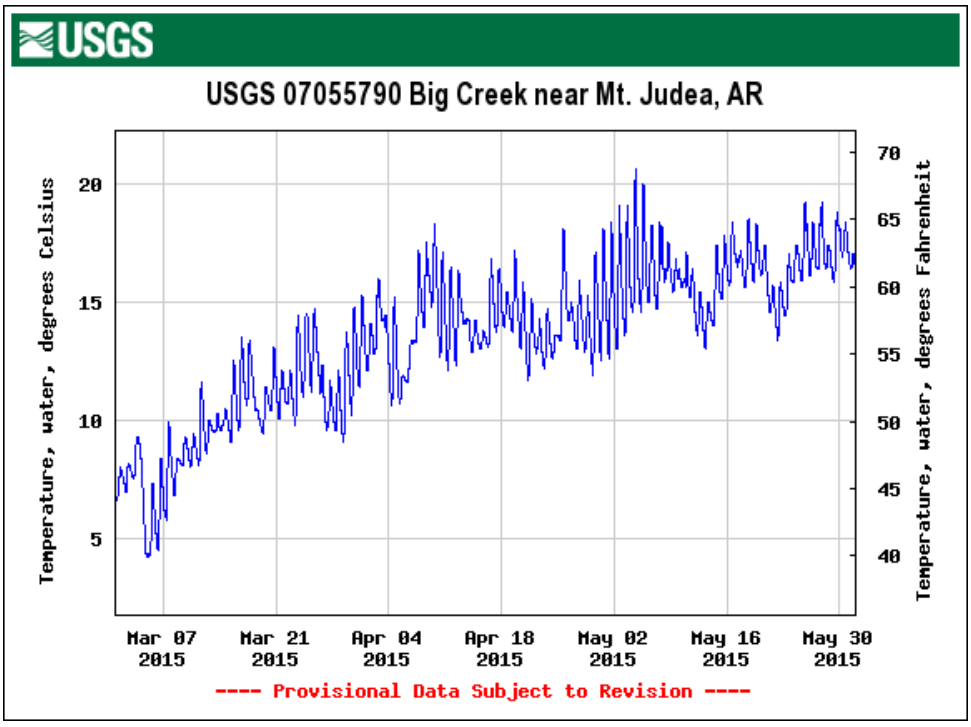

Figure 14. Water temperature at the Big Creek monitoring site downstream of the C&H Farm during the 2nd quarter of 2015.

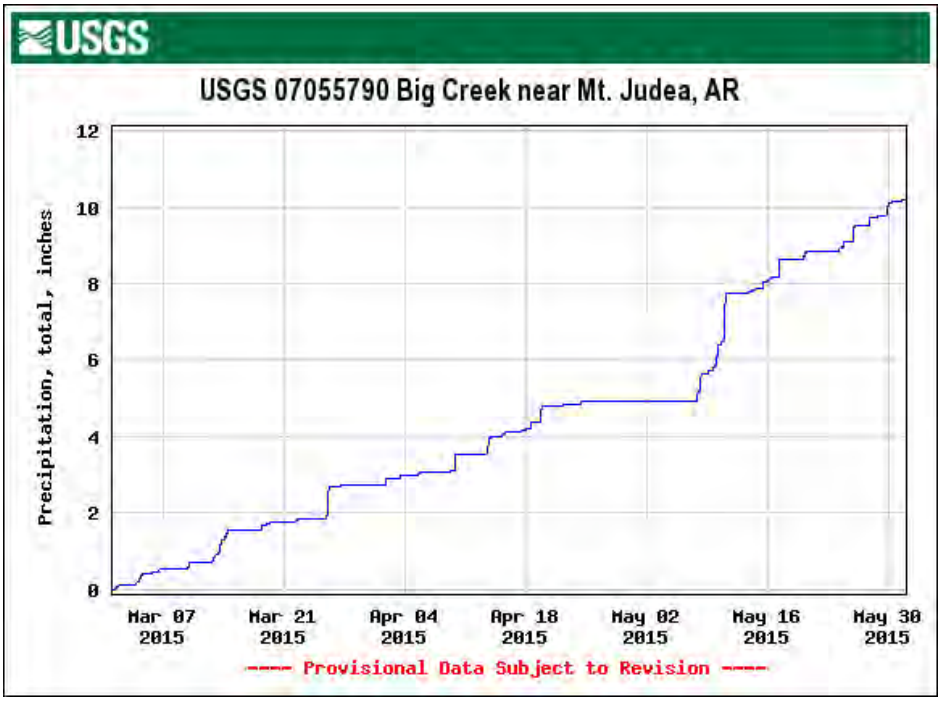

Figure 15. Precipitation at the Big Creek monitoring site downstream of the C&H Farm during the 2nd quarter of 2015.

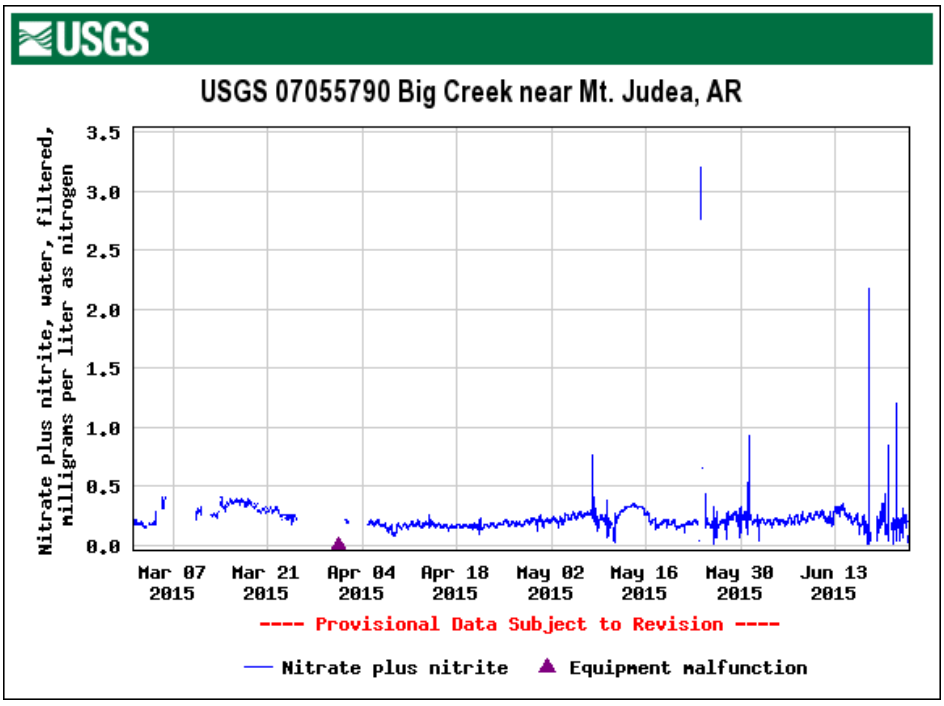

Figure 16. Nitrate concentration at the Big Creek monitoring site downstream of the C&H Farm during the 2nd quarter of 2015.

USGS 07055792 Left Fork Big Creek near Vendor, AR

http://waterdata.usgs.gov/ar/nwis/uv?cb_00065=on&format=gif_default&site_no=07055792&period=&begin_date=2015-05-01&end_date=2015-06-27

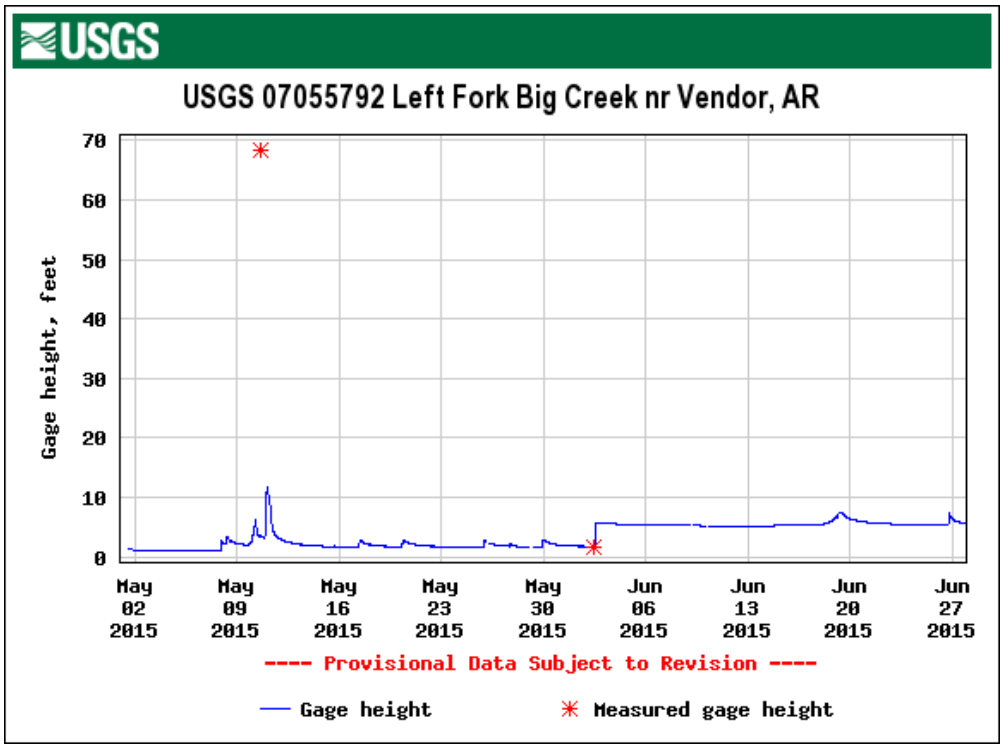

Figure 17. Gage height at the Left Fork monitoring site downstream of the C&H Farm during the 2nd quarter of 2015.

Big Creek Research and Extension Team Monitoring Data

Nutrients, Sediment, and Bacteria by Date of Sampling

Table 5. Water quality analyses at each sample site. Coliform units are Most Probable Number (MPN) per 100 mL of water for the 2nd Quarter of 2015.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
			---------- mg/L ----------							-- MPN/100 mL --	
1/8/2015	**1/8/2015**	**Base flow**									
11:05	15:05	Spring	0.010	0.014	<0.03	0.376	0.56	2.0	3.80	14.8	686.7
11:25	15:05	Upstream farm	0.009	0.022	<0.03	0.187	0.21	2.3	1.41	30.9	547.5
10:53	15:05	Downstream farm	0.011	0.024	<0.03	0.376	0.39	2.5	1.22	42.6	980.4
11:40	15:05	Ephemeral stream	0.008	0.022	<0.03	0.448	0.59	2.4	1.73	25.6	1203.3
12:00	15:05	Trench 1	0.005	0.022	<0.03	0.769	0.75	4.7	0.88	1.0	13130.0
1/14/2015	**1/14/2015**	**Base flow**									
11:30	15:20	Spring	0.010	0.028	<0.03	0.473	0.66	1.1	10.20	21.6	613.1
11:45	15:20	Upstream farm	0.012	0.032	<0.03	0.135	0.19	1.1	3.02	88.2	727.0
11:15	15:20	Downstream farm	0.011	0.020	<0.03	0.388	0.34	1.0	2.03	25.6	613.1
12:00	15:20	Ephemeral stream	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
1/21/2015	**1/21/2015**	**Base flow**									
11:15	15:28	Spring	0.009	0.020	<0.03	0.552	0.69	1.5	2.29	9.8	461.1
11:52	15:28	Upstream farm	0.008	0.018	<0.03	0.089	0.12	1.1	0.95	70.3	579.4
11:05	15:28	Downstream farm	0.010	0.026	0.06	0.197	0.30	1.1	1.60	37.4	613.1
11:25	15:28	Ephemeral stream	0.005	0.016	<0.03	0.370	0.46	1.0	2.34	155.3	2419.2
1/29/2015	**1/29/2015**	**Base flow**									
10:40	15:28	Spring	0.010	0.018	0.03	0.886	0.74	2.3	4.27	1.0	2850.0
11:45	15:28	Upstream farm	0.006	0.060	<0.03	0.065	0.21	47.8	1.71	727.0	1413.6
1:20	15:28	Downstream farm	0.009	0.020	0.04	0.168	0.27	1.3	1.50	19.9	1046.2
2/3/2015	**2/3/2015**	**Base flow**									
11:05	15:40	Spring	0.008	0.018	<0.03	0.691	0.77	3.8	7.64	1.0	461.1
11:40	15:40	Upstream farm	0.006	0.022	<0.03	0.051	0.28	1.1	2.69	4.1	1203.3
10:50	15:40	Downstream farm	0.009	0.018	<0.03	0.140	0.29	4.1	2.66	1.0	547.5
2/10/2015	**2/10/2015**	**Base flow**									
10:38	15:08	Spring	0.010	0.010	<0.03	0.544	0.64	1.9	0.76	2.0	686.7
11:05	15:08	Upstream farm	0.009	0.012	<0.03	0.056	0.09	0.7	1.04	1119.1	2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:25	15:08	Downstream farm	0.011	0.012	<0.03	0.143	0.23	1.0	1.15	7.4	1553.1
2/26/2015	**2/26/2015**	**Base flow**									
10:45	15:30	Spring	0.009	0.042	0.02	0.237	0.38	5.0	3.97	37.3	2419.2
11:36	15:30	Upstream farm	0.006	0.024	<0.03	0.100	0.13	0.6	1.20	47.9	686.7
10:34	15:30	Downstream farm	0.008	0.026	0.02	0.200	0.25	0.8	1.17	48.7	866.4
10:55	15:30	Ephemeral stream	0.006	0.022	<0.03	0.530	0.57	1.3	1.38	16.1	4790.0
11:15	15:30	Trench 1	0.004	0.028	0.01	0.712	0.76	46.0	0.60	1.0	41063.0
3/3/2015	**3/3/2015**	**Base flow**									
11:07	15:33	Spring	0.008	0.052	<0.03	0.124	0.35	13.5	4.90	N.S.	N.S.
11:50	15:33	Upstream farm	0.006	0.026	0.02	0.048	0.11	2.3	1.50	N.S.	N.S.
10:55	15:33	Downstream farm	0.007	0.028	<0.03	0.138	0.23	1.3	1.50	N.S.	N.S.
11:18	15:33	Ephemeral stream	0.006	0.020	<0.03	0.477	0.52	2.0	1.84	N.S.	N.S.
11:30	15:33	Trench 1	0.003	0.024	<0.03	0.867	0.89	14.9	0.95	N.S.	N.S.
3/11/2015	**3/11/2015**	**Storm Flow**									
11:30	14:58	Spring	0.009	0.030	<0.03	0.242	2.37	5.5	14.79	19.5	111.9

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:30	14:58	Upstream farm	0.005	0.026	0.02	0.118	0.16	2.1	3.38	34.5	579.4
11:20	14:58	Downstream farm	0.007	0.030	0.02	0.209	0.27	1.8	1.44	66.3	770.1
11:45	14:58	Ephemeral stream	0.006	0.022	0.04	0.567	0.60	0.5	2.20	6.3	410.0
12:10	14:58	Trench 1	0.003	0.014	0.07	0.989	0.97	0.3	2.00	<1.0	2419.2
12:15	14:58	Trench 2	0.003	0.056	0.04	1.443	1.59	1.2	3.51	<1.0	2419.2
3/19/2015	**3/19/2015**	**Base flow**									
10:59	15:10	Spring	0.010	0.028	0.03	0.184	0.29	10.6	7.37	38.9	79.4
12:00	15:10	Upstream farm	0.007	0.024	0.04	0.111	0.20	1.7	2.53	42.6	866.4
11:13	15:10	Downstream farm	0.009	0.028	0.04	0.234	0.35	2.8	2.87	71.7	1119.9
11:08	15:10	Ephemeral stream	0.007	0.018	0.01	0.529	0.63	1.0	4.31	14.6	866.4
11:13	15:10	House well	0.009	0.020	0.02	0.467	0.55	1.2	4.93	1.0	31.3
11:30	15:10	Trench 1	0.003	0.012	0.01	0.849	0.93	<6.58	3.11	1.0	275.5
11:35	15:10	Trench 2	0.004	0.062	0.09	1.036	1.42	1.9	5.12	5.2	2419.2
3/25/2015	**3/25/2015**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:45	15:20	Spring	0.006	0.014	0.02	0.197	0.39	1.6	1.45	23.1	275.5
13:30	15:20	Upstream farm	0.006	0.028	0.02	0.056	0.16	2.9	1.36	125.9	2419.2
11:30	15:20	Downstream farm	0.008	0.036	0.04	0.162	0.29	5.0	1.41	547.5	3410.0
12:00	15:20	Ephemeral stream	0.007	0.014	0.02	0.462	0.53	1.1	0.64	8.6	344.8
12:20	15:20	House well	0.007	0.016	<0.03	0.450	0.52	1.9	0.03	18.5	30.1
12:30	15:20	Trench 1	0.003	0.008	<0.03	0.838	0.88	0.2	0.59	<1.0	410.6
3/26/2015	**3/26/2015**	**Storm flow**									
13:10	15:25	Upstream farm	0.013	0.064	0.06	0.090	0.30	11.4	3.71	547.5	5200.0
13:35	15:25	Downstream farm	0.013	0.076	0.06	0.144	0.41	14.1	3.94	816.4	4960.0
12:55	15:25	Trench 1	0.004	0.026	0.02	0.904	1.00	15.4	0.69	<1.0	1553.1
12:50	15:25	Trench 2	0.004	0.126	0.13	0.873	1.44	22.2	4.63	105.4	6950.0
13:20	15:25	Field 1	0.143	0.346	0.41	0.216	2.68	65.5	15.65	N.S.	N.S.
12:30	15:25	Field 5a	0.813	1.330	0.39	0.225	2.59	72.3	15.95	N.S.	N.S.
4/2/2015	**4/2/2015**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:50	15:25	Spring	0.008	0.042	0.04	0.173	0.35	3.5	10.47	248.1	1299.7
12:15	15:25	Upstream farm	0.007	0.040	0.02	0.045	0.14	3.1	3.61	166.9	2419.2
1:30	15:25	Downstream farm	0.007	0.042	0.02	0.139	0.22	2.5	2.71	121.1	1986.3
12:30	15:25	Ephemeral stream	0.006	0.032	0.02	0.467	0.46	1.8	4.41	5.2	547.5
12:48	15:25	House well	0.008	0.030	<0.03	0.477	0.50	0.7	6.05	39.3	9060.0
12:54	15:25	Trench 1	0.003	0.028	0.02	0.865	0.87	0.3	3.34	1.1	308.6
4/9/2015	**4/9/2015**	**Base flow**									
11:45	15:30	Spring	0.011	0.034	0.01	0.257	0.42	4.9	9.11	7380.0	9040.0
12:30	15:30	Upstream farm	0.011	0.042	0.04	0.066	0.18	13.1	2.13	86.0	2650.0
12:50	15:30	Downstream farm	0.010	0.048	0.03	0.157	0.25	19.7	1.82	47.2	1986.3
12:00	15:30	House well	0.011	0.026	<0.03	0.499	0.50	1.5	0.74	4.1	325.5
12:10	15:30	Trench 1	0.006	0.018	<0.03	0.790	0.83	0.8	2.99	<1.0	187.2
4/15/2015	**4/15/2015**	**Storm Flow**									
11:38	14:55	Spring	0.007	0.034	<0.03	0.210	0.39	7.7	4.70	275.5	2280.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:23	14:55	Upstream farm	0.007	0.040	0.03	0.090	0.16	3.5	3.24	648.8	4040.0
12:40	14:55	Downstream farm	0.009	0.048	0.03	0.166	0.26	4.4	2.67	344.8	2920.0
11:48	14:55	Ephemeral stream	0.005	0.026	0.03	0.472	0.56	0.8	1.26	305.0	2430.0
11:58	14:55	House well	0.008	0.022	0.02	0.475	0.60	1.2	3.72	9.6	80.9
12:10	14:55	Trench 1	0.003	0.020	<0.03	0.857	0.93	1.3	4.29	<1.0	3180.0
4/23/2015	**4/23/2015**	**Base Flow**									
12:23	15:30	Spring	0.008	0.034	<0.03	0.264	0.36	7.4	3.64	71.7	648.8
13:00	15:30	Upstream farm	0.007	0.032	0.03	0.083	0.18	4.0	5.11	104.6	2419.2
12:15	15:30	Downstream farm	0.007	0.032	0.03	0.162	0.25	2.6	2.51	65.7	2419.2
11:55	15:30	Ephemeral stream	0.008	0.026	0.03	0.520	0.56	2.0	1.78	12.0	3270.0
11:35	15:30	House well	0.008	0.082	<0.03	0.496	0.53	1.4	1.69	18.5	35.0
11:48	15:30	Trench 1	0.003	0.034	<0.03	0.877	0.97	1.2	1.18	3.1	2690.0
4/29/2015	**4/29/2015**	**Base flow**									
11:25	14:05	Spring	0.010	0.028	<0.03	0.419	0.59	9.0	4.28	25.6	1732.9

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:53	14:05	Upstream farm	0.010	0.020	0.03	0.082	0.13	2.7	1.58	58.3	1732.4
12:13	14:05	Downstream farm	0.012	0.018	0.03	0.189	9.82	2.1	1.64	58.6	1986.3
11:30	14:05	Ephemeral stream	0.012	0.018	0.02	0.569	0.61	3.5	1.98	14.3	4080.0
11:35	14:05	House well	0.010	0.006	<0.03	0.517	0.51	0.7	2.26	248.1	5040.0
5/7/2015	**5/7/2015**	**Base flow**									
11:10	14:10	Spring	0.011	0.036	0.02	0.499	0.58	9.9	44.04	135.4	980.4
11:43	14:10	Upstream farm	0.008	0.032	0.01	0.110	0.16	7.5	10.16	77.6	3280.0
12:05	14:10	Downstream farm	0.009	0.034	<0.03	0.267	0.36	4.5	7.70	27.8	2280.0
11:18	14:10	Ephemeral stream	0.013	0.066	0.02	0.628	0.71	3.2	16.41	71.7	7170.0
11:23	14:10	House well	0.008	0.022	0.01	0.512	0.49	<6.58	28.63	3.1	59.4
5/8/2015	**5/8/2015**	**Storm flow**									
13:25	15:32	Upstream farm	0.134	0.354	0.16	0.340	1.12	51.4	9.30	N.S.	N.S.
13:25	15:32	Downstream farm	0.195	0.544	0.27	0.292	1.20	113.2	7.47	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:43	15:32	Ephemeral stream	0.005	0.254	0.41	2.287	3.23	127.1	6.45	N.S.	N.S.
13:00	15:32	Field 1	0.525	0.714	0.16	0.475	2.19	16.9	13.28	N.S.	N.S.
12:38	15:32	Field 12	0.675	0.956	0.14	0.303	1.82	57.0	16.00	N.S.	N.S.
5/11/2015	**5/12/2015**	**Storm Flow**									
11:35	8:30	Spring	0.008	0.058	0.01	0.339	0.49	8.7	3.67	N.S.	N.S.
11:28	8:30	Upstream farm	0.004	0.074	0.04	0.004	0.24	4.5	4.31	N.S.	N.S.
12:47	8:30	Downstream farm	0.031	0.530	0.11	0.071	1.12	277.5	8.48	N.S.	N.S.
12:05	8:30	Ephemeral stream	0.008	0.146	0.15	0.941	1.80	22.0	8.09	N.S.	N.S.
12:15	8:30	House well	0.009	0.038	0.02	0.541	0.55	4.2	0.89	N.S.	N.S.
12:25	8:30	Trench 1	0.003	0.060	0.02	0.916	0.97	27.6	1.78	N.S.	N.S.
12:35	8:30	Trench 2	0.003	0.042	0.05	0.553	0.76	8.8	3.44	N.S.	N.S.
11:25	8:30	Field 1	0.251	0.386	0.09	0.055	0.86	44.4	6.31	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:40	8:30	Field 5a	0.248	0.968	0.26	0.127	1.50	320.1	8.58	N.S.	N.S.
1:05	8:30	Field 12	0.194	0.364	0.09	0.135	0.83	36.7	7.03	N.S.	N.S.
5/14/2015	**5/14/2015**	**Base flow**									
12:35	15:12	Spring	0.009	0.062	0.02	0.222	0.35	41.5	2.84	121.1	2419.2
12:28	15:12	Upstream farm	0.011	0.046	0.02	0.177	0.23	2.8	1.35	145.5	2470.0
12:47	15:12	Downstream farm	0.015	0.050	0.02	0.326	0.39	6.1	1.16	128.1	4370.0
12:57	15:12	Left Fork	0.015	0.038	0.02	0.321	0.38	3.3	1.36	83.3	2690.0
12:15	15:12	Ephemeral stream	0.010	0.022	0.01	0.527	0.50	1.7	0.73	41.3	1986.3
12:05	15:12	Trench 1	0.005	0.042	0.02	0.904	0.94	29.9	1.20	81.6	1732.9
5/18/2015	**5/18/2015**	**Storm Flow**									
10:45	14:43	Spring	0.005	0.084	0.05	0.209	0.56	114.2	2.79	98.7	1413.6
11:57	14:43	Upstream farm	0.007	0.034	0.02	0.110	0.15	5.2	1.29	137.6	2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:17	14:43	Downstream farm	0.009	0.040	0.03	0.201	0.25	6.1	1.47	185.0	6770.0
12:29	14:43	Left Fork	0.011	0.040	0.04	0.209	0.29	4.1	1.90	167.4	8300.0
11:14	14:43	Ephemeral stream	0.007	0.028	0.03	0.525	0.55	0.7	1.18	90.7	7630.0
11:20	14:43	House well	0.008	0.018	<0.03	0.529	0.53	0.9	0.90	5.2	13.4
12:55	14:43	Trench 1	0.002	0.020	<0.03	0.897	0.93	0.3	1.28	32.3	1732.9
10:58	14:43	Field 1	0.208	0.512	0.54	0.410	3.59	53.7	26.12	N.S.	N.S.

N.S. is No Sample.

Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

Nutrients, Sediment, and Bacteria by Date Spring, Upstream, and Downstream Sites

Table 6. Water quality analyses at the spring and in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application for the 2nd Quarter of 2015.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
1/8/2015									
Spring	0.010	0.014	<0.03	0.376	0.56	2.0	3.80	14.8	686.7
Upstream	0.009	0.022	<0.03	0.187	0.21	2.3	1.41	30.9	547.5
Downstream	0.011	0.024	<0.03	0.376	0.39	2.5	1.22	42.6	980.4
1/14/2015									
Spring	0.010	0.028	<0.03	0.473	0.66	1.1	10.20	21.6	613.1
Upstream	0.012	0.032	<0.03	0.135	0.19	1.1	3.02	88.2	727.0
Downstream	0.011	0.020	<0.03	0.388	0.34	1.0	2.03	25.6	613.1
1/21/2015									
Spring	0.009	0.020	<0.03	0.552	0.69	1.5	2.29	9.8	461.1
Upstream	0.008	0.018	<0.03	0.089	0.12	1.1	0.95	70.3	579.4
Downstream	0.010	0.026	0.06	0.197	0.30	1.1	1.60	37.4	613.1

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
1/29/2015									
Spring	0.010	0.018	0.03	0.886	0.74	2.3	4.27	1.0	2850.0
Upstream	0.006	0.060	<0.03	0.065	0.21	47.8	1.71	727.0	1413.6
Downstream	0.009	0.020	0.04	0.168	0.27	1.3	1.50	19.9	1046.2
2/3/2015									
Spring	0.008	0.018	<0.03	0.191	0.77	3.8	7.64	1.0	461.1
Upstream	0.006	0.022	<0.03	0.051	0.28	1.1	2.69	4.1	1203.3
Downstream	0.009	0.018	<0.03	0.140	0.29	4.1	2.66	1.0	547.5
2/10/2015									
Spring	0.010	0.010	<0.03	0.544	0.64	1.9	0.76	2.0	686.7
Upstream	0.009	0.012	<0.03	0.056	0.09	0.7	1.04	1119.1	2419.2
Downstream	0.011	0.012	<0.03	0.143	0.23	1.0	1.15	7.4	1553.1
2/26/2015									
Spring	0.009	0.042	0.02	0.237	0.38	5.0	3.97	37.3	2419.2
Upstream	0.006	0.024	<0.03	0.100	0.13	0.6	1.20	47.9	686.7
Downstream	0.008	0.026	0.02	0.200	0.25	0.8	1.17	48.7	866.4

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/3/2015									
Spring	0.008	0.052	<0.03	0.124	0.35	N.D.	4.90	N.S.	N.S.
Upstream	0.006	0.026	0.02	0.048	0.11	N.D.	1.50	N.S.	N.S.
Downstream	0.007	0.028	<0.03	0.138	0.23	N.D.	1.50	N.S.	N.S.
3/11/2015									
Spring	0.009	0.030	<0.03	0.242	2.37	5.5	14.79	19.5	111.9
Upstream	0.005	0.026	0.02	0.118	0.16	2.1	3.38	34.5	579.4
Downstream	0.007	0.030	0.02	0.209	0.27	1.8	1.44	66.3	770.1
3/19/2015									
Spring	0.010	0.028	0.03	0.184	0.29	10.6	7.37	38.9	79.4
Upstream	0.007	0.024	0.04	0.111	0.20	1.7	2.53	42.6	866.4
Downstream	0.009	0.028	0.04	0.234	0.35	2.8	2.87	71.7	1119.9
3/25/2015									
Spring	0.006	0.014	0.02	0.197	0.39	1.6	1.45	23.1	275.5
Upstream	0.006	0.028	0.02	0.056	0.16	2.9	1.36	125.9	2419.2
Downstream	0.008	0.036	0.04	0.162	0.29	5.0	1.41	547.5	3410.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/26/2015									
Spring	0.013	0.064	0.06	0.090	0.30	11.4	3.71	547.5	5200.0
Upstream	0.013	0.076	0.06	0.144	0.41	14.1	3.94	816.4	4960.0
Downstream	0.004	0.026	0.02	0.904	1.00	15.4	0.69	<1.0	1553.1
4/2/2015									
Spring	0.008	0.042	0.04	0.173	0.35	3.5	10.47	248.1	1299.7
Upstream	0.007	0.040	0.02	0.045	0.14	3.1	3.61	166.9	2419.2
Downstream	0.007	0.042	0.02	0.139	0.22	2.5	2.71	121.1	1986.3
4/9/2015									
Spring	0.011	0.034	0.01	0.257	0.42	4.9	9.11	7380.0	9040.0
Upstream	0.011	0.042	0.04	0.066	0.18	13.1	2.13	86.0	2650.0
Downstream	0.010	0.048	0.03	0.157	0.25	19.7	1.82	47.2	1986.3
4/15/2015									
Spring	0.007	0.034	<0.03	0.210	0.39	7.7	4.70	275.5	2280.0
Upstream	0.007	0.040	0.03	0.090	0.16	3.5	3.24	648.8	4040.0
Downstream	0.009	0.048	0.03	0.166	0.26	4.4	2.67	344.8	2920.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
4/23/2015									
Spring	0.008	0.034	<0.03	0.264	0.36	7.4	3.64	71.7	648.8
Upstream	0.007	0.032	0.03	0.083	0.18	4.0	5.11	104.6	2419.2
Downstream	0.007	0.032	0.03	0.162	0.25	2.6	2.51	65.7	2419.2
4/29/2015									
Spring	0.010	0.028	<0.03	0.419	0.59	9.0	4.28	25.6	1732.9
Upstream	0.010	0.020	0.03	0.082	0.13	2.7	1.58	58.3	1732.4
Downstream	0.012	0.018	0.03	0.189	9.82	2.1	1.64	58.6	1986.3
5/7/2015									
Spring	0.011	0.036	0.02	0.499	0.58	9.9	44.04	135.4	980.4
Upstream	0.008	0.032	0.01	0.110	0.16	7.5	10.16	77.6	3280.0
Downstream	0.009	0.034	<0.03	0.267	0.36	4.5	7.70	27.8	2280.0
5/8/2015									
Spring	0.134	0.354	0.16	0.340	1.12	51.4	9.30	N.S.	N.S.
Upstream	0.195	0.544	0.27	0.292	1.20	113.2	7.47	N.S.	N.S.
Downstream	0.005	0.254	0.41	2.287	3.23	127.1	6.45	N.S.	N.S.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/11/2015									
Spring	0.008	0.058	0.01	0.339	0.49	8.7	3.67	N.S.	N.S.
Upstream	0.004	0.074	0.04	0.004	0.24	4.5	4.31	N.S.	N.S.
Downstream	0.031	0.530	0.11	0.071	1.12	277.5	8.48	N.S.	N.S.
5/14/2015									
Spring	0.009	0.062	0.02	0.222	0.35	41.5	2.84	121.1	2419.2
Upstream	0.011	0.046	0.02	0.177	0.23	2.8	1.35	145.5	2470.0
Downstream	0.015	0.050	0.02	0.326	0.39	6.1	1.16	128.1	4370.0
5/18/2015									
Spring	0.005	0.084	0.05	0.209	0.56	114.2	2.79	98.7	1413.6
Upstream	0.007	0.034	0.02	0.110	0.15	5.2	1.29	137.6	2419.2
Downstream	0.009	0.040	0.03	0.201	0.25	6.1	1.47	185.0	6770.0

N.S. is No Sample.

Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

Nutrients, Sediment, and Bacteria by Site for Ephemeral Stream, House Well, Trenches, Left Fork and Field Runoff

Table 7. Water quality analyses at the ephemeral stream draining the subwatershed containing the production houses and manure holding ponds, the well adjacent to the ponds, and surface runoff from Fields 1, 5a, and 12 for the 2nd Quarter of 2015.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
Ephemeral stream									
1/8/2015	0.008	0.022	<0.03	0.448	0.59	2.4	1.73	25.6	1203.3
1/15/2015	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6
1/21/2015	0.005	0.016	<0.03	0.370	0.46	1.0	2.34	155.3	2419.2
2/26/2015	0.006	0.022	<0.03	0.530	0.57	1.3	1.38	16.1	4790.0
3/3/2015	0.006	0.020	<0.03	0.477	0.52	ND	1.84	N.S.	N.S.
3/11//2015	0.006	0.022	0.04	0.567	0.60	0.5	2.20	6.3	410.0
3/19/2015	0.007	0.018	0.01	0.529	0.63	1.0	4.31	14.6	866.4
3/25/2015	0.007	0.014	0.02	0.462	0.53	1.1	0.64	8.6	344.8
4/2/2015	0.006	0.032	0.02	0.467	0.46	1.8	4.41	5.2	547.5
4/15/2015	0.005	0.026	0.03	0.472	0.56	0.8	1.26	305.0	2430.0
4/23/2015	0.008	0.026	0.03	0.520	0.56	2.0	1.78	12.0	3270.0
4/29/2015	0.012	0.018	0.02	0.569	0.61	3.5	1.98	14.3	4080.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/7/2015	0.013	0.066	0.02	0.628	0.71	3.2	16.41	71.7	7170.0
5/8/2015	0.005	0.254	0.41	2.287	3.23	127.1	6.45	5200.0	241920
5/11/2015	0.008	0.146	0.15	0.941	1.80	22.0	8.09	N.S.	N.S.
5/14/2015	0.010	0.022	0.01	0.527	0.50	1.7	0.73	41.3	1986.3
5/18/2015	0.007	0.028	0.03	0.525	0.55	0.7	1.18	90.7	7630.0
House well									
3/19/2015	0.009	0.020	0.02	0.467	0.55	1.2	4.93	1.0	31.3
3/25/2015	0.007	0.016	<0.03	0.450	0.52	1.9	0.03	18.5	30.1
4/2/2015	0.008	0.030	<0.03	0.477	0.50	0.7	6.05	39.3	9060.0
4/9/2015	0.011	0.026	<0.03	0.499	0.50	1.5	0.74	4.1	325.5
4/15/2015	0.008	0.022	0.02	0.475	0.60	1.2	3.72	9.6	80.9
4/23/2015	0.008	0.082	<0.03	0.496	0.53	1.4	1.69	18.5	35.0
4/29/2015	0.010	0.006	<0.03	0.517	0.51	0.7	2.26	248.1	5040.0
5/7/2015	0.008	0.022	0.01	0.512	0.49	<6.58	28.63	3.1	59.4
5/11/2015	0.009	0.038	0.02	0.541	0.55	4.2	0.89	N.S.	N.S.
5/18/2015	0.008	0.018	<0.03	0.529	0.53	0.9	0.90	5.2	13.4

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Interceptor Trench 1 (South)									
1/8/2015	0.005	0.022	<0.03	0.769	0.75	4.7	0.88	1.0	13130.0
1/14/2015	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6
2/26/2015	0.004	0.028	0.01	0.712	0.76	46.0	0.60	1.0	41063.0
3/3/2015	0.003	0.024	<0.03	0.867	0.89	N.D.	0.95	N.S.	N.S.
3/11/2015	0.003	0.014	0.07	0.989	0.97	0.3	2.00	<1.0	2419.2
3/19/2015	0.003	0.012	0.01	0.849	0.93	<6.58	3.11	1.0	275.5
3/25/2015	0.003	0.008	<0.03	0.838	0.88	0.2	0.59	<1.0	410.6
3/26/2015	0.004	0.026	0.02	0.904	1.00	15.4	0.69	<1.0	1553.1
4/2/2015	0.003	0.028	0.02	0.865	0.87	0.3	3.34	1.1	308.6
4/9/2015	0.006	0.018	<0.03	0.790	0.83	0.8	2.99	<1.0	187.2
4/15/2015	0.003	0.020	<0.03	0.857	0.93	1.3	4.29	<1.0	3180.0
4/23/2015	0.003	0.034	<0.03	0.877	0.97	1.2	1.18	3.1	2690.0
5/11/2015	0.003	0.060	0.02	0.916	0.97	27.6	1.78	N.S.	N.S.
Interceptor Trench 2 (North)									

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/11//2015	0.003	0.056	0.04	1.443	1.59	1.2	3.51	<1.0	2419.2
3/19/2015	0.004	0.062	0.09	1.036	1.42	1.9	5.12	5.2	2419.2
3/26/2015	0.004	0.126	0.13	0.873	1.44	22.2	4.63	105.4	6950.0
5/11/2015	0.003	0.042	0.05	0.553	0.76	8.8	3.44	N.S.	N.S.
5/14/2015	0.005	0.042	0.02	0.904	0.94	29.9	1.20	81.6	1732.9
5/18/2015	0.002	0.020	<0.03	0.897	0.93	0.3	1.28	32.3	1732.9
Left Fork									
5/14/2015	0.015	0.038	0.02	0.321	0.38	3.3	1.36	83.3	2690.0
5/18/2015	0.011	0.040	0.04	0.209	0.29	4.1	1.90	167.4	8300.0
Field 1									
3/26/2015	0.143	0.346	0.41	0.216	2.68	65.5	15.65	N.S.	N.S.
5/8/2015	0.525	0.714	0.16	0.475	2.19	16.9	13.28	N.S.	N.S.
5/11/2015	0.251	0.386	0.09	0.055	0.86	44.4	6.31	N.S.	N.S.
5/18/2015	0.208	0.512	0.54	0.410	3.59	53.7	26.12	N.S.	N.S.
Field 5a									

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/26/2015	0.813	1.330	0.39	0.225	2.59	72.3	15.95	N.S.	N.S.
5/8/2015	0.248	0.968	0.26	0.127	1.50	320.1	8.58	N.S.	N.S.
Field 12									
5/8/2015	0.675	0.956	0.14	0.303	1.82	57.0	16.00	N.S.	N.S.
5/11/2015	0.194	0.364	0.09	0.135	0.83	36.7	7.03	N.S.	N.S.

N.S. is No Sample.

N.D. is No Data

E. coli and total coliform were not measured on surface runoff samples collected by ISCO samplers when sample holding time exceeded the required 8-hour threshold.

Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

Water pH, Alkalinity, Chloride, Electrical Conductivity, and Total Dissolved Solids for Several Big Creek Sites

At the beginning of 2015, the pH, alkalinity, chloride concentration, electrical conductivity and total dissolved solids were determined on water samples collected at the upstream and downstream sites, spring, house well, and trenches, to build a data base that will enable to eventually source track the major water source pathways at these sites. These values are given below in Table 8.

Table 8. The pH, Chloride concentration, electrical conducting, and total solids concentration of water samples collected at upstream, downstream, spring, house well and trench sites, initiated at the beginning of 2015.

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
		mg/L	mg/L	µS/cm	mg/L
Upstream					
1/8/2015	7.3	36.0	1.8	90.4	71.6
1/14/2015			2.1	104.6	49.1
1/21/2015	7.6	48.0	1.9	121.3	71.1
1/29/2015			2.1	139.9	71.3
2/3/2015	7.74	54.0	2.400	128.5	71.1
2/10/2015			2.507	131.5	67.6
2/26/2015	7.59	40.0	1.976	107.0	56.4
3/3/2015			2.080	111.7	58.9
3/11/2015	7.79	30.0	1.878	85.3	269.3
3/19/2015			1.552	98.0	58.0
3/25/2015	8.01	42.0	1.767	110.1	67.6
3/26/2015			1.328	114.8	64.4
4/2/2015	8.0	42.0	1.566	109.7	76.0
4/9/2015			1.732	115.5	74.9
4/15/2015	7.7	36.0	1.376	90.8	63.8

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
4/23/2015			1.651	94.5	60.4
4/29/2015	8.1	50.0	1.556	85.1	54.3
5/7/2015			1.797	157.1	88.4
5/8/2015			1.628	131.2	110.0
5/11/2015	7.5	24.0	1.553	143.1	79.3
5/14/2015			1.197	106.6	56.2
5/18/2015			1.095	89.6	58.4
5/26/2015	7.7	28.0	1.083	77.7	55.3
Median	7.74	40.0	1.732	109.7	67.6
			Downstream		
1/8/2015	7.56	64	2.023	143.8	89.3
1/14/2015			2.755	166.3	79.8
1/21/2015	7.55	84	2.442	190.8	91.1
1/29/2015			2.512	204.5	109.1
2/3/2015	7.71	88.0	2.823	196.4	103.3
2/10/2015			3.012	204.4	105.5
2/26/2015	7.75	66.0	2.270	161.9	88.0
3/3/2015			2.393	170.1	80.0
3/11/2015	7.78	52.0	2.020	127.9	77.3
3/19/2015			1.753	147.7	84.9
3/25/2015	7.83	64.0	2.072	158.0	88.7
3/26/2015			1.457	82.9	78.7
4/2/2015	8.1	68.0	1.946	163.3	103.0
4/9/2015			2.081	167.5	100.4
4/15/2015	7.8	56.0	1.541	129.9	82.0
4/23/2015			1.812	142.4	81.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
4/29/2015	8.0	80.0	2.150	150.4	97.3
5/7/2015			2.497	225.0	125.8
5/8/2015			1.731	148.9	130.9
5/11/2015	7.5	36.0	1.059	103.1	80.2
5/14/2015			1.545	150.3	58.7
5/18/2015			1.248	136.6	89.1
5/26/2015	7.7	46.0	1.202	125.1	93.3
Median	7.75	64.0	2.023	150.4	89.1
Spring					
1/8/2015			2.274	534	321.1
1/14/2015			2.79	517	310
1/21/2015			2.272	553	324
2/3/2015			2.199	562.0	321.8
2/10/2015			2.437	581.0	314.2
2/26/2015			1.740	491.0	266.4
3/3/2015			1.569	430.0	234.9
3/11/2015			1.626	495.0	54.7
3/19/2015			1.537	474.0	220.0
3/25/2015			2.076	544.0	277.6
4/2/2015			1.778	515.0	289.8
4/9/2015			2.029	509.0	305.8
4/15/2015			1.761	480.0	276.9
4/23/2015			1.928	512.0	297.3
4/29/2015			2.545	564.0	294.9
5/7/2015			2.293	623.0	318.9
5/8/2015			1.107	408.0	202.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
5/14/2015			1.349	507.0	259.6
5/18/2015			1.167	508.0	265.8
5/26/2015			1.084	516.0	250.4
Median			1.853	513.5	283.7
House well					
3/19/2015			4.787	458.0	232.2
3/25/2015			5.270	453.0	221.6
4/2/2015			4.908	453.0	256.0
4/9/2015			5.100	419.0	242.2
4/15/2015			5.023	426.0	240.9
4/23/2015			4.826	414.0	237.3
4/29/2015			4.960	436.0	226.4
5/7/2015			5.104	452.0	238.2
5/14/2015			5.189	484.0	234.7
5/18/2015			4.817	481.0	178.0
5/26/2015			5.018	488.0	249.6
Median			5.018	453.0	237.3
Trench 1					
2/26/2015			2.079	171.4	78.4
3/3/2015			2.106	177.1	86.7
3/11/2015			1.945	193.3	114.0
3/19/2015			1.702	209.4	109.3
3/25/2015			2.132	238.2	105.1
3/26/2015			1.639	209.0	120.2
4/2/2015			1.944	260.6	151.3
4/9/2015			1.985	260.0	154.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
4/15/2015			1.801	259.5	146.7
4/23/2015			2.060	230.9	132.7
5/11/2015			2.086	262.0	126.5
5/14/2015			1.857	299.0	156.5
5/18/2015			1.566	346.0	173.1
5/26/2015			1.650	297.0	146.0
Median			1.945	248.9	129.6
Trench 2					
3/11/2015			1.769	158.9	140.8
3/19/2015			1.043	167.5	104.9
3/26/2015			0.778	134.8	160.9
5/11/2015			0.411	164.9	88.5
5/26/2015			0.934	284.0	141.3
Median			0.934	164.9	140.8

Nutrient and Bacteria Concentration in Big Creek over the Monitoring Period

The difference in dissolved P, total P, nitrate-N, total N, E. coli, and total coliform between down- and up-stream monitoring sites are presented in Figures 18, 19, and 20, respectively. No consistent differences in the trends in concentrations at the downstream site on Big Creek compared with the upstream site appear evident over the current monitoring period.

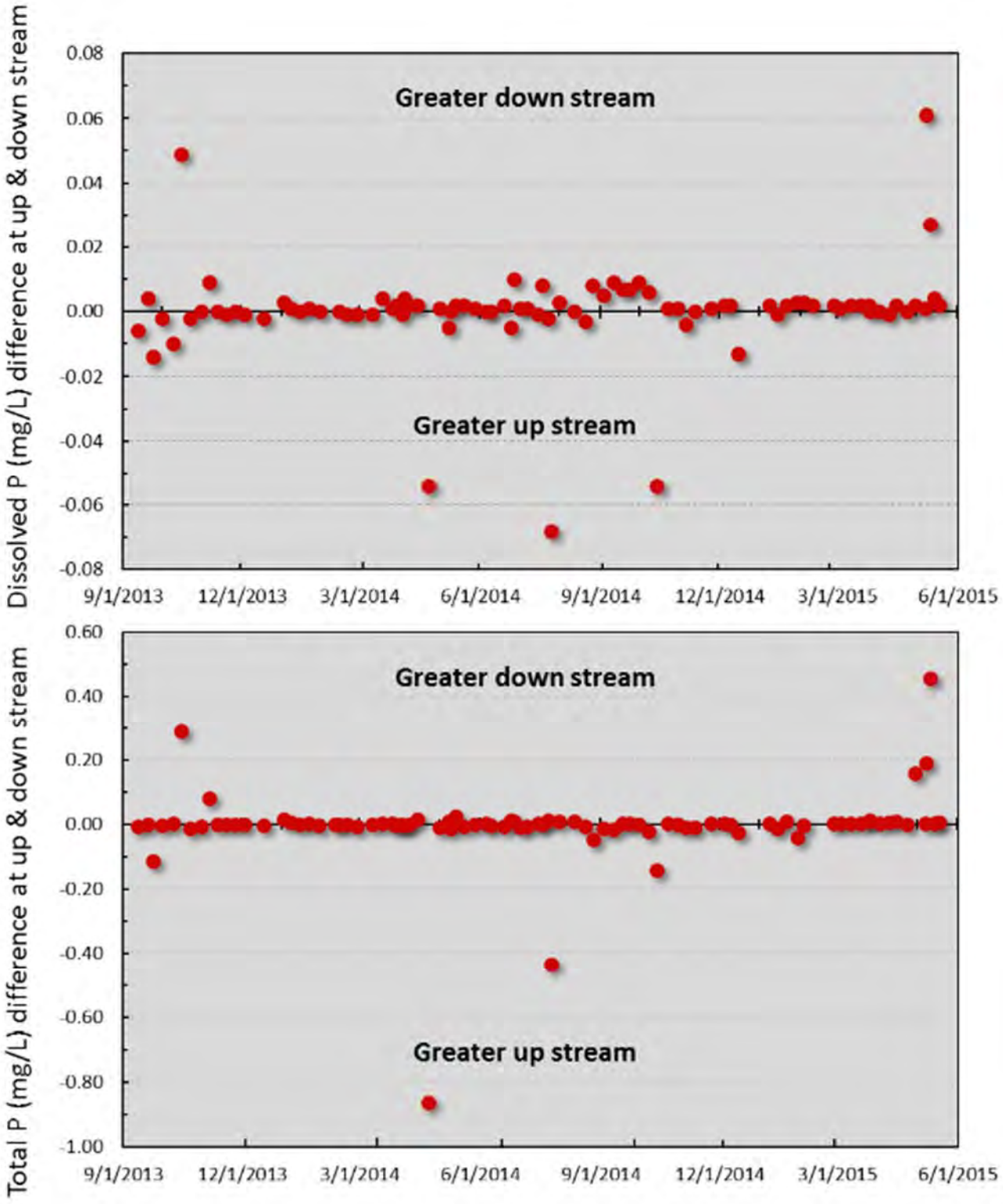

Figure 18. Differences in phosphorus concentrations between up and downstream sites on Big Creek.

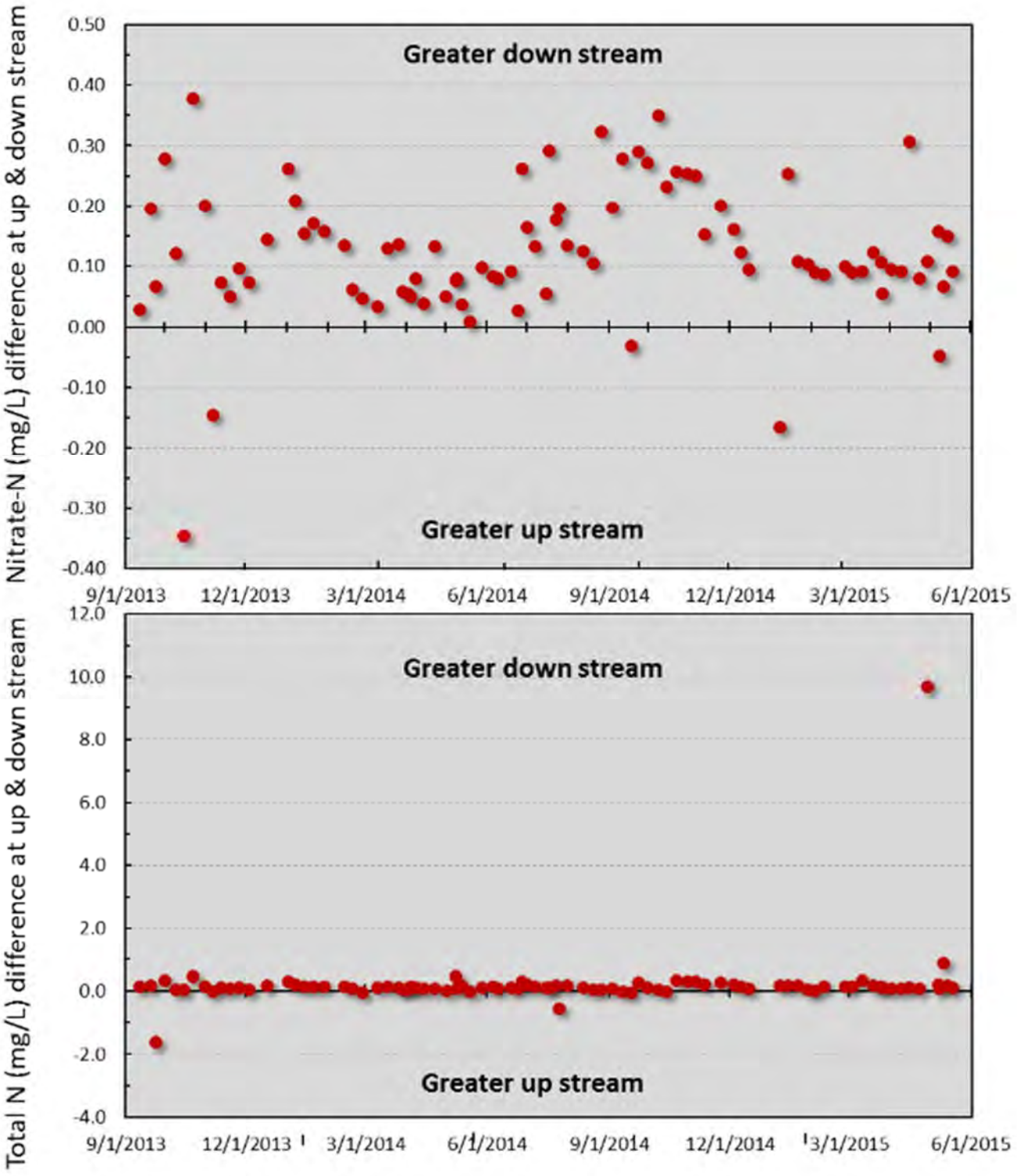

Figure 19. Differences in nitrogen concentrations between up and downstream sites on Big Creek.

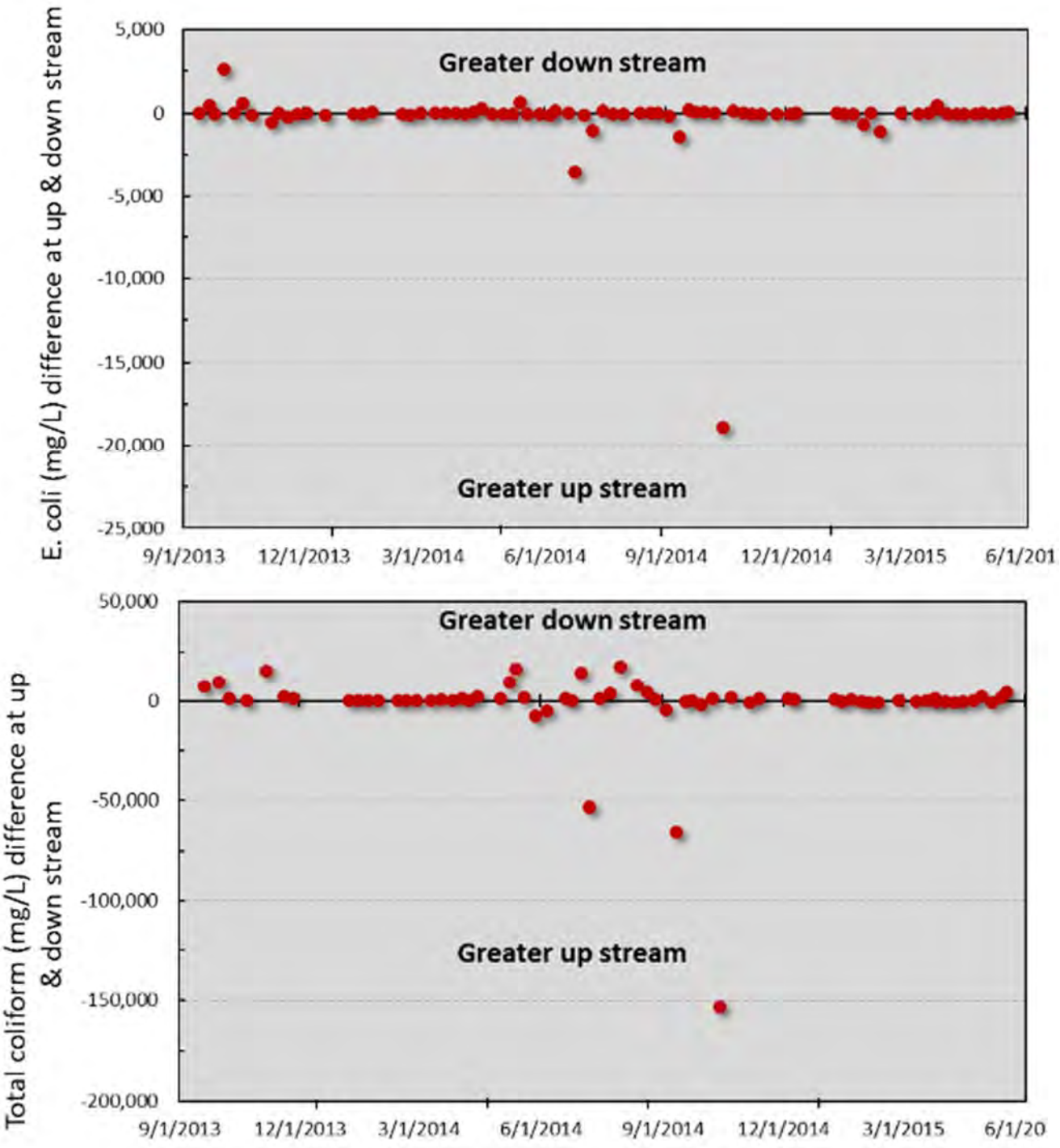

Figure 20. Differences in bacteria concentrations between up and downstream sites on Big Creek.

Table 9. Soil analyses of 0 – 4 inch samples collected from Field 5a in January, 2015.

Lab Number	Site	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B	CEC
58314	19	6.6	34	98	3168	108	16	16	116	138	2	7.3	0.9	20.1
58318	20	7	36	115	3404	96	15	15	154	214	2.5	6.9	1	20.2
58323	21	6.4	17	71	2413	92	28	10	111	197	2.2	3.5	0.6	16.6
58329	22	5.6	35	56	1692	86	13	11	143	230	2.7	4.2	0.4	14.4
58332	23	5.4	55	49	1028	81	9	12	197	212	0.9	2.9	0.4	10.5
58338	24	5.9	40	40	1299	71	9	10	177	169	1.1	3.8	0.4	10.7
58343	25	6	28	45	1578	83	9	10	178	204	1.3	3.3	0.5	12.2
58348	30	6.3	27	49	2031	85	11	11	147	211	1.4	4	0.6	14.5
58354	31	6	26	44	1762	72	13	11	161	188	1.2	3.6	0.3	13.1
58359	32	5.5	74	55	1040	69	14	11	230	210	1.1	2.9	0.1	10.5
58364	33	5.6	61	61	987	57	10	11	180	198	1.4	1.8	0.1	9.6
58369	34	6.4	29	65	1984	57	16	11	143	268	1.9	3.3	0.3	14.1
58375	35	6.1	23	65	2257	66	11	12	123	186	1.9	3.7	0.3	15.5
58380	45	6.6	32	103	2914	95	17	15	123	227	2.1	5.4	0.6	18.7
58383	46	5.4	50	63	840	93	14	14	192	275	1.4	2.6	0.1	9.7
58389	47	5.5	86	70	877	76	10	14	207	341	2	4.4	0.2	9.7
58394	48	5.3	59	50	922	65	11	13	188	215	0.9	2	0.1	9.8
58400	49	6.2	19	42	2055	82	11	12	135	223	1.6	4.7	0.5	14.6
58404	50	6.1	22	46	1776	81	13	12	130	224	1.4	5.1	0.4	13.2
58410	59	5.2	33	44	565	63	13	15	151	247	1.1	1.5	0.1	9.0

Lab Number	Site	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B	CEC
58415	60	5	51	57	584	69	13	17	170	232	0.9	1.2	0.1	9.2
58420	61	5.1	55	176	795	70	11	13	176	285	2	3.3	0.2	10.6
58426	62	5.3	69	78	846	83	11	15	161	163	0.8	1.6	0.2	9.7
58431	72	5.1	43	46	574	54	12	15	142	249	1.2	1.2	0.1	9.0
58436	73	4.8	47	48	484	50	13	20	153	254	1.1	0.9	0.1	9.0
58441	74	5.3	51	39	513	61	13	14	148	246	1.1	1.9	0.1	7.7
58444	75	5.3	85	51	829	61	14	15	167	167	0.8	1.8	0.2	9.3
58450	84	4.9	61	60	628	81	12	16	122	143	1	1.7	0	10.5
58455	85	5	54	38	350	62	11	14	118	200	1	1.5	0	7.9
58461	86	4.5	91	25	167	32	6	11	163	110	0.7	1	0	6.2
58466	87	6.4	18	60	2016	57	11	9	96	150	1.6	2.8	0.3	14.3
58471	98	4.6	51	25	359	42	8	14	155	168	0.8	1.2	0	8.2
58476	99	4.8	64	29	315	49	5	12	138	129	0.6	1.1	0	8.1
58482	100	6.4	20	81	2022	53	7	11	104	157	1.5	3.4	0.4	14.3
58487	111	4.8	38	70	682	52	9	7	115	39	0.4	0.3	0	10.6
58492	112	5	23	46	644	53	7	13	118	128	0.4	0.7	0	9.3
Mean, mg/kg		5.6	45	60	1289	70	12	13	151	200	1.3	2.8	0.3	11.7
Median, mg/kg		5.5	42	53	955	69	11	13	150	207	1.2	2.9	0.2	10.5
Minimum, mg/kg		4.5	17	25	167	32	5	7	96	39	0.4	0.3	0.0	6.2
Maximum, mg/kg		7.0	91	176	3404	108	28	20	230	341	2.7	7.3	1.0	20.2
Standard dev., mg/kg		0.7	20	28	855	17	4	3	31	57	0.6	1.7	0.3	3.5
Coeff. variation, %		11.7	46	47	66	24	33	20	20	28	42.7	59.4	94.9	30.0

Table 10. Soil analyses of 4 – 8 inch samples collected from Field 5a in January, 2015.

Lab Number	Site	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B	CEC
58315	19	6.5	13	78	3125	67	14	10	100	156	2.2	4.7	0.6	19.4
58319	20	6.8	15	89	3397	66	15	12	114	214	2.6	5.2	0.8	20.3
58324	21	6.8	9	70	2443	58	15	7	105	230	2.5	2.7	0.5	15.4
58333	23	5.4	33	47	915	47	9	8	157	150	1	2.3	0.3	9.6
58339	24	5.8	31	40	991	32	9	8	180	145	1	2.4	0.3	9.4
58344	25	6.1	23	50	1490	56	9	7	183	197	1.3	2.8	0.4	11.6
58350	30	6.3	16	43	1632	49	11	8	146	173	1.2	2.6	0.3	12.2
58355	31	6.3	21	29	1139	29	9	6	161	138	0.8	2.3	0.2	9.1
58360	32	5.8	62	54	1016	43	9	7	204	171	1.1	2.3	0.1	9.6
58365	33	6	61	78	1331	46	17	8	196	184	1.9	1.3	0.1	10.8
58370	34	6.1	25	70	1992	43	19	8	156	242	2.3	2.7	0.2	14.1
58376	35	6.4	10	68	2295	35	12	9	126	212	2.2	3	0.3	15.5
58384	46	5.6	31	56	881	55	9	8	177	192	1.4	1.9	0.1	9.0
58390	47	5.4	58	66	929	42	12	10	193	265	2.4	3.2	0.2	9.7
58395	48	5.6	48	55	1038	42	13	8	167	128	0.8	0.9	0.1	9.7
58401	49	6.6	11	52	2211	55	12	8	130	201	1.9	2.9	0.4	14.7
58405	50	6.4	15	36	1172	43	9	7	124	149	1.1	2.9	0.2	9.3
58411	59	5.4	15	44	607	54	11	11	146	242	1.1	1.2	0.1	8.1
58416	60	5.1	34	56	564	46	12	11	158	179	0.9	0.6	0.1	8.9
58422	61	5.3	43	65	934	46	18	10	160	223	2.1	2.6	1.9	9.8

Lab Number	Site	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B	CEC
58427	62	5.2	72	77	923	61	13	9	146	87	0.7	0.5	0.1	10.9
58437	73	5.2	19	44	558	35	16	14	138	222	1.2	0.6	0.1	8.8
58446	75	4.8	44	57	687	41	17	10	109	62	1.5	1.6	1.1	10.5
58451	84	4.8	37	56	543	49	13	11	105	75	1	0.6	0	9.3
58456	85	5.3	19	35	403	44	9	9	96	151	1.1	1	0	7.0
58462	86	4.8	56	23	206	22	5	7	134	115	0.7	1.1	0	7.3
58467	87	6.5	10	51	1685	34	10	6	97	174	1.5	1.8	0.1	11.9
58472	98	4.7	36	21	270	20	6	10	136	117	0.7	1	0	7.6
58477	99	5.2	27	32	492	33	7	6	104	102	0.7	2.4	0	8.3
58483	100	6.5	10	74	2087	29	8	7	95	143	1.6	2.2	0.3	13.9
58488	111	5.3	22	56	722	50	6	8	139	164	0.8	0.8	0	8.7
58494	112	4.8	19	52	669	39	13	14	122	127	0.4	0.8	0	10.4
Mean, mg/kg		5.7	30	54	1230	44	11	9	141	167	1.4	2.0	0.3	11.0
Median, mg/kg		5.6	24	55	963	44	12	8	138.5	167.5	1.2	2.3	0.2	9.7
Minimum, mg/kg		4.7	9	21	206	20	5	6	95	62	0.4	0.5	0.0	7.0
Maximum, mg/kg		6.8	72	89	3397	67	19	14	204	265	2.6	5.2	1.9	20.3
Standard dev., mg/kg		0.7	18	17	805	12	4	2	32	51	0.6	1.1	0.4	3.3
Coeff. variation, %		11.5	60	31	65	26	32	24	23	30	45.5	56.6	138.7	29.7

Table 11. Soil analyses of 8 – 12 inch samples collected from Field 5a in January, 2015.

Lab Number	Site	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B	CEC
58320	20	6.9	10	102	3976	51	22	8	102	197	2.5	4.2	0.6	23.2
58326	21	6.7	7	83	2719	52	14	6	117	235	2.7	1.6	0.6	17.3
58334	23	5.7	37	56	1187	35	9	5	165	162	1.4	2	0.4	10.9
58340	24	5.9	32	60	1419	38	9	7	178	194	1.8	3.1	0.3	11.1
58345	25	6.1	24	76	2165	79	12	7	165	205	2.1	3.2	0.5	15.2
58351	30	6.3	15	37	1261	37	10	6	147	150	1	2	0.2	9.8
58356	31	6.4	21	40	1247	33	10	5	254	164	1.1	2.1	0.2	9.7
58366	33	6.1	88	104	1635	46	17	6	202	145	2	1	0.1	12.4
58371	34	6.3	36	81	1842	36	21	5	158	181	2.2	1.8	0.1	13.3
58377	35	6.6	10	71	2216	28	13	8	137	236	2.4	2.7	0.3	14.6
58381	45	7	9	82	2498	60	14	7	107	228	1.8	2.9	0.3	15.3
58386	46	5.9	45	83	1335	69	14	7	194	174	1.7	3.2	0.2	11.0
58391	47	5.9	70	86	1273	36	13	6	208	202	2.1	1.5	0.2	10.4
58396	48	6	76	105	1852	49	14	5	176	86	0.8	0.6	0.1	13.5
58402	49	6.3	11	79	2524	64	12	7	144	193	1.8	2.4	0.3	16.9
58406	50	6.3	17	37	908	35	10	5	124	122	0.8	2.3	0.1	7.5
58412	59	5.5	11	68	994	56	12	9	159	256	1.4	0.8	0.2	10.2
58417	60	5.3	36	77	725	47	12	10	156	114	1	0.3	0.1	8.8
58423	61	5.4	50	67	1076	36	12	8	178	216	2	2	0.8	10.4
58428	62	5.2	97	86	989	56	13	8	146	41	0.5	0.3	0.1	11.2
58432	72	5.4	27	63	800	33	18	8	150	136	1.4	0.3	0.1	9.0

Lab Number	Site	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B	CEC
58438	73	5.1	25	61	589	30	15	14	133	134	1.1	0.6	0.1	8.9
58447	75	4.7	37	67	636	47	14	11	107	40	1.6	0.9	0.5	10.3
58452	84	5	51	65	624	53	13	10	103	25	0.8	0.7	0.0	9.3
58458	85	5.5	13	45	609	37	10	7	103	135	1	0.5	0.0	8.0
58463	86	5.1	35	37	411	29	7	5	119	118	0.9	0.8	0.0	7.9
58468	87	6.6	11	50	1391	30	14	5	99	184	1.5	1.3	0.0	9.9
58473	98	5.4	18	64	1069	27	9	8	109	92	0.9	0.3	0.0	10.3
58478	99	5.4	14	63	855	37	12	9	105	95	0.8	0.3	0.0	9.3
58484	100	6.7	8	70	2109	27	10	5	104	173	1.6	1.7	0.2	14.0
58489	111	5	29	60	680	45	8	7	140	144	0.8	0.5	0.0	9.5
58495	112	4.9	12	65	642	38	11	22	117	94	0.3	0.5	0.0	10.2
Mean, mg/kg		5.8	31	68	1383	43	13	8	144	152	1.4	1.5	0.2	11.5
Median, mg/kg		5.9	25	67	1217	38	12	7	142	156	1.4	1.4	0.2	10.4
Minimum, mg/kg		4.7	7	37	411	27	7	5	99	25	0.3	0.3	0.0	7.5
Maximum, mg/kg		7.0	97	105	3976	79	22	22	254	256	2.7	4.2	0.8	23.2
Standard dev., mg/kg		0.6	24	18	795	13	3	3	38	59	0.6	1.1	0.2	3.3
Coeff. variation, %		11.0	78	27	57	30	27	43	26	39	43.2	71.1	100.8	28.9

Table 12. Soil analyses of 12 - 18 inch samples collected from Field 5a in January, 2015.

Lab Number	Site	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B	CEC
58316	19	6.5	8	93	3225	54	15	7	110	184	2.2	3.7	0.6	19.9
58321	20	7.3	8	95	3806	44	19	6	99	214	2.4	3.7	0.6	21.7
58327	21	6.6	5	102	3126	51	17	5	122	173	2.2	0.7	0.5	19.4
58330	22	6.3	12	94	2807	70	15	6	122	153	2.3	1.7	0.6	18.4
58335	23	6	65	76	1906	39	12	7	184	190	2.4	3.6	0.5	13.6
58341	24	6	37	87	2276	54	13	7	193	232	2.6	4.6	0.5	15.6
58346	25	6.2	26	92	2330	78	14	8	165	205	2	3.2	0.5	16.1
58352	30	6.3	22	46	1416	35	11	6	164	168	1.2	2.5	0.2	10.5
58357	31	6.4	16	66	2037	49	11	6	174	261	1.7	3.1	0.3	14.3
58362	32	6.3	300	103	2752	49	15	8	168	278	3.7	9.1	0.7	18.0
58367	33	6.3	115	124	1837	49	19	5	191	86	1.9	0.7	0.1	13.5
58372	34	6.4	35	84	1812	41	18	5	160	158	2.1	1.3	0.2	13.2
58378	35	6.4	7	85	2140	36	15	6	144	182	1.7	0.8	0.3	14.8
58382	45	6.8	20	94	2167	53	14	5	120	147	1.1	1.7	0.1	14.1
58387	46	6.2	61	101	1569	86	16	5	197	131	1.5	1.2	0.2	11.9
58392	47	6.4	97	111	1666	33	13	5	218	146	1.3	1	0.2	12.4
58398	48	6.1	77	102	1846	50	15	5	166	58	0.9	0.6	0.1	13.5
58403	49	6.3	15	86	2597	64	14	7	148	175	1.7	2	0.3	17.3
58407	50	6.4	16	46	1152	35	10	4	124	139	0.9	2.1	0.1	9.2
58413	59	6	14	94	1402	61	15	7	167	167	1.2	0.4	0.2	11.3
58418	60	5.1	30	85	676	49	13	13	149	68	0.8	0.3	0.1	9.6
58424	61	5.9	56	79	1203	42	13	5	175	158	1.5	0.8	0.4	10.1

Lab Number	Site	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B	CEC
58429	62	5.2	106	98	1100	63	14	9	159	33	0.7	0.3	0.1	11.8
58434	72	5.6	107	95	1035	59	16	8	160	34	0.6	0.4	0.1	10.0
58439	73	4.7	30	72	491	30	14	17	131	77	0.9	0.3	0.1	9.0
58442	74	5.8	12	58	888	35	14	7	157	248	1.4	0.9	0.2	8.9
58448	75	4.7	35	79	665	63	13	11	113	40	1.8	1.2	0.1	10.6
58453	84	4.8	42	62	523	48	12	12	110	21	0.6	0.7	0.0	9.2
58459	85	5.6	18	65	793	37	11	6	96	65	0.7	0.2	0.0	8.5
58464	86	5.7	40	55	703	39	13	4	104	58	1	0.3	0.0	8.0
58470	87	6.7	14	51	1366	22	8	4	106	195	1.5	1.2	0.0	9.7
58474	98	4.8	17	67	627	41	10	13	114	53	1.1	0.5	0.0	10.2
58479	99	4.9	14	69	653	59	9	13	113	93	0.6	0.2	0.0	10.5
58485	100	6.7	11	67	1914	24	11	4	108	182	1.5	1.4	0.1	13.0
58490	111	5.4	29	51	753	70	4	8	121	104	0.7	1.4	0.0	9.0
58496	112	4.9	7	64	511	40	11	27	110	65	0.3	0.4	0.0	9.1
Mean, mg/kg		5.9	42	81	1605	49	13	8	143	137	1.5	1.6	0.2	12.7
Median, mg/kg		6.0	30	79	1384	49	13	7	153	143	1.3	0.9	0.1	11.0
Minimum, mg/kg		4.7	7	46	491	22	4	4	96	21	0.3	0.2	0.0	8.0
Maximum, mg/kg		6.8	300	124	2752	86	19	27	218	278	3.7	9.1	0.7	18.0
Standard dev., mg/kg		0.7	54	19	873	15	3	4	33	70	0.7	1.7	0.2	3.6
Coeff. variation, %		11.4	127	24	54	30	23	58	23	51	49.5	107.9	95.1	28.8

Table 13. Soil analyses of 18 - 24 inch samples collected from Field 5a in January, 2015.

Lab Number	Site	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B	CEC
58317	19	6.8	6	73	3146	48	14	6	97	353	2.6	3.9	0.7	18.9
58322	20	7.3	8	99	3084	44	20	5	116	187	2.6	1.7	0.5	18.1
58328	21	6.8	5	110	3098	51	24	4	114	114	1.6	0.9	0.4	18.8
58331	22	6.3	8	102	2820	77	16	5	125	117	1.9	1.1	0.5	18.6
58336	23	6.1	52	77	1965	38	13	6	177	175	2.3	3	0.5	13.9
58342	24	6.3	24	108	3228	78	14	8	177	237	2.8	5.1	0.8	20.6
58347	25	6.1	22	105	2759	86	16	8	159	204	2	3	0.5	18.9
58353	30	6.5	15	47	1727	31	11	6	170	202	1.3	3.5	0.3	12.1
58358	31	6.2	9	100	3212	79	15	7	157	250	2.1	2.8	0.4	20.5
58363	32	6.3	262	109	2886	51	12	7	171	282	3.8	8	0.8	18.7
58368	33	6.3	136	135	1970	54	15	4	193	70	2	0.9	0.1	14.2
58374	34	6.4	41	85	1765	41	13	5	157	117	1.5	0.8	0.2	12.9
58379	35	6.5	9	76	2084	28	17	8	144	245	2.1	2.3	0.4	13.9
58388	46	6.3	72	116	1820	111	15	5	182	95	1.5	1.1	0.2	13.9
58393	47	6.5	118	115	1807	35	14	5	207	109	1.3	0.8	0.2	12.7
58399	48	5.8	77	104	1818	56	17	6	183	62	0.8	2	0.1	14.9
58408	50	6.4	19	40	979	32	9	4	133	140	0.8	2.3	0.1	7.8
58414	59	6.1	21	114	1673	73	16	6	162	109	1.2	0.4	0.2	12.8
58419	60	4.8	30	87	633	55	15	14	145	60	0.9	0.4	0.2	10.4
58425	61	6.1	74	91	1340	59	14	5	167	136	1.4	0.7	0.2	11.0
58430	62	5.2	90	100	1079	74	15	10	152	36	0.6	0.4	0.1	11.8
58435	72	5.1	40	93	816	62	18	11	152	74	0.6	0.3	0.1	10.4

Lab Number	Site	pH	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B	CEC
58440	73	4.7	32	75	500	46	14	15	128	71	0.7	0.2	0.1	9.1
58443	74	5.8	24	82	1201	78	15	6	163	153	1.4	0.4	0.2	11.4
58449	75	4.6	34	76	619	68	14	10	112	37	1.9	1.4	0.0	10.4
58454	84	4.8	40	62	439	47	12	15	106	31	0.7	0.8	0.0	8.8
58460	85	5.4	19	62	648	48	9	10	92	49	0.5	0.2	0.0	8.3
58465	86	5.7	46	87	1008	51	17	4	139	50	0.8	0.3	0.0	9.8
58475	98	5.1	15	41	704	22	7	7	116	117	0.9	0.7	0.0	9.3
58480	99	4.9	14	67	536	88	11	19	111	67	0.5	0.2	0.0	9.6
58486	100	6.8	15	67	1765	22	10	3	109	190	1.3	1	0.0	11.7
58491	111	4.8	27	65	528	48	7	8	105	45	0.3	0.3	0.0	9.2
58497	112	4.7	8	58	400	40	12	27	108	57	0.4	0.5	0.0	8.5
Mean, mg/kg		5.9	43	86	1638	55	14	8	143	129	1.4	1.6	0.2	13.1
Median, mg/kg		6.1	25.5	87.0	1700.0	51.0	14.0	6.5	148.5	111.5	1.3	0.8	0.2	11.9
Minimum, mg/kg		4.6	5.0	40.0	400.0	22.0	7.0	3.0	92.0	31.0	0.3	0.2	0.0	7.8
Maximum, mg/kg		7.3	262.0	135.0	3228.0	111.0	24.0	27.0	207.0	282.0	3.8	8.0	0.8	20.6
Standard dev., mg/kg		0.8	51	23	952	21	4	5	31	81	0.8	1.7	0.2	3.9
Coeff. variation, %		12.9	119	27	58	38	25	62	22	63	57.3	108.8	101.3	30.0

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April 1 to June 30, 2015

Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – July 1 to September 30, 2015

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

The mission of the **Division of Agriculture** is to advance the stewardship of natural resources and the environment, cultivate the improvement of agriculture and agribusiness, develop leadership skills and productive citizenship among youth and adults, enhance economic security and financial responsibility among the citizens of the state, ensure a safe, nutritious food supply, improve the quality of life in communities across Arkansas, and strengthen Arkansas families.

Dr. Mark J. Cochran
Vice President for Agriculture

Executive Summary

This is the third Quarterly Report of 2015 for the Big Creek Research and Extension Team that details the following progress made from July 1 through September 30, 2015.

1. We continue to collect weekly baseflow and periodic storm flow water samples from Big Creek above and below the C&H Farm, along with water from a spring, ephemeral stream, surface runoff sites on Fields 1, 5a, and 12, two interceptor trenches below the slurry holding ponds, and house well for chemical and bacterial analysis.

2. Nitrate-N concentration in Big Creek below the C&H Farm continue to be greater than those measured at the upstream site. Based on numerous stream-water monitoring studies conducted by USGS, U.S. EPA, and Land-Grant entities, we know that there are temporal and spatial factors, such as land use in the drainage watershed, which influence stream water nitrate-N concentrations. We will continue to monitor nitrate-N and other constituents to determine if and when they exceed known standards. For nitrate-N, the drinking water standard is 10.0 mg/L., which has not been exceeded. Standards or thresholds related to recreational or increased algal productivity involve phosphorus and not nitrogen forms.

3. Concentrations of nitrate-N and bacteria collected from the house well, which is approximately 400 ft deep and adjacent to the manure holding ponds have periodic high values. These increases were inconsistent, highly sporadic, and other constituents did not show similar increases. We investigated further and discovered intermittent potential sources of contamination between the sampling port and wellhead, which is not representative of the quality of ground water in the aquifer. We have installed a new sampling port closer to the wellhead at the beginning of October, 2015 to ensure that there is reduced potential for contamination of the water from external sources. We will continue to closely monitor the site.

Big Creek Research Team

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Brian Breaker, M.Sc., Hydrologic Technician, stream flow and constituent collection, analysis, and statistical evaluation of trends.

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Rick Cartwright, Ph.D., Professor – Associate Director of Extension for Agriculture and Natural Resources

Mark Cochran, Ph.D., – Vice President, University of Arkansas System Division of Agriculture.

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Ed Gbur, Ph.D., Professor and Director, Agricultural Statistics Laboratory - Experimental design, linear and generalized linear mixed models, regression, agricultural applications of statistics.

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Phil Hays, Ph.D. Ground Water Specialist, U.S. Geological Survey and Research Professor with Geosciences Dept., University of Arkansas, application of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems

Tim Kresse, M.Sc., Water Quality Specialist, U.S. Geological Survey, natural geochemical evolution of groundwater and separating these processes from anthropogenic sources of contamination

Nathan McKinney, Ph.D., – Assistant Director, Agriculture Experiment Station

Morteza Mozaffari, Ph.D. – Director, Univ. of Arkansas Soil Testing and Research Laboratory, Marianna.

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Thad Scott, Ph.D., Associate Professor - Water quality, transport of contaminants to and within water bodies

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Jun Zhu, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians - The Big Creek Research and Extension Team are ably supported by several excellent Program Technicians based in Little Rock and Fayetteville.

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Water Sampling and Analytical Methods

Sampling Locations

Water quality monitoring sites are shown in Figure 1 and are;

Site 1. Edge-of-field monitoring on Field 1 permitted to receive slurry.

Site 2. Edge-of-field monitoring on Field 5a excluded from receiving slurry.

Site 3. Edge-of-field monitoring on Field 12 permitted to receive slurry.

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities.

Site 5. Spring below Field 1.

Site 6. Big Creek upstream of the C&H Farm operation.

Site 7. Big Creak downstream of the C&H Farm operation.

Site 8. Manure holding pond trench. The site was visited weekly and trench water sampled when flowing.

Sampling Protocols and Analyses

The following protocols were used to collect, prepare, and analyze all water samples:

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface, where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted, and samples placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
6. Analyses included Alkalinity (APHA 2320-B), Ammonia (EPA 351.2), Chloride (EPA 300.0), Dissolved Phosphorus (EPA 365.2), E. coli (APHA 9223-B), Electrical Conductivity (EPA 120.1), Nitrate (EPA 300.0), pH (EPA 150.1), Total Coliforms (APHA 9223-B), Total Dissolved Solids (EPA 160.1), Total Nitrogen (APHA 4500-P J), Total Phosphorus (APHA 4500-P J), and Total Suspended Solids (EPA 160.2). APHA is American Public Health Association from the Wadeable Streams Assessment, Water Chemistry Laboratory Manual http://www.epa.gov/owow/monitoring/wsa/WRS_lab_manual.pdf
7. The minimum detection limits (MDLs) for each chemical and biological constituent measured are listed in Table 1.
8. Chemical and biological analyses of samples collected from the beginning of 2015 to the end of August, 2015 are presented in Tables 2, 3, and 4.

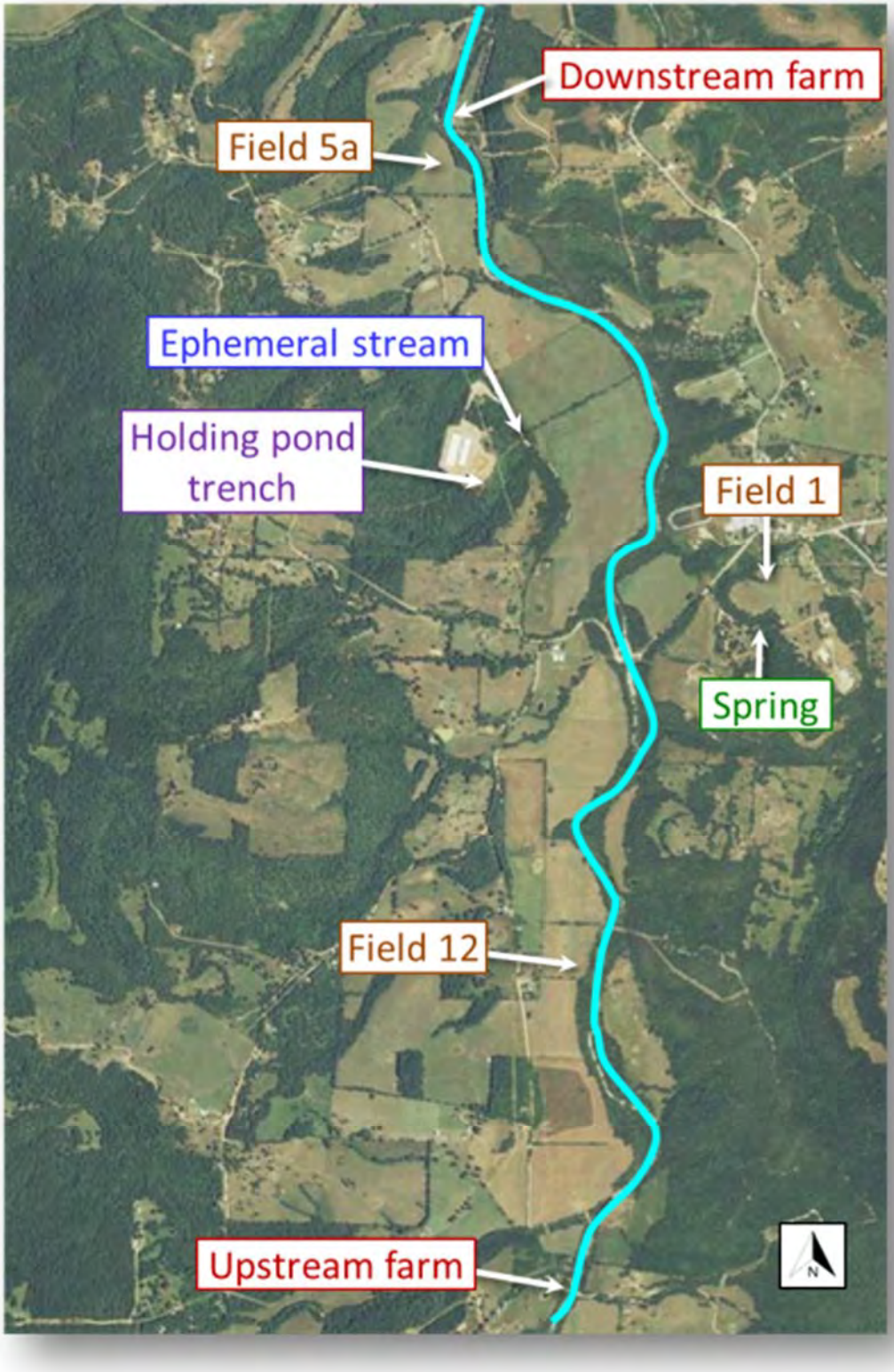

Figure 1. Location of water quality sampling sites on Big Creek and the C&H Farm.

Table 1. Minimum detection limits (MDLs) for each chemical and biological constituent measured.

Constituent	Minimum detection limit [1]
Alkalinity, mg/L as $CaCO_3$	2
Chloride, mg/L	0.093
Dissolved P, mg/L	0.002
Conductivity, uS/cm	1
Ammonia-N, mg/L	0.03
Dissolved organic carbon, mg/L	0.18
E. coli, MPN/100 mL	1
Nitrate-N, mg/L	0.004
pH	0.1
Total coliform, MPN/100 mL	1
Total dissolved solids, mg/L	15.22
Total N, mg/L	0.006
Total P, mg/L	0.012
Total suspended solids, mg/L	6.58

[1] MDL the Minimum Detection Limit of a analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. MDL is also known as the Method Detection Limit. Further information is available on the U.S. EPA website at http://water.usgs.gov/owq/OFR_99-193/detection.html

USGS Stations

Big Creek Continuous Flow

We are collaborating with USGS at Big Creek near Mt. Judea (USGS 705579; downstream of the C&H Farm operation) and at Left Fork Big Creek near Vendor (USGS 07055792), to collect base and storm water flows for N, P, and bacteria analysis. The USGS Big Creek site is instrumented with continuous flow gaging equipment and a nitrate sensor, which provides real-time flow, water temperature, nitrate-N, and precipitation data. These data are available on line at the USGS website below. Gage height, water temperature, precipitation, and continuous nitrate concentrations for the USGS downstream site for the last quarter are shown in Figures 2, 3, 4, and 5.

USGS 07055790 Big Creek near Mt. Judea, AR

http://nwis.waterdata.usgs.gov/ar/nwis/uv/?site_no=07055790&agency_cd=USGS

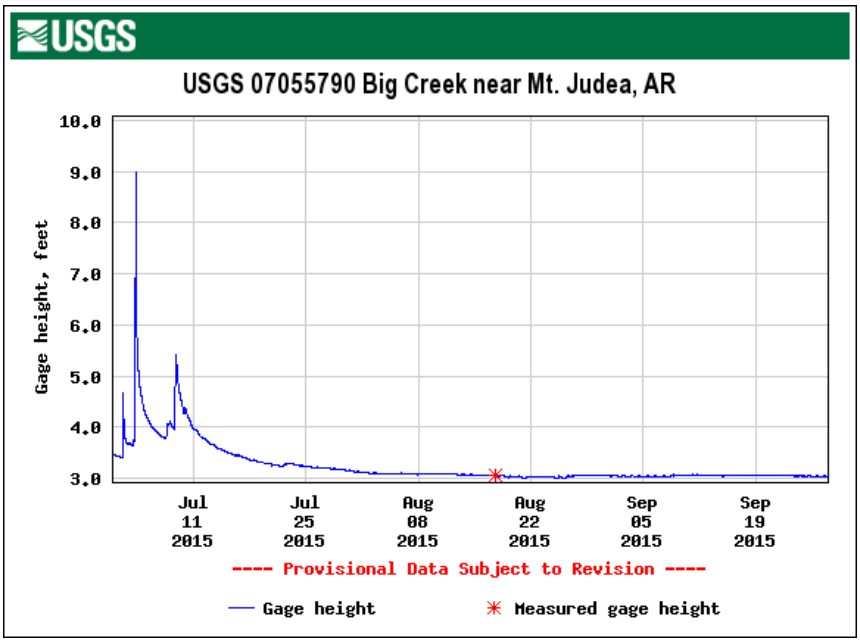

Figure 2. Gage height at the Big Creek monitoring site downstream of the C&H Farm during the 3nd quarter of 2015.

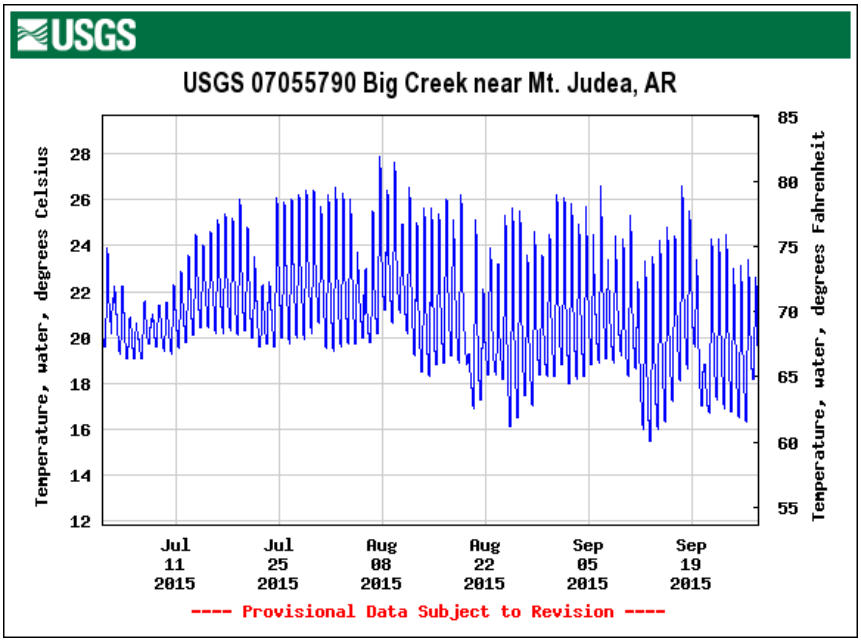

Figure 3. Water temperature at the Big Creek monitoring site downstream of the C&H Farm during the 3nd quarter of 2015.

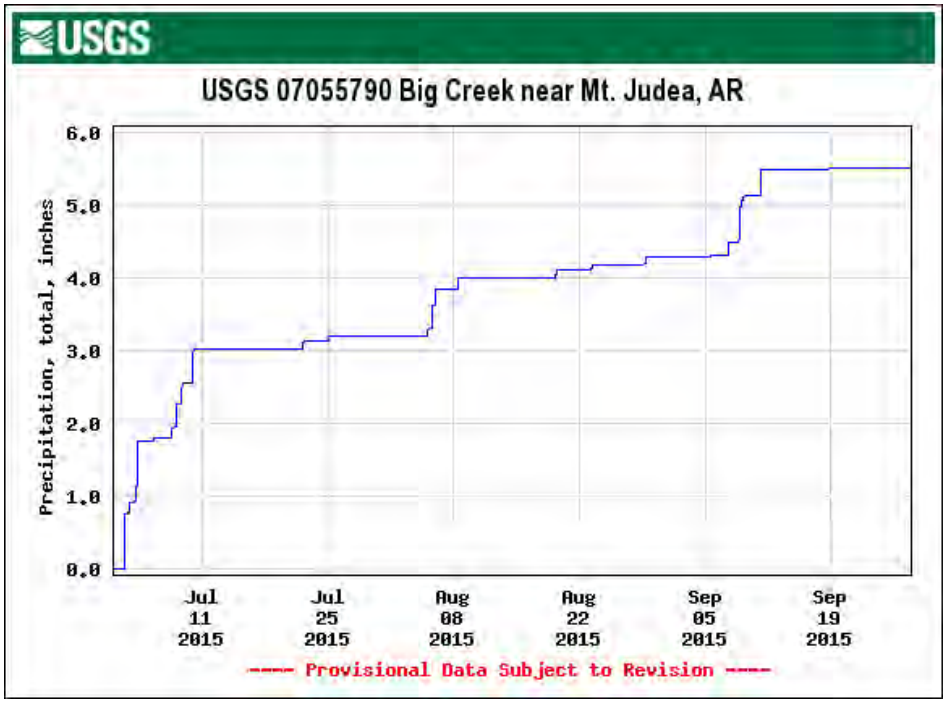

Figure 4. Precipitation at the Big Creek monitoring site downstream of the C&H Farm during the 3nd quarter of 2015.

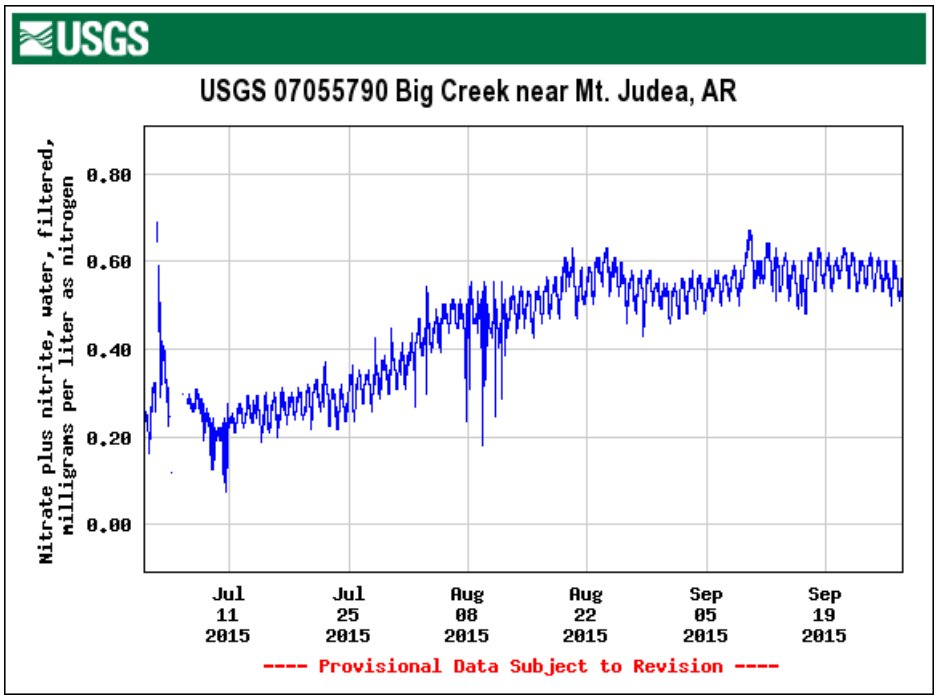

Figure 5. Nitrate concentration at the Big Creek monitoring site downstream of the C&H Farm during the 3nd quarter of 2015.

Big Creek Research and Extension Team Monitoring Data

Nutrients, Sediment, and Bacteria by Date of Sampling

Table 2. Water quality analyses at each sample site. Coliform units are Most Probable Number (MPN) per 100 mL of water for the 3rd Quarter of 2015.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
			mg/L							MPN/100 mL	
1/8/2015	**1/8/2015**	**Base flow**									
11:05	15:05	Spring	0.010	0.014	<0.03 ¶	0.376	0.56	2.0	3.80	14.8	686.7
11:25	15:05	Upstream farm	0.009	0.022	<0.03	0.187	0.21	2.3	1.41	30.9	547.5
10:53	15:05	Downstream farm	0.011	0.024	<0.03	0.376	0.39	2.5	1.22	42.6	980.4
11:40	15:05	Ephemeral stream	0.008	0.022	<0.03	0.448	0.59	2.4	1.73	25.6	1203.3
12:00	15:05	Trench 1	0.005	0.022	<0.03	0.769	0.75	4.7	0.88	1.0	13130.0
1/14/2015	**1/14/2015**	**Base flow**									
11:30	15:20	Spring	0.010	0.028	<0.03	0.473	0.66	1.1	10.20	21.6	613.1
11:45	15:20	Upstream farm	0.012	0.032	<0.03	0.135	0.19	1.1	3.02	88.2	727.0
11:15	15:20	Downstream farm	0.011	0.020	<0.03	0.388	0.34	1.0	2.03	25.6	613.1
12:00	15:20	Ephemeral stream	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
1/21/2015	**1/21/2015**	**Base flow**									
11:15	15:28	Spring	0.009	0.020	<0.03	0.552	0.69	1.5	2.29	9.8	461.1
11:52	15:28	Upstream farm	0.008	0.018	<0.03	0.089	0.12	1.1	0.95	70.3	579.4
11:05	15:28	Downstream farm	0.010	0.026	0.06	0.197	0.30	1.1	1.60	37.4	613.1
11:25	15:28	Ephemeral stream	0.005	0.016	<0.03	0.370	0.46	1.0	2.34	155.3	2419.2
1/29/2015	**1/29/2015**	**Base flow**									
10:40	15:28	Spring	0.010	0.018	0.03	0.886	0.74	2.3	4.27	1.0	2850.0
11:45	15:28	Upstream farm	0.006	0.060	<0.03	0.065	0.21	47.8	1.71	727.0	1413.6
1:20	15:28	Downstream farm	0.009	0.020	0.04	0.168	0.27	1.3	1.50	19.9	1046.2
2/3/2015	**2/3/2015**	**Base flow**									
11:05	15:40	Spring	0.008	0.018	<0.03	0.691	0.77	3.8	7.64	1.0	461.1
11:40	15:40	Upstream farm	0.006	0.022	<0.03	0.051	0.28	1.1	2.69	4.1	1203.3
10:50	15:40	Downstream farm	0.009	0.018	<0.03	0.140	0.29	4.1	2.66	1.0	547.5
2/10/2015	**2/10/2015**	**Base flow**									
10:38	15:08	Spring	0.010	0.010	<0.03	0.544	0.64	1.9	0.76	2.0	686.7
11:05	15:08	Upstream farm	0.009	0.012	<0.03	0.056	0.09	0.7	1.04	1119.1	2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:25	15:08	Downstream farm	0.011	0.012	<0.03	0.143	0.23	1.0	1.15	7.4	1553.1
2/26/2015	**2/26/2015**	**Base flow**									
10:45	15:30	Spring	0.009	0.042	0.02	0.237	0.38	5.0	3.97	37.3	2419.2
11:36	15:30	Upstream farm	0.006	0.024	<0.03	0.100	0.13	0.6	1.20	47.9	686.7
10:34	15:30	Downstream farm	0.008	0.026	0.02	0.200	0.25	0.8	1.17	48.7	866.4
10:55	15:30	Ephemeral stream	0.006	0.022	<0.03	0.530	0.57	1.3	1.38	16.1	4790.0
11:15	15:30	Trench 1	0.004	0.028	0.01	0.712	0.76	46.0	0.60	1.0	41063.0
3/3/2015	**3/3/2015**	**Base flow**									
11:07	15:33	Spring	0.008	0.052	<0.03	0.124	0.35	13.5	4.90	N.S. §	N.S.
11:50	15:33	Upstream farm	0.006	0.026	0.02	0.048	0.11	2.3	1.50	N.S.	N.S.
10:55	15:33	Downstream farm	0.007	0.028	<0.03	0.138	0.23	1.3	1.50	N.S.	N.S.
11:18	15:33	Ephemeral stream	0.006	0.020	<0.03	0.477	0.52	2.0	1.84	N.S.	N.S.
11:30	15:33	Trench 1	0.003	0.024	<0.03	0.867	0.89	14.9	0.95	N.S.	N.S.
3/11/2015	**3/11/2015**	**Storm Flow**									
11:30	14:58	Spring	0.009	0.030	<0.03	0.242	2.37	5.5	14.79	19.5	111.9

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:30	14:58	Upstream farm	0.005	0.026	0.02	0.118	0.16	2.1	3.38	34.5	579.4
11:20	14:58	Downstream farm	0.007	0.030	0.02	0.209	0.27	1.8	1.44	66.3	770.1
11:45	14:58	Ephemeral stream	0.006	0.022	0.04	0.567	0.60	0.5	2.20	6.3	410.0
12:10	14:58	Trench 1	0.003	0.014	0.07	0.989	0.97	0.3	2.00	<1.0	2419.2
12:15	14:58	Trench 2	0.003	0.056	0.04	1.443	1.59	1.2	3.51	<1.0	2419.2
3/19/2015	**3/19/2015**	**Base flow**									
10:59	15:10	Spring	0.010	0.028	0.03	0.184	0.29	10.6	7.37	38.9	79.4
12:00	15:10	Upstream farm	0.007	0.024	0.04	0.111	0.20	1.7	2.53	42.6	866.4
11:13	15:10	Downstream farm	0.009	0.028	0.04	0.234	0.35	2.8	2.87	71.7	1119.9
11:08	15:10	Ephemeral stream	0.007	0.018	0.01	0.529	0.63	1.0	4.31	14.6	866.4
11:13	15:10	House well	0.009	0.020	0.02	0.467	0.55	1.2	4.93	1.0	31.3
11:30	15:10	Trench 1	0.003	0.012	0.01	0.849	0.93	<6.58	3.11	1.0	275.5
11:35	15:10	Trench 2	0.004	0.062	0.09	1.036	1.42	1.9	5.12	5.2	2419.2
3/25/2015	**3/25/2015**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:45	15:20	Spring	0.006	0.014	0.02	0.197	0.39	1.6	1.45	23.1	275.5
13:30	15:20	Upstream farm	0.006	0.028	0.02	0.056	0.16	2.9	1.36	125.9	2419.2
11:30	15:20	Downstream farm	0.008	0.036	0.04	0.162	0.29	5.0	1.41	547.5	3410.0
12:00	15:20	Ephemeral stream	0.007	0.014	0.02	0.462	0.53	1.1	0.64	8.6	344.8
12:20	15:20	House well	0.007	0.016	<0.03	0.450	0.52	1.9	0.03	18.5	30.1
12:30	15:20	Trench 1	0.003	0.008	<0.03	0.838	0.88	0.2	0.59	<1.0	410.6
3/26/2015	**3/26/2015**	**Storm flow**									
13:10	15:25	Upstream farm	0.013	0.064	0.06	0.090	0.30	11.4	3.71	547.5	5200.0
13:35	15:25	Downstream farm	0.013	0.076	0.06	0.144	0.41	14.1	3.94	816.4	4960.0
12:55	15:25	Trench 1	0.004	0.026	0.02	0.904	1.00	15.4	0.69	<1.0	1553.1
12:50	15:25	Trench 2	0.004	0.126	0.13	0.873	1.44	22.2	4.63	105.4	6950.0
13:20	15:25	Field 1	0.143	0.346	0.41	0.216	2.68	65.5	15.65	N.S.	N.S.
12:30	15:25	Field 5a	0.813	1.330	0.39	0.225	2.59	72.3	15.95	N.S.	N.S.
4/2/2015	**4/2/2015**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:50	15:25	Spring	0.008	0.042	0.04	0.173	0.35	3.5	10.47	248.1	1299.7
12:15	15:25	Upstream farm	0.007	0.040	0.02	0.045	0.14	3.1	3.61	166.9	2419.2
1:30	15:25	Downstream farm	0.007	0.042	0.02	0.139	0.22	2.5	2.71	121.1	1986.3
12:30	15:25	Ephemeral stream	0.006	0.032	0.02	0.467	0.46	1.8	4.41	5.2	547.5
12:48	15:25	House well	0.008	0.030	<0.03	0.477	0.50	0.7	6.05	39.3	9060.0
12:54	15:25	Trench 1	0.003	0.028	0.02	0.865	0.87	0.3	3.34	1.1	308.6
4/9/2015	**4/9/2015**	**Base flow**									
11:45	15:30	Spring	0.011	0.034	0.01	0.257	0.42	4.9	9.11	7380.0	9040.0
12:30	15:30	Upstream farm	0.011	0.042	0.04	0.066	0.18	13.1	2.13	86.0	2650.0
12:50	15:30	Downstream farm	0.010	0.048	0.03	0.157	0.25	19.7	1.82	47.2	1986.3
12:00	15:30	House well	0.011	0.026	<0.03	0.499	0.50	1.5	0.74	4.1	325.5
12:10	15:30	Trench 1	0.006	0.018	<0.03	0.790	0.83	0.8	2.99	<1.0	187.2
4/15/2015	**4/15/2015**	**Storm Flow**									
11:38	14:55	Spring	0.007	0.034	<0.03	0.210	0.39	7.7	4.70	275.5	2280.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:23	14:55	Upstream farm	0.007	0.040	0.03	0.090	0.16	3.5	3.24	648.8	4040.0
12:40	14:55	Downstream farm	0.009	0.048	0.03	0.166	0.26	4.4	2.67	344.8	2920.0
11:48	14:55	Ephemeral stream	0.005	0.026	0.03	0.472	0.56	0.8	1.26	305.0	2430.0
11:58	14:55	House well	0.008	0.022	0.02	0.475	0.60	1.2	3.72	9.6	80.9
12:10	14:55	Trench 1	0.003	0.020	<0.03	0.857	0.93	1.3	4.29	<1.0	3180.0
4/23/2015	**4/23/2015**	**Base Flow**									
12:23	15:30	Spring	0.008	0.034	<0.03	0.264	0.36	7.4	3.64	71.7	648.8
13:00	15:30	Upstream farm	0.007	0.032	0.03	0.083	0.18	4.0	5.11	104.6	2419.2
12:15	15:30	Downstream farm	0.007	0.032	0.03	0.162	0.25	2.6	2.51	65.7	2419.2
11:55	15:30	Ephemeral stream	0.008	0.026	0.03	0.520	0.56	2.0	1.78	12.0	3270.0
11:35	15:30	House well	0.008	0.082	<0.03	0.496	0.53	1.4	1.69	18.5	35.0
11:48	15:30	Trench 1	0.003	0.034	<0.03	0.877	0.97	1.2	1.18	3.1	2690.0
4/29/2015	**4/29/2015**	**Base flow**									
11:25	14:05	Spring	0.010	0.028	<0.03	0.419	0.59	9.0	4.28	25.6	1732.9

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:53	14:05	Upstream farm	0.010	0.020	0.03	0.082	0.13	2.7	1.58	58.3	1732.4
12:13	14:05	Downstream farm	0.012	0.018	0.03	0.189	0.82	2.1	1.64	58.6	1986.3
11:30	14:05	Ephemeral stream	0.012	0.018	0.02	0.569	0.61	3.5	1.98	14.3	4080.0
11:35	14:05	House well	0.010	0.006	<0.03	0.517	0.51	0.7	2.26	248.1	5040.0
5/7/2015	**5/7/2015**	**Base flow**									
11:10	14:10	Spring	0.011	0.036	0.02	0.499	0.58	9.9	44.04	135.4	980.4
11:43	14:10	Upstream farm	0.008	0.032	0.01	0.110	0.16	7.5	10.16	77.6	3280.0
12:05	14:10	Downstream farm	0.009	0.034	<0.03	0.267	0.36	4.5	7.70	27.8	2280.0
11:18	14:10	Ephemeral stream	0.013	0.066	0.02	0.628	0.71	3.2	16.41	71.7	7170.0
11:23	14:10	House well	0.008	0.022	0.01	0.512	0.49	<6.58	28.63	3.1	59.4
5/8/2015	**5/8/2015**	**Storm flow**									
13:25	15:32	Upstream farm	0.134	0.354	0.16	0.340	1.12	51.4	9.30	N.S.	N.S.
13:25	15:32	Downstream farm	0.195	0.544	0.27	0.292	1.20	113.2	7.47	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:43	15:32	Ephemeral stream	0.005	0.254	0.41	2.287	3.23	127.1	6.45	N.S.	N.S.
13:00	15:32	Field 1	0.525	0.714	0.16	0.475	2.19	16.9	13.28	N.S.	N.S.
12:38	15:32	Field 12	0.675	0.956	0.14	0.303	1.82	57.0	16.00	N.S.	N.S.
5/11/2015	**5/12/2015**	**Storm Flow**									
11:35	8:30	Spring	0.008	0.058	0.01	0.339	0.49	8.7	3.67	N.S.	N.S.
11:28	8:30	Upstream farm	0.004	0.074	0.04	0.004	0.24	4.5	4.31	N.S.	N.S.
12:47	8:30	Downstream farm	0.031	0.530	0.11	0.071	1.12	277.5	8.48	N.S.	N.S.
12:05	8:30	Ephemeral stream	0.008	0.146	0.15	0.941	1.80	22.0	8.09	N.S.	N.S.
12:15	8:30	House well	0.009	0.038	0.02	0.541	0.55	4.2	0.89	N.S.	N.S.
12:25	8:30	Trench 1	0.003	0.060	0.02	0.916	0.97	27.6	1.78	N.S.	N.S.
12:35	8:30	Trench 2	0.003	0.042	0.05	0.553	0.76	8.8	3.44	N.S.	N.S.
11:25	8:30	Field 1	0.251	0.386	0.09	0.055	0.86	44.4	6.31	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:40	8:30	Field 5a	0.248	0.968	0.26	0.127	1.50	320.1	8.58	N.S.	N.S.
1:05	8:30	Field 12	0.194	0.364	0.09	0.135	0.83	36.7	7.03	N.S.	N.S.
5/14/2015	**5/14/2015**	**Base flow**									
12:35	15:12	Spring	0.009	0.062	0.02	0.222	0.35	41.5	2.84	121.1	2419.2
12:28	15:12	Upstream farm	0.011	0.046	0.02	0.177	0.23	2.8	1.35	145.5	2470.0
12:47	15:12	Downstream farm	0.015	0.050	0.02	0.326	0.39	6.1	1.16	128.1	4370.0
12:57	15:12	Left Fork	0.015	0.038	0.02	0.321	0.38	3.3	1.36	83.3	2690.0
12:15	15:12	Ephemeral stream	0.010	0.022	0.01	0.527	0.50	1.7	0.73	41.3	1986.3
12:05	15:12	Trench 1	0.005	0.042	0.02	0.904	0.94	29.9	1.20	81.6	1732.9
5/18/2015	**5/18/2015**	**Storm Flow**									
10:45	14:43	Spring	0.005	0.084	0.05	0.209	0.56	114.2	2.79	98.7	1413.6
11:57	14:43	Upstream farm	0.007	0.034	0.02	0.110	0.15	5.2	1.29	137.6	2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:17	14:43	Downstream farm	0.009	0.040	0.03	0.201	0.25	6.1	1.47	185.0	6770.0
12:29	14:43	Left Fork	0.011	0.040	0.04	0.209	0.29	4.1	1.90	167.4	8300.0
11:14	14:43	Ephemeral stream	0.007	0.028	0.03	0.525	0.55	0.7	1.18	90.7	7630.0
11:20	14:43	House well	0.008	0.018	<0.03	0.529	0.53	0.9	0.90	5.2	13.4
12:55	14:43	Trench 1	0.002	0.020	<0.03	0.897	0.93	0.3	1.28	32.3	1732.9
10:58	14:43	Field 1	0.208	0.512	0.54	0.410	3.59	53.7	26.12	N.S.	N.S.
5/26/2015	**5/26/2015**	**Base flow**									
11:49	15:48	Spring	0.021	0.020	<0.03	0.205	0.29	1.2	2.66	N.S.	N.S.
13:20	15:48	Upstream farm	0.012	0.044	0.04	0.080	0.19	6.4	1.50	N.S.	N.S.
13:32	15:48	Downstream farm	0.045	0.200	0.11	0.096	0.56	94.7	4.57	N.S.	N.S.
13:45	15:48	Left Fork	0.014	0.048	0.04	0.139	0.29	6.1	2.41	N.S.	N.S.
13:11	15:48	Ephemeral stream	0.017	0.030	0.03	0.514	0.60	0.9	1.12	N.S.	N.S.
12:43	15:48	House well	0.013	0.020	<0.03	0.514	0.54	2.7	0.87	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:55	15:48	Trench 1	0.007	0.012	0.01	0.752	0.80	1.0	0.78	N.S.	N.S.
1:00	15:48	Trench 2	0.007	0.112	0.04	1.190	1.44	131.9	1.23	N.S.	N.S.
12:09	15:48	Field 1	0.245	0.432	0.20	0.174	1.66	37.8	11.28	N.S.	N.S.
6/1/2015	**6/1/2015**	**Storm Flow**									
13:15	15:20	Downstream farm	0.006	0.050	0.05	0.109	0.25	13.7	1.80	N.S.	N.S.
12:00	15:20	Ephemeral stream	0.002	0.056	0.01	0.851	1.05	18.3	2.46	N.S.	N.S.
6/4/2015	**6/4/2015**	**Base Flow**									
12:50	15:20	Spring	0.010	0.028	<0.03	0.239	0.3	6.2	9.54	44.3	1413.8
12:00	15:20	Upstream farm	0.008	0.026	0.03	0.083	0.11	2.3	2.93	38.6	>2419.2
13:05	15:20	Downstream farm	0.009	0.034	<0.03	0.184	0.23	1.7	2.64	24.7	2419.2
13:13	15:20	Left Fork	0.008	0.022	<0.03	0.145	0.19	2.1	3.15	38.9	2560.0
11:40	15:20	Ephemeral stream	0.010	0.024	0.02	0.572	0.58	0.8	5.35	21.6	3890.0
11:35	15:20	House well	0.012	0.022	0.02	0.561	0.52	1.3	6.07	<1.0	14.6
6/8/2015	**6/8/2015**	**Base flow**									
11:36	15:30	House well	0.008	0.018	0.27	0.475	0.82	0.7	6.67	<1.0	<1.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:45	15:30	Spring	0.011	0.046	0.03	0.322	0.53	12.7	11.18	20.1	1986.3
12:26	15:30	Upstream farm	0.010	0.030	0.06	0.058	0.24	4.5	3.63	866.4	2780.0
13:12	15:30	Downstream farm	0.009	0.022	0.05	0.185	0.27	0.9	2.66	57.4	4640.0
13:25	15:30	Left Fork	0.006	0.024	0.02	0.102	0.23	1.1	2.78	32.7	4550.0
11:51	15:30	Ephemeral stream	0.009	0.020	0.03	0.560	0.62	0.6	2.81	65.7	9870.0
6/17/2015	**6/17/2015**	**Base flow**									
12:08	15:40	Spring	0.009	0.046	0.07	0.224	0.47	9.4	8.92	517.2	24890.0
10:10	15:40	Upstream farm	0.009	0.036	0.03	0.050	0.16	3.5	2.83	435.2	13130.0
12:49	15:40	Downstream farm	0.007	0.034	0.03	0.106	0.23	2.3	2.92	344.8	20980.0
13:01	15:40	Left Fork	0.005	0.026	0.04	0.112	0.22	2.8	1.62	26.2	8550.0
11:50	15:40	Ephemeral stream	0.009	0.032	0.04	0.948	1.04	6.7	0.97	770.1	8840.0
11:47	15:40	House well	0.010	0.028	0.03	0.466	0.52	0.06	3.08	488.4	15390.0
6/22/2015	**6/22/15**	**Storm flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:30	15:55	Spring	0.009	0.032	0.03	0.218	0.26	5.3	3.01	61.3	1413.6
12:15	15:55	Upstream farm	0.010	0.030	0.01	0.042	0.05	2.9	0.99	78.0	4960.0
12:55	15:55	Downstream farm	0.009	0.032	0.04	0.136	0.16	2.9	1.15	36.8	5040.0
13:10	15:55	Left Fork	0.011	0.030	0.02	0.147	0.18	2.5	1.59	35.4	5910.0
10:50	15:55	Ephemeral stream	0.011	0.026	0.05	0.563	0.61	1.3	1.21	37.9	2419.2
10:45	15:55	House well	0.010	0.032	0.02	0.459	0.43	0.4	1.85	27.2	1732.9
10:30	15:55	Trench 1	0.005	0.048	0.07	0.653	0.76	47.3	1.86	21.1	1986.3
6/29/2015	**6/29/2015**	**Storm flow**									
10:47	15:32	Spring	0.013	0.018	0.03	0.235	0.30	1.7	5.26	93.3	2419.2
12:30	15:32	Upstream farm	0.010	0.028	0.14	0.055	0.13	2.7	2.49	117.8	4710
13:22	15:32	Downstream farm	0.068	0.748	0.17	0.147	1.88	571	6.57	135.4	7540
13:30	15:32	Left Fork	0.010	0.026	0.02	0.189	0.26	2.9	2.80	53.6	10170
12:20	15:32	Ephemeral stream	0.067	1.268	0.34	0.580	3.42	1366.8	11.04	69.7	4040
12:15	15:32	Trench 1	0.008	0.022	0.05	0.394	0.42	56.8	4.17	82.3	11450

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:48	15:32	Field 1	0.354	0.524	0.37	0.226	1.64	11	11.32	N.S.	N.S.
7/6/2015	**7/7/2015**	**Storm flow**									
19:45	14:58	Downstream farm	0.275	0.380	0.22	0.204	1.03	19.1	7.91	N.S.	N.S.
17:10	14:58	Ephemeral stream	0.063	0.658	0.37	0.717	2.75	567.3	8.52	N.S	N.S.
13:25	14:58	Field 1	0.387	0.444	0.23	0.345	1.30	4.9	8.32	N.S.	N.S.
16:45	14:58	Field 12	0.796	0.910	0.13	0.567	1.58	29.0	7.67	N.S.	N.S.
18:25	14:58	Field 5a	0.094	0.448	0.13	0.172	1.01	261.3	4.38		
7/9/2015	**7/9/2015**	**Base flow**									
13:37	15:15	Spring	0.011	0.048	0.09	0.144	0.41	4.3	6.47	77.1	3050.0
12:25	15:15	Upstream farm	0.013	0.048	0.02	0.087	0.18	6.8	2.75	201.4	10140.0
12:55	15:15	Downstream farm	0.014	0.050	0.03	0.117	0.24	8.8	2.32	275.5	10760.0
13:15	15:15	Left Fork	0.015	0.058	0.04	0.138	0.31	11.4	2.67	387.3	12670.0
12:12	15:15	Ephemeral stream	0.010	0.034	<0.03	0.569	0.71	4.9	2.56	78.9	5560.0
12:07	15:15	House well	0.011	0.024	0.01	0.423	0.48	2.0	1.69	9.8	4160.0
12:00	15:15	Trench 1	0.007	0.030	<0.03	0.520	0.62	7.1	2.52	63.7	12330.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
7/16/2015	**7/16/2015**	**Base flow**									
12:15	15:10	Upstream farm	0.010	0.024	0.02	0.065	0.15	0.5	1.91	41.3	52.0
12:54	15:10	Downstream farm	0.011	0.030	<0.03	0.195	0.33	0.5	1.35	11.8	6310.0
13:03	15:10	Left Fork	0.010	0.042	0.01	0.181	0.28	0.9	1.64	21.6	9330.0
12:33	15:10	Ephemeral stream	0.011	0.046	0.01	0.517	0.61	0.4	2.16	45.7	14830.0
12:28	15:10	House well	0.012	0.024	0.01	0.471	0.47	0.0	4.00	2.0	727.0
12:42	15:10	Spring	0.010	0.024	0.01	0.303	0.41	5.7	5.54	22.8	1413.6
7/23/2015	**7/23/2015**	**Storm flow**									
10:55	15:20	Spring	0.010	0.026	<0.03	0.436	0.60	2.7	1.12	61.3	1046.2
11:15	15:20	Upstream farm	0.009	0.026	0.02	0.096	0.18	1.3	0.97	93.3	7490.0
12:40	15:20	Downstream farm	0.011	0.028	0.02	0.198	0.31	0.8	1.06	16.8	4870.0
13:02	15:20	Left Fork	0.009	0.028	0.04	0.239	0.40	1.4	1.21	35.4	8360.0
12:00	15:20	Ephemeral stream	0.011	0.034	<0.03	0.511	0.68	11.3	0.33	201.4	24950.0
12:23	15:20	House well	0.015	0.030	<0.03	0.442	0.52	1.0	0.89	8.5	35.0
7/30/2015	**7/30/2015**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:28	15:20	Spring	0.011	0.026	0.03	0.479	0.65	6.3	4.73	6.3	920.8
12:17	15:20	Upstream farm	0.014	0.024	<0.03	0.101	0.15	0.9	1.61	27.2	2880.0
12:50	15:20	Downstream farm	0.012	0.022	0.02	0.268	0.38	1.9	2.16	11.9	6500.0
13:00	15:20	Left Fork	0.008	0.020	0.04	0.221	0.37	2.3	2.60	30.3	8160.0
11:58	15:20	House well	0.013	0.014	0.02	0.466	0.51	0.3	0.90	1.0	7.4
8/6/2015	**8/6/2015**	**Storm flow**									
12:05	14:50	Spring	0.008	0.240	0.07	0.265	0.97	0.0	7.10	23.1	48840.0
11:36	14:50	Upstream farm	0.009	0.028	<0.03	0.147	0.24	1.8	3.37	488.4	13540.0
12:22	14:50	Downstream farm	0.010	0.028	0.03	0.406	0.52	1.7	3.06	40.2	10390.0
12:37	14:50	Left Fork	0.007	0.026	0.04	0.310	0.47	1.2	3.16	217.8	8130.0
10:37	14:50	House well	0.010	0.018	0.04	0.482	0.52	0.5	3.33	920.8	21870.0
8/13/2015	**8/13/2015**	**Base flow**									
11:40	15:30	Spring	0.009	0.360	0.15	0.735	1.12	254.9	7.29	21.6	3360.0
12:06	15:30	Upstream farm	0.013	0.018	0.04	0.124	0.16	0.3	4.32	13.4	2460.0
13:01	15:30	Downstream farm	0.011	0.024	<0.03	0.384	0.50	4.0	3.74	24.0	3310.0
13:12	15:30	Left Fork	0.007	0.016	0.03	0.192	0.52	1.4	4.50	13.2	4810.0
11:53	15:30	House well	0.025	0.012	0.03	0.498	0.58	0.5	6.15	4.1	228.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
8/20/2015	**8/20/2015**	**Storm flow**									
11:32	14:05	Spring	0.009	0.276	0.07	0.337	0.89	223.6	17.88	148.3	3270.0
11:49	14:05	Downstream farm	0.015	0.022	0.03	0.491	0.53	2.2	5.94	39.3	66.3
12:04	14:05	Left Fork	0.009	0.028	0.04	0.306	0.42	2.3	5.12	48.8	3930.0
10:52	14:05	House well	0.012	0.018	<0.03	0.545	0.56	0.9	6.63	1.0	29.5
8/27/2015	**8/27/2015**	**Base flow**									
12:48	15:35	Spring	0.007	0.158	0.04	0.329	0.69	103.7	9.07	27.2	7540.0
12:37	15:35	Upstream farm	0.005	0.028	0.04	0.084	0.28	2.9	4.30	104.6	7710.0
1:20	15:35	Downstream farm	0.013	0.024	<0.03	0.450	0.54	2.5	4.43	137.4	5730.0
1:30	15:35	Left Fork	0.008	0.024	0.02	0.218	0.33	2.0	3.79	7.4	3010.0
12:20	15:35	House well	0.012	0.018	<0.03	0.599	0.61	1.6	3.66	1.0	61.3

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.
§ N.S. is No Sample.

Nutrients, Sediment, and Bacteria by Date Spring, Upstream, and Downstream Sites

Table 3. Water quality analyses at the spring and in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application for the 3rd Quarter of 2015.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
1/8/2015									
Spring	0.010	0.014	<0.03 ¶	0.376	0.56	2.0	3.80	14.8	686.7
Upstream	0.009	0.022	<0.03	0.187	0.21	2.3	1.41	30.9	547.5
Downstream	0.011	0.024	<0.03	0.376	0.39	2.5	1.22	42.6	980.4
1/14/2015									
Spring	0.010	0.028	<0.03	0.473	0.66	1.1	10.20	21.6	613.1
Upstream	0.012	0.032	<0.03	0.135	0.19	1.1	3.02	88.2	727.0
Downstream	0.011	0.020	<0.03	0.388	0.34	1.0	2.03	25.6	613.1
1/21/2015									
Spring	0.009	0.020	<0.03	0.552	0.69	1.5	2.29	9.8	461.1
Upstream	0.008	0.018	<0.03	0.089	0.12	1.1	0.95	70.3	579.4
Downstream	0.010	0.026	0.06	0.197	0.30	1.1	1.60	37.4	613.1

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
1/29/2015									
Spring	0.010	0.018	0.03	0.886	0.74	2.3	4.27	1.0	2850.0
Upstream	0.006	0.060	<0.03	0.065	0.21	47.8	1.71	727.0	1413.6
Downstream	0.009	0.020	0.04	0.168	0.27	1.3	1.50	19.9	1046.2
2/3/2015									
Spring	0.008	0.018	<0.03	0.191	0.77	3.8	7.64	1.0	461.1
Upstream	0.006	0.022	<0.03	0.051	0.28	1.1	2.69	4.1	1203.3
Downstream	0.009	0.018	<0.03	0.140	0.29	4.1	2.66	1.0	547.5
2/10/2015									
Spring	0.010	0.010	<0.03	0.544	0.64	1.9	0.76	2.0	686.7
Upstream	0.009	0.012	<0.03	0.056	0.09	0.7	1.04	1119.1	2419.2
Downstream	0.011	0.012	<0.03	0.143	0.23	1.0	1.15	7.4	1553.1
2/26/2015									
Spring	0.009	0.042	0.02	0.237	0.38	5.0	3.97	37.3	2419.2
Upstream	0.006	0.024	<0.03	0.100	0.13	0.6	1.20	47.9	686.7
Downstream	0.008	0.026	0.02	0.200	0.25	0.8	1.17	48.7	866.4

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/3/2015									
Spring	0.008	0.052	<0.03	0.124	0.35	N.D.†	4.90	N.S. §	N.S.
Upstream	0.006	0.026	0.02	0.048	0.11	N.D.	1.50	N.S.	N.S.
Downstream	0.007	0.028	<0.03	0.138	0.23	N.D.	1.50	N.S.	N.S.
3/11/2015									
Spring	0.009	0.030	<0.03	0.242	2.37	5.5	14.79	19.5	111.9
Upstream	0.005	0.026	0.02	0.118	0.16	2.1	3.38	34.5	579.4
Downstream	0.007	0.030	0.02	0.209	0.27	1.8	1.44	66.3	770.1
3/19/2015									
Spring	0.010	0.028	0.03	0.184	0.29	10.6	7.37	38.9	79.4
Upstream	0.007	0.024	0.04	0.111	0.20	1.7	2.53	42.6	866.4
Downstream	0.009	0.028	0.04	0.234	0.35	2.8	2.87	71.7	1119.9
3/25/2015									
Spring	0.006	0.014	0.02	0.197	0.39	1.6	1.45	23.1	275.5
Upstream	0.006	0.028	0.02	0.056	0.16	2.9	1.36	125.9	2419.2
Downstream	0.008	0.036	0.04	0.162	0.29	5.0	1.41	547.5	3410.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/26/2015									
Spring	0.013	0.064	0.06	0.090	0.30	11.4	3.71	547.5	5200.0
Upstream	0.013	0.076	0.06	0.144	0.41	14.1	3.94	816.4	4960.0
Downstream	0.004	0.026	0.02	0.904	1.00	15.4	0.69	<1.0	1553.1
4/2/2015									
Spring	0.008	0.042	0.04	0.173	0.35	3.5	10.47	248.1	1299.7
Upstream	0.007	0.040	0.02	0.045	0.14	3.1	3.61	166.9	2419.2
Downstream	0.007	0.042	0.02	0.139	0.22	2.5	2.71	121.1	1986.3
4/9/2015									
Spring	0.011	0.034	0.01	0.257	0.42	4.9	9.11	7380.0	9040.0
Upstream	0.011	0.042	0.04	0.066	0.18	13.1	2.13	86.0	2650.0
Downstream	0.010	0.048	0.03	0.157	0.25	19.7	1.82	47.2	1986.3
4/15/2015									
Spring	0.007	0.034	<0.03	0.210	0.39	7.7	4.70	275.5	2280.0
Upstream	0.007	0.040	0.03	0.090	0.16	3.5	3.24	648.8	4040.0
Downstream	0.009	0.048	0.03	0.166	0.26	4.4	2.67	344.8	2920.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
4/23/2015									
Spring	0.008	0.034	<0.03	0.264	0.36	7.4	3.64	71.7	648.8
Upstream	0.007	0.032	0.03	0.083	0.18	4.0	5.11	104.6	2419.2
Downstream	0.007	0.032	0.03	0.162	0.25	2.6	2.51	65.7	2419.2
4/29/2015									
Spring	0.010	0.028	<0.03	0.419	0.59	9.0	4.28	25.6	1732.9
Upstream	0.010	0.020	0.03	0.082	0.13	2.7	1.58	58.3	1732.4
Downstream	0.012	0.018	0.03	0.189	0.82	2.1	1.64	58.6	1986.3
5/7/2015									
Spring	0.011	0.036	0.02	0.499	0.58	9.9	44.04	135.4	980.4
Upstream	0.008	0.032	0.01	0.110	0.16	7.5	10.16	77.6	3280.0
Downstream	0.009	0.034	<0.03	0.267	0.36	4.5	7.70	27.8	2280.0
5/8/2015									
Spring	0.134	0.354	0.16	0.340	1.12	51.4	9.30	N.S.	N.S.
Upstream	0.195	0.544	0.27	0.292	1.20	113.2	7.47	N.S.	N.S.
Downstream	0.005	0.254	0.41	2.287	3.23	127.1	6.45	N.S.	N.S.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/11/2015									
Spring	0.008	0.058	0.01	0.339	0.49	8.7	3.67	N.S.	N.S.
Upstream	0.004	0.074	0.04	0.004	0.24	4.5	4.31	N.S.	N.S.
Downstream	0.031	0.530	0.11	0.071	1.12	277.5	8.48	N.S.	N.S.
5/14/2015									
Spring	0.009	0.062	0.02	0.222	0.35	41.5	2.84	121.1	2419.2
Upstream	0.011	0.046	0.02	0.177	0.23	2.8	1.35	145.5	2470.0
Downstream	0.015	0.050	0.02	0.326	0.39	6.1	1.16	128.1	4370.0
5/18/2015									
Spring	0.005	0.084	0.05	0.209	0.56	114.2	2.79	98.7	1413.6
Upstream	0.007	0.034	0.02	0.110	0.15	5.2	1.29	137.6	2419.2
Downstream	0.009	0.040	0.03	0.201	0.25	6.1	1.47	185.0	6770.0
5/26/2015									
Spring	0.021	0.020	<0.03	0.205	0.29	1.2	2.66	N.S.	N.S.
Upstream	0.012	0.044	0.04	0.080	0.19	6.4	1.50	N.S.	N.S.
Downstream	0.045	0.200	0.11	0.096	0.56	94.7	4.57	N.S.	N.S.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
6/1/2015									
Downstream	0.006	0.050	0.05	0.109	0.25	13.7	1.80	N.S.	N.S.
6/4/2015									
Spring	0.010	0.028	<0.03	0.239	0.3	6.2	9.54	44.3	1413.8
Upstream	0.008	0.026	0.03	0.083	0.11	2.3	2.93	38.6	>2419.2
Downstream	0.009	0.034	<0.03	0.184	0.23	1.7	2.64	24.7	2419.2
6/8/2015									
Spring	0.011	0.046	0.03	0.322	0.53	12.7	11.18	20.1	1986.3
Upstream	0.010	0.030	0.06	0.058	0.24	4.5	3.63	866.4	2780.0
Downstream	0.009	0.022	0.05	0.185	0.27	0.9	2.66	57.4	4640.0
6/17/2015									
Spring	0.009	0.046	0.07	0.224	0.47	9.4	8.92	517.2	24890.0
Upstream farm	0.009	0.036	0.03	0.050	0.16	3.5	2.83	435.2	13130.0
Downstream	0.007	0.034	0.03	0.106	0.23	2.3	2.92	344.8	20980.0
6/22/2015									
Spring	0.009	0.032	0.03	0.218	0.26	5.3	3.01	61.3	1413.6

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.010	0.030	0.01	0.042	0.05	2.9	0.99	78.0	4960.0
Downstream	0.009	0.032	0.04	0.136	0.16	2.9	1.15	36.8	5040.0
6/29/2015									
Spring	0.013	0.018	0.03	0.235	0.30	1.7	5.26	93.3	2419.2
Upstream	0.010	0.028	0.14	0.055	0.13	2.7	2.49	117.8	4710
Downstream	0.068	0.748	0.17	0.147	1.88	571	6.57	N.S.	N.S.
7/6/2015									
Downstream	0.275	0.380	0.22	0.204	1.03	19.1	7.91	N.S.	N.S.
7/9/2015									
Spring	0.011	0.048	0.09	0.144	0.41	4.3	6.47	77.1	3050.0
Upstream	0.013	0.048	0.02	0.087	0.18	6.8	2.75	201.4	10140.0
Downstream	0.014	0.050	0.03	0.117	0.24	8.8	2.32	275.5	10760.0
7/16/2015									
Spring	0.010	0.024	0.01	0.303	0.41	5.7	5.54	22.8	1413.6
Downstream	0.011	0.030	<0.03	0.195	0.33	0.5	1.35	11.8	6310.0
7/23/2015									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Spring	0.010	0.026	<0.03	0.436	0.60	2.7	1.12	61.3	1046.2
Upstream	0.009	0.026	0.02	0.096	0.18	1.3	0.97	93.3	7490.0
Downstream	0.011	0.028	0.02	0.198	0.31	0.8	1.06	16.8	4870.0
7/30/2015									
Spring	0.011	0.026	0.03	0.479	0.65	6.3	4.73	6.3	920.8
Upstream	0.014	0.024	<0.03	0.101	0.15	0.9	1.61	27.2	2880.0
Downstream	0.012	0.022	0.02	0.268	0.38	1.9	2.16	11.9	6500.0
8/6/2015									
Spring	0.008	0.240	0.07	0.265	0.97	0.0	7.10	23.1	48840.0
Upstream	0.009	0.028	<0.03	0.147	0.24	1.8	3.37	488.4	13540.0
Downstream	0.010	0.028	0.03	0.406	0.52	1.7	3.06	40.2	10390.0
8/13/2015									
Spring	0.009	0.360	0.15	0.735	1.12	254.9	7.29	21.6	3360.0
Upstream	0.013	0.018	0.04	0.124	0.16	0.3	4.32	13.4	2460.0
Downstream	0.011	0.024	<0.03	0.384	0.50	4.0	3.74	24.0	3310.0
8/20/2015									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Spring	0.009	0.276	0.07	0.337	0.89	223.6	17.88	148.3	3270.0
Downstream	0.015	0.022	0.03	0.491	0.53	2.2	5.94	39.3	66.3
8/27/2015									
Spring	0.007	0.158	0.04	0.329	0.69	103.7	9.07	27.2	7540.0
Upstream	0.005	0.028	0.04	0.084	0.28	2.9	4.30	104.6	7710.0
Downstream	0.013	0.024	<0.03	0.450	0.54	2.5	4.43	137.4	5730.0

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

§ N.S. is No Sample.

† N.D. is No Data.

Nutrients, Sediment, and Bacteria by Site for Ephemeral Stream, House Well, Trenches, Left Fork and Field Runoff

Table 4. Water quality analyses at the ephemeral stream draining the subwatershed containing the production houses and manure holding ponds, the well adjacent to the ponds, and surface runoff from Fields 1, 5a, and 12 for the 3rd Quarter of 2015.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
Ephemeral stream									
1/8/2015	0.008	0.022	<0.03 ¶	0.448	0.59	2.4	1.73	25.6	1203.3
1/15/2015	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6
1/21/2015	0.005	0.016	<0.03	0.370	0.46	1.0	2.34	155.3	2419.2
2/26/2015	0.006	0.022	<0.03	0.530	0.57	1.3	1.38	16.1	4790.0
3/3/2015	0.006	0.020	<0.03	0.477	0.52	ND	1.84	N.S. §	N.S.
3/11//2015	0.006	0.022	0.04	0.567	0.60	0.5	2.20	6.3	410.0
3/19/2015	0.007	0.018	0.01	0.529	0.63	1.0	4.31	14.6	866.4
3/25/2015	0.007	0.014	0.02	0.462	0.53	1.1	0.64	8.6	344.8
4/2/2015	0.006	0.032	0.02	0.467	0.46	1.8	4.41	5.2	547.5
4/15/2015	0.005	0.026	0.03	0.472	0.56	0.8	1.26	305.0	2430.0
4/23/2015	0.008	0.026	0.03	0.520	0.56	2.0	1.78	12.0	3270.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
4/29/2015	0.012	0.018	0.02	0.569	0.61	3.5	1.98	14.3	4080.0
5/7/2015	0.013	0.066	0.02	0.628	0.71	3.2	16.41	71.7	7170.0
5/8/2015	0.005	0.254	0.41	2.287	3.23	127.1	6.45	5200.0	241920
5/11/2015	0.008	0.146	0.15	0.941	1.80	22.0	8.09	N.S.	N.S.
5/14/2015	0.010	0.022	0.01	0.527	0.50	1.7	0.73	41.3	1986.3
5/18/2015	0.007	0.028	0.03	0.525	0.55	0.7	1.18	90.7	7630.0
5/26/2015	0.017	0.030	0.03	0.514	0.60	0.9	1.12	N.S.	N.S.
6/1/2015	0.002	0.056	0.01	0.851	1.05	18.3	2.46	N.S.	N.S.
6/4/2015	0.010	0.024	0.02	0.572	0.58	0.8	5.35	21.6	3890.0
6/8/2015	0.009	0.020	0.03	0.560	0.62	0.6	2.81	65.7	9870.0
6/17/2015	0.009	0.032	0.04	0.948	1.04	6.7	0.97	770.1	8840.0
6/22/2015	0.011	0.026	0.05	0.563	0.61	1.3	1.21	37.9	2419.2
6/29/2015	0.067	1.268	0.34	0.580	3.42	1366.8	11.04	N.S.	N.S.
7/6/2015	0.063	0.658	0.37	0.717	2.75	567.3	8.52	N.S	N.S.
7/9/2015	0.010	0.034	<0.03	0.569	0.71	4.9	2.56	78.9	5560.0
7/16/2015	0.011	0.046	0.01	0.517	0.61	0.4	2.16	45.7	14830.0
7/23/2015	0.011	0.034	<0.03	0.511	0.68	11.3	0.33	201.4	24950.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
House well									
3/19/2015	0.009	0.020	0.02	0.467	0.55	1.2	4.93	1.0	31.3
3/25/2015	0.007	0.016	<0.03	0.450	0.52	1.9	0.03	18.5	30.1
4/2/2015	0.008	0.030	<0.03	0.477	0.50	0.7	6.05	39.3	9060.0
4/9/2015	0.011	0.026	<0.03	0.499	0.50	1.5	0.74	4.1	325.5
4/15/2015	0.008	0.022	0.02	0.475	0.60	1.2	3.72	9.6	80.9
4/23/2015	0.008	0.082	<0.03	0.496	0.53	1.4	1.69	18.5	35.0
4/29/2015	0.010	0.006	<0.03	0.517	0.51	0.7	2.26	248.1	5040.0
5/7/2015	0.008	0.022	0.01	0.512	0.49	<6.58	28.63	3.1	59.4
5/11/2015	0.009	0.038	0.02	0.541	0.55	4.2	0.89	N.S.	N.S.
5/18/2015	0.008	0.018	<0.03	0.529	0.53	0.9	0.90	5.2	13.4
5/26/2015	0.013	0.020	<0.03	0.514	0.54	2.7	0.87	N.S.	N.S.
6/4/2015	0.012	0.022	0.02	0.561	0.52	1.3	6.07	<1.0	14.6
6/8/2015	0.008	0.018	0.27	0.475	0.82	0.7	6.67	<1.0	<1.0
6/17/2015	0.010	0.028	0.03	0.466	0.52	0.06	3.08	488.4	15390.0
6/22/2015	0.010	0.032	0.02	0.459	0.43	0.4	1.85	27.2	1732.9

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
7/9/2015	0.011	0.024	0.01	0.423	0.48	2.0	1.69	9.8	4160.0
7/16/2015	0.012	0.024	0.01	0.471	0.47	0.0	4.00	2.0	727.0
7/23/2015	0.015	0.030	<0.03	0.442	0.52	1.0	0.89	8.5	35.0
7/30/2015	0.013	0.014	0.02	0.466	0.51	0.3	0.90	1.0	7.4
8/6/2015	0.010	0.018	0.04	0.482	0.52	0.5	3.33	920.8	21870.0
8/13/2015	0.025	0.012	0.03	0.498	0.58	0.5	6.15	4.1	228.2
8/20/2015	0.012	0.018	<0.03	0.545	0.56	0.9	6.63	1.0	29.5
8/27/2015	0.012	0.018	<0.03	0.599	0.61	1.6	3.66	1.0	61.3
Interceptor Trench 1 (South)									
1/8/2015	0.005	0.022	<0.03	0.769	0.75	4.7	0.88	1.0	13130.0
1/14/2015	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6
2/26/2015	0.004	0.028	0.01	0.712	0.76	46.0	0.60	1.0	41063.0
3/3/2015	0.003	0.024	<0.03	0.867	0.89	N.D. †	0.95	N.S.	N.S.
3/11/2015	0.003	0.014	0.07	0.989	0.97	0.3	2.00	<1.0	2419.2
3/19/2015	0.003	0.012	0.01	0.849	0.93	<6.58	3.11	1.0	275.5
3/25/2015	0.003	0.008	<0.03	0.838	0.88	0.2	0.59	<1.0	410.6

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/26/2015	0.004	0.026	0.02	0.904	1.00	15.4	0.69	<1.0	1553.1
4/2/2015	0.003	0.028	0.02	0.865	0.87	0.3	3.34	1.1	308.6
4/9/2015	0.006	0.018	<0.03	0.790	0.83	0.8	2.99	<1.0	187.2
4/15/2015	0.003	0.020	<0.03	0.857	0.93	1.3	4.29	<1.0	3180.0
4/23/2015	0.003	0.034	<0.03	0.877	0.97	1.2	1.18	3.1	2690.0
5/11/2015	0.003	0.060	0.02	0.916	0.97	27.6	1.78	N.S.	N.S.
5/14/2015	0.005	0.042	0.02	0.904	0.94	29.9	1.20	81.6	1732.9
5/18/2015	0.002	0.020	<0.03	0.897	0.93	0.3	1.28	32.3	1732.9
5/26/2015	0.007	0.012	0.01	0.752	0.80	1.0	0.78	N.S.	N.S.
6/22/2015	0.005	0.048	0.07	0.653	0.76	47.3	1.86	21.1	1986.3
6/29/2015	0.008	0.022	0.05	0.394	0.42	56.8	4.17	82.3	11450
7/9/2015	0.007	0.030	<0.03	0.520	0.62	7.1	2.52	63.7	12330.0
Interceptor Trench 2 (North)									
3/11/2015	0.003	0.056	0.04	1.443	1.59	1.2	3.51	<1.0	2419.2
3/19/2015	0.004	0.062	0.09	1.036	1.42	1.9	5.12	5.2	2419.2

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/26/2015	0.004	0.126	0.13	0.873	1.44	22.2	4.63	105.4	6950.0
5/11/2015	0.003	0.042	0.05	0.553	0.76	8.8	3.44	N.S.	N.S.
5/14/2015	0.005	0.042	0.02	0.904	0.94	29.9	1.20	81.6	1732.9
5/18/2015	0.002	0.020	<0.03	0.897	0.93	0.3	1.28	32.3	1732.9
5/26/2015	0.007	0.112	0.04	1.190	1.44	131.9	1.23	N.S.	N.S.
Left Fork									
5/14/2015	0.015	0.038	0.02	0.321	0.38	3.3	1.36	83.3	2690.0
5/18/2015	0.011	0.040	0.04	0.209	0.29	4.1	1.90	167.4	8300.0
5/26/2015	0.014	0.048	0.04	0.139	0.29	6.1	2.41	N.S.	N.S.
6/4/2015	0.008	0.022	<0.03	0.145	0.19	2.1	3.15	38.9	2560.0
6/8/2015	0.006	0.024	0.02	0.102	0.23	1.1	2.78	32.7	4550.0
6/17/2015	0.005	0.026	0.04	0.112	0.22	2.8	1.62	26.2	8550.0
6/22/2015	0.011	0.030	0.02	0.147	0.18	2.5	1.59	35.4	5910.0
6/29/2015	0.010	0.026	0.02	0.189	0.26	2.9	2.80	53.6	10170
7/9/2015	0.015	0.058	0.04	0.138	0.31	11.4	2.67	387.3	12670.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
7/16/2015	0.010	0.042	0.01	0.181	0.28	0.9	1.64	21.6	9330.0
7/23/2015	0.009	0.028	0.04	0.239	0.40	1.4	1.21	35.4	8360.0
7/30/2015	0.008	0.020	0.04	0.221	0.37	2.3	2.60	30.3	8160.0
8/6/2015	0.007	0.026	0.04	0.310	0.47	1.2	3.16	217.8	8130.0
8/13/2015	0.007	0.016	0.03	0.192	0.52	1.4	4.50	13.2	4810.0
8/20/2015	0.009	0.028	0.04	0.306	0.42	2.3	5.12	48.8	3930.0
8/27/2015	0.008	0.024	0.02	0.218	0.33	2.0	3.79	7.4	3010.0
Field 1									
3/26/2015	0.143	0.346	0.41	0.216	2.68	65.5	15.65	N.S.	N.S.
5/8/2015	0.525	0.714	0.16	0.475	2.19	16.9	13.28	N.S.	N.S.
5/11/2015	0.251	0.386	0.09	0.055	0.86	44.4	6.31	N.S.	N.S.
5/18/2015	0.208	0.512	0.54	0.410	3.59	53.7	26.12	N.S.	N.S.
5/26/2015	0.245	0.432	0.20	0.174	1.66	37.8	11.28	N.S.	N.S.
6/29/2015	0.354	0.524	0.37	0.226	1.64	11	11.32	N.S.	N.S.
7/6/2015	0.387	0.444	0.23	0.345	1.30	4.9	8.32	N.S.	N.S.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Field 5a									
3/26/2015	0.813	1.330	0.39	0.225	2.59	72.3	15.95	N.S.	N.S.
5/8/2015	0.248	0.968	0.26	0.127	1.50	320.1	8.58	N.S.	N.S.
7/6/2015	0.796	0.910	0.13	0.567	1.58	29.0	7.67	N.S.	N.S.
Field 12									
5/8/2015	0.675	0.956	0.14	0.303	1.82	57.0	16.00	N.S.	N.S.
5/11/2015	0.194	0.364	0.09	0.135	0.83	36.7	7.03	N.S.	N.S.
7/6/2015	0.094	0.448	0.13	0.172	1.01	261.3	4.38	N.S.	N.S.

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.

§ N.S. is No Sample. E. coli and total coliform were not measured on surface runoff samples collected by ISCO samplers when sample holding time exceeded the required 8-hour threshold.

† N.D. is No Data

Water pH, Alkalinity, Chloride, Electrical Conductivity, and Total Dissolved Solids for Several Big Creek Sites

At the beginning of 2015, the pH, alkalinity, chloride concentration, electrical conductivity and total dissolved solids were determined on water samples collected at the upstream and downstream sites, spring, house well, and trenches, to build a data base that will enable to eventually source track the major water source pathways at these sites. These values are given below in Table 5.

Table 5. The pH, Chloride concentration, electrical conducting, and total solids concentration of water samples collected at upstream, downstream, spring, house well and trench sites, initiated at the beginning of 2015.

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
		mg/L	mg/L	µS/cm	mg/L
Upstream					
1/8/2015	7.3	36	1.80	90	71.6
1/14/2015			2.09	105	49.1
1/21/2015	7.6	48	1.85	121	71.1
1/29/2015			2.09	140	71.3
2/3/2015	7.7	54	2.40	129	71.1
2/10/2015			2.51	132	67.6
2/26/2015	7.6	40	1.98	107	56.4
3/3/2015			2.08	112	58.9
3/11/2015	7.8	30	1.88	85	269.3
3/19/2015			1.55	98	58.0
3/25/2015	8.0	42	1.77	110	67.6
3/26/2015			1.33	115	64.4
4/2/2015	8.0	42	1.57	110	76.0
4/9/2015			1.73	116	74.9
4/15/2015	7.7	36	1.38	91	63.8
4/23/2015			1.65	95	60.4
4/29/2015	8.1	50	1.56	85	54.3

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
5/7/2015			1.40	123	70.7
5/8/2015			1.80	157	88.4
5/11/2015	7.5	24	1.63	131	110.0
5/14/2015			1.55	143	79.3
5/18/2015			1.20	107	56.2
5/26/2015	7.7	28	1.10	90	58.4
6/4/2015			1.08	78	55.3
6/8/2015	8.2	60	2.03	149	111.3
6/17/2015			1.51	128	70.2
6/22/2015	8.2	40	1.36	114	64.9
6/29/2015			1.74	55	49.8
7/9/2015	7.7	32	1.53	90	64.7
7/16/2015			1.33	161	78.9
7/23/2015	7.9	78	1.63	180	50.2
7/30/2015			1.75	224	113.3
8/6/2015	7.7	100	1.84	218	75.3
8/13/2015			1.91	210	121.6
8/20/2015	7.3	108	2.15	219	120.0
8/27/2015			2.11	240	131.3
Median	**7.8**	**42**	**1.74**	**115**	**70.5**
Downstream					
1/8/2015	7.6	64	2.02	144	89.3
1/14/2015			2.76	166	79.8
1/21/2015	7.6	84	2.44	191	91.1
1/29/2015			2.51	205	109.1
2/3/2015	7.7	88	2.82	196	103.3

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
2/10/2015			3.01	204	105.5
2/26/2015	7.8	66	2.27	162	88.0
3/3/2015			2.39	170	80.0
3/11/2015	7.8	52	2.02	128	77.3
3/19/2015			1.75	148	84.9
3/25/2015	7.8	64	2.07	158	88.7
3/26/2015			1.46	83	78.7
4/2/2015	8.1	68	1.95	163	103.0
4/9/2015			2.08	168	100.4
4/15/2015	7.8	56	1.54	130	82.0
4/23/2015			1.81	142	81.0
4/29/2015	8.0	80	2.15	150	97.3
5/4/2015					
5/7/2015			1.84	185	101.1
5/8/2015			2.50	225	125.8
5/11/2015	7.5	36	1.73	149	130.9
5/14/2015			1.06	103	80.2
5/18/2015			1.55	150	58.7
5/26/2015	7.7	46	1.25	137	89.1
6/1/2015			1.20	125	93.3
6/8/2015	8.0	94	1.44	163	86.9
6/17/2015			2.14	216	141.3
6/22/2015	7.9	76	1.76	204	106.5
7/7/2015			1.55	177	79.3
7/9/2015	7.7	50	1.63	116	77.6
7/16/2015			1.50	124	72.2
7/23/2015	7.8	108	1.84	223	111.8

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
7/30/2015			2.18	248	122.0
8/6/2015	7.6	154	2.31	286	142.9
8/13/2015			2.78	283	159.1
8/20/2015	7.2	142	2.83	287	156.0
8/27/2015			3.01	300	153.3
Median	**7.8**	**68**	**2.02**	**166**	**93.3**
Spring					
1/8/2015			2.27	534	321.1
1/14/2015			2.79	517	310
1/21/2015			2.27	553	324
2/3/2015			2.20	562	321.8
2/10/2015			2.44	581	314.2
2/26/2015			1.74	491	266.4
3/3/2015			1.57	430	234.9
3/11/2015			1.63	495	54.7
3/19/2015			1.54	474	220.0
3/25/2015			2.08	544	277.6
4/2/2015			1.78	515	289.8
4/9/2015			2.03	509	305.8
4/15/2015			1.76	480	276.9
4/23/2015			1.93	512	297.3
4/29/2015			2.55	564	294.9
5/4/2015			1.57	554	251.8
5/7/2015			2.29	623	318.9
5/11/2015			1.11	408	202.0
5/14/2015			1.35	507	259.6

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
5/18/2015			1.17	508	265.8
5/26/2015			1.08	516	250.4
6/8/2015			1.95	615	341.8
6/17/2015			1.65	532	276.0
6/22/2015			1.79	601	301.1
7/9/2015			1.43	542	266.9
7/16/2015			2.02	629	309.3
7/23/2015			2.17	656	312.0
7/30/2015			2.26	648	334.9
8/6/2015			0.92	606	330.7
8/13/2015			2.71	522	328.0
8/20/2015			2.09	554	330.9
8/27/2015			2.01	575	318.2
Median			**1.86**	**518**	**269.4**
House well					
3/19/2015			4.79	458	232.2
3/25/2015			5.27	453	221.6
4/2/2015			4.91	453	256.0
4/9/2015			5.10	419	242.2
4/15/2015			5.02	426	240.9
4/23/2015			4.83	414	237.3
4/29/2015			4.96	436	226.4
5/7/2015			5.08	458	243.6
5/14/2015			5.10	452	238.2
5/18/2015			5.19	484	234.7
5/26/2015			4.82	481	178.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
6/4/2015			5.02	488	249.6
6/8/2015			7.09	437	246.4
6/17/2015			5.13	493	234.0
6/22/2015			5.17	481	240.2
7/9/2015			5.86	481	240.7
7/16/2015			5.38	495	254.9
7/23/2015			5.42	481	234.0
7/30/2015			5.85	499	251.8
8/6/2015			5.74	449	233.8
8/13/2015			4.89	448	240.0
8/20/2015			4.65	427	234.0
8/27/2015			4.81	441	245.1
Median			**5.10**	**453**	**240.0**
Trench 1					
1/8/2015			2.01	154	103.6
1/14/2015			2.81	166	81.8
2/26/2015			2.08	171	78.4
3/3/2015			2.11	177	86.7
3/11/2015			1.95	193	114.0
3/19/2015			1.70	209	109.3
3/25/2015			2.13	238	105.1
3/26/2015			1.64	209	120.2
4/2/2015			1.94	261	151.3
4/9/2015			1.99	260	154.0
4/15/2015			1.80	260	146.7
4/23/2015			2.06	231	132.7

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
5/11/2015			2.09	262	126.5
5/14/2015			1.86	299	156.5
5/18/2015			1.57	346	173.1
5/26/2015			1.65	297	146.0
6/22/2015			1.99	341	169.8
6/29/2015			2.63	342	167.8
7/9/2015			2.08	171	78.4
Median			**1.97**	**260**	**139.3**
Trench 2					
3/11/2015			1.77	159	140.8
3/19/2015			1.04	168	104.9
3/26/2015			0.78	135	160.9
5/11/2015			0.41	165	88.5
5/26/2015			0.93	284	141.3
Median			**0.93**	**165**	**140.8**

Nutrient and Bacteria Concentration in Big Creek over the Monitoring Period

Upstream and Downstream Trends

The difference in dissolved P, total P, nitrate-N, total N, E. coli, and total coliform between down- and upstream monitoring sites are presented in Figures 6, 7, and 8, respectively. No consistent differences in the trends in concentrations at the downstream site on Big Creek compared with the upstream site appear evident over the current monitoring period, except for nitrate-N, which tends to be higher downstream. For nitrate-N, concentrations in Big Creek below the C&H Farm are generally greater than above it (Figure 7).

Several metrics of nutrient and bacteria concentrations were determined for measured concentrations in Big Creek since inception of the monitoring. These include the mean, standard error

of the mean, median, minimum, maximum and standard deviation of measured constituents for 2013, 2014, and 2015. Metrics for concentrations at the upstream site are given in Table 6 and for the downstream site in Table 7.

Upstream of C&H, median E. coli increased slightly for each period (71, 97, and 93 MPN/100 mL for 2013, 2014, and 2015, respectively), while median nitrate-N (0.245, 0.114, and 0.087 mg/L for 2013, 2014, and 2015, respectively) and total N (0.33, 0.19, 0.17, for 2013, 2014, and 2015, respectively; Table 6) decreased over the same period of record. Downstream of C&H, median concentrations of dissolved and total P remained fairly constant from year to year, although the maximum total P value increased (e.g., 0.316, 0.450, and 0.544 total P mg/L; Table 7). Median nitrate-N concentrations decreased slightly from 2013 through 2015, and were 0.419, 0.256, and 0.189 mg/L, respectively, as did E. coli, which decreased from 87, 70, to 47 MPN/100mL, respectively (Table 7).

Few clear trends in measured concentrations are apparent at this time, reflecting fluctuating watershed hydrology, as well as a difference in rainfall amounts and distribution over the monitoring period.

Table 6. Mean, standard error of mean, median, minimum, maximum, and standard deviation of chemical constituents measured upstream of the C&H Farm pre-January 1, 2014 (before slurry applications started) and post-January 1, 2014 (after slurry applications started) through September 1, 2015.

UPSTREAM						
	Mean	St error of mean	Median	Minimum	Maximum	Standard Deviation
PRE 12/31/2013 – NUMBER OF SAMPLES IS 14						
Dissolved P, mg/L	0.014	0.002	0.013	0.007	0.032	0.006
Total P, mg/L	0.038	0.009	0.031	0.010	0.140	0.033
Ammonia-N, mg/L	0.034	0.003	0.030	0.020	0.060	0.012
Nitrate-N, mg/L	0.328	0.063	0.245	0.123	1.024	0.235
Total N, mg/L	0.536	0.143	0.330	0.140	2.200	0.536
Total suspended solids, mg/L	3.0	1.3	1.1	0.3	17.9	4.7
Log. E. coli §	1.913	0.212	1.852	0.799	3.611	0.795
Log. Total Coliform §	3.308	0.131	3.339	2.476	4.455	0.489
E. coli, MPN/100mL ¶	82		71	6	4,080	
Total Coliform, MPN/100mL ¶	2,034		2,183	299	28,510	
1/1/2014 to 12/31/2014 – NUMBER OF SAMPLES IS 57						
Dissolved P, mg/L	0.013	0.002	0.010	0.001	0.081	0.015
Total P, mg/L	0.057	0.017	0.028	0.010	0.888	0.129
Ammonia-N, mg/L	0.039	0.003	0.030	0.010	0.100	0.022
Nitrate-N, mg/L	0.130	0.011	0.114	0.004	0.555	0.084

UPSTREAM						
	Mean	St error of mean	Median	Minimum	Maximum	Standard Deviation
Total N, mg/L	0.232	0.021	0.190	0.090	0.860	0.161
Total suspended solids, mg/L	11.4	7.8	1.9	0.3	447.1	59.0
Log. E. coli §	2.089	0.101	1.989	0.491	4.455	
Log. Total Coliform §	3.415	0.090	3.384	2.322	5.239	
E. coli, MPN/100mL ¶	123		97	3	28,510	
Total Coliform, MPN/100mL ¶	2,997		2,419	210	173,290	
1/1/2015 to 9/1/2015 – NUMBER OF SAMPLES IS 35						
Dissolved P, mg/L	0.012	0.004	0.009	0.004	0.134	0.021
Total P, mg/L	0.125	0.084	0.030	0.012	2.956	0.496
Ammonia-N, mg/L	0.032	0.004	0.030	0.000	0.160	0.026
Nitrate-N, mg/L	0.095	0.010	0.087	0.004	0.340	0.057
Total N, mg/L	0.276	0.076	0.170	0.050	2.640	0.451
Total suspended solids, mg/L	6.0	1.9	2.9	0.3	51.4	11.3
Log. E. coli §	2.063	0.101	1.970	0.613	3.303	0.598
Log. Total Coliform §	3.379	0.092	3.384	1.716	4.714	0.546
E. coli, MPN/100mL ¶	116		99	4	2,010	
Total Coliform, MPN/100mL ¶	2,396		2,440	52	51,720	

§ E. coli and Total Coliform values were Log transformed.

¶ Mean, median, minimum, and maximum values for Log. transformed E. coli and Total Coliform are back transformed to natural numbers for ease of reference.

Table 7. Mean, standard error of mean, median, minimum, maximum, and standard deviation of chemical constituents measured downstream of the C&H Farm pre-January 1, 2014 (before slurry applications started) and post-January, 2014 (after slurry applications started) through September 1, 2015.

DOWNSTREAM						
	Mean	St error of mean	Median	Minimum	Maximum	Standard Deviation
PRE 12/31/2013 – NUMBER OF SAMPLES IS 14						
Dissolved P, mg/L	0.016	0.005	0.011	0.006	0.067	0.017
Total P, mg/L	0.054	0.022	0.024	0.010	0.316	0.083
Ammonia-N, mg/L	0.049	0.014	0.030	0.010	0.200	0.051
Nitrate-N, mg/L	0.415	0.047	0.419	0.172	0.723	0.177
Total N, mg/L	0.541	0.062	0.555	0.240	1.070	0.233
Total suspended solids, mg/L	11.3	7.2	1.5	0.0	101.1	27.0
Log. E. coli §	2.046	0.248	1.937	0.716	3.544	0.927
Log. Total Coliform §	3.627	0.149	3.384	2.465	4.639	0.557
E. coli, MPN/100mL ¶	111		87	5	3,500	
Total Coliform, MPN/100mL ¶	4,241		2,419	292	43,520	
1/1/2014 to 12/31/2014– NUMBER OF SAMPLES IS 55						
Dissolved P, mg/L	0.013	0.002	0.011	0.004	0.110	0.014
Total P, mg/L	0.037	0.008	0.026	0.008	0.450	0.058
Ammonia-N, mg/L	0.038	0.004	0.030	0.010	0.230	0.032
Nitrate-N, mg/L	0.271	0.016	0.256	0.108	0.523	0.117
Total N, mg/L	0.357	0.022	0.330	0.110	1.030	0.160

DOWNSTREAM						
	Mean	St error of mean	Median	Minimum	Maximum	Standard Deviation
Total suspended solids, mg/L	6.3	3.1	2.1	0.0	171.2	22.9
Log. E. coli §	1.950	0.100	1.843	0.301	4.397	0.745
Log. Total Coliform §	3.546	0.075	3.622	2.435	4.464	0.558
E. coli, MPN/100mL ¶	89		70	2	24,950	
Total Coliform, MPN/100mL ¶	3,513		4,115	272	29,090	
1/1/2015 to 9/1/2015 – NUMBER OF SAMPLES IS 37						
Dissolved P, mg/L	0.024	0.009	0.010	0.006	0.275	0.053
Total P, mg/L	0.073	0.021	0.030	0.010	0.544	0.129
Ammonia-N, mg/L	0.045	0.009	0.030	0.000	0.270	0.054
Nitrate-N, mg/L	0.221	0.018	0.189	0.071	0.491	0.108
Total N, mg/L	0.391	0.043	0.295	0.090	1.200	0.259
Total suspended solids, mg/L	17.1	8.2	2.5	0.5	277.5	49.8
Log. E. coli §	1.719	0.097	1.674	0.000	2.912	0.593
Log. Total Coliform §	3.378	0.081	3.384	1.822	4.322	0.495
E. coli, MPN/100mL ¶	52		47	1	816	
Total Coliform, MPN/100mL ¶	2,387		2,419	66	20,980	

§ E. coli and Total Coliform values were Log transformed.

¶ Mean, median, minimum, and maximum values for Log. transformed E. coli and Total Coliform are back transformed to natural numbers for ease of reference.

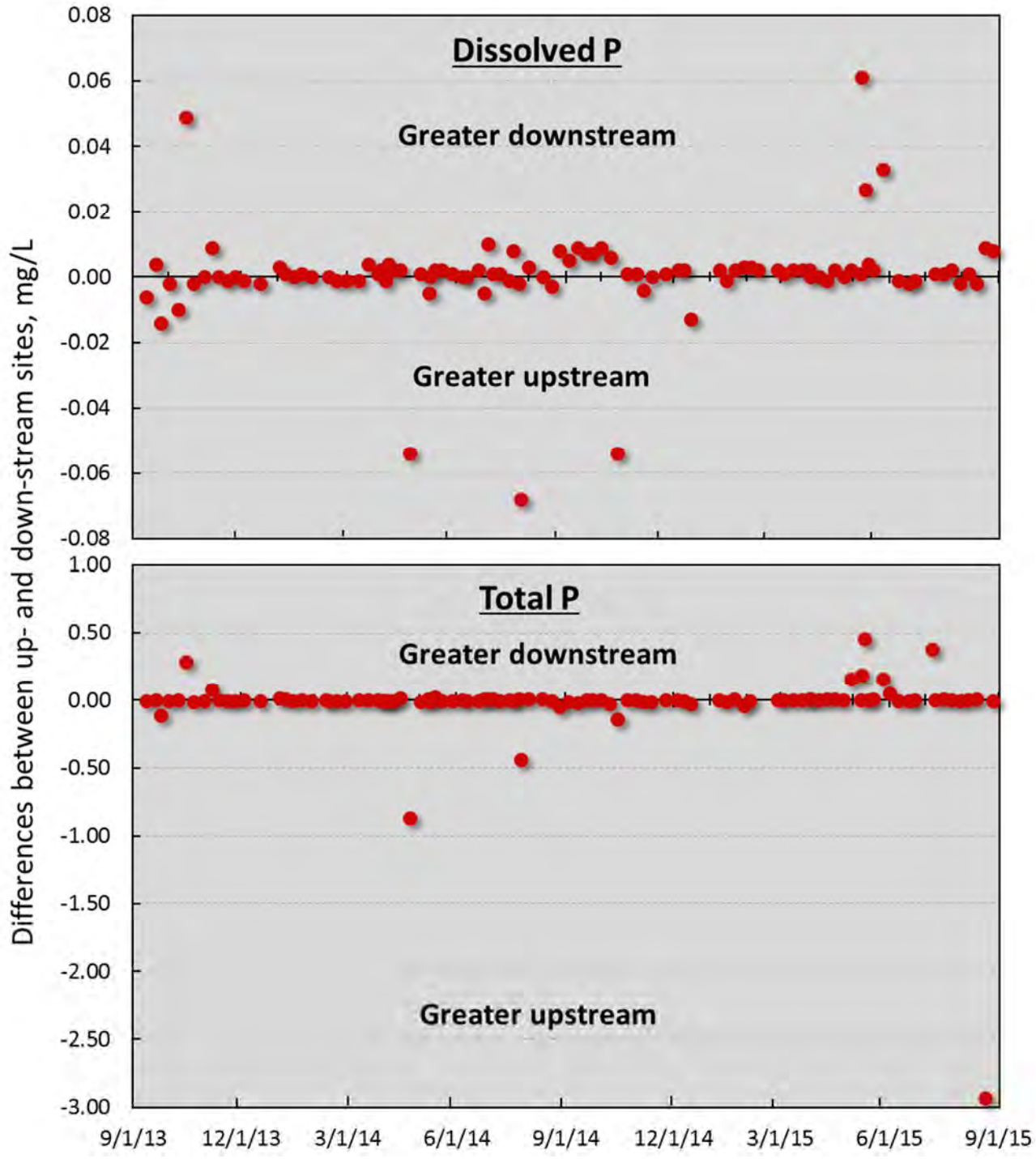

Figure 6. Differences in phosphorus concentrations between upstream and downstream sites on Big Creek.

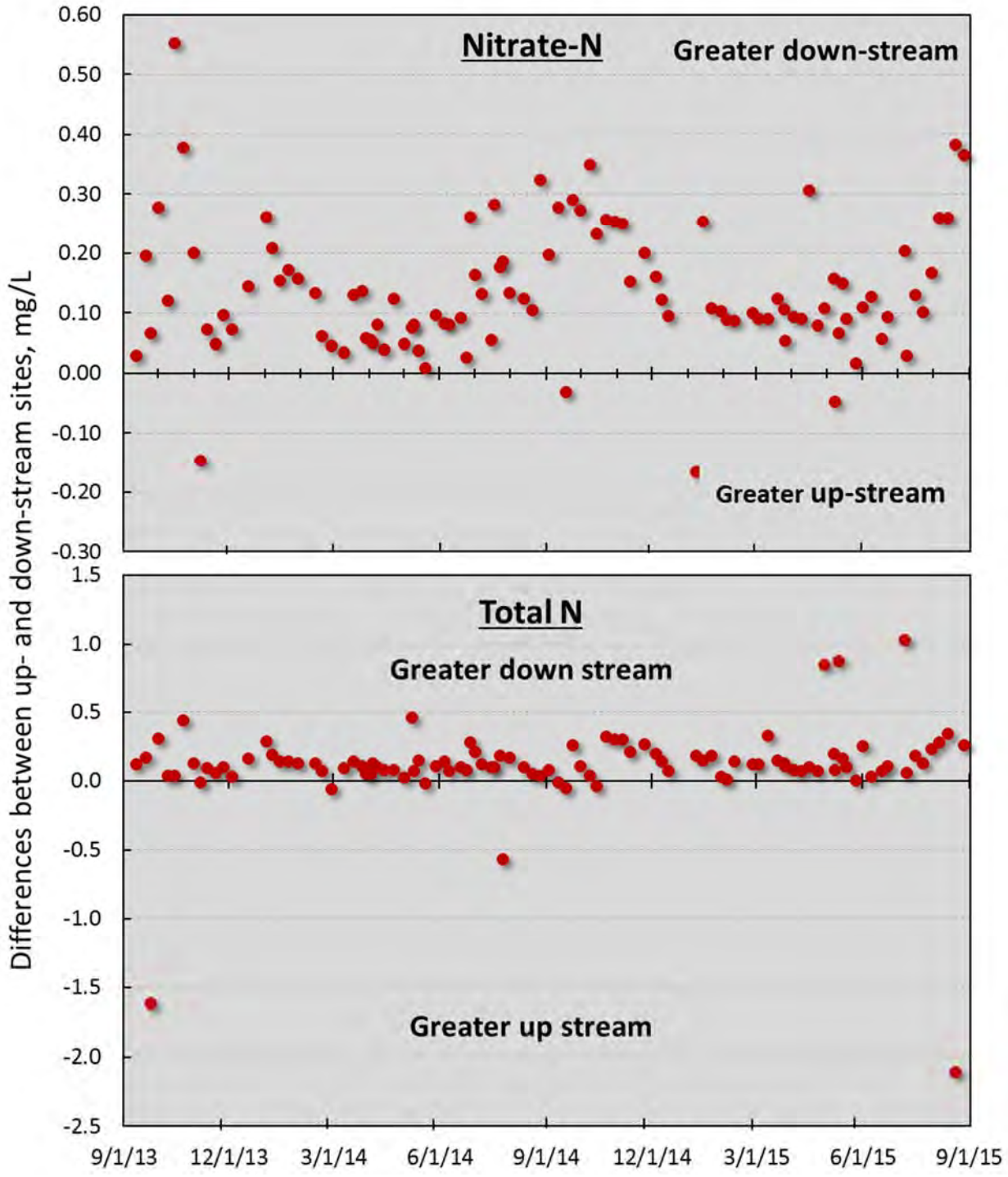

Figure 7. Differences in nitrogen concentrations between upstream and downstream sites on Big Creek.

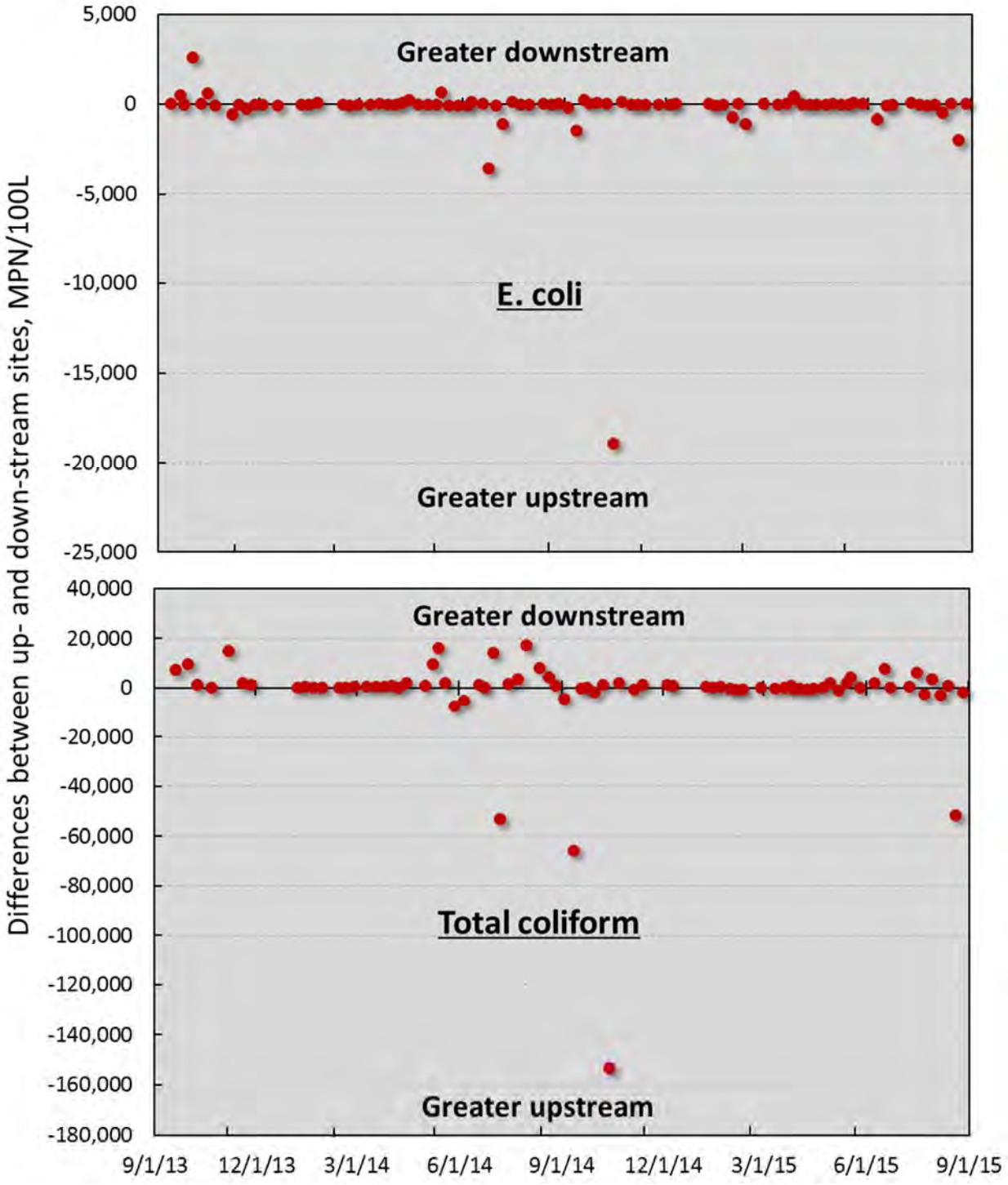

Figure 8. Differences in bacteria concentrations between up and downstream sites on Big Creek.

Temporal Trends in Nitrate-N Concentration in Big Creek

A strong seasonal fluctuation in nitrate-N concentration is apparent at the up and downstream sites on Big Creek, since we initiated monitoring on September 13, 2013 (Figure 9). Nitrate –N concentrations peak in late summer, around August to October and are at their lowest in April and May at both up and downstream sites.

These fluctuations are consistent with other watersheds of similar size and land use, and likely reflect the dominant pathways of water contributing to flow in Big Creek. In April and June (late spring), flows in Big Creek tend to be dominated by surface flows as a result of spring rains. However, in August through October, flows in Big Creek tend to be dominated more by base or groundwater flows, which generally have a higher concentration of nitrate-N than in surface runoff.

Further, the fact that the late summer nitrate-N peak was more clearly defined in 2014 than 2015, reflects the drier summer of 2014 than 2015. In May, June, July, and August 2014 there was 536 mm rainfall, while during the same months in 2015 there was 650 mm rainfall, as a consequence, the baseflow signature would have been stronger in the drier 2014 than the wetter 2015 (Figure 9).

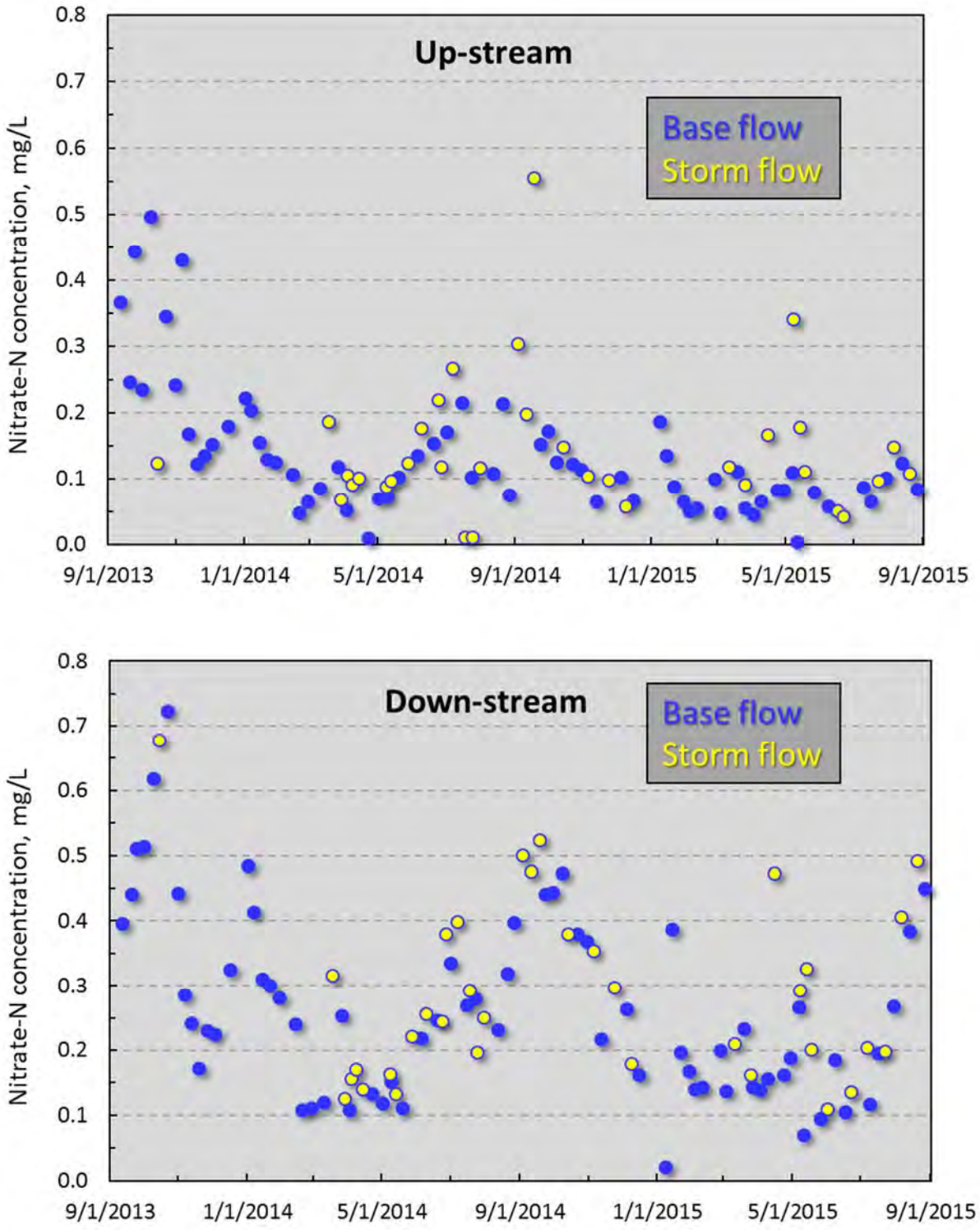

Figure 9. Temporal variation in nitrate-N concentrations upstream and downstream of the C&H Farm, Newton County, over a two-year period of monitoring (Sept. 2013 to Sept. 2015).

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Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – October 1 to December 31, 2015

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

The mission of the **Division of Agriculture** is to advance the stewardship of natural resources and the environment, cultivate the improvement of agriculture and agribusiness, develop leadership skills and productive citizenship among youth and adults, enhance economic security and financial responsibility among the citizens of the state, ensure a safe, nutritious food supply, improve the quality of life in communities across Arkansas, and strengthen Arkansas families.

Dr. Mark J. Cochran
Vice President for Agriculture

Executive Summary

This is the fourth Quarterly Report of 2015 for the Big Creek Research and Extension Team that details progress made from October 1 through December 31, 2015.

1. We continue to collect weekly baseflow and periodic storm flow water samples from Big Creek above and below the C&H Farm, along with water from a spring, ephemeral stream, surface runoff sites on Fields 1, 5a, and 12, two interceptor trenches below the slurry holding ponds, and reconfigured house well for chemical and bacterial analysis.

2. The sample collection point for the house well adjacent to the animal house facilities and slurry holding ponds was reconfigured to exclude any potential sources of sample contamination. It was determined that the risk of contamination was a result of factors such as well-head pump and in-house maintenance, In addition to installing a new well-water sampling site, USGS water quality sampling guidelines were used, which involved collection of a well sample when in-situ field measurement of well water temperature, pH, and electrical conductivity had stabilized. Well water analyses from samples collected after the new sampling port and sampling protocol were in operation are summarized below.

	Dissolved P	Total P	Nitrate-N	Total N	E. coli	Total coliform	Conductivity
	---------- mg/L ----------				--- MPN/100L ---		µS/cm
9/30/2015	0.009	0.016	0.499	0.60	<1.0	2.0	446
10/8/2015	0.008	0.020	0.518	0.53	<1.0	<1	455
10/14/2015	0.012	0.020	0.490	0.63	<1.0	<1	461
10/22/2015	0.010	0.014	0.478	0.50	<1.0	2.0	453
10/28/2015	0.008	0.016	0.391	0.54	<1.0	<1	456
11/4/2015	0.010	0.016	0.468	0.54	<1.0	<1	455
11/12/2015	0.009	0.012	0.501	0.55	<1.0	<1	458
11/18/2015	0.009	0.014	0.464	0.59	<1.0	<1	458
12/2/2015	0.011	0.014	0.480	0.60	1.0	1.0	422

Big Creek Research Team

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Brian Breaker, M.Sc., Hydrologic Technician, stream flow and constituent collection, analysis, and statistical evaluation of trends.

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Rick Cartwright, Ph.D., Professor – Associate Director of Extension for Agriculture and Natural Resources

Mark Cochran, Ph.D., – Vice President, University of Arkansas System Division of Agriculture.

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Ed Gbur, Ph.D., Professor and Director, Agricultural Statistics Laboratory - Experimental design, linear and generalized linear mixed models, regression, agricultural applications of statistics.

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Phil Hays, Ph.D. Ground Water Specialist, U.S. Geological Survey and Research Professor with Geosciences Dept., University of Arkansas, application of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems

Tim Kresse, M.Sc., Water Quality Specialist, U.S. Geological Survey, natural geochemical evolution of groundwater and separating these processes from anthropogenic sources of contamination

Nathan McKinney, Ph.D., – Assistant Director, Agriculture Experiment Station

Morteza Mozaffari, Ph.D. – Director, Univ. of Arkansas Soil Testing and Research Laboratory, Marianna.

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Thad Scott, Ph.D., Associate Professor - Water quality, transport of contaminants to and within water bodies

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Jun Zhu, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians - The Big Creek Research and Extension Team are ably supported by several excellent Program Technicians based in Little Rock and Fayetteville.

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Water Sampling and Analytical Methods

Sampling Locations

Water quality monitoring sites are;

Site 1. Edge-of-field monitoring on Field 1 permitted to receive slurry.

Site 2. Edge-of-field monitoring on Field 5a excluded from receiving slurry.

Site 3. Edge-of-field monitoring on Field 12 permitted to receive slurry.

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities.

Site 5. Spring below Field 1.

Site 6. Big Creek upstream of the C&H Farm operation.

Site 7. Big Creak downstream of the C&H Farm operation.

Site 8. Left Fork downstream of the C&H Farm operation.

Site 9. Manure holding pond north trench. The site was visited weekly and trench water sampled when flowing.

Site 10. Manure holding pond south trench.

Site 11. Well at animal facility.

Sampling Protocols and Analyses

The following protocols were used to collect, prepare, and analyze all water samples:

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface, where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted, and samples placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
6. Analyses included Alkalinity (APHA 2320-B), Ammonia (EPA 351.2), Chloride (EPA 300.0), Dissolved Phosphorus (EPA 365.2), E. coli (APHA 9223-B), Electrical Conductivity (EPA 120.1), Nitrate (EPA 300.0), pH (EPA 150.1), Total Coliforms (APHA 9223-B), Total Dissolved Solids (EPA 160.1), Total Nitrogen (APHA 4500-P J), Total Phosphorus (APHA 4500-P J), and Total Suspended Solids (EPA 160.2). APHA is American Public Health Association from the Wadeable Streams Assessment, Water Chemistry Laboratory Manual http://www.epa.gov/owow/monitoring/wsa/WRS_lab_manual.pdf
7. Following installation of the new well sampling port adjacent to the animal facilities and slurry holding ponds, the following well-water sampling protocol was adopted, where each time a sample of well water is collected, the well will be initially purged and water temperature, pH, and electrical conductivity measured on-site every 30 seconds until all values stabilize (primarily water

temperature). At that point a sample of water is collected in a 1-L acid-washed bottle. This method is taken from USGS and EPA well-water sampling protocols. See USGS methods for sampling at https://water.usgs.gov/owq/FieldManual/chapter4/pdf/Chap4_v2.pdf. Specific and detailed guidance on the collected of water quality data can be found in the USGS National Field Manual at file:///U:/Words/C&H%20Farm/Publications/Planning/USGS%20National%20Field%20Mannual_complete%202015.pdf

Similarly, the U.S. EPA recommend that selected water quality parameters such as temperature, pH, conductivity, and dissolved oxygen can be monitored during low-rate purging, with stabilization of these parameters indicating when the discharge water represents aquifer water or source well water. See: http://www.csus.edu/indiv/h/hornert/Geol_210_Summer_2012/Week%202%20readings/Puls%20and%20Barcelona%201996%20Low%20flow%20sampling.pdf and https://in-situ.com/wp-content/uploads/2015/01/Low-Flow-Groundwater-Sampling-Techniques-Improve-Sample-Quality-and-Reduce-Monitoring-Program-Costs-Case-Study.pdf

8. The minimum detection limits (MDLs) for each chemical and biological constituent measured are listed in Table 1.
9. Chemical and biological analyses of samples collected from the beginning of 2015 to early December, 2015 are presented in Tables 2, 3, and 4.

Table 1. Minimum detection limits (MDLs) for each chemical and biological constituent measured.

Constituent	Minimum detection limit [1]
Alkalinity, mg/L as $CaCO_3$	2
Chloride, mg/L	0.093
Dissolved P, mg/L	0.002
Conductivity, uS/cm	1
Ammonia-N, mg/L	0.03
Dissolved organic carbon, mg/L	0.18
E. coli, MPN/100 mL	1
Nitrate-N, mg/L	0.004
pH	0.1
Total coliform, MPN/100 mL	1
Total dissolved solids, mg/L	15.22
Total N, mg/L	0.006
Total P, mg/L	0.012
Total suspended solids, mg/L	6.58

[1] MDL the Minimum Detection Limit of an analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. Further information is available at http://water.usgs.gov/owq/OFR_99-193/detection.html

USGS Stations

Big Creek Continuous Flow

We are collaborating with USGS at Big Creek near Mt. Judea (USGS 705579; downstream of the C&H Farm operation) and at Left Fork Big Creek near Vendor (USGS 07055792), to collect base and storm water flows for N, P, and bacteria analysis. The USGS Big Creek site is instrumented with continuous flow gaging equipment and a nitrate sensor, which provides real-time flow, water temperature, nitrate-N, and precipitation data. These data are available on line at the USGS website below. Gage height, water temperature, precipitation, and continuous nitrate concentrations for the USGS downstream site for the last quarter are shown in Figures 1, 2, 3, and 4.

USGS 07055790 Big Creek near Mt. Judea, AR

http://nwis.waterdata.usgs.gov/ar/nwis/uv/?site_no=07055790&agency_cd=USGS

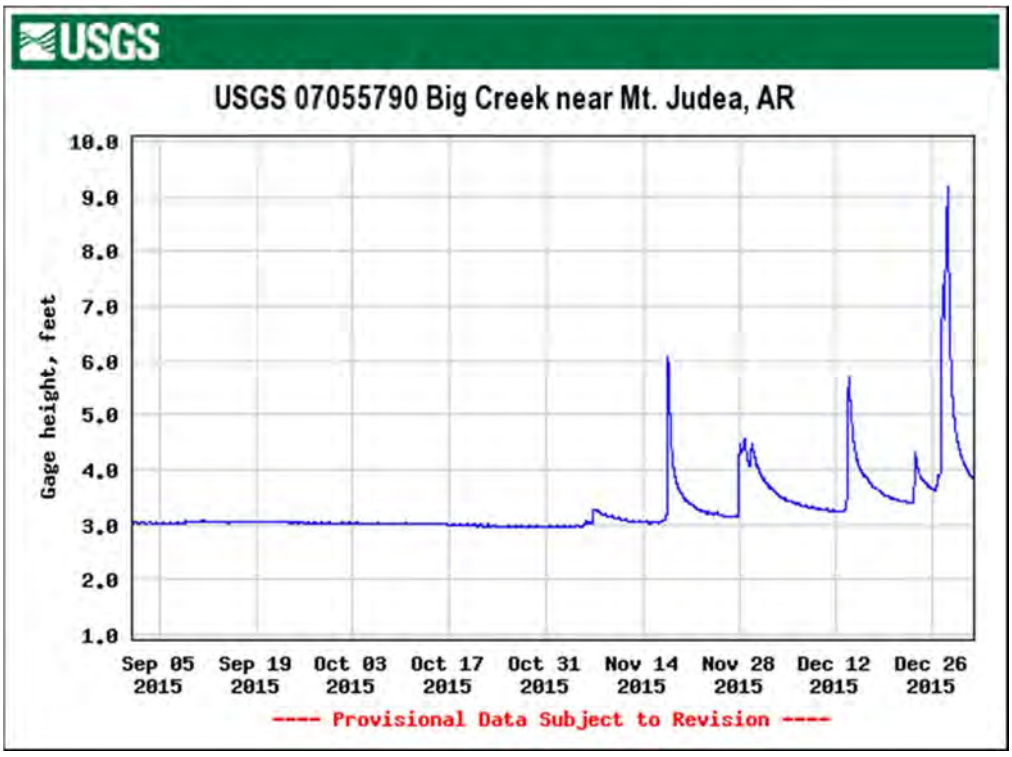

Figure 1. Gage height at the Big Creek monitoring site downstream of the C&H Farm during the 4th quarter of 2015.

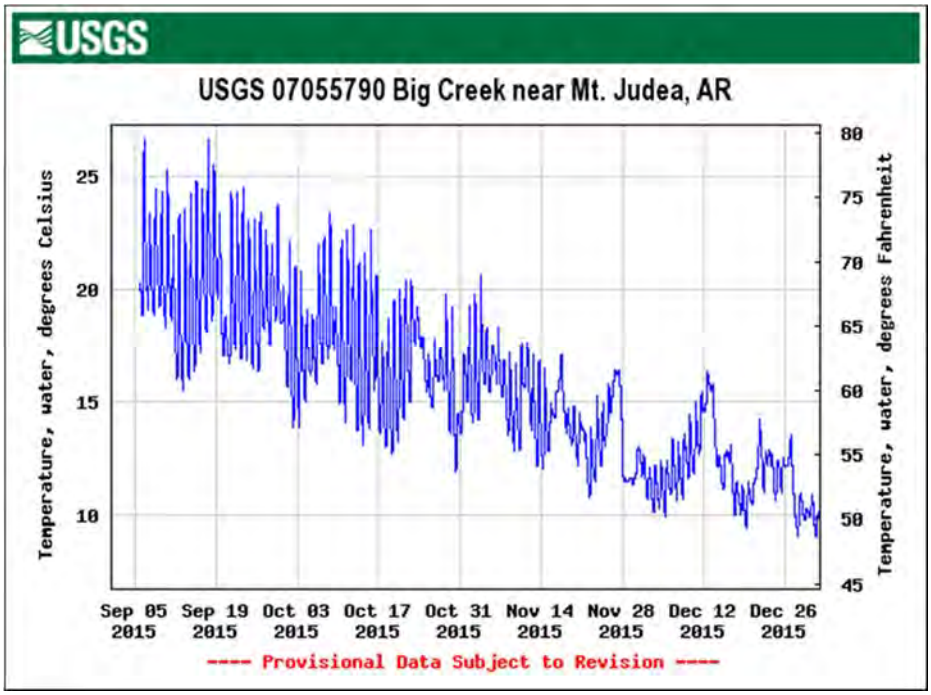

Figure 2. Water temperature at the Big Creek monitoring site downstream of the C&H Farm during the 4th quarter of 2015.

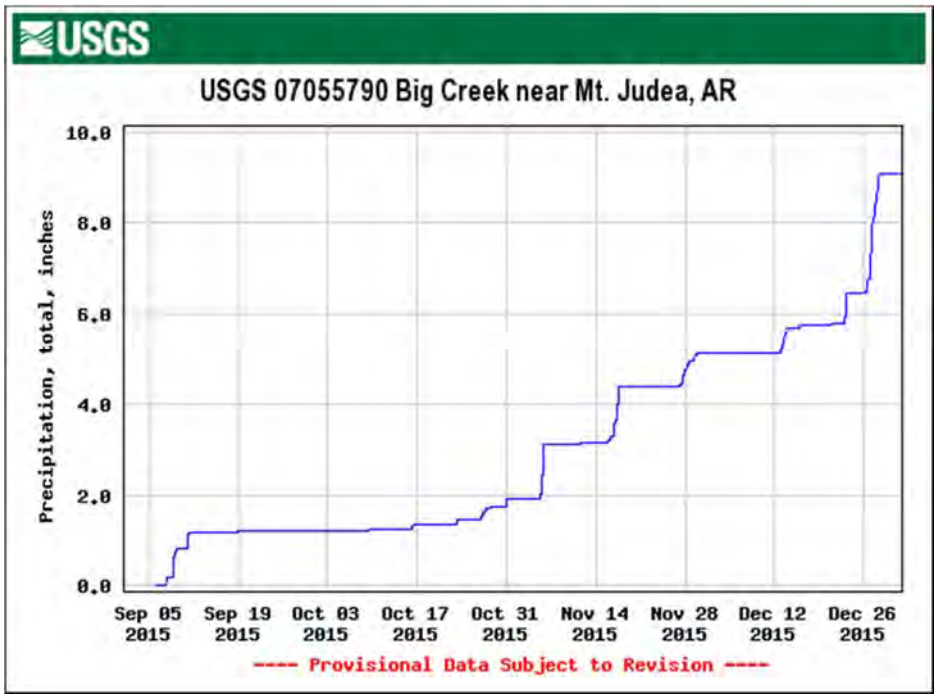

Figure 3. Precipitation at the Big Creek monitoring site downstream of the C&H Farm during the 4th quarter of 2015.

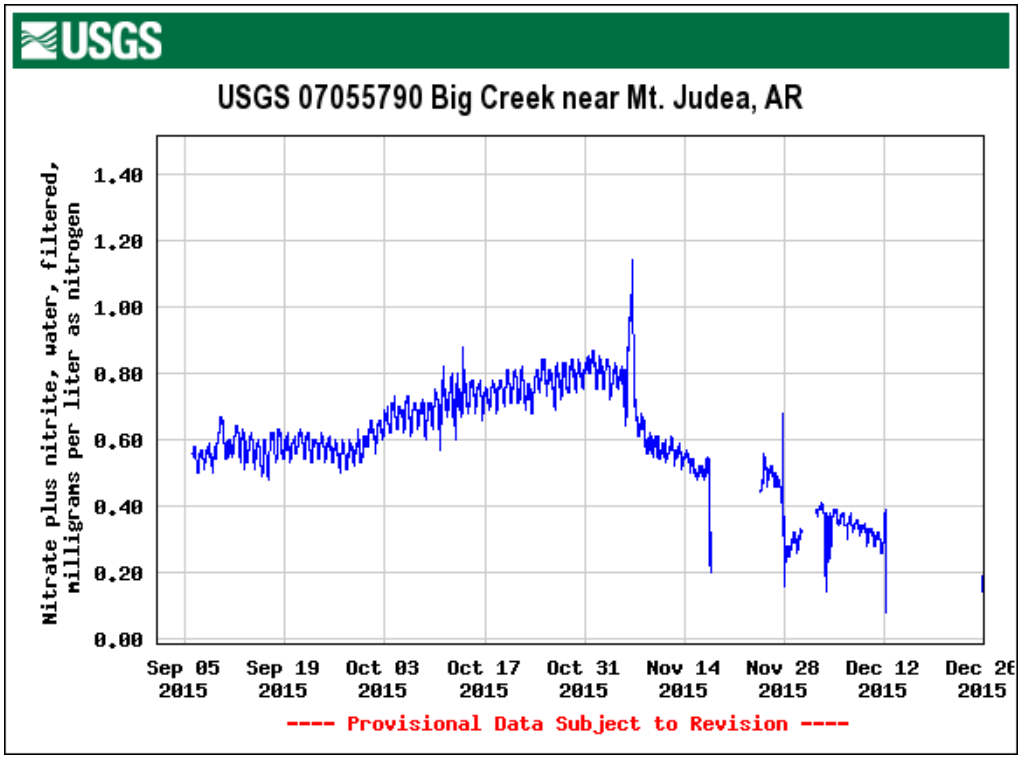

Figure 4. Nitrate concentration at the Big Creek monitoring site downstream of the C&H Farm during the 4th quarter of 2015.

Big Creek Research and Extension Team Monitoring Data

Nutrients, Sediment, and Bacteria by Date of Sampling

Table 2. Water quality analyses at each sample site for 2015, with those collected since the last report noted. Coliform units are Most Probable Number (MPN) per 100 mL of water.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
			---------- mg/L ----------							-- MPN/100 mL --	
1/8/2015	**1/8/2015**	**Base flow**									
11:05	15:05	Spring	0.010	0.014	<0.03 ¶	0.376	0.56	2.0	3.80	14.8	686.7
11:25	15:05	Upstream farm	0.009	0.022	<0.03	0.187	0.21	2.3	1.41	30.9	547.5
10:53	15:05	Downstream farm	0.011	0.024	<0.03	0.376	0.39	2.5	1.22	42.6	980.4
11:40	15:05	Ephemeral stream	0.008	0.022	<0.03	0.448	0.59	2.4	1.73	25.6	1203.3
12:00	15:05	Trench 1	0.005	0.022	<0.03	0.769	0.75	4.7	0.88	1.0	13130.0
1/14/2015	**1/14/2015**	**Base flow**									
11:30	15:20	Spring	0.010	0.028	<0.03	0.473	0.66	1.1	10.20	21.6	613.1
11:45	15:20	Upstream farm	0.012	0.032	<0.03	0.135	0.19	1.1	3.02	88.2	727.0
11:15	15:20	Downstream farm	0.011	0.020	<0.03	0.388	0.34	1.0	2.03	25.6	613.1
12:00	15:20	Ephemeral stream	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
1/21/2015	**1/21/2015**	**Base flow**									
11:15	15:28	Spring	0.009	0.020	<0.03	0.552	0.69	1.5	2.29	9.8	461.1
11:52	15:28	Upstream farm	0.008	0.018	<0.03	0.089	0.12	1.1	0.95	70.3	579.4
11:05	15:28	Downstream farm	0.010	0.026	0.06	0.197	0.30	1.1	1.60	37.4	613.1
11:25	15:28	Ephemeral stream	0.005	0.016	<0.03	0.370	0.46	1.0	2.34	155.3	2419.2
1/29/2015	**1/29/2015**	**Base flow**									
10:40	15:28	Spring	0.010	0.018	0.03	0.886	0.74	2.3	4.27	1.0	2850.0
11:45	15:28	Upstream farm	0.006	0.060	<0.03	0.065	0.21	47.8	1.71	727.0	1413.6
1:20	15:28	Downstream farm	0.009	0.020	0.04	0.168	0.27	1.3	1.50	19.9	1046.2
2/3/2015	**2/3/2015**	**Base flow**									
11:05	15:40	Spring	0.008	0.018	<0.03	0.691	0.77	3.8	7.64	1.0	461.1
11:40	15:40	Upstream farm	0.006	0.022	<0.03	0.051	0.28	1.1	2.69	4.1	1203.3
10:50	15:40	Downstream farm	0.009	0.018	<0.03	0.140	0.29	4.1	2.66	1.0	547.5
2/10/2015	**2/10/2015**	**Base flow**									
10:38	15:08	Spring	0.010	0.010	<0.03	0.544	0.64	1.9	0.76	2.0	686.7
11:05	15:08	Upstream farm	0.009	0.012	<0.03	0.056	0.09	0.7	1.04	1119.1	2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:25	15:08	Downstream farm	0.011	0.012	<0.03	0.143	0.23	1.0	1.15	7.4	1553.1
2/26/2015	**2/26/2015**	**Base flow**									
10:45	15:30	Spring	0.009	0.042	0.02	0.237	0.38	5.0	3.97	37.3	2419.2
11:36	15:30	Upstream farm	0.006	0.024	<0.03	0.100	0.13	0.6	1.20	47.9	686.7
10:34	15:30	Downstream farm	0.008	0.026	0.02	0.200	0.25	0.8	1.17	48.7	866.4
10:55	15:30	Ephemeral stream	0.006	0.022	<0.03	0.530	0.57	1.3	1.38	16.1	4790.0
11:15	15:30	Trench 1	0.004	0.028	0.01	0.712	0.76	46.0	0.60	1.0	41063.0
3/3/2015	**3/3/2015**	**Base flow**									
11:07	15:33	Spring	0.008	0.052	<0.03	0.124	0.35	13.5	4.90	N.S. §	N.S.
11:50	15:33	Upstream farm	0.006	0.026	0.02	0.048	0.11	2.3	1.50	N.S.	N.S.
10:55	15:33	Downstream farm	0.007	0.028	<0.03	0.138	0.23	1.3	1.50	N.S.	N.S.
11:18	15:33	Ephemeral stream	0.006	0.020	<0.03	0.477	0.52	2.0	1.84	N.S.	N.S.
11:30	15:33	Trench 1	0.003	0.024	<0.03	0.867	0.89	14.9	0.95	N.S.	N.S.
3/11/2015	**3/11/2015**	**Storm Flow**									
11:30	14:58	Spring	0.009	0.030	<0.03	0.242	2.37	5.5	14.79	19.5	111.9

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:30	14:58	Upstream farm	0.005	0.026	0.02	0.118	0.16	2.1	3.38	34.5	579.4
11:20	14:58	Downstream farm	0.007	0.030	0.02	0.209	0.27	1.8	1.44	66.3	770.1
11:45	14:58	Ephemeral stream	0.006	0.022	0.04	0.567	0.60	0.5	2.20	6.3	410.0
12:10	14:58	Trench 1	0.003	0.014	0.07	0.989	0.97	0.3	2.00	<1.0	2419.2
12:15	14:58	Trench 2	0.003	0.056	0.04	1.443	1.59	1.2	3.51	<1.0	2419.2
3/19/2015	**3/19/2015**	**Base flow**									
10:59	15:10	Spring	0.010	0.028	0.03	0.184	0.29	10.6	7.37	38.9	79.4
12:00	15:10	Upstream farm	0.007	0.024	0.04	0.111	0.20	1.7	2.53	42.6	866.4
11:13	15:10	Downstream farm	0.009	0.028	0.04	0.234	0.35	2.8	2.87	71.7	1119.9
11:08	15:10	Ephemeral stream	0.007	0.018	0.01	0.529	0.63	1.0	4.31	14.6	866.4
11:13	15:10	House well	0.009	0.020	0.02	0.467	0.55	1.2	4.93	1.0	31.3
11:30	15:10	Trench 1	0.003	0.012	0.01	0.849	0.93	<6.58	3.11	1.0	275.5
11:35	15:10	Trench 2	0.004	0.062	0.09	1.036	1.42	1.9	5.12	5.2	2419.2
3/25/2015	**3/25/2015**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:45	15:20	Spring	0.006	0.014	0.02	0.197	0.39	1.6	1.45	23.1	275.5
13:30	15:20	Upstream farm	0.006	0.028	0.02	0.056	0.16	2.9	1.36	125.9	2419.2
11:30	15:20	Downstream farm	0.008	0.036	0.04	0.162	0.29	5.0	1.41	547.5	3410.0
12:00	15:20	Ephemeral stream	0.007	0.014	0.02	0.462	0.53	1.1	0.64	8.6	344.8
12:20	15:20	House well	0.007	0.016	<0.03	0.450	0.52	1.9	0.03	18.5	30.1
12:30	15:20	Trench 1	0.003	0.008	<0.03	0.838	0.88	0.2	0.59	<1.0	410.6
3/26/2015	**3/26/2015**	**Storm flow**									
13:10	15:25	Upstream farm	0.013	0.064	0.06	0.090	0.30	11.4	3.71	547.5	5200.0
13:35	15:25	Downstream farm	0.013	0.076	0.06	0.144	0.41	14.1	3.94	816.4	4960.0
12:55	15:25	Trench 1	0.004	0.026	0.02	0.904	1.00	15.4	0.69	<1.0	1553.1
12:50	15:25	Trench 2	0.004	0.126	0.13	0.873	1.44	22.2	4.63	105.4	6950.0
13:20	15:25	Field 1	0.143	0.346	0.41	0.216	2.68	65.5	15.65	N.S.	N.S.
12:30	15:25	Field 5a	0.813	1.330	0.39	0.225	2.59	72.3	15.95	N.S.	N.S.
4/2/2015	**4/2/2015**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:50	15:25	Spring	0.008	0.042	0.04	0.173	0.35	3.5	10.47	248.1	1299.7
12:15	15:25	Upstream farm	0.007	0.040	0.02	0.045	0.14	3.1	3.61	166.9	2419.2
1:30	15:25	Downstream farm	0.007	0.042	0.02	0.139	0.22	2.5	2.71	121.1	1986.3
12:30	15:25	Ephemeral stream	0.006	0.032	0.02	0.467	0.46	1.8	4.41	5.2	547.5
12:48	15:25	House well	0.008	0.030	<0.03	0.477	0.50	0.7	6.05	39.3	9060.0
12:54	15:25	Trench 1	0.003	0.028	0.02	0.865	0.87	0.3	3.34	1.1	308.6
4/9/2015	**4/9/2015**	**Base flow**									
11:45	15:30	Spring	0.011	0.034	0.01	0.257	0.42	4.9	9.11	7380.0	9040.0
12:30	15:30	Upstream farm	0.011	0.042	0.04	0.066	0.18	13.1	2.13	86.0	2650.0
12:50	15:30	Downstream farm	0.010	0.048	0.03	0.157	0.25	19.7	1.82	47.2	1986.3
12:00	15:30	House well	0.011	0.026	<0.03	0.499	0.50	1.5	0.74	4.1	325.5
12:10	15:30	Trench 1	0.006	0.018	<0.03	0.790	0.83	0.8	2.99	<1.0	187.2
4/15/2015	**4/15/2015**	**Storm Flow**									
11:38	14:55	Spring	0.007	0.034	<0.03	0.210	0.39	7.7	4.70	275.5	2280.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:23	14:55	Upstream farm	0.007	0.040	0.03	0.090	0.16	3.5	3.24	648.8	4040.0
12:40	14:55	Downstream farm	0.009	0.048	0.03	0.166	0.26	4.4	2.67	344.8	2920.0
11:48	14:55	Ephemeral stream	0.005	0.026	0.03	0.472	0.56	0.8	1.26	305.0	2430.0
11:58	14:55	House well	0.008	0.022	0.02	0.475	0.60	1.2	3.72	9.6	80.9
12:10	14:55	Trench 1	0.003	0.020	<0.03	0.857	0.93	1.3	4.29	<1.0	3180.0
4/23/2015	**4/23/2015**	**Base Flow**									
12:23	15:30	Spring	0.008	0.034	<0.03	0.264	0.36	7.4	3.64	71.7	648.8
13:00	15:30	Upstream farm	0.007	0.032	0.03	0.083	0.18	4.0	5.11	104.6	2419.2
12:15	15:30	Downstream farm	0.007	0.032	0.03	0.162	0.25	2.6	2.51	65.7	2419.2
11:55	15:30	Ephemeral stream	0.008	0.026	0.03	0.520	0.56	2.0	1.78	12.0	3270.0
11:35	15:30	House well	0.008	0.082	<0.03	0.496	0.53	1.4	1.69	18.5	35.0
11:48	15:30	Trench 1	0.003	0.034	<0.03	0.877	0.97	1.2	1.18	3.1	2690.0
4/29/2015	**4/29/2015**	**Base flow**									
11:25	14:05	Spring	0.010	0.028	<0.03	0.419	0.59	9.0	4.28	25.6	1732.9

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:53	14:05	Upstream farm	0.010	0.020	0.03	0.082	0.13	2.7	1.58	58.3	1732.4
12:13	14:05	Downstream farm	0.012	0.018	0.03	0.189	0.82	2.1	1.64	58.6	1986.3
11:30	14:05	Ephemeral stream	0.012	0.018	0.02	0.569	0.61	3.5	1.98	14.3	4080.0
11:35	14:05	House well	0.010	0.006	<0.03	0.517	0.51	0.7	2.26	248.1	5040.0
5/7/2015	**5/7/2015**	**Base flow**									
11:10	14:10	Spring	0.011	0.036	0.02	0.499	0.58	9.9	44.04	135.4	980.4
11:43	14:10	Upstream farm	0.008	0.032	0.01	0.110	0.16	7.5	10.16	77.6	3280.0
12:05	14:10	Downstream farm	0.009	0.034	<0.03	0.267	0.36	4.5	7.70	27.8	2280.0
11:18	14:10	Ephemeral stream	0.013	0.066	0.02	0.628	0.71	3.2	16.41	71.7	7170.0
11:23	14:10	House well	0.008	0.022	0.01	0.512	0.49	<6.58	28.63	3.1	59.4
5/8/2015	**5/8/2015**	**Storm flow**									
13:25	15:32	Upstream farm	0.134	0.354	0.16	0.340	1.12	51.4	9.30	N.S.	N.S.
13:25	15:32	Downstream farm	0.195	0.544	0.27	0.292	1.20	113.2	7.47	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:43	15:32	Ephemeral stream	0.005	0.254	0.41	2.287	3.23	127.1	6.45	N.S.	N.S.
13:00	15:32	Field 1	0.525	0.714	0.16	0.475	2.19	16.9	13.28	N.S.	N.S.
12:38	15:32	Field 12	0.675	0.956	0.14	0.303	1.82	57.0	16.00	N.S.	N.S.
5/11/2015	**5/12/2015**	**Storm Flow**									
11:35	8:30	Spring	0.008	0.058	0.01	0.339	0.49	8.7	3.67	N.S.	N.S.
11:28	8:30	Upstream farm	0.004	0.074	0.04	0.004	0.24	4.5	4.31	N.S.	N.S.
12:47	8:30	Downstream farm	0.031	0.530	0.11	0.071	1.12	277.5	8.48	N.S.	N.S.
12:05	8:30	Ephemeral stream	0.008	0.146	0.15	0.941	1.80	22.0	8.09	N.S.	N.S.
12:15	8:30	House well	0.009	0.038	0.02	0.541	0.55	4.2	0.89	N.S.	N.S.
12:25	8:30	Trench 1	0.003	0.060	0.02	0.916	0.97	27.6	1.78	N.S.	N.S.
12:35	8:30	Trench 2	0.003	0.042	0.05	0.553	0.76	8.8	3.44	N.S.	N.S.
11:25	8:30	Field 1	0.251	0.386	0.09	0.055	0.86	44.4	6.31	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:40	8:30	Field 5a	0.248	0.968	0.26	0.127	1.50	320.1	8.58	N.S.	N.S.
1:05	8:30	Field 12	0.194	0.364	0.09	0.135	0.83	36.7	7.03	N.S.	N.S.
5/14/2015	**5/14/2015**	**Base flow**									
12:35	15:12	Spring	0.009	0.062	0.02	0.222	0.35	41.5	2.84	121.1	2419.2
12:28	15:12	Upstream farm	0.011	0.046	0.02	0.177	0.23	2.8	1.35	145.5	2470.0
12:47	15:12	Downstream farm	0.015	0.050	0.02	0.326	0.39	6.1	1.16	128.1	4370.0
12:57	15:12	Left Fork	0.015	0.038	0.02	0.321	0.38	3.3	1.36	83.3	2690.0
12:15	15:12	Ephemeral stream	0.010	0.022	0.01	0.527	0.50	1.7	0.73	41.3	1986.3
12:05	15:12	Trench 1	0.005	0.042	0.02	0.904	0.94	29.9	1.20	81.6	1732.9
5/18/2015	**5/18/2015**	**Storm Flow**									
10:45	14:43	Spring	0.005	0.084	0.05	0.209	0.56	114.2	2.79	98.7	1413.6
11:57	14:43	Upstream farm	0.007	0.034	0.02	0.110	0.15	5.2	1.29	137.6	2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:17	14:43	Downstream farm	0.009	0.040	0.03	0.201	0.25	6.1	1.47	185.0	6770.0
12:29	14:43	Left Fork	0.011	0.040	0.04	0.209	0.29	4.1	1.90	167.4	8300.0
11:14	14:43	Ephemeral stream	0.007	0.028	0.03	0.525	0.55	0.7	1.18	90.7	7630.0
11:20	14:43	House well	0.008	0.018	<0.03	0.529	0.53	0.9	0.90	5.2	13.4
12:55	14:43	Trench 1	0.002	0.020	<0.03	0.897	0.93	0.3	1.28	32.3	1732.9
10:58	14:43	Field 1	0.208	0.512	0.54	0.410	3.59	53.7	26.12	N.S.	N.S.
5/26/2015	**5/26/2015**	**Base flow**									
11:49	15:48	Spring	0.021	0.020	<0.03	0.205	0.29	1.2	2.66	N.S.	N.S.
13:20	15:48	Upstream farm	0.012	0.044	0.04	0.080	0.19	6.4	1.50	N.S.	N.S.
13:32	15:48	Downstream farm	0.045	0.200	0.11	0.096	0.56	94.7	4.57	N.S.	N.S.
13:45	15:48	Left Fork	0.014	0.048	0.04	0.139	0.29	6.1	2.41	N.S.	N.S.
13:11	15:48	Ephemeral stream	0.017	0.030	0.03	0.514	0.60	0.9	1.12	N.S.	N.S.
12:43	15:48	House well	0.013	0.020	<0.03	0.514	0.54	2.7	0.87	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:55	15:48	Trench 1	0.007	0.012	0.01	0.752	0.80	1.0	0.78	N.S.	N.S.
1:00	15:48	Trench 2	0.007	0.112	0.04	1.190	1.44	131.9	1.23	N.S.	N.S.
12:09	15:48	Field 1	0.245	0.432	0.20	0.174	1.66	37.8	11.28	N.S.	N.S.
6/1/2015	**6/1/2015**	**Storm Flow**									
13:15	15:20	Downstream farm	0.006	0.050	0.05	0.109	0.25	13.7	1.80	N.S.	N.S.
12:00	15:20	Ephemeral stream	0.002	0.056	0.01	0.851	1.05	18.3	2.46	N.S.	N.S.
6/4/2015	**6/4/2015**	**Base Flow**									
12:50	15:20	Spring	0.010	0.028	<0.03	0.239	0.3	6.2	9.54	44.3	1413.8
12:00	15:20	Upstream farm	0.008	0.026	0.03	0.083	0.11	2.3	2.93	38.6	>2419.2
13:05	15:20	Downstream farm	0.009	0.034	<0.03	0.184	0.23	1.7	2.64	24.7	2419.2
13:13	15:20	Left Fork	0.008	0.022	<0.03	0.145	0.19	2.1	3.15	38.9	2560.0
11:40	15:20	Ephemeral stream	0.010	0.024	0.02	0.572	0.58	0.8	5.35	21.6	3890.0
11:35	15:20	House well	0.012	0.022	0.02	0.561	0.52	1.3	6.07	<1.0	14.6
6/8/2015	**6/8/2015**	**Base flow**									
11:36	15:30	House well	0.008	0.018	0.27	0.475	0.82	0.7	6.67	<1.0	<1.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:45	15:30	Spring	0.011	0.046	0.03	0.322	0.53	12.7	11.18	20.1	1986.3
12:26	15:30	Upstream farm	0.010	0.030	0.06	0.058	0.24	4.5	3.63	866.4	2780.0
13:12	15:30	Downstream farm	0.009	0.022	0.05	0.185	0.27	0.9	2.66	57.4	4640.0
13:25	15:30	Left Fork	0.006	0.024	0.02	0.102	0.23	1.1	2.78	32.7	4550.0
11:51	15:30	Ephemeral stream	0.009	0.020	0.03	0.560	0.62	0.6	2.81	65.7	9870.0
6/17/2015	**6/17/2015**	**Base flow**									
12:08	15:40	Spring	0.009	0.046	0.07	0.224	0.47	9.4	8.92	517.2	24890.0
10:10	15:40	Upstream farm	0.009	0.036	0.03	0.050	0.16	3.5	2.83	435.2	13130.0
12:49	15:40	Downstream farm	0.007	0.034	0.03	0.106	0.23	2.3	2.92	344.8	20980.0
13:01	15:40	Left Fork	0.005	0.026	0.04	0.112	0.22	2.8	1.62	26.2	8550.0
11:50	15:40	Ephemeral stream	0.009	0.032	0.04	0.948	1.04	6.7	0.97	770.1	8840.0
11:47	15:40	House well	0.010	0.028	0.03	0.466	0.52	0.06	3.08	488.4	15390.0
6/22/2015	**6/22/15**	**Storm flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:30	15:55	Spring	0.009	0.032	0.03	0.218	0.26	5.3	3.01	61.3	1413.6
12:15	15:55	Upstream farm	0.010	0.030	0.01	0.042	0.05	2.9	0.99	78.0	4960.0
12:55	15:55	Downstream farm	0.009	0.032	0.04	0.136	0.16	2.9	1.15	36.8	5040.0
13:10	15:55	Left Fork	0.011	0.030	0.02	0.147	0.18	2.5	1.59	35.4	5910.0
10:50	15:55	Ephemeral stream	0.011	0.026	0.05	0.563	0.61	1.3	1.21	37.9	2419.2
10:45	15:55	House well	0.010	0.032	0.02	0.459	0.43	0.4	1.85	27.2	1732.9
10:30	15:55	Trench 1	0.005	0.048	0.07	0.653	0.76	47.3	1.86	21.1	1986.3
6/29/2015	**6/29/2015**	**Storm flow**									
10:47	15:32	Spring	0.013	0.018	0.03	0.235	0.30	1.7	5.26	93.3	2419.2
12:30	15:32	Upstream farm	0.010	0.028	0.14	0.055	0.13	2.7	2.49	117.8	4710
13:22	15:32	Downstream farm	0.068	0.748	0.17	0.147	1.88	571	6.57	135.4	7540
13:30	15:32	Left Fork	0.010	0.026	0.02	0.189	0.26	2.9	2.80	53.6	10170
12:20	15:32	Ephemeral stream	0.067	1.268	0.34	0.580	3.42	1366.8	11.04	69.7	4040
12:15	15:32	Trench 1	0.008	0.022	0.05	0.394	0.42	56.8	4.17	82.3	11450

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:48	15:32	Field 1	0.354	0.524	0.37	0.226	1.64	11	11.32	N.S.	N.S.
7/6/2015	**7/7/2015**	**Storm flow**									
19:45	14:58	Downstream farm	0.275	0.380	0.22	0.204	1.03	19.1	7.91	N.S.	N.S.
17:10	14:58	Ephemeral stream	0.063	0.658	0.37	0.717	2.75	567.3	8.52	N.S	N.S.
13:25	14:58	Field 1	0.387	0.444	0.23	0.345	1.30	4.9	8.32	N.S.	N.S.
16:45	14:58	Field 12	0.796	0.910	0.13	0.567	1.58	29.0	7.67	N.S.	N.S.
18:25	14:58	Field 5a	0.094	0.448	0.13	0.172	1.01	261.3	4.38		
7/9/2015	**7/9/2015**	**Base flow**									
13:37	15:15	Spring	0.011	0.048	0.09	0.144	0.41	4.3	6.47	77.1	3050.0
12:25	15:15	Upstream farm	0.013	0.048	0.02	0.087	0.18	6.8	2.75	201.4	10140.0
12:55	15:15	Downstream farm	0.014	0.050	0.03	0.117	0.24	8.8	2.32	275.5	10760.0
13:15	15:15	Left Fork	0.015	0.058	0.04	0.138	0.31	11.4	2.67	387.3	12670.0
12:12	15:15	Ephemeral stream	0.010	0.034	<0.03	0.569	0.71	4.9	2.56	78.9	5560.0
12:07	15:15	House well	0.011	0.024	0.01	0.423	0.48	2.0	1.69	9.8	4160.0
12:00	15:15	Trench 1	0.007	0.030	<0.03	0.520	0.62	7.1	2.52	63.7	12330.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
7/16/2015	**7/16/2015**	**Base flow**									
12:15	15:10	Upstream farm	0.010	0.024	0.02	0.065	0.15	0.5	1.91	41.3	52.0
12:54	15:10	Downstream farm	0.011	0.030	<0.03	0.195	0.33	0.5	1.35	11.8	6310.0
13:03	15:10	Left Fork	0.010	0.042	0.01	0.181	0.28	0.9	1.64	21.6	9330.0
12:33	15:10	Ephemeral stream	0.011	0.046	0.01	0.517	0.61	0.4	2.16	45.7	14830.0
12:28	15:10	House well	0.012	0.024	0.01	0.471	0.47	0.0	4.00	2.0	727.0
12:42	15:10	Spring	0.010	0.024	0.01	0.303	0.41	5.7	5.54	22.8	1413.6
7/23/2015	**7/23/2015**	**Storm flow**									
10:55	15:20	Spring	0.010	0.026	<0.03	0.436	0.60	2.7	1.12	61.3	1046.2
11:15	15:20	Upstream farm	0.009	0.026	0.02	0.096	0.18	1.3	0.97	93.3	7490.0
12:40	15:20	Downstream farm	0.011	0.028	0.02	0.198	0.31	0.8	1.06	16.8	4870.0
13:02	15:20	Left Fork	0.009	0.028	0.04	0.239	0.40	1.4	1.21	35.4	8360.0
12:00	15:20	Ephemeral stream	0.011	0.034	<0.03	0.511	0.68	11.3	0.33	201.4	24950.0
12:23	15:20	House well	0.015	0.030	<0.03	0.442	0.52	1.0	0.89	8.5	35.0
7/30/2015	**7/30/2015**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:28	15:20	Spring	0.011	0.026	0.03	0.479	0.65	6.3	4.73	6.3	920.8
12:17	15:20	Upstream farm	0.014	0.024	<0.03	0.101	0.15	0.9	1.61	27.2	2880.0
12:50	15:20	Downstream farm	0.012	0.022	0.02	0.268	0.38	1.9	2.16	11.9	6500.0
13:00	15:20	Left Fork	0.008	0.020	0.04	0.221	0.37	2.3	2.60	30.3	8160.0
11:58	15:20	House well	0.013	0.014	0.02	0.466	0.51	0.3	0.90	1.0	7.4
8/6/2015	**8/6/2015**	**Storm flow**									
12:05	14:50	Spring	0.008	0.240	0.07	0.265	0.97	<6.58	7.10	23.1	48840.0
11:36	14:50	Upstream farm	0.009	0.028	<0.03	0.147	0.24	1.8	3.37	488.4	13540.0
12:22	14:50	Downstream farm	0.010	0.028	0.03	0.406	0.52	1.7	3.06	40.2	10390.0
12:37	14:50	Left Fork	0.007	0.026	0.04	0.310	0.47	1.2	3.16	217.8	8130.0
10:37	14:50	House well	0.010	0.018	0.04	0.482	0.52	0.5	3.33	920.8	21870.0
8/13/2015	**8/13/2015**	**Base flow**									
11:40	15:30	Spring	0.009	0.360	0.15	0.735	1.12	254.9	7.29	21.6	3360.0
12:06	15:30	Upstream farm	0.013	0.018	0.04	0.124	0.16	0.3	4.32	13.4	2460.0
13:01	15:30	Downstream farm	0.011	0.024	<0.03	0.384	0.50	4.0	3.74	24.0	3310.0
13:12	15:30	Left Fork	0.007	0.016	0.03	0.192	0.52	1.4	4.50	13.2	4810.0
11:53	15:30	House well	0.025	0.012	0.03	0.498	0.58	0.5	6.15	4.1	228.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
8/20/2015	**8/20/2015**	**Storm flow**									
11:32	14:05	Spring	0.009	0.276	0.07	0.337	0.89	223.6	17.88	148.3	3270.0
11:49	14:05	Downstream farm	0.015	0.022	0.03	0.491	0.53	2.2	5.94	39.3	66.3
12:04	14:05	Left Fork	0.009	0.028	0.04	0.306	0.42	2.3	5.12	48.8	3930.0
10:52	14:05	House well	0.012	0.018	<0.03	0.545	0.56	0.9	6.63	1.0	29.5
8/27/2015	**8/27/2015**	**Base flow**									
12:48	15:35	Spring	0.007	0.158	0.04	0.329	0.69	103.7	9.07	27.2	7540.0
12:37	15:35	Upstream farm	0.005	0.028	0.04	0.084	0.28	2.9	4.30	104.6	7710.0
1:20	15:35	Downstream farm	0.013	0.024	<0.03	0.450	0.54	2.5	4.43	137.4	5730.0
1:30	15:35	Left Fork	0.008	0.024	0.02	0.218	0.33	2.0	3.79	7.4	3010.0
12:20	15:35	House well	0.012	0.018	<0.03	0.599	0.61	1.6	3.66	1.0	61.3
Sample analyses since the last quarterly report											
9/2/2015	**9/2/2015**	**Base flow**									
12:06	14:45	Spring	0.007	0.620	0.10	0.304	1.27	2.47	402.7	155.3	15530.0
12:19	14:45	Downstream farm	0.007	0.042	0.07	0.047	0.39	3.37	5.5	46.4	9070.0
12:30	14:45	Left Fork	0.010	0.020	0.01	0.449	0.55	3.19	4.8	20.3	6630.0
11:30	14:45	House well	0.007	0.020	0.03	0.109	0.33	1.67	3.8	26.9	5290.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
9/10/2015	**9/10/2015**	**Base flow**									
12:45	15:15	Spring	0.004	0.026	0.02	0.197	0.39	6.50	3.5	980.4	38730.0
12:59	15:15	Downstream farm	0.008	0.028	0.02	0.464	0.58	3.96	2.9	66.3	5470.0
13:10	15:15	Left Fork	0.006	0.026	<0.03	0.198	0.34	4.09	2.5	21.6	7230.0
11:56	15:15	House well	0.010	0.018	<0.03	0.576	0.60	3.21	0.3	8.6	727.0
9/16/2015	**9/16/2015**	**Base flow**									
11:41	14:40	Spring	0.004	0.176	<0.03	0.260	0.70	5.84	111.2	130.9	8330.0
12:06	14:40	Upstream farm	0.004	0.024	<0.03	0.104	0.30	4.62	2.1	50.4	3590.0
12:24	14:40	Downstream farm	0.009	0.030	0.01	0.404	0.62	4.59	1.4	6.2	4800.0
12:36	14:40	Left Fork	0.006	0.032	<0.03	0.146	0.48	2.49	1.3	38.2	6333.0
11:52	14:40	House well	0.009	0.020	<0.03	0.559	0.60	2.58	0.2	1.0	148.3
9/24/2015	**9/24/2015**	**Base flow**									
11:40	14:30	Spring	0.006	0.024	<0.03	0.216	0.42	10.59	12.3	8.6	1119.9
11:30	14:30	Upstream farm	0.006	0.078	<0.03	0.200	0.41	5.92	14.8	17.1	4570.0
12:07	14:30	Downstream farm	0.009	0.018	<0.03	0.449	0.56	5.58	1.2	29.9	7540.0
12:18	14:30	Left Fork	0.007	0.016	0.01	0.098	0.20	3.08	0.6	31.3	3410.0
11:19	14:30	House well	0.009	0.012	<0.03	0.543	0.58	7.72	0.3	<1.0	24.6

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
9/30/2015	**9/30/2015**	**Base flow**									
12:00	15:15	Spring	0.005	0.630	0.11	0.178	1.15	15.88	450.3	137.6	36540.0
11:50	15:15	Downstream farm	0.008	0.022	0.01	0.472	0.66	5.43	4.5	31.7	5290.0
11:42	15:15	Left Fork	0.007	0.018	<0.03	0.082	0.20	4.98	1.2	18.3	5940.0
12:43	15:15	House well	0.009	0.016	<0.03	0.499	0.60	4.20	0.5	<1.0	2.0
10/8/2015	**10/8/2015**	**Base flow**									
11:32	14:05	Spring	0.003	0.018	0.02	0.176	0.27	4.5	2.43	<1.0	686.7
11:20	14:05	Downstream farm	0.005	0.020	0.02	0.517	0.60	1.5	1.62	21.3	12360.0
11:10	14:05	Left Fork	0.003	0.020	0.02	0.069	0.15	1.5	1.58	59.8	3640.0
12:15	14:05	House well	0.008	0.020	0.02	0.518	0.53	0.5	1.54	<1.0	<1
10/14/2015	**10/14/2015**	**Base flow**									
11:42	14:40	Spring	0.008	0.056	0.03	0.193	0.36	27.5	1.50	<1.0	248.1
11:28	14:40	Downstream farm	0.010	0.056	0.03	0.603	0.76	12.4	1.33	7.3	8164.0
11:17	14:40	Left Fork	0.009	0.022	0.01	0.078	0.16	2.2	1.28	9.8	1986.3
12:10	14:40	House well	0.012	0.020	<0.03	0.490	0.63	0.3	0.94	<1.0	<1
10/22/2015	**10/22/2015**	**Base flow**									
12:35	13:45	Spring	0.005	0.028	0.03	0.173	0.33	11.4	6.99	<1.0	307.6

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:15	13:45	Downstream farm	0.008	0.018	0.07	0.548	0.69	2.3	3.64	17.8	3140.0
12:05	13:45	Left Fork	0.008	0.018	<0.03	0.069	0.13	1.9	3.57	3.1	1732.9
13:10	13:45	House well	0.010	0.014	0.04	0.478	0.50	0.4	1.93	<1.0	2.0
10/28/2015	**10/28/2015**	**Base flow**									
12:10	14:25	Spring	0.005	0.112	0.05	0.247	0.55	66.2	4.89	179.3	3950.0
11:56	14:25	Downstream farm	0.009	0.032	0.03	0.544	0.78	1.7	3.91	35.0	6700.0
11:46	14:25	Left Fork	0.007	0.024	0.02	0.060	0.24	1.9	2.90	61.3	3410.0
12:55	14:25	House well	0.008	0.016	0.01	0.391	0.54	<6.58	2.40	<1.0	<1
11/4/2015	**11/4/2015**	**Base flow**									
12:14	14:50	Spring	0.007	0.026	0.07	0.139	0.33	0.7	5.44	8.4	920.8
12:03	14:50	Downstream farm	0.010	0.038	<0.03	0.607	0.76	1.7	3.79	23.1	2880.0
11:54	14:50	Left Fork	0.007	0.018	<0.03	0.072	0.18	0.7	3.98	77.6	>2419.2
12:41	14:50	House well	0.010	0.016	<0.03	0.468	0.54	0.0	2.62	<1.0	<1
11/12/2015	**11/12/2015**	**Base flow**									
12:15	15:00	Spring	0.007	0.064	<0.03	0.187	0.43	33.6	5.46	72.7	>2419.2
12:26	15:00	Upstream farm	0.015	0.022	<0.03	0.127	0.22	0.9	2.51	117.8	2620.0
12:03	15:00	Downstream farm	0.013	0.044	<0.03	0.439	0.64	6.9	2.14	75.9	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:54	15:00	Left Fork	0.005	0.016	<0.03	0.215	0.34	1.1	2.50	25.6	3360.0
12:42	15:00	House well	0.009	0.012	<0.03	0.501	0.55	0.3	3.71	<1.0	<1
11/18/2015	**11/18/2015**	**Base flow**									
11:37	15:05	Spring	0.011	0.030	0.01	0.168	0.43	1.8	5.47	461.1	13130.0
11:50	15:05	Upstream farm	0.013	0.046	0.06	0.229	0.41	4.0	2.55	517.2	5810.0
11:25	15:05	Downstream farm	0.017	0.050	0.09	0.334	0.56	4.5	2.88	435.2	14550.0
11:15	15:05	Left Fork	0.020	0.062	0.08	0.432	0.73	7.4	3.72	686.7	23590.0
12:15	15:05	Ephemeral stream	0.012	0.040	0.07	1.262	1.57	2.7	3.23	325.5	10710.0
12:28	15:05	Trench 1	0.005	0.030	0.02	0.264	0.52	1.9	1.74	65.7	17930.0
12:50	15:05	House well	0.009	0.014	<0.03	0.464	0.59	0.4	0.48	<1.0	<1
12/2/2015	**12/2/2015**	**Base flow**									
12:15	15:35	Spring	0.011	0.014	<0.03	1.262	1.63	1.9	2.51	109.2	2419.2
13:22	15:35	Upstream farm	0.010	0.020	0.03	0.135	0.22	1.4	0.98	55.6	1986.3
11:57	15:35	Downstream farm	0.012	0.022	0.02	0.266	0.39	1.6	0.94	48.0	9600.0
11:40	15:35	Left Fork	0.014	0.024	0.01	0.302	0.43	1.6	1.36	66.9	1986.3
12:27	15:35	Ephemeral stream	0.011	0.024	<0.03	0.613	0.89	1.0	1.01	145.0	1986.3

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:48	15:35	Trench 1	0.006	0.008	<0.03	0.218	0.33	1.3	1.10	6.3	5810.0
13:38	15:35	House well	0.011	0.014	0.02	0.480	0.60	0.9	1.38	1.0	1.0

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.
§ N.S. is No Sample.

Nutrients, Sediment, and Bacteria by Date Spring, Upstream, and Downstream Sites

Table 3. Water quality analyses in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application for 2015, with those collected since the last report noted.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
1/8/2015									
Upstream	0.009	0.022	<0.03	0.187	0.21	2.3	1.41	30.9	547.5
Downstream	0.011	0.024	<0.03	0.376	0.39	2.5	1.22	42.6	980.4
1/14/2015									
Upstream	0.012	0.032	<0.03	0.135	0.19	1.1	3.02	88.2	727.0
Downstream	0.011	0.020	<0.03	0.388	0.34	1.0	2.03	25.6	613.1
1/21/2015									
Upstream	0.008	0.018	<0.03	0.089	0.12	1.1	0.95	70.3	579.4
Downstream	0.010	0.026	0.06	0.197	0.30	1.1	1.60	37.4	613.1
1/29/2015									
Upstream	0.006	0.060	<0.03	0.065	0.21	47.8	1.71	727.0	1413.6
Downstream	0.009	0.020	0.04	0.168	0.27	1.3	1.50	19.9	1046.2

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
2/3/2015									
Upstream	0.006	0.022	<0.03	0.051	0.28	1.1	2.69	4.1	1203.3
Downstream	0.009	0.018	<0.03	0.140	0.29	4.1	2.66	1.0	547.5
2/10/2015									
Upstream	0.009	0.012	<0.03	0.056	0.09	0.7	1.04	1119.1	2419.2
Downstream	0.011	0.012	<0.03	0.143	0.23	1.0	1.15	7.4	1553.1
2/26/2015									
Upstream	0.006	0.024	<0.03	0.100	0.13	0.6	1.20	47.9	686.7
Downstream	0.008	0.026	0.02	0.200	0.25	0.8	1.17	48.7	866.4
3/3/2015									
Upstream	0.006	0.026	0.02	0.048	0.11	N.D.	1.50	N.S.	N.S.
Downstream	0.007	0.028	<0.03	0.138	0.23	N.D.	1.50	N.S.	N.S.
3/11/2015									
Upstream	0.005	0.026	0.02	0.118	0.16	2.1	3.38	34.5	579.4
Downstream	0.007	0.030	0.02	0.209	0.27	1.8	1.44	66.3	770.1
3/19/2015									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.007	0.024	0.04	0.111	0.20	1.7	2.53	42.6	866.4
Downstream	0.009	0.028	0.04	0.234	0.35	2.8	2.87	71.7	1119.9
3/25/2015									
Upstream	0.006	0.028	0.02	0.056	0.16	2.9	1.36	125.9	2419.2
Downstream	0.008	0.036	0.04	0.162	0.29	5.0	1.41	547.5	3410.0
3/26/2015									
Upstream	0.013	0.076	0.06	0.144	0.41	14.1	3.94	816.4	4960.0
Downstream	0.004	0.026	0.02	0.904	1.00	15.4	0.69	<1.0	1553.1
4/2/2015									
Upstream	0.007	0.040	0.02	0.045	0.14	3.1	3.61	166.9	2419.2
Downstream	0.007	0.042	0.02	0.139	0.22	2.5	2.71	121.1	1986.3
4/9/2015									
Upstream	0.011	0.042	0.04	0.066	0.18	13.1	2.13	86.0	2650.0
Downstream	0.010	0.048	0.03	0.157	0.25	19.7	1.82	47.2	1986.3
4/15/2015									
Upstream	0.007	0.040	0.03	0.090	0.16	3.5	3.24	648.8	4040.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.009	0.048	0.03	0.166	0.26	4.4	2.67	344.8	2920.0
4/23/2015									
Upstream	0.007	0.032	0.03	0.083	0.18	4.0	5.11	104.6	2419.2
Downstream	0.007	0.032	0.03	0.162	0.25	2.6	2.51	65.7	2419.2
4/29/2015									
Upstream	0.010	0.020	0.03	0.082	0.13	2.7	1.58	58.3	1732.4
Downstream	0.012	0.018	0.03	0.189	0.82	2.1	1.64	58.6	1986.3
5/7/2015									
Upstream	0.008	0.032	0.01	0.110	0.16	7.5	10.16	77.6	3280.0
Downstream	0.009	0.034	<0.03	0.267	0.36	4.5	7.70	27.8	2280.0
5/8/2015									
Upstream	0.195	0.544	0.27	0.292	1.20	113.2	7.47	N.S.	N.S.
Downstream	0.005	0.254	0.41	2.287	3.23	127.1	6.45	N.S.	N.S.
5/11/2015									
Upstream	0.004	0.074	0.04	0.004	0.24	4.5	4.31	N.S.	N.S.
Downstream	0.031	0.530	0.11	0.071	1.12	277.5	8.48	N.S.	N.S.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/14/2015									
Upstream	0.011	0.046	0.02	0.177	0.23	2.8	1.35	145.5	2470.0
Downstream	0.015	0.050	0.02	0.326	0.39	6.1	1.16	128.1	4370.0
5/18/2015									
Upstream	0.007	0.034	0.02	0.110	0.15	5.2	1.29	137.6	2419.2
Downstream	0.009	0.040	0.03	0.201	0.25	6.1	1.47	185.0	6770.0
5/26/2015									
Upstream	0.012	0.044	0.04	0.080	0.19	6.4	1.50	N.S.	N.S.
Downstream	0.045	0.200	0.11	0.096	0.56	94.7	4.57	N.S.	N.S.
6/1/2015									
Downstream	0.006	0.050	0.05	0.109	0.25	13.7	1.80	N.S.	N.S.
6/4/2015									
Upstream	0.008	0.026	0.03	0.083	0.11	2.3	2.93	38.6	>2419.2
Downstream	0.009	0.034	<0.03	0.184	0.23	1.7	2.64	24.7	2419.2
6/8/2015									
Upstream	0.010	0.030	0.06	0.058	0.24	4.5	3.63	866.4	2780.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.009	0.022	0.05	0.185	0.27	0.9	2.66	57.4	4640.0
6/17/2015									
Upstream farm	0.009	0.036	0.03	0.050	0.16	3.5	2.83	435.2	13130.0
Downstream	0.007	0.034	0.03	0.106	0.23	2.3	2.92	344.8	20980.0
6/22/2015									
Upstream	0.010	0.030	0.01	0.042	0.05	2.9	0.99	78.0	4960.0
Downstream	0.009	0.032	0.04	0.136	0.16	2.9	1.15	36.8	5040.0
6/29/2015									
Upstream	0.010	0.028	0.14	0.055	0.13	2.7	2.49	117.8	4710
Downstream	0.068	0.748	0.17	0.147	1.88	571	6.57	N.S.	N.S.
7/6/2015									
Downstream	0.275	0.380	0.22	0.204	1.03	19.1	7.91	N.S.	N.S.
7/9/2015									
Upstream	0.013	0.048	0.02	0.087	0.18	6.8	2.75	201.4	10140.0
Downstream	0.014	0.050	0.03	0.117	0.24	8.8	2.32	275.5	10760.0
7/16/2015									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.011	0.030	<0.03	0.195	0.33	0.5	1.35	11.8	6310.0
7/23/2015									
Upstream	0.009	0.026	0.02	0.096	0.18	1.3	0.97	93.3	7490.0
Downstream	0.011	0.028	0.02	0.198	0.31	0.8	1.06	16.8	4870.0
7/30/2015									
Upstream	0.014	0.024	<0.03	0.101	0.15	0.9	1.61	27.2	2880.0
Downstream	0.012	0.022	0.02	0.268	0.38	1.9	2.16	11.9	6500.0
8/6/2015									
Upstream	0.009	0.028	<0.03	0.147	0.24	1.8	3.37	488.4	13540.0
Downstream	0.010	0.028	0.03	0.406	0.52	1.7	3.06	40.2	10390.0
8/13/2015									
Upstream	0.013	0.018	0.04	0.124	0.16	0.3	4.32	13.4	2460.0
Downstream	0.011	0.024	<0.03	0.384	0.50	4.0	3.74	24.0	3310.0
8/20/2015									
Downstream	0.015	0.022	0.03	0.491	0.53	2.2	5.94	39.3	66.3
8/27/2015									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.005	0.028	0.04	0.084	0.28	2.9	4.30	104.6	7710.0
Downstream	0.013	0.024	<0.03	0.450	0.54	2.5	4.43	137.4	5730.0
Sample analyses since the last quarterly report									
9/2/2015									
Downstream	0.007	0.042	0.07	0.047	0.39	3.37	5.5	46.4	9070.0
9/10/2015									
Downstream	0.008	0.028	0.02	0.464	0.58	3.96	2.9	66.3	5470.0
9/16/2015									
Upstream	0.004	0.024	<0.03	0.104	0.30	4.62	2.1	50.4	3590.0
Downstream	0.009	0.030	0.01	0.404	0.62	4.59	1.4	6.2	4800.0
9/24/2015									
Upstream	0.006	0.078	<0.03	0.200	0.41	5.92	14.8	17.1	4570.0
Downstream	0.009	0.018	<0.03	0.449	0.56	5.58	1.2	29.9	7540.0
9/30/2015									
Downstream	0.008	0.022	0.01	0.472	0.66	5.43	4.5	31.7	5290.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
10/8/2015									
Downstream	0.005	0.020	0.02	0.517	0.60	1.5	1.62	21.3	12360.0
10/14/2015									
Downstream	0.005	0.020	0.02	0.517	0.60	1.5	1.62	21.3	12360.0
10/14/2015									
Downstream	0.010	0.056	0.03	0.603	0.76	12.4	1.33	7.3	8164.0
10/22/2015									
Downstream	0.008	0.018	0.07	0.548	0.69	2.3	3.64	17.8	3140.0
10/28/2015									
Downstream	0.009	0.032	0.03	0.544	0.78	1.7	3.91	35.0	6700.0
11/4/2015									
Downstream	0.010	0.038	<0.03	0.607	0.76	1.7	3.79	23.1	2880.0
11/12/2015									
Upstream	0.015	0.022	<0.03	0.127	0.22	0.9	2.51	117.8	2620.0
Downstream	0.013	0.044	<0.03	0.439	0.64	6.9	2.14	75.9	>2419.2
11/18/2015									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.013	0.046	0.06	0.229	0.41	4.0	2.55	517.2	5810.0
Downstream	0.017	0.050	0.09	0.334	0.56	4.5	2.88	435.2	14550.0
12/2/2015									
Upstream	0.010	0.020	0.03	0.135	0.22	1.4	0.98	55.6	1986.3
Downstream	0.012	0.022	0.02	0.266	0.39	1.6	0.94	48.0	9600.0

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

§ N.S. is No Sample.

† N.D. is No Data.

Nutrients, Sediment, and Bacteria by Site for Ephemeral Stream, House Well, Trenches, Left Fork and Field Runoff

Table 4. Water quality analyses at the ephemeral stream draining the subwatershed containing the production houses and manure holding ponds, and surface runoff from Fields 1, 5a, and 12 for 2015, with those collected since the last report noted.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
Ephemeral stream									
1/8/2015	0.008	0.022	<0.03 ¶	0.448	0.59	2.4	1.73	25.6	1203.3
1/15/2015	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6
1/21/2015	0.005	0.016	<0.03	0.370	0.46	1.0	2.34	155.3	2419.2
2/26/2015	0.006	0.022	<0.03	0.530	0.57	1.3	1.38	16.1	4790.0
3/3/2015	0.006	0.020	<0.03	0.477	0.52	ND	1.84	N.S. §	N.S.
3/11//2015	0.006	0.022	0.04	0.567	0.60	0.5	2.20	6.3	410.0
3/19/2015	0.007	0.018	0.01	0.529	0.63	1.0	4.31	14.6	866.4
3/25/2015	0.007	0.014	0.02	0.462	0.53	1.1	0.64	8.6	344.8
4/2/2015	0.006	0.032	0.02	0.467	0.46	1.8	4.41	5.2	547.5
4/15/2015	0.005	0.026	0.03	0.472	0.56	0.8	1.26	305.0	2430.0
4/23/2015	0.008	0.026	0.03	0.520	0.56	2.0	1.78	12.0	3270.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
4/29/2015	0.012	0.018	0.02	0.569	0.61	3.5	1.98	14.3	4080.0
5/7/2015	0.013	0.066	0.02	0.628	0.71	3.2	16.41	71.7	7170.0
5/8/2015	0.005	0.254	0.41	2.287	3.23	127.1	6.45	5200.0	241920
5/11/2015	0.008	0.146	0.15	0.941	1.80	22.0	8.09	N.S.	N.S.
5/14/2015	0.010	0.022	0.01	0.527	0.50	1.7	0.73	41.3	1986.3
5/18/2015	0.007	0.028	0.03	0.525	0.55	0.7	1.18	90.7	7630.0
5/26/2015	0.017	0.030	0.03	0.514	0.60	0.9	1.12	N.S.	N.S.
6/1/2015	0.002	0.056	0.01	0.851	1.05	18.3	2.46	N.S.	N.S.
6/4/2015	0.010	0.024	0.02	0.572	0.58	0.8	5.35	21.6	3890.0
6/8/2015	0.009	0.020	0.03	0.560	0.62	0.6	2.81	65.7	9870.0
6/17/2015	0.009	0.032	0.04	0.948	1.04	6.7	0.97	770.1	8840.0
6/22/2015	0.011	0.026	0.05	0.563	0.61	1.3	1.21	37.9	2419.2
6/29/2015	0.067	1.268	0.34	0.580	3.42	1366.8	11.04	N.S.	N.S.
7/6/2015	0.063	0.658	0.37	0.717	2.75	567.3	8.52	N.S	N.S.
7/9/2015	0.010	0.034	<0.03	0.569	0.71	4.9	2.56	78.9	5560.0
7/16/2015	0.011	0.046	0.01	0.517	0.61	0.4	2.16	45.7	14830.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
7/23/2015	0.011	0.034	<0.03	0.511	0.68	11.3	0.33	201.4	24950.0
Sample analyses since the last quarterly report									
11/18/2015	0.012	0.040	0.07	1.262	1.57	2.7	3.23	325.5	10710
12/2/2015	0.011	0.024	0.00	0.613	0.89	1.0	1.01	145.0	1986.3
Interceptor Trench 1 (South)									
1/8/2015	0.005	0.022	<0.03	0.769	0.75	4.7	0.88	1.0	13130.0
1/14/2015	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6
2/26/2015	0.004	0.028	0.01	0.712	0.76	46.0	0.60	1.0	41063.0
3/3/2015	0.003	0.024	<0.03	0.867	0.89	N.D. †	0.95	N.S.	N.S.
3/11/2015	0.003	0.014	0.07	0.989	0.97	0.3	2.00	<1.0	2419.2
3/19/2015	0.003	0.012	0.01	0.849	0.93	<6.58	3.11	1.0	275.5
3/25/2015	0.003	0.008	<0.03	0.838	0.88	0.2	0.59	<1.0	410.6
3/26/2015	0.004	0.026	0.02	0.904	1.00	15.4	0.69	<1.0	1553.1
4/2/2015	0.003	0.028	0.02	0.865	0.87	0.3	3.34	1.1	308.6
4/9/2015	0.006	0.018	<0.03	0.790	0.83	0.8	2.99	<1.0	187.2

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
4/15/2015	0.003	0.020	<0.03	0.857	0.93	1.3	4.29	<1.0	3180.0
4/23/2015	0.003	0.034	<0.03	0.877	0.97	1.2	1.18	3.1	2690.0
5/11/2015	0.003	0.060	0.02	0.916	0.97	27.6	1.78	N.S.	N.S.
5/14/2015	0.005	0.042	0.02	0.904	0.94	29.9	1.20	81.6	1732.9
5/18/2015	0.002	0.020	<0.03	0.897	0.93	0.3	1.28	32.3	1732.9
5/26/2015	0.007	0.012	0.01	0.752	0.80	1.0	0.78	N.S.	N.S.
6/22/2015	0.005	0.048	0.07	0.653	0.76	47.3	1.86	21.1	1986.3
6/29/2015	0.008	0.022	0.05	0.394	0.42	56.8	4.17	82.3	11450
7/9/2015	0.007	0.030	<0.03	0.520	0.62	7.1	2.52	63.7	12330.0
Sample analyses since the last quarterly report									
11/18/2015	0.005	0.030	0.02	0.264	0.52	1.9	1.74	65.7	17930.0
12/2/2015	0.006	0.008	0.00	0.218	0.33	1.3	1.10	6.3	5810.0
Interceptor Trench 2 (North)									
3/11/2015	0.003	0.056	0.04	1.443	1.59	1.2	3.51	<1.0	2419.2
3/19/2015	0.004	0.062	0.09	1.036	1.42	1.9	5.12	5.2	2419.2

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/26/2015	0.004	0.126	0.13	0.873	1.44	22.2	4.63	105.4	6950.0
5/11/2015	0.003	0.042	0.05	0.553	0.76	8.8	3.44	N.S.	N.S.
5/14/2015	0.005	0.042	0.02	0.904	0.94	29.9	1.20	81.6	1732.9
5/18/2015	0.002	0.020	<0.03	0.897	0.93	0.3	1.28	32.3	1732.9
5/26/2015	0.007	0.112	0.04	1.190	1.44	131.9	1.23	N.S.	N.S.
Left Fork									
5/14/2015	0.015	0.038	0.02	0.321	0.38	3.3	1.36	83.3	2690.0
5/18/2015	0.011	0.040	0.04	0.209	0.29	4.1	1.90	167.4	8300.0
5/26/2015	0.014	0.048	0.04	0.139	0.29	6.1	2.41	N.S.	N.S.
6/4/2015	0.008	0.022	<0.03	0.145	0.19	2.1	3.15	38.9	2560.0
6/8/2015	0.006	0.024	0.02	0.102	0.23	1.1	2.78	32.7	4550.0
6/17/2015	0.005	0.026	0.04	0.112	0.22	2.8	1.62	26.2	8550.0
6/22/2015	0.011	0.030	0.02	0.147	0.18	2.5	1.59	35.4	5910.0
6/29/2015	0.010	0.026	0.02	0.189	0.26	2.9	2.80	53.6	10170
7/9/2015	0.015	0.058	0.04	0.138	0.31	11.4	2.67	387.3	12670.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
7/16/2015	0.010	0.042	0.01	0.181	0.28	0.9	1.64	21.6	9330.0
7/23/2015	0.009	0.028	0.04	0.239	0.40	1.4	1.21	35.4	8360.0
7/30/2015	0.008	0.020	0.04	0.221	0.37	2.3	2.60	30.3	8160.0
8/6/2015	0.007	0.026	0.04	0.310	0.47	1.2	3.16	217.8	8130.0
8/13/2015	0.007	0.016	0.03	0.192	0.52	1.4	4.50	13.2	4810.0
8/20/2015	0.009	0.028	0.04	0.306	0.42	2.3	5.12	48.8	3930.0
8/27/2015	0.008	0.024	0.02	0.218	0.33	2.0	3.79	7.4	3010.0
Sample analyses since the last quarterly report									
9/2/2015	0.007	0.020	0.03	0.109	0.33	1.67	3.8	26.9	5290.0
9/10/2015	0.006	0.026	0.00	0.198	0.34	4.09	2.5	21.6	7230.0
9/16/2015	0.006	0.032	0.00	0.146	0.48	2.49	1.3	38.2	6333.0
9/24/2015	0.007	0.016	0.01	0.098	0.20	3.08	0.6	31.3	3410.0
9/30/2015	0.007	0.018	0.00	0.082	0.20	4.98	1.2	18.3	5940.0
10/8/2015	0.003	0.020	0.02	0.069	0.15	1.5	1.58	59.8	3640.0
10/14/2015	0.009	0.022	0.01	0.078	0.16	2.2	1.28	9.8	1986.3

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
10/22/2015	0.008	0.018	0.00	0.069	0.13	1.9	3.57	3.1	1732.9
10/28/2015	0.007	0.024	0.02	0.060	0.24	1.9	2.90	61.3	3410.0
11/4/2015	0.007	0.018	0.00	0.072	0.18	0.7	3.98	77.6	>2419.2
11/12/2015	0.005	0.016	0.00	0.215	0.34	1.1	2.50	25.6	3360.0
11/18/2015	0.020	0.062	0.08	0.432	0.73	7.4	3.72	686.7	23590.0
12/2/2015	0.014	0.024	0.01	0.302	0.43	1.6	1.36	66.9	1986.3
Field 1									
3/26/2015	0.143	0.346	0.41	0.216	2.68	65.5	15.65	N.S.	N.S.
5/8/2015	0.525	0.714	0.16	0.475	2.19	16.9	13.28	N.S.	N.S.
5/11/2015	0.251	0.386	0.09	0.055	0.86	44.4	6.31	N.S.	N.S.
5/18/2015	0.208	0.512	0.54	0.410	3.59	53.7	26.12	N.S.	N.S.
5/26/2015	0.245	0.432	0.20	0.174	1.66	37.8	11.28	N.S.	N.S.
6/29/2015	0.354	0.524	0.37	0.226	1.64	11	11.32	N.S.	N.S.
7/6/2015	0.387	0.444	0.23	0.345	1.30	4.9	8.32	N.S.	N.S.
Field 5a									

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/26/2015	0.813	1.330	0.39	0.225	2.59	72.3	15.95	N.S.	N.S.
5/8/2015	0.248	0.968	0.26	0.127	1.50	320.1	8.58	N.S.	N.S.
7/6/2015	0.796	0.910	0.13	0.567	1.58	29.0	7.67	N.S.	N.S.
Field 12									
5/8/2015	0.675	0.956	0.14	0.303	1.82	57.0	16.00	N.S.	N.S.
5/11/2015	0.194	0.364	0.09	0.135	0.83	36.7	7.03	N.S.	N.S.
7/6/2015	0.094	0.448	0.13	0.172	1.01	261.3	4.38	N.S.	N.S.

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.

§ N.S. is No Sample. E. coli and total coliform were not measured on surface runoff samples collected by ISCO samplers when sample holding time exceeded the required 8-hour threshold.

† N.D. is No Data

Temporal Trends in Phosphorus, Nitrogen and Bacteria in Big Creek Above and Below the C&H Farm

The concentration of P, N and bacteria forms in Big Creek above and below the C&H Farm are presented in subsequent figures to show the season / temporal trends in measured concentrations (Figures 5, 6, 7, 8, 9, and 10).

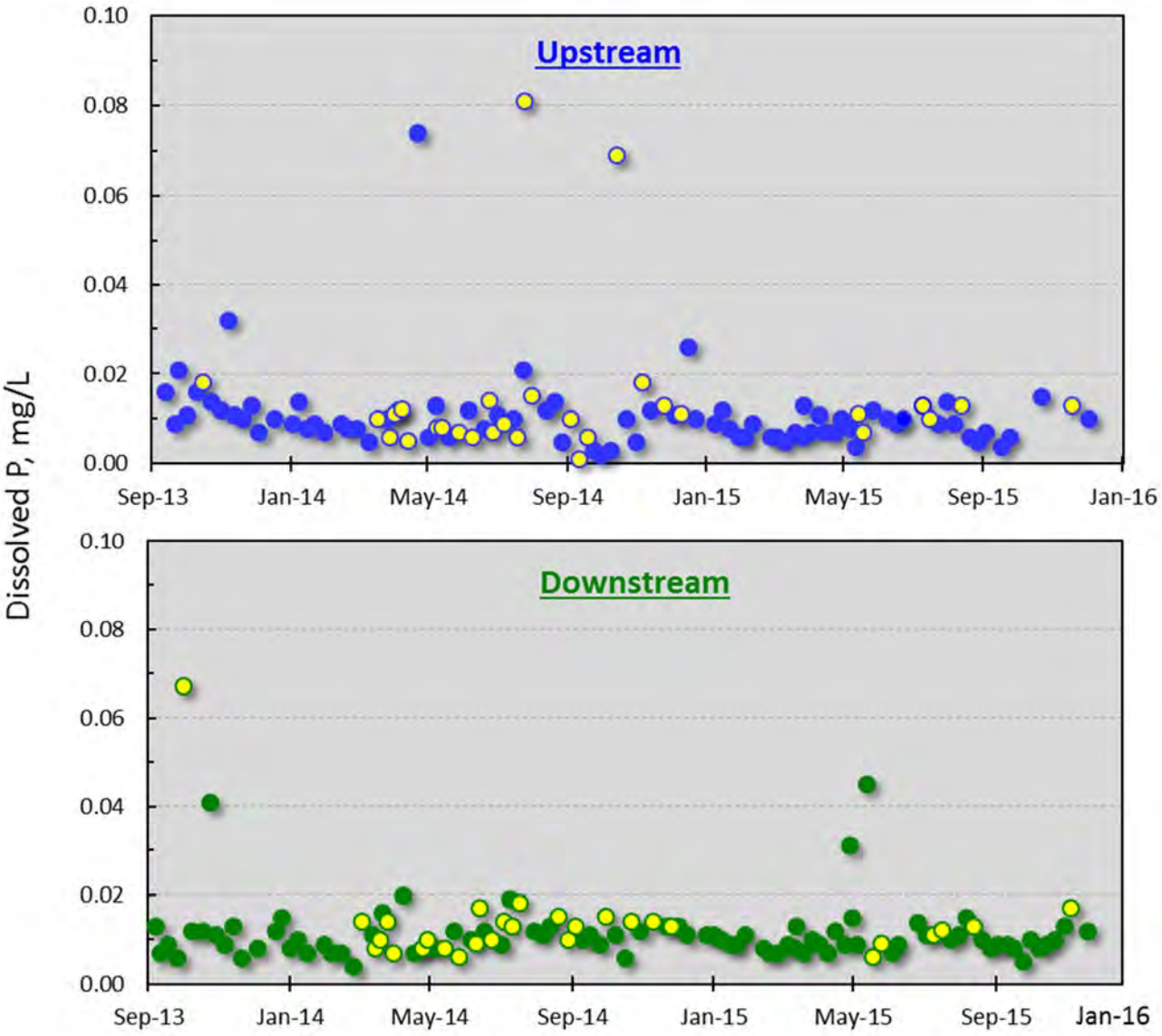

Figure 5. Dissolved P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

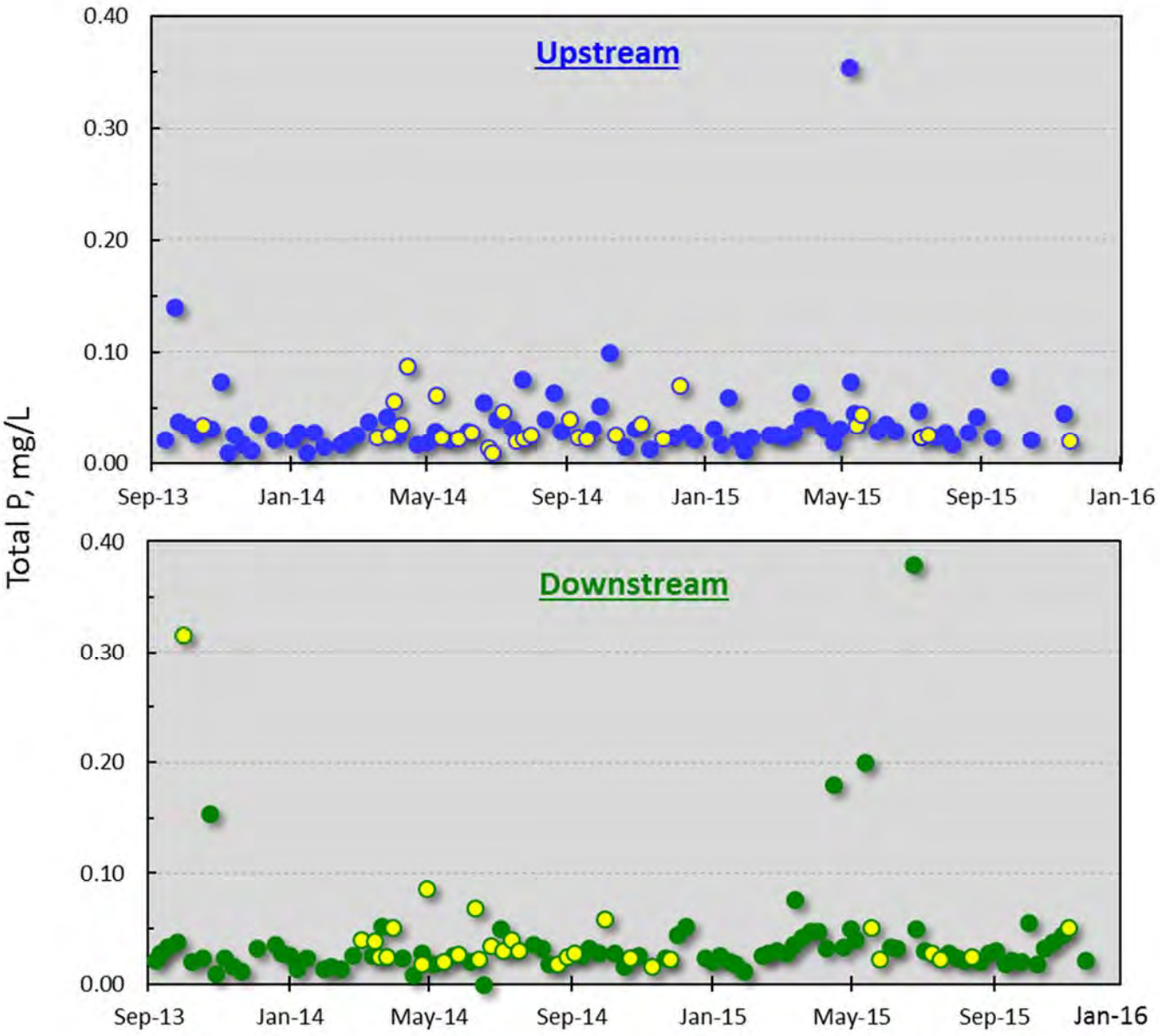

Figure 6. Total P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

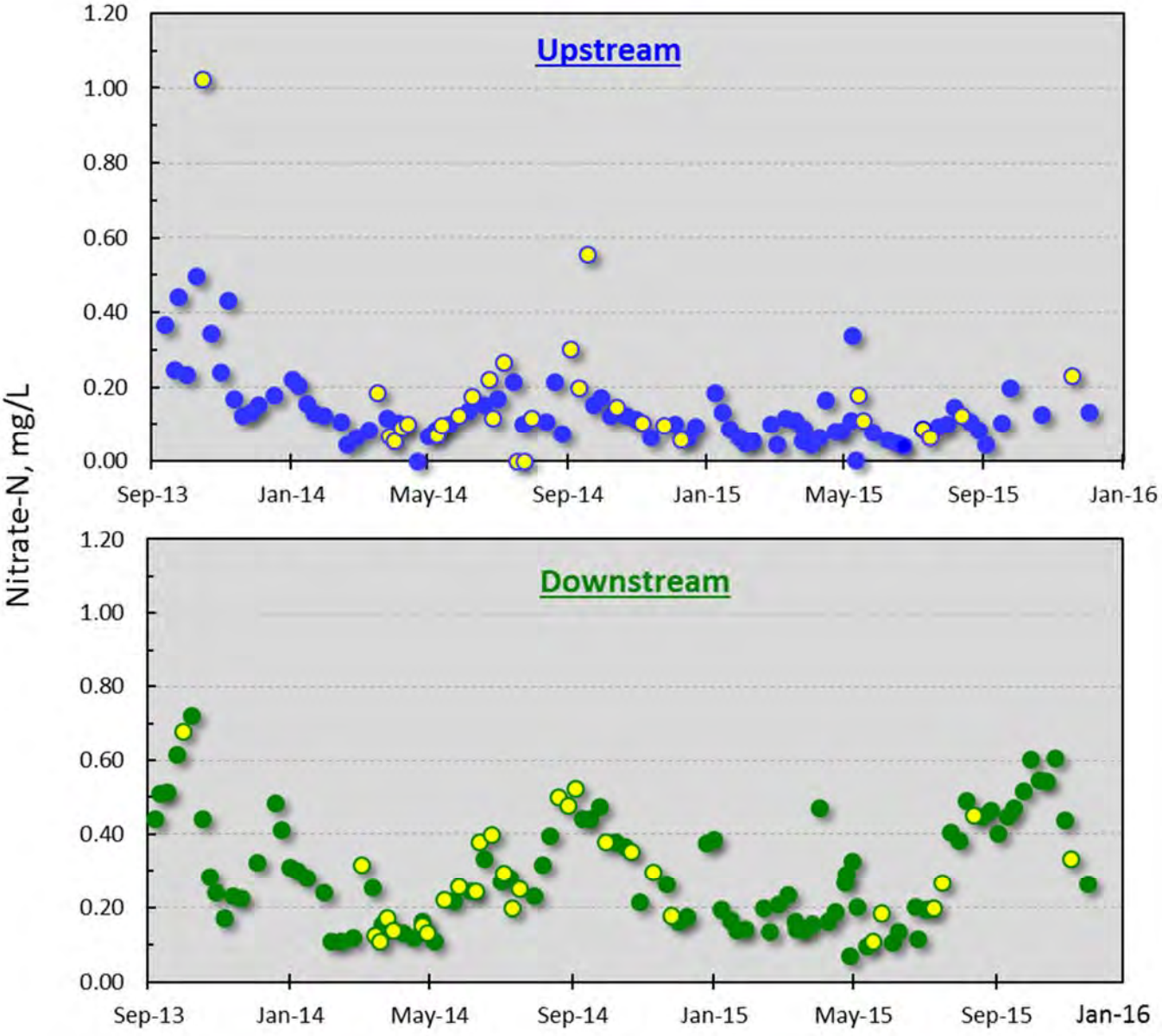

Figure 7. Nitrate-N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

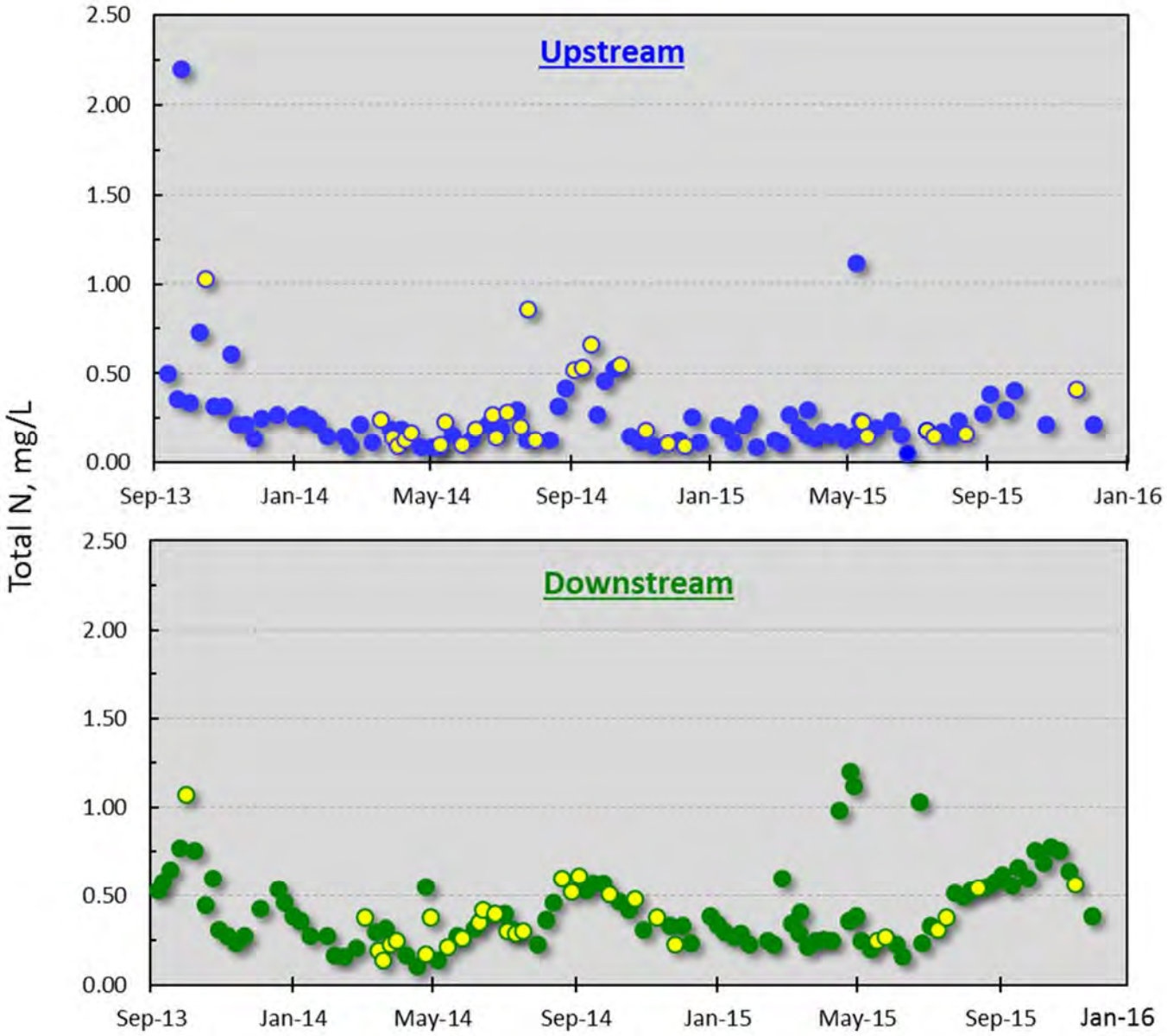

Figure 8. Total N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

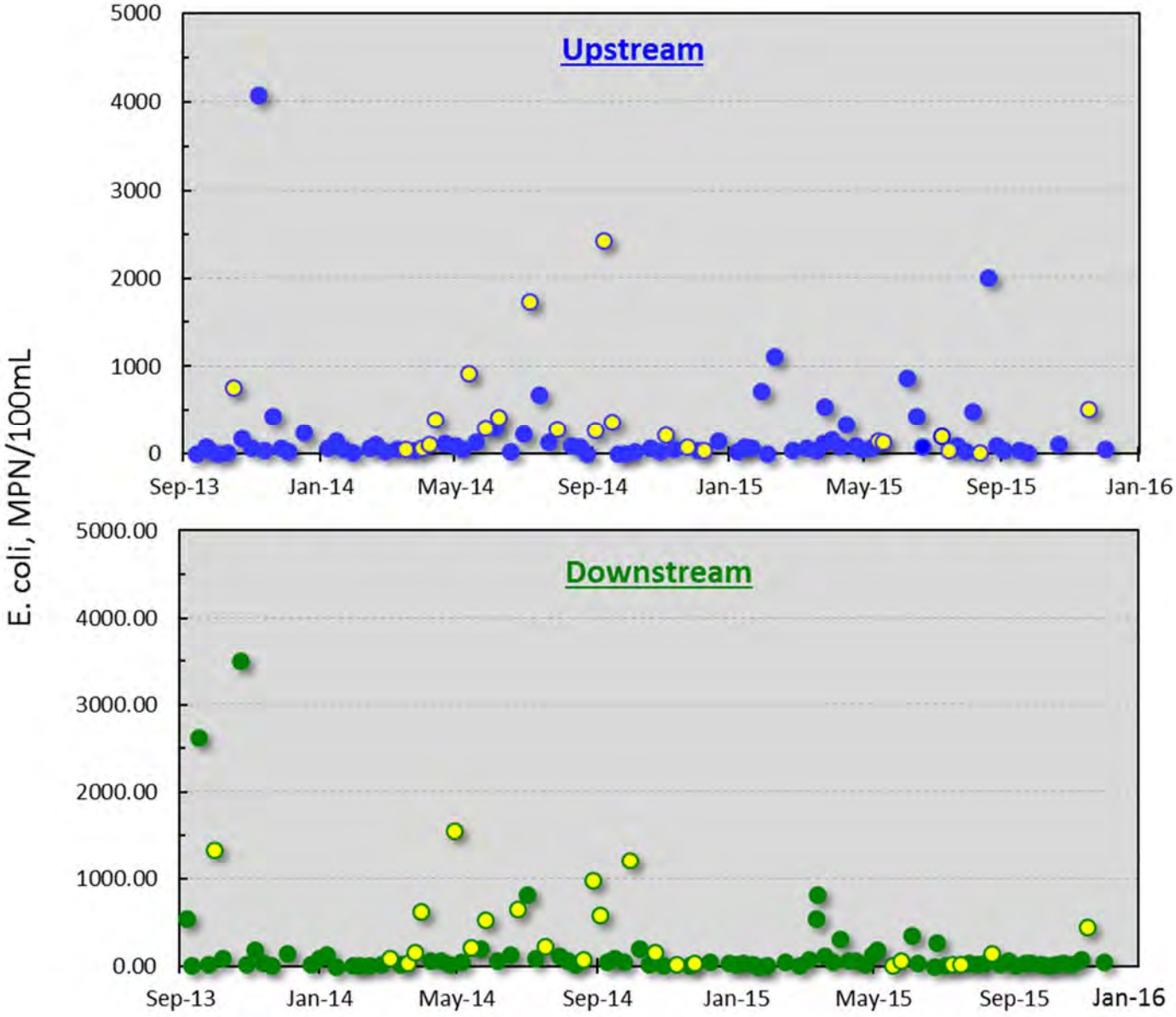

Figure 9. E. coli numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

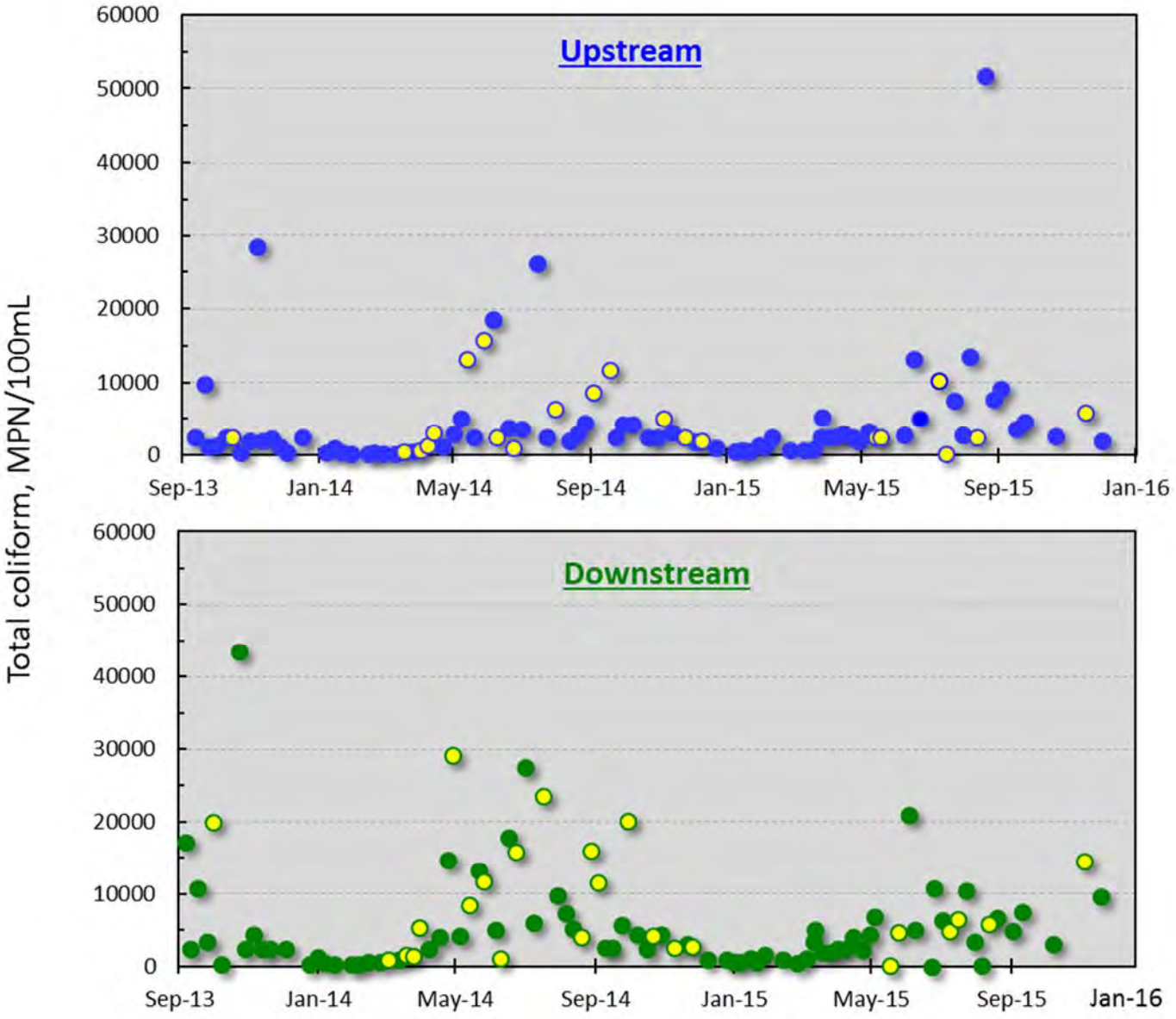

Figure 10. Total coliform numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

Water pH, Alkalinity, Chloride, Electrical Conductivity, and Total Dissolved Solids for Several Big Creek Sites

At the beginning of 2015, the pH, alkalinity, chloride concentration, electrical conductivity and total dissolved solids were determined on water samples collected at the upstream and downstream sites, spring, house well, and trenches, to build a data base that will enable to eventually source track the major water source pathways at these sites. These values are given below in Table 5.

Table 5. The pH, Chloride concentration, electrical conducting, and total solids concentration of water samples collected at upstream, downstream, spring, house well and trench sites, initiated at the beginning of 2015, with those collected since the last report noted.

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
		mg/L	mg/L	µS/cm	mg/L
Upstream					
1/8/2015	7.3	36	1.80	90	71.6
1/14/2015			2.09	105	49.1
1/21/2015	7.6	48	1.85	121	71.1
1/29/2015			2.09	140	71.3
2/3/2015	7.7	54	2.40	129	71.1
2/10/2015			2.51	132	67.6
2/26/2015	7.6	40	1.98	107	56.4
3/3/2015			2.08	112	58.9
3/11/2015	7.8	30	1.88	85	269.3
3/19/2015			1.55	98	58.0
3/25/2015	8.0	42	1.77	110	67.6
3/26/2015			1.33	115	64.4
4/2/2015	8.0	42	1.57	110	76.0
4/9/2015			1.73	116	74.9
4/15/2015	7.7	36	1.38	91	63.8
4/23/2015			1.65	95	60.4
4/29/2015	8.1	50	1.56	85	54.3

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
5/7/2015			1.40	123	70.7
5/8/2015			1.80	157	88.4
5/11/2015	7.5	24	1.63	131	110.0
5/14/2015			1.55	143	79.3
5/18/2015			1.20	107	56.2
5/26/2015	7.7	28	1.10	90	58.4
6/4/2015			1.08	78	55.3
6/8/2015	8.2	60	2.03	149	111.3
6/17/2015			1.51	128	70.2
6/22/2015	8.2	40	1.36	114	64.9
6/29/2015			1.74	55	49.8
7/9/2015	7.7	32	1.53	90	64.7
7/16/2015			1.33	161	78.9
7/23/2015	7.9	78	1.63	180	50.2
7/30/2015			1.75	224	113.3
8/6/2015	7.7	100	1.84	218	75.3
8/13/2015			1.91	210	121.6
8/20/2015	7.3	108	2.15	219	120.0
8/27/2015			2.11	240	131.3
Sample analyses since the last quarterly report					
9/2/2015	7.1	122	2.498	262	129.3
9/16/2015	7.6	132	3.046	272	151.3
9/24/2015			2.743	271	149.3
11/12/2015	8.0	104	2.125	228	115
11/18/2015			1.355	83.6	55.6
12/2/2015			1.518	82.6	100

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
Median	**7.72**	**45**	**1.75**	**118.4**	**71.1**
Downstream					
1/8/2015	7.6	64	2.02	144	89.3
1/14/2015			2.76	166	79.8
1/21/2015	7.6	84	2.44	191	91.1
1/29/2015			2.51	205	109.1
2/3/2015	7.7	88	2.82	196	103.3
2/10/2015			3.01	204	105.5
2/26/2015	7.8	66	2.27	162	88.0
3/3/2015			2.39	170	80.0
3/11/2015	7.8	52	2.02	128	77.3
3/19/2015			1.75	148	84.9
3/25/2015	7.8	64	2.07	158	88.7
3/26/2015			1.46	83	78.7
4/2/2015	8.1	68	1.95	163	103.0
4/9/2015			2.08	168	100.4
4/15/2015	7.8	56	1.54	130	82.0
4/23/2015			1.81	142	81.0
4/29/2015	8.0	80	2.15	150	97.3
5/7/2015			1.84	185	101.1
5/8/2015			2.50	225	125.8
5/11/2015	7.5	36	1.73	149	130.9
5/14/2015			1.06	103	80.2
5/18/2015			1.55	150	58.7
5/26/2015	7.7	46	1.25	137	89.1
6/1/2015			1.20	125	93.3

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
6/8/2015	8.0	94	1.44	163	86.9
6/17/2015			2.14	216	141.3
6/22/2015	7.9	76	1.76	204	106.5
7/7/2015			1.55	177	79.3
7/9/2015	7.7	50	1.63	116	77.6
7/16/2015			1.50	124	72.2
7/23/2015	7.8	108	1.84	223	111.8
7/30/2015			2.18	248	122.0
8/6/2015	7.6	154	2.31	286	142.9
8/13/2015			2.78	283	159.1
8/20/2015	7.2	142	2.83	287	156.0
8/27/2015			3.01	300	153.3
Sample analyses since the last quarterly report					
9/2/2015	7.5	146	3.134	322.0	159.6
9/10/2015			3.468	309.0	172.7
9/16/2015	7.4	152	3.871	310.0	169.3
9/24/201			3.460	308.0	168.3
9/30/2015	7.6	148	3.979	322.0	174.5
10/8/2015			3.424	344.0	179.8
10/14/2015	7.8	16	3.715	362.0	181.0
10/22/2015			3.450	362.0	168.8
10/28/2015	7.8	164	3.398	351.0	168.3
11/4/2015			4.047	358.0	181.0
11/12/2015	7.9	128	2.801	281.0	152.0
11/18/2015			1.552	119.5	77.8
12/2/2015			1.864	126.9	68.9

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
Median	**7.8**	**80.0**	**2.2**	**187.7**	**103.2**
Spring					
1/8/2015			2.27	534	321.1
1/14/2015			2.79	517	310
1/21/2015			2.27	553	324
2/3/2015			2.20	562	321.8
2/10/2015			2.44	581	314.2
2/26/2015			1.74	491	266.4
3/3/2015			1.57	430	234.9
3/11/2015			1.63	495	54.7
3/19/2015			1.54	474	220.0
3/25/2015			2.08	544	277.6
4/2/2015			1.78	515	289.8
4/9/2015			2.03	509	305.8
4/15/2015			1.76	480	276.9
4/23/2015			1.93	512	297.3
4/29/2015			2.55	564	294.9
5/4/2015			1.57	554	251.8
5/7/2015			2.29	623	318.9
5/11/2015			1.11	408	202.0
5/14/2015			1.35	507	259.6
5/18/2015			1.17	508	265.8
5/26/2015			1.08	516	250.4
6/8/2015			1.95	615	341.8
6/17/2015			1.65	532	276.0
6/22/2015			1.79	601	301.1

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
7/9/2015			1.43	542	266.9
7/16/2015			2.02	629	309.3
7/23/2015			2.17	656	312.0
7/30/2015			2.26	648	334.9
8/6/2015			0.92	606	330.7
8/13/2015			2.71	522	328.0
8/20/2015			2.09	554	330.9
8/27/2015			2.01	575	318.2
Sample analyses since the last quarterly report					
9/2/2015			2.082	581.0	311.1
9/10/2015			1.993	485.0	254.8
9/16/2015			0.000	557.0	294.9
9/24/2015			1.952	574.0	311.5
9/30/2015			2.000	573.0	321.3
10/8/2015			1.920	581.0	333.8
10/14/2015			1.942	610.0	313.0
10/22/2015			1.856	581.0	273.8
10/28/201			1.811	537.0	292.3
11/4/2015			2.114	572.0	299.0
11/12/2015			2.196	565.0	294.5
11/18/2015			1.797	395.0	215.6
12/2/2015			4.139	487.0	302.2
Median			**1.950**	**533.0**	**299.0**
Trench 1					
1/8/2015			2.01	154	103.6
1/14/2015			2.81	166	81.8

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
2/26/2015			2.08	171	78.4
3/3/2015			2.11	177	86.7
3/11/2015			1.95	193	114.0
3/19/2015			1.70	209	109.3
3/25/2015			2.13	238	105.1
3/26/2015			1.64	209	120.2
4/2/2015			1.94	261	151.3
4/9/2015			1.99	260	154.0
4/15/2015			1.80	260	146.7
4/23/2015			2.06	231	132.7
5/11/2015			2.09	262	126.5
5/14/2015			1.86	299	156.5
5/18/2015			1.57	346	173.1
5/26/2015			1.65	297	146.0
6/22/2015			1.99	341	169.8
6/29/2015			2.63	342	167.8
7/9/2015			2.08	171	78.4
Sample analyses since the last quarterly report					
11/18/2015			1.147	151.9	86.7
12/2/2015			1.471	162.0	108.9
Median			**1.97**	**234.6**	**123.4**
Trench 2					
3/11/2015			1.77	159	140.8
3/19/2015			1.04	168	104.9
3/26/2015			0.78	135	160.9
5/11/2015			0.41	165	88.5

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
5/26/2015			0.93	284	141.3
Median			**0.93**	**165**	**140.8**

Well Water Analyses

The sample collection point for the house well adjacent to the animal house facilities and slurry holding ponds was reconfigured to exclude any potential sources of sample contamination. It was determined that the risk of contamination was a result of factors such as well-head pump and in-house maintenance, In addition to installing a new well-water sampling site, USGS water quality sampling guidelines were used, which involved collection of a well sample when in-situ field measurement of well water temperature, pH, and electrical conductivity had stabilized. Well water analyses from samples collected after the new sampling port and sampling protocol were in operation are given in Table 6.

Table 6. Water quality analyses for samples collected from the well adjacent to the animal houses and slurry holding ponds following installation of new sampling port at the beginning of October, 2015.

	Dissolved P	Total P	Ammonia -N	Nitrate-N	Total N	Total suspended solids	Dissolved organic C	E. coli	Total coliform	Chloride	Conduct -ivity	Total dissolved Solids
9/30/2015	0.009	0.016	<0.03	0.499	0.60	4.2	0.5	<1.0	2.0	7.307	446	236.3
10/8/2015	0.008	0.020	0.02	0.518	0.53	0.5	1.54	<1.0	<1	5.782	455	250.3
10/14/2015	0.012	0.020	<0.03	0.490	0.63	0.3	0.94	<1.0	<1	5.235	461	230.0
10/22/2015	0.010	0.014	0.04	0.478	0.50	0.4	1.93	<1.0	2.0	5.845	453	241.0
10/28/2015	0.008	0.016	0.01	0.391	0.54	<6.58	2.40	<1.0	<1	4.837	456	234.0
11/4/2015	0.010	0.016	<0.03	0.468	0.54	<6.58	2.62	<1.0	<1	5.159	455	239.3
11/12/2015	0.009	0.012	<0.03	0.501	0.55	0.3	3.71	<1.0	<1	5.590	458	237.0
11/18/2015	0.009	0.014	<0.03	0.464	0.59	0.4	0.48	<1.0	<1	4.657	458	231.1
12/2/2015	0.011	0.014	0.02	0.480	0.60	0.9	1.38	1.0	1.0	5.557	422	253.3

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Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – January 1 to March 31, 2016

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

The mission of the **Division of Agriculture** is to advance the stewardship of natural resources and the environment, cultivate the improvement of agriculture and agribusiness, develop leadership skills and productive citizenship among youth and adults, enhance economic security and financial responsibility among the citizens of the state, ensure a safe, nutritious food supply, improve the quality of life in communities across Arkansas, and strengthen Arkansas families.

Dr. Mark J. Cochran
Vice President for Agriculture

Executive Summary

This is the first Quarterly Report of 2016 for the Big Creek Research and Extension Team that details progress made from January 1 through March 31, 2016.

1. We continue to collect weekly base flow and periodic storm flow water samples from Big Creek above and below the C&H Farm, along with water from a spring, ephemeral stream, surface runoff sites on Fields 1, 5a, and 12, two interceptor trenches below the slurry holding ponds, and reconfigured house well for chemical and bacterial analysis.

2. House well-water analyses from samples collected after the new sampling port and sampling protocol were in operation are summarized below.

	Dissolved P	Total P	Nitrate-N	Total N	E. coli	Total coliform	Conductivity
	---------- mg/L ----------				--- MPN/100L ---		µS/cm
9/30/2015	0.009	0.016	0.499	0.60	<1.0	2.0	446
10/8/2015	0.008	0.020	0.518	0.53	<1.0	<1.0	455
10/14/2015	0.012	0.020	0.490	0.63	<1.0	<1.0	461
10/22/2015	0.010	0.014	0.478	0.50	<1.0	2.0	453
10/28/2015	0.008	0.016	0.391	0.54	<1.0	<1.0	456
11/4/2015	0.010	0.016	0.468	0.54	<1.0	<1.0	455
11/12/2015	0.009	0.012	0.501	0.55	<1.0	<1.0	458
11/18/2015	0.009	0.014	0.464	0.59	<1.0	<1.0	458
12/2/2015	0.011	0.014	0.480	0.60	1.0	1.0	422
12/14/2015	0.011	0.010	0.545	0.57	<1.0	1.0	460
12/22/2015	0.010	0.016	0.534	0.59	<1.0	<1.0	458
1/5/2016	0.008	0.020	0.528	0.57	<1.0	1.0	439
1/25/2016	0.012	0.020	0.602	0.55	<1.0	<1.0	462
2/10/2016	0.007	0.014	0.542	0.56	<1.0	<1.0	468
2/24/2016	0.010	0.010	0.582	0.55	<1.0	<1.0	447

Big Creek Research Team

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Brian Breaker, M.Sc., Surface-Water Specialist, stream flow and constituent collection, analysis, and statistical evaluation of trends.

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Rick Cartwright, Ph.D., Professor – Associate Director of Extension for Agriculture and Natural Resources

Mark Cochran, Ph.D., – Vice President, University of Arkansas System Division of Agriculture.

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Ed Gbur, Ph.D., Professor and Director, Agricultural Statistics Laboratory - Experimental design, linear and generalized linear mixed models, regression, agricultural applications of statistics.

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Phil Hays, Ph.D. Ground Water Specialist, U.S. Geological Survey and Research Professor with Geosciences Dept., University of Arkansas, application of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems

Tim Kresse, M.Sc., Water Quality Specialist, U.S. Geological Survey, natural geochemical evolution of groundwater and separating these processes from anthropogenic sources of contamination

Nathan McKinney, Ph.D., – Assistant Director, Agriculture Experiment Station

Morteza Mozaffari, Ph.D. – Director, Univ. of Arkansas Soil Testing and Research Laboratory, Marianna.

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Thad Scott, Ph.D., Associate Professor - Water quality, transport of contaminants to and within water bodies

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Jun Zhu, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians - The Big Creek Research and Extension Team are ably supported by several excellent Program Technicians based in Little Rock and Fayetteville.

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Water Sampling and Analytical Methods

Sampling Locations

Water quality monitoring sites are;

Site 1. Edge-of-field monitoring on Field 1 permitted to receive slurry.

Site 2. Edge-of-field monitoring on Field 5a excluded from receiving slurry.

Site 3. Edge-of-field monitoring on Field 12 permitted to receive slurry.

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities.

Site 5. Spring below Field 1.

Site 6. Big Creek upstream of the C&H Farm operation.

Site 7. Big Creak downstream of the C&H Farm operation.

Site 8. Left Fork downstream of the C&H Farm operation.

Site 9. Manure holding pond north trench. The site was visited weekly and trench water sampled when flowing.

Site 10. Manure holding pond south trench.

Site 11. Well at animal facility.

Table 1. Location of sampling sites on the Big Creek Research and Extension Team project.

Site description	Latitude	Longitude	Elevation, ft
Field 1	35 55’ 06.42”	93 03’ 38.34”	984
Field 5a	35 56’03.01”	93 04’ 25.85”	778
Field 12	35 54’ 13.57”	93 04’ 04.76”	838
Ephemeral stream	35 55’ 25.89”	93 04’ 14.94”	824
Spring	35 54’ 57.06”	90 03’ 34.64”	977
Big Creek upstream of farm	35 53’ 32.28”	93 04’ 06.38”	857
Big Creek downstream of farm	35 56’ 18.98”	93 04’ 21.81”	769
Left Fork	35 5’”48.04”	93 04” 02.02”	760
Trench 1 (south)	35 55’ 19.24”	93 04’ 23.04”	896
Trench 2 (north)	35 55’ 21.39”	93 04’ 19.93”	883
House well	35 55’ 27.02”	93 04’ 22.71”	915

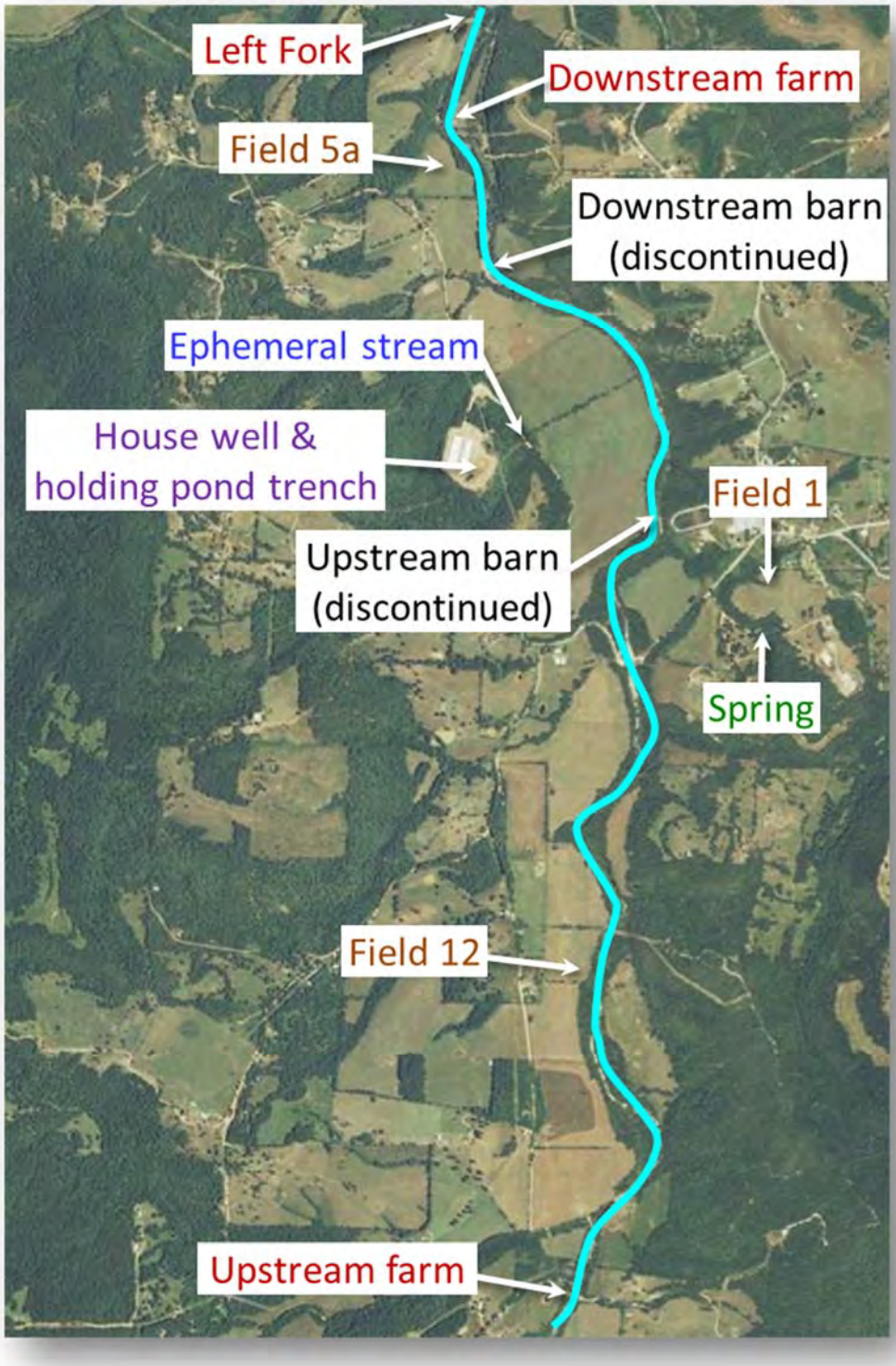

Figure 1. Location of sampling sites for the Big Creek Research and Extension Team project.

Sampling Protocols and Analyses

The following protocols were used to collect, prepare, and analyze all water samples:

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface, where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted, and samples placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
6. Analyses included Alkalinity (APHA 2320-B), Ammonia (EPA 351.2), Chloride (EPA 300.0), Dissolved Phosphorus (EPA 365.2), E. coli (APHA 9223-B), Electrical Conductivity (EPA 120.1), Nitrate (EPA 300.0), pH (EPA 150.1), Total Coliforms (APHA 9223-B), Total Dissolved Solids (EPA 160.1), Total Nitrogen (APHA 4500-P J), Total Phosphorus (APHA 4500-P J), and Total Suspended Solids (EPA 160.2). APHA is American Public Health Association from the Wadeable Streams Assessment, Water Chemistry Laboratory Manual http://www.epa.gov/owow/monitoring/wsa/WRS_lab_manual.pdf
7. Prior to collection of a house well water sample, the well is purged and water temperature, pH, and electrical conductivity measured on-site every 30 seconds until all values stabilize (primarily water temperature). At that point a sample of water is collected in a 1-L acid-washed bottle. This method is taken from USGS and EPA well-water sampling protocols. See USGS methods for sampling at https://water.usgs.gov/owq/FieldManual/chapter4/pdf/Chap4_v2.pdf. Specific and detailed guidance on the collected of water quality data can be found in the USGS National Field Manual at file:///U:/Words/C&H%20Farm/Publications/Planning/USGS%20National%20Field%20Mannual_complete%202015.pdf

   The U.S. EPA also recommend that selected water quality parameters can be monitored during low-rate purging, with stabilization of these parameters indicating when the discharge water represents aquifer water or source well water. See: http://www.csus.edu/indiv/h/hornert/Geol_210_Summer_2012/Week%202%20readings/Puls%20and%20Barcelona%201996%20Low%20flow%20sampling.pdf and https://in-situ.com/wp-content/uploads/2015/01/Low-Flow-Groundwater-Sampling-Techniques-Improve-Sample-Quality-and-Reduce-Monitoring-Program-Costs-Case-Study.pdf
8. Minimum detection limits (MDLs) for each chemical and biological constituent are listed in Table 1. Some constituent concentrations were reported by the laboratory as less than the MDL but greater than zero. Those values are given in subsequent tables but have less confidence in their accuracy than concentrations above the MDL.
9. Chemical and biological analyses of samples collected from the beginning of 2015 to March 31, 2016 are given in Tables 2, 3, and 4.

Table 2. Minimum detection limits (MDLs) for each chemical and biological constituent.

Constituent	Minimum detection limit [1]
Alkalinity, mg/L as $CaCO_3$	2
Chloride, mg/L	0.093
Dissolved P, mg/L	0.002
Conductivity, uS/cm	1
Ammonia-N, mg/L	0.03
Dissolved organic carbon, mg/L	0.18
E. coli, MPN/100 mL	1
Nitrate-N, mg/L	0.004
pH	0.1
Total coliform, MPN/100 mL	1
Total dissolved solids, mg/L	15.22
Total N, mg/L	0.006
Total P, mg/L	0.012
Total suspended solids, mg/L	6.58

[1] MDL the Minimum Detection Limit of an analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. Further information is available at http://water.usgs.gov/owq/OFR_99-193/detection.html

USGS Stations

Big Creek Continuous Flow

We are collaborating with USGS at Big Creek near Mt. Judea (USGS 705579; downstream of the C&H Farm operation) and at Left Fork Big Creek near Vendor (USGS 07055792), to collect base and storm water flows for N, P, and bacteria analysis. The USGS Big Creek site is instrumented with continuous flow gaging equipment and a nitrate sensor, which provides real-time flow, water temperature, nitrate-N, and precipitation data. These data are available on line at the USGS website below.

USGS 07055790 Big Creek near Mt. Judea, AR

http://nwis.waterdata.usgs.gov/ar/nwis/uv/?site_no=07055790&agency_cd=USGS

Big Creek Research and Extension Team Monitoring Data

Nutrients, Sediment, and Bacteria by Date of Sampling

Table 3. Water quality analyses at each sample site since 2015, with those collected since the last report noted. Coliform units are Most Probable Number (MPN) per 100 mL of water.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
			---------- mg/L ----------							-- MPN/100 mL --	
1/8/2015	**1/8/2015**	**Base flow**									
11:05	15:05	Spring	0.010	0.014	<0.03 ¶	0.376	0.56	2.0	3.80	14.8	686.7
11:25	15:05	Upstream farm	0.009	0.022	<0.03	0.187	0.21	2.3	1.41	30.9	547.5
10:53	15:05	Downstream farm	0.011	0.024	<0.03	0.376	0.39	2.5	1.22	42.6	980.4
11:40	15:05	Ephemeral stream	0.008	0.022	<0.03	0.448	0.59	2.4	1.73	25.6	1203.3
12:00	15:05	Trench 1	0.005	0.022	<0.03	0.769	0.75	4.7	0.88	1.0	13130.0
1/14/2015	**1/14/2015**	**Base flow**									
11:30	15:20	Spring	0.010	0.028	<0.03	0.473	0.66	1.1	10.20	21.6	613.1
11:45	15:20	Upstream farm	0.012	0.032	<0.03	0.135	0.19	1.1	3.02	88.2	727.0
11:15	15:20	Downstream farm	0.011	0.020	<0.03	0.388	0.34	1.0	2.03	25.6	613.1
12:00	15:20	Ephemeral stream	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
1/21/2015	**1/21/2015**	**Base flow**									
11:15	15:28	Spring	0.009	0.020	<0.03	0.552	0.69	1.5	2.29	9.8	461.1
11:52	15:28	Upstream farm	0.008	0.018	<0.03	0.089	0.12	1.1	0.95	70.3	579.4
11:05	15:28	Downstream farm	0.010	0.026	0.06	0.197	0.30	1.1	1.60	37.4	613.1
11:25	15:28	Ephemeral stream	0.005	0.016	<0.03	0.370	0.46	1.0	2.34	155.3	2419.2
1/29/2015	**1/29/2015**	**Base flow**									
10:40	15:28	Spring	0.010	0.018	0.03	0.886	0.74	2.3	4.27	1.0	2850.0
11:45	15:28	Upstream farm	0.006	0.060	<0.03	0.065	0.21	47.8	1.71	727.0	1413.6
1:20	15:28	Downstream farm	0.009	0.020	0.04	0.168	0.27	1.3	1.50	19.9	1046.2
2/3/2015	**2/3/2015**	**Base flow**									
11:05	15:40	Spring	0.008	0.018	<0.03	0.691	0.77	3.8	7.64	1.0	461.1
11:40	15:40	Upstream farm	0.006	0.022	<0.03	0.051	0.28	1.1	2.69	4.1	1203.3
10:50	15:40	Downstream farm	0.009	0.018	<0.03	0.140	0.29	4.1	2.66	1.0	547.5
2/10/2015	**2/10/2015**	**Base flow**									
10:38	15:08	Spring	0.010	0.010	<0.03	0.544	0.64	1.9	0.76	2.0	686.7
11:05	15:08	Upstream farm	0.009	0.012	<0.03	0.056	0.09	0.7	1.04	1119.1	2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:25	15:08	Downstream farm	0.011	0.012	<0.03	0.143	0.23	1.0	1.15	7.4	1553.1
2/26/2015	**2/26/2015**	**Base flow**									
10:45	15:30	Spring	0.009	0.042	0.02	0.237	0.38	5.0	3.97	37.3	2419.2
11:36	15:30	Upstream farm	0.006	0.024	<0.03	0.100	0.13	0.6	1.20	47.9	686.7
10:34	15:30	Downstream farm	0.008	0.026	0.02	0.200	0.25	0.8	1.17	48.7	866.4
10:55	15:30	Ephemeral stream	0.006	0.022	<0.03	0.530	0.57	1.3	1.38	16.1	4790.0
11:15	15:30	Trench 1	0.004	0.028	0.01	0.712	0.76	46.0	0.60	1.0	41063.0
3/3/2015	**3/3/2015**	**Base flow**									
11:07	15:33	Spring	0.008	0.052	<0.03	0.124	0.35	13.5	4.90	N.S. §	N.S.
11:50	15:33	Upstream farm	0.006	0.026	0.02	0.048	0.11	2.3	1.50	N.S.	N.S.
10:55	15:33	Downstream farm	0.007	0.028	<0.03	0.138	0.23	1.3	1.50	N.S.	N.S.
11:18	15:33	Ephemeral stream	0.006	0.020	<0.03	0.477	0.52	2.0	1.84	N.S.	N.S.
11:30	15:33	Trench 1	0.003	0.024	<0.03	0.867	0.89	14.9	0.95	N.S.	N.S.
3/11/2015	**3/11/2015**	**Storm Flow**									
11:30	14:58	Spring	0.009	0.030	<0.03	0.242	2.37	5.5	14.79	19.5	111.9

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:30	14:58	Upstream farm	0.005	0.026	0.02	0.118	0.16	2.1	3.38	34.5	579.4
11:20	14:58	Downstream farm	0.007	0.030	0.02	0.209	0.27	1.8	1.44	66.3	770.1
11:45	14:58	Ephemeral stream	0.006	0.022	0.04	0.567	0.60	0.5	2.20	6.3	410.0
12:10	14:58	Trench 1	0.003	0.014	0.07	0.989	0.97	0.3	2.00	<1.0	2419.2
12:15	14:58	Trench 2	0.003	0.056	0.04	1.443	1.59	1.2	3.51	<1.0	2419.2
3/19/2015	**3/19/2015**	**Base flow**									
10:59	15:10	Spring	0.010	0.028	0.03	0.184	0.29	10.6	7.37	38.9	79.4
12:00	15:10	Upstream farm	0.007	0.024	0.04	0.111	0.20	1.7	2.53	42.6	866.4
11:13	15:10	Downstream farm	0.009	0.028	0.04	0.234	0.35	2.8	2.87	71.7	1119.9
11:08	15:10	Ephemeral stream	0.007	0.018	0.01	0.529	0.63	1.0	4.31	14.6	866.4
11:13	15:10	House well	0.009	0.020	0.02	0.467	0.55	1.2	4.93	1.0	31.3
11:30	15:10	Trench 1	0.003	0.012	0.01	0.849	0.93	<6.58	3.11	1.0	275.5
11:35	15:10	Trench 2	0.004	0.062	0.09	1.036	1.42	1.9	5.12	5.2	2419.2
3/25/2015	**3/25/2015**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:45	15:20	Spring	0.006	0.014	0.02	0.197	0.39	1.6	1.45	23.1	275.5
13:30	15:20	Upstream farm	0.006	0.028	0.02	0.056	0.16	2.9	1.36	125.9	2419.2
11:30	15:20	Downstream farm	0.008	0.036	0.04	0.162	0.29	5.0	1.41	547.5	3410.0
12:00	15:20	Ephemeral stream	0.007	0.014	0.02	0.462	0.53	1.1	0.64	8.6	344.8
12:20	15:20	House well	0.007	0.016	<0.03	0.450	0.52	1.9	0.03	18.5	30.1
12:30	15:20	Trench 1	0.003	0.008	<0.03	0.838	0.88	0.2	0.59	<1.0	410.6
3/26/2015	**3/26/2015**	**Storm flow**									
13:10	15:25	Upstream farm	0.013	0.064	0.06	0.090	0.30	11.4	3.71	547.5	5200.0
13:35	15:25	Downstream farm	0.013	0.076	0.06	0.144	0.41	14.1	3.94	816.4	4960.0
12:55	15:25	Trench 1	0.004	0.026	0.02	0.904	1.00	15.4	0.69	<1.0	1553.1
12:50	15:25	Trench 2	0.004	0.126	0.13	0.873	1.44	22.2	4.63	105.4	6950.0
13:20	15:25	Field 1	0.143	0.346	0.41	0.216	2.68	65.5	15.65	N.S.	N.S.
12:30	15:25	Field 5a	0.813	1.330	0.39	0.225	2.59	72.3	15.95	N.S.	N.S.
4/2/2015	**4/2/2015**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:50	15:25	Spring	0.008	0.042	0.04	0.173	0.35	3.5	10.47	248.1	1299.7
12:15	15:25	Upstream farm	0.007	0.040	0.02	0.045	0.14	3.1	3.61	166.9	2419.2
1:30	15:25	Downstream farm	0.007	0.042	0.02	0.139	0.22	2.5	2.71	121.1	1986.3
12:30	15:25	Ephemeral stream	0.006	0.032	0.02	0.467	0.46	1.8	4.41	5.2	547.5
12:48	15:25	House well	0.008	0.030	<0.03	0.477	0.50	0.7	6.05	39.3	9060.0
12:54	15:25	Trench 1	0.003	0.028	0.02	0.865	0.87	0.3	3.34	1.1	308.6
4/9/2015	**4/9/2015**	**Base flow**									
11:45	15:30	Spring	0.011	0.034	0.01	0.257	0.42	4.9	9.11	7380.0	9040.0
12:30	15:30	Upstream farm	0.011	0.042	0.04	0.066	0.18	13.1	2.13	86.0	2650.0
12:50	15:30	Downstream farm	0.010	0.048	0.03	0.157	0.25	19.7	1.82	47.2	1986.3
12:00	15:30	House well	0.011	0.026	<0.03	0.499	0.50	1.5	0.74	4.1	325.5
12:10	15:30	Trench 1	0.006	0.018	<0.03	0.790	0.83	0.8	2.99	<1.0	187.2
4/15/2015	**4/15/2015**	**Storm Flow**									
11:38	14:55	Spring	0.007	0.034	<0.03	0.210	0.39	7.7	4.70	275.5	2280.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:23	14:55	Upstream farm	0.007	0.040	0.03	0.090	0.16	3.5	3.24	648.8	4040.0
12:40	14:55	Downstream farm	0.009	0.048	0.03	0.166	0.26	4.4	2.67	344.8	2920.0
11:48	14:55	Ephemeral stream	0.005	0.026	0.03	0.472	0.56	0.8	1.26	305.0	2430.0
11:58	14:55	House well	0.008	0.022	0.02	0.475	0.60	1.2	3.72	9.6	80.9
12:10	14:55	Trench 1	0.003	0.020	<0.03	0.857	0.93	1.3	4.29	<1.0	3180.0
4/23/2015	**4/23/2015**	**Base Flow**									
12:23	15:30	Spring	0.008	0.034	<0.03	0.264	0.36	7.4	3.64	71.7	648.8
13:00	15:30	Upstream farm	0.007	0.032	0.03	0.083	0.18	4.0	5.11	104.6	2419.2
12:15	15:30	Downstream farm	0.007	0.032	0.03	0.162	0.25	2.6	2.51	65.7	2419.2
11:55	15:30	Ephemeral stream	0.008	0.026	0.03	0.520	0.56	2.0	1.78	12.0	3270.0
11:35	15:30	House well	0.008	0.082	<0.03	0.496	0.53	1.4	1.69	18.5	35.0
11:48	15:30	Trench 1	0.003	0.034	<0.03	0.877	0.97	1.2	1.18	3.1	2690.0
4/29/2015	**4/29/2015**	**Base flow**									
11:25	14:05	Spring	0.010	0.028	<0.03	0.419	0.59	9.0	4.28	25.6	1732.9

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:53	14:05	Upstream farm	0.010	0.020	0.03	0.082	0.13	2.7	1.58	58.3	1732.4
12:13	14:05	Downstream farm	0.012	0.018	0.03	0.189	0.82	2.1	1.64	58.6	1986.3
11:30	14:05	Ephemeral stream	0.012	0.018	0.02	0.569	0.61	3.5	1.98	14.3	4080.0
11:35	14:05	House well	0.010	0.006	<0.03	0.517	0.51	0.7	2.26	248.1	5040.0
5/7/2015	**5/7/2015**	**Base flow**									
11:10	14:10	Spring	0.011	0.036	0.02	0.499	0.58	9.9	44.04	135.4	980.4
11:43	14:10	Upstream farm	0.008	0.032	0.01	0.110	0.16	7.5	10.16	77.6	3280.0
12:05	14:10	Downstream farm	0.009	0.034	<0.03	0.267	0.36	4.5	7.70	27.8	2280.0
11:18	14:10	Ephemeral stream	0.013	0.066	0.02	0.628	0.71	3.2	16.41	71.7	7170.0
11:23	14:10	House well	0.008	0.022	0.01	0.512	0.49	<6.58	28.63	3.1	59.4
5/8/2015	**5/8/2015**	**Storm flow**									
13:25	15:32	Upstream farm	0.134	0.354	0.16	0.340	1.12	51.4	9.30	N.S.	N.S.
13:25	15:32	Downstream farm	0.195	0.544	0.27	0.292	1.20	113.2	7.47	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:43	15:32	Ephemeral stream	0.005	0.254	0.41	2.287	3.23	127.1	6.45	N.S.	N.S.
13:00	15:32	Field 1	0.525	0.714	0.16	0.475	2.19	16.9	13.28	N.S.	N.S.
12:38	15:32	Field 12	0.675	0.956	0.14	0.303	1.82	57.0	16.00	N.S.	N.S.
5/11/2015	**5/12/2015**	**Storm Flow**									
11:35	8:30	Spring	0.008	0.058	0.01	0.339	0.49	8.7	3.67	N.S.	N.S.
11:28	8:30	Upstream farm	0.004	0.074	0.04	0.004	0.24	4.5	4.31	N.S.	N.S.
12:47	8:30	Downstream farm	0.031	0.530	0.11	0.071	1.12	277.5	8.48	N.S.	N.S.
12:05	8:30	Ephemeral stream	0.008	0.146	0.15	0.941	1.80	22.0	8.09	N.S.	N.S.
12:15	8:30	House well	0.009	0.038	0.02	0.541	0.55	4.2	0.89	N.S.	N.S.
12:25	8:30	Trench 1	0.003	0.060	0.02	0.916	0.97	27.6	1.78	N.S.	N.S.
12:35	8:30	Trench 2	0.003	0.042	0.05	0.553	0.76	8.8	3.44	N.S.	N.S.
11:25	8:30	Field 1	0.251	0.386	0.09	0.055	0.86	44.4	6.31	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:40	8:30	Field 5a	0.248	0.968	0.26	0.127	1.50	320.1	8.58	N.S.	N.S.
1:05	8:30	Field 12	0.194	0.364	0.09	0.135	0.83	36.7	7.03	N.S.	N.S.
5/14/2015	**5/14/2015**	**Base flow**									
12:35	15:12	Spring	0.009	0.062	0.02	0.222	0.35	41.5	2.84	121.1	2419.2
12:28	15:12	Upstream farm	0.011	0.046	0.02	0.177	0.23	2.8	1.35	145.5	2470.0
12:47	15:12	Downstream farm	0.015	0.050	0.02	0.326	0.39	6.1	1.16	128.1	4370.0
12:57	15:12	Left Fork	0.015	0.038	0.02	0.321	0.38	3.3	1.36	83.3	2690.0
12:15	15:12	Ephemeral stream	0.010	0.022	0.01	0.527	0.50	1.7	0.73	41.3	1986.3
12:05	15:12	Trench 1	0.005	0.042	0.02	0.904	0.94	29.9	1.20	81.6	1732.9
5/18/2015	**5/18/2015**	**Storm Flow**									
10:45	14:43	Spring	0.005	0.084	0.05	0.209	0.56	114.2	2.79	98.7	1413.6
11:57	14:43	Upstream farm	0.007	0.034	0.02	0.110	0.15	5.2	1.29	137.6	2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:17	14:43	Downstream farm	0.009	0.040	0.03	0.201	0.25	6.1	1.47	185.0	6770.0
12:29	14:43	Left Fork	0.011	0.040	0.04	0.209	0.29	4.1	1.90	167.4	8300.0
11:14	14:43	Ephemeral stream	0.007	0.028	0.03	0.525	0.55	0.7	1.18	90.7	7630.0
11:20	14:43	House well	0.008	0.018	<0.03	0.529	0.53	0.9	0.90	5.2	13.4
12:55	14:43	Trench 1	0.002	0.020	<0.03	0.897	0.93	0.3	1.28	32.3	1732.9
10:58	14:43	Field 1	0.208	0.512	0.54	0.410	3.59	53.7	26.12	N.S.	N.S.
5/26/2015	**5/26/2015**	**Base flow**									
11:49	15:48	Spring	0.021	0.020	<0.03	0.205	0.29	1.2	2.66	N.S.	N.S.
13:20	15:48	Upstream farm	0.012	0.044	0.04	0.080	0.19	6.4	1.50	N.S.	N.S.
13:32	15:48	Downstream farm	0.045	0.200	0.11	0.096	0.56	94.7	4.57	N.S.	N.S.
13:45	15:48	Left Fork	0.014	0.048	0.04	0.139	0.29	6.1	2.41	N.S.	N.S.
13:11	15:48	Ephemeral stream	0.017	0.030	0.03	0.514	0.60	0.9	1.12	N.S.	N.S.
12:43	15:48	House well	0.013	0.020	<0.03	0.514	0.54	2.7	0.87	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:55	15:48	Trench 1	0.007	0.012	0.01	0.752	0.80	1.0	0.78	N.S.	N.S.
1:00	15:48	Trench 2	0.007	0.112	0.04	1.190	1.44	131.9	1.23	N.S.	N.S.
12:09	15:48	Field 1	0.245	0.432	0.20	0.174	1.66	37.8	11.28	N.S.	N.S.
6/1/2015	**6/1/2015**	**Storm Flow**									
13:15	15:20	Downstream farm	0.006	0.050	0.05	0.109	0.25	13.7	1.80	N.S.	N.S.
12:00	15:20	Ephemeral stream	0.002	0.056	0.01	0.851	1.05	18.3	2.46	N.S.	N.S.
6/4/2015	**6/4/2015**	**Base Flow**									
12:50	15:20	Spring	0.010	0.028	<0.03	0.239	0.3	6.2	9.54	44.3	1413.8
12:00	15:20	Upstream farm	0.008	0.026	0.03	0.083	0.11	2.3	2.93	38.6	>2419.2
13:05	15:20	Downstream farm	0.009	0.034	<0.03	0.184	0.23	1.7	2.64	24.7	2419.2
13:13	15:20	Left Fork	0.008	0.022	<0.03	0.145	0.19	2.1	3.15	38.9	2560.0
11:40	15:20	Ephemeral stream	0.010	0.024	0.02	0.572	0.58	0.8	5.35	21.6	3890.0
11:35	15:20	House well	0.012	0.022	0.02	0.561	0.52	1.3	6.07	<1.0	14.6
6/8/2015	**6/8/2015**	**Base flow**									
11:36	15:30	House well	0.008	0.018	0.27	0.475	0.82	0.7	6.67	<1.0	<1.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:45	15:30	Spring	0.011	0.046	0.03	0.322	0.53	12.7	11.18	20.1	1986.3
12:26	15:30	Upstream farm	0.010	0.030	0.06	0.058	0.24	4.5	3.63	866.4	2780.0
13:12	15:30	Downstream farm	0.009	0.022	0.05	0.185	0.27	0.9	2.66	57.4	4640.0
13:25	15:30	Left Fork	0.006	0.024	0.02	0.102	0.23	1.1	2.78	32.7	4550.0
11:51	15:30	Ephemeral stream	0.009	0.020	0.03	0.560	0.62	0.6	2.81	65.7	9870.0
6/17/2015	**6/17/2015**	**Base flow**									
12:08	15:40	Spring	0.009	0.046	0.07	0.224	0.47	9.4	8.92	517.2	24890.0
10:10	15:40	Upstream farm	0.009	0.036	0.03	0.050	0.16	3.5	2.83	435.2	13130.0
12:49	15:40	Downstream farm	0.007	0.034	0.03	0.106	0.23	2.3	2.92	344.8	20980.0
13:01	15:40	Left Fork	0.005	0.026	0.04	0.112	0.22	2.8	1.62	26.2	8550.0
11:50	15:40	Ephemeral stream	0.009	0.032	0.04	0.948	1.04	6.7	0.97	770.1	8840.0
11:47	15:40	House well	0.010	0.028	0.03	0.466	0.52	0.06	3.08	488.4	15390.0
6/22/2015	**6/22/15**	**Storm flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:30	15:55	Spring	0.009	0.032	0.03	0.218	0.26	5.3	3.01	61.3	1413.6
12:15	15:55	Upstream farm	0.010	0.030	0.01	0.042	0.05	2.9	0.99	78.0	4960.0
12:55	15:55	Downstream farm	0.009	0.032	0.04	0.136	0.16	2.9	1.15	36.8	5040.0
13:10	15:55	Left Fork	0.011	0.030	0.02	0.147	0.18	2.5	1.59	35.4	5910.0
10:50	15:55	Ephemeral stream	0.011	0.026	0.05	0.563	0.61	1.3	1.21	37.9	2419.2
10:45	15:55	House well	0.010	0.032	0.02	0.459	0.43	0.4	1.85	27.2	1732.9
10:30	15:55	Trench 1	0.005	0.048	0.07	0.653	0.76	47.3	1.86	21.1	1986.3
6/29/2015	**6/29/2015**	**Storm flow**									
10:47	15:32	Spring	0.013	0.018	0.03	0.235	0.30	1.7	5.26	93.3	2419.2
12:30	15:32	Upstream farm	0.010	0.028	0.14	0.055	0.13	2.7	2.49	117.8	4710
13:22	15:32	Downstream farm	0.068	0.748	0.17	0.147	1.88	571	6.57	135.4	7540
13:30	15:32	Left Fork	0.010	0.026	0.02	0.189	0.26	2.9	2.80	53.6	10170
12:20	15:32	Ephemeral stream	0.067	1.268	0.34	0.580	3.42	1366.8	11.04	69.7	4040
12:15	15:32	Trench 1	0.008	0.022	0.05	0.394	0.42	56.8	4.17	82.3	11450

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:48	15:32	Field 1	0.354	0.524	0.37	0.226	1.64	11	11.32	N.S.	N.S.
7/6/2015	**7/7/2015**	**Storm flow**									
19:45	14:58	Downstream farm	0.275	0.380	0.22	0.204	1.03	19.1	7.91	N.S.	N.S.
17:10	14:58	Ephemeral stream	0.063	0.658	0.37	0.717	2.75	567.3	8.52	N.S	N.S.
13:25	14:58	Field 1	0.387	0.444	0.23	0.345	1.30	4.9	8.32	N.S.	N.S.
16:45	14:58	Field 12	0.796	0.910	0.13	0.567	1.58	29.0	7.67	N.S.	N.S.
18:25	14:58	Field 5a	0.094	0.448	0.13	0.172	1.01	261.3	4.38		
7/9/2015	**7/9/2015**	**Base flow**									
13:37	15:15	Spring	0.011	0.048	0.09	0.144	0.41	4.3	6.47	77.1	3050.0
12:25	15:15	Upstream farm	0.013	0.048	0.02	0.087	0.18	6.8	2.75	201.4	10140.0
12:55	15:15	Downstream farm	0.014	0.050	0.03	0.117	0.24	8.8	2.32	275.5	10760.0
13:15	15:15	Left Fork	0.015	0.058	0.04	0.138	0.31	11.4	2.67	387.3	12670.0
12:12	15:15	Ephemeral stream	0.010	0.034	<0.03	0.569	0.71	4.9	2.56	78.9	5560.0
12:07	15:15	House well	0.011	0.024	0.01	0.423	0.48	2.0	1.69	9.8	4160.0
12:00	15:15	Trench 1	0.007	0.030	<0.03	0.520	0.62	7.1	2.52	63.7	12330.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
7/16/2015	**7/16/2015**	**Base flow**									
12:15	15:10	Upstream farm	0.010	0.024	0.02	0.065	0.15	0.5	1.91	41.3	52.0
12:54	15:10	Downstream farm	0.011	0.030	<0.03	0.195	0.33	0.5	1.35	11.8	6310.0
13:03	15:10	Left Fork	0.010	0.042	0.01	0.181	0.28	0.9	1.64	21.6	9330.0
12:33	15:10	Ephemeral stream	0.011	0.046	0.01	0.517	0.61	0.4	2.16	45.7	14830.0
12:28	15:10	House well	0.012	0.024	0.01	0.471	0.47	0.0	4.00	2.0	727.0
12:42	15:10	Spring	0.010	0.024	0.01	0.303	0.41	5.7	5.54	22.8	1413.6
7/23/2015	**7/23/2015**	**Storm flow**									
10:55	15:20	Spring	0.010	0.026	<0.03	0.436	0.60	2.7	1.12	61.3	1046.2
11:15	15:20	Upstream farm	0.009	0.026	0.02	0.096	0.18	1.3	0.97	93.3	7490.0
12:40	15:20	Downstream farm	0.011	0.028	0.02	0.198	0.31	0.8	1.06	16.8	4870.0
13:02	15:20	Left Fork	0.009	0.028	0.04	0.239	0.40	1.4	1.21	35.4	8360.0
12:00	15:20	Ephemeral stream	0.011	0.034	<0.03	0.511	0.68	11.3	0.33	201.4	24950.0
12:23	15:20	House well	0.015	0.030	<0.03	0.442	0.52	1.0	0.89	8.5	35.0
7/30/2015	**7/30/2015**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:28	15:20	Spring	0.011	0.026	0.03	0.479	0.65	6.3	4.73	6.3	920.8
12:17	15:20	Upstream farm	0.014	0.024	<0.03	0.101	0.15	0.9	1.61	27.2	2880.0
12:50	15:20	Downstream farm	0.012	0.022	0.02	0.268	0.38	1.9	2.16	11.9	6500.0
13:00	15:20	Left Fork	0.008	0.020	0.04	0.221	0.37	2.3	2.60	30.3	8160.0
11:58	15:20	House well	0.013	0.014	0.02	0.466	0.51	0.3	0.90	1.0	7.4
8/6/2015	**8/6/2015**	**Storm flow**									
12:05	14:50	Spring	0.008	0.240	0.07	0.265	0.97	<6.58	7.10	23.1	48840.0
11:36	14:50	Upstream farm	0.009	0.028	<0.03	0.147	0.24	1.8	3.37	488.4	13540.0
12:22	14:50	Downstream farm	0.010	0.028	0.03	0.406	0.52	1.7	3.06	40.2	10390.0
12:37	14:50	Left Fork	0.007	0.026	0.04	0.310	0.47	1.2	3.16	217.8	8130.0
10:37	14:50	House well	0.010	0.018	0.04	0.482	0.52	0.5	3.33	920.8	21870.0
8/13/2015	**8/13/2015**	**Base flow**									
11:40	15:30	Spring	0.009	0.360	0.15	0.735	1.12	254.9	7.29	21.6	3360.0
12:06	15:30	Upstream farm	0.013	0.018	0.04	0.124	0.16	0.3	4.32	13.4	2460.0
13:01	15:30	Downstream farm	0.011	0.024	<0.03	0.384	0.50	4.0	3.74	24.0	3310.0
13:12	15:30	Left Fork	0.007	0.016	0.03	0.192	0.52	1.4	4.50	13.2	4810.0
11:53	15:30	House well	0.025	0.012	0.03	0.498	0.58	0.5	6.15	4.1	228.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
8/20/2015	**8/20/2015**	**Storm flow**									
11:32	14:05	Spring	0.009	0.276	0.07	0.337	0.89	223.6	17.88	148.3	3270.0
11:49	14:05	Downstream farm	0.015	0.022	0.03	0.491	0.53	2.2	5.94	39.3	66.3
12:04	14:05	Left Fork	0.009	0.028	0.04	0.306	0.42	2.3	5.12	48.8	3930.0
10:52	14:05	House well	0.012	0.018	<0.03	0.545	0.56	0.9	6.63	1.0	29.5
8/27/2015	**8/27/2015**	**Base flow**									
12:48	15:35	Spring	0.007	0.158	0.04	0.329	0.69	103.7	9.07	27.2	7540.0
12:37	15:35	Upstream farm	0.005	0.028	0.04	0.084	0.28	2.9	4.30	104.6	7710.0
1:20	15:35	Downstream farm	0.013	0.024	<0.03	0.450	0.54	2.5	4.43	137.4	5730.0
1:30	15:35	Left Fork	0.008	0.024	0.02	0.218	0.33	2.0	3.79	7.4	3010.0
12:20	15:35	House well	0.012	0.018	<0.03	0.599	0.61	1.6	3.66	1.0	61.3
9/2/2015	**9/2/2015**	**Base flow**									
12:06	14:45	Spring	0.007	0.620	0.10	0.304	1.27	2.47	402.7	155.3	15530.0
11:50	14:45	Upstream farm	0.007	0.042	0.07	0.047	0.39	3.37	5.5	46.4	9070.0
12:19	14:45	Downstream farm	0.010	0.020	0.01	0.449	0.55	3.2	4.80	20.3	6630.0
12:30	14:45	Left Fork	0.010	0.020	0.01	0.449	0.55	3.19	4.8	20.3	6630.0
11:30	14:45	House well	0.007	0.020	0.03	0.109	0.33	1.67	3.8	26.9	5290.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
9/10/2015	**9/10/2015**	**Base flow**									
12:45	15:15	Spring	0.004	0.026	0.02	0.197	0.39	6.50	3.5	980.4	38730.0
12:59	15:15	Downstream farm	0.008	0.028	0.02	0.464	0.58	3.96	2.9	66.3	5470.0
13:10	15:15	Left Fork	0.006	0.026	<0.03	0.198	0.34	4.09	2.5	21.6	7230.0
11:56	15:15	House well	0.010	0.018	<0.03	0.576	0.60	3.21	0.3	8.6	727.0
9/16/2015	**9/16/2015**	**Base flow**									
11:41	14:40	Spring	0.004	0.176	<0.03	0.260	0.70	5.84	111.2	130.9	8330.0
12:06	14:40	Upstream farm	0.004	0.024	<0.03	0.104	0.30	4.62	2.1	50.4	3590.0
12:24	14:40	Downstream farm	0.009	0.030	0.01	0.404	0.62	4.59	1.4	6.2	4800.0
12:36	14:40	Left Fork	0.006	0.032	<0.03	0.146	0.48	2.49	1.3	38.2	6333.0
11:52	14:40	House well	0.009	0.020	<0.03	0.559	0.60	2.58	0.2	1.0	148.3
9/24/2015	**9/24/2015**	**Base flow**									
11:40	14:30	Spring	0.006	0.024	<0.03	0.216	0.42	10.59	12.3	8.6	1119.9
11:30	14:30	Upstream farm	0.006	0.078	<0.03	0.200	0.41	5.92	14.8	17.1	4570.0
12:07	14:30	Downstream farm	0.009	0.018	<0.03	0.449	0.56	5.58	1.2	29.9	7540.0
12:18	14:30	Left Fork	0.007	0.016	0.01	0.098	0.20	3.08	0.6	31.3	3410.0
11:19	14:30	House well	0.009	0.012	<0.03	0.543	0.58	7.72	0.3	<1.0	24.6

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
9/30/2015	**9/30/2015**	**Base flow**									
12:00	15:15	Spring	0.005	0.630	0.11	0.178	1.15	15.88	450.3	137.6	36540.0
11:50	15:15	Downstream farm	0.008	0.022	0.01	0.472	0.66	5.43	4.5	31.7	5290.0
11:42	15:15	Left Fork	0.007	0.018	<0.03	0.082	0.20	4.98	1.2	18.3	5940.0
12:43	15:15	House well	0.009	0.016	<0.03	0.499	0.60	4.20	0.5	<1.0	2.0
10/8/2015	**10/8/2015**	**Base flow**									
11:32	14:05	Spring	0.003	0.018	0.02	0.176	0.27	4.5	2.43	<1.0	686.7
11:20	14:05	Downstream farm	0.005	0.020	0.02	0.517	0.60	1.5	1.62	21.3	12360.0
11:10	14:05	Left Fork	0.003	0.020	0.02	0.069	0.15	1.5	1.58	59.8	3640.0
12:15	14:05	House well	0.008	0.020	0.02	0.518	0.53	0.5	1.54	<1.0	<1
10/14/2015	**10/14/2015**	**Base flow**									
11:42	14:40	Spring	0.008	0.056	0.03	0.193	0.36	27.5	1.50	<1.0	248.1
11:28	14:40	Downstream farm	0.010	0.056	0.03	0.603	0.76	12.4	1.33	7.3	8164.0
11:17	14:40	Left Fork	0.009	0.022	0.01	0.078	0.16	2.2	1.28	9.8	1986.3
12:10	14:40	House well	0.012	0.020	<0.03	0.490	0.63	0.3	0.94	<1.0	<1
10/22/2015	**10/22/2015**	**Base flow**									
12:35	13:45	Spring	0.005	0.028	0.03	0.173	0.33	11.4	6.99	<1.0	307.6

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:15	13:45	Downstream farm	0.008	0.018	0.07	0.548	0.69	2.3	3.64	17.8	3140.0
12:05	13:45	Left Fork	0.008	0.018	<0.03	0.069	0.13	1.9	3.57	3.1	1732.9
13:10	13:45	House well	0.010	0.014	0.04	0.478	0.50	0.4	1.93	<1.0	2.0
10/28/2015	**10/28/2015**	**Base flow**									
12:10	14:25	Spring	0.005	0.112	0.05	0.247	0.55	66.2	4.89	179.3	3950.0
11:56	14:25	Downstream farm	0.009	0.032	0.03	0.544	0.78	1.7	3.91	35.0	6700.0
11:46	14:25	Left Fork	0.007	0.024	0.02	0.060	0.24	1.9	2.90	61.3	3410.0
12:55	14:25	House well	0.008	0.016	0.01	0.391	0.54	<6.58	2.40	<1.0	<1
11/4/2015	**11/4/2015**	**Base flow**									
12:14	14:50	Spring	0.007	0.026	0.07	0.139	0.33	0.7	5.44	8.4	920.8
12:03	14:50	Downstream farm	0.010	0.038	<0.03	0.607	0.76	1.7	3.79	23.1	2880.0
11:54	14:50	Left Fork	0.007	0.018	<0.03	0.072	0.18	0.7	3.98	77.6	>2419.2
12:41	14:50	House well	0.010	0.016	<0.03	0.468	0.54	<6.58	2.62	<1.0	<1
11/12/2015	**11/12/2015**	**Base flow**									
12:15	15:00	Spring	0.007	0.064	<0.03	0.187	0.43	33.6	5.46	72.7	>2419.2
12:26	15:00	Upstream farm	0.015	0.022	<0.03	0.127	0.22	0.9	2.51	117.8	2620.0
12:03	15:00	Downstream farm	0.013	0.044	<0.03	0.439	0.64	6.9	2.14	75.9	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:54	15:00	Left Fork	0.005	0.016	<0.03	0.215	0.34	1.1	2.50	25.6	3360.0
12:42	15:00	House well	0.009	0.012	<0.03	0.501	0.55	0.3	3.71	<1.0	<1
11/18/2015	**11/18/2015**	**Base flow**									
11:37	15:05	Spring	0.011	0.030	0.01	0.168	0.43	1.8	5.47	461.1	13130.0
11:50	15:05	Upstream farm	0.013	0.046	0.06	0.229	0.41	4.0	2.55	517.2	5810.0
11:25	15:05	Downstream farm	0.017	0.050	0.09	0.334	0.56	4.5	2.88	435.2	14550.0
11:15	15:05	Left Fork	0.020	0.062	0.08	0.432	0.73	7.4	3.72	686.7	23590.0
12:15	15:05	Ephemeral stream	0.012	0.040	0.07	1.262	1.57	2.7	3.23	325.5	10710.0
12:28	15:05	Trench 1	0.005	0.030	0.02	0.264	0.52	1.9	1.74	65.7	17930.0
12:50	15:05	House well	0.009	0.014	<0.03	0.464	0.59	0.4	0.48	<1.0	<1
12/2/2015	**12/2/2015**	**Base flow**									
12:15	15:35	Spring	0.011	0.014	<0.03	1.262	1.63	1.9	2.51	109.2	2419.2
13:22	15:35	Upstream farm	0.010	0.020	0.03	0.135	0.22	1.4	0.98	55.6	1986.3
11:57	15:35	Downstream farm	0.012	0.022	0.02	0.266	0.39	1.6	0.94	48.0	9600.0
11:40	15:35	Left Fork	0.014	0.024	0.01	0.302	0.43	1.6	1.36	66.9	1986.3
12:27	15:35	Ephemeral stream	0.011	0.024	<0.03	0.613	0.89	1.0	1.01	145.0	1986.3

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:48	15:35	Trench 1	0.006	0.008	<0.03	0.218	0.33	1.3	1.10	6.3	5810.0
13:38	15:35	House well	0.011	0.014	0.02	0.480	0.60	0.9	1.38	1.0	1.0
Sample analyses since the last quarterly report											
12/14/2015	**12/14/2015**	**Base flow**									
12:45	16:00	Spring	0.007	0.024	<0.03	0.744	0.94	0.5	3.86	No Data	3230.0
13:00	16:00	Upstream farm	0.009	0.030	<0.03	0.364	0.58	3.4	11.89	118.7	2810.0
12:30	16:00	Downstream farm	0.009	0.034	0.05	0.181	0.27	4.1	4.10	410.6	4080.0
12:20	16:00	Left Fork	0.012	0.048	0.07	0.235	0.38	11.2	3.24	325.5	4520.0
15:15	16:00	Ephemeral stream	0.014	0.056	0.06	0.298	0.50	10.8	3.92	410.6	6010.0
13:30	16:00	Trench 1	0.004	0.012	<0.03	0.299	0.36	1.1	3.44	8.4	10460.0
13:38	16:00	House well	0.011	0.010	<0.03	0.545	0.57	0.1	10.15	<1.0	1.0
12/22/2015	**12/22/2015**	**Base flow**									
11:35	14:45	Spring	0.008	0.018	<0.03	0.531	0.58	0.7	1.23	146.7	1203.3
12:38	14:45	Upstream	0.010	0.020	<0.03	0.092	0.14	0.4	0.94	50.4	648.8
11:02	14:45	Downstream	0.011	0.020	<0.03	0.245	0.32	1.0	1.12	31.8	980.4
10:48	14:45	Left Fork	0.013	0.020	<0.03	0.267	0.35	0.1	1.36	26.5	1299.7
11:46	14:45	Ephemeral	0.010	0.016	<0.03	1.452	1.68	0.7	2.41	52.9	1299.7

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:14	14:45	Trench 1	0.005	0.010	<0.03	0.157	0.20	0.3	0.89	1.0	435.2
12:25	14:45	House well	0.010	0.016	<0.03	0.534	0.59	0.3	1.40	<1.0	<1.0
1/5/2016	**1/25/2016**	**Base flow**									
11:52	15:29	Spring	0.007	0.024	<0.03	0.584	0.63	0.7	1.39	16.0	816.4
13:00	15:29	Upstream	0.008	0.026	<0.03	0.158	0.20	0.5	0.95	67.7	648.8
11:40	15:29	Downstream	0.011	0.026	<0.03	0.419	0.46	0.1	1.13	40.8	648.8
11:30	15:29	Left Fork	0.013	0.028	<0.03	0.427	0.48	0.7	1.51	34.1	686.7
12:02	15:29	Ephemeral	0.007	0.018	<0.03	0.883	1.00	1.2	2.15	32.7	686.7
12:13	15:29	Trench 1	0.003	0.016	<0.03	0.243	0.29	0.9	1.11	1.0	209.8
12:44	15:29	House well	0.008	0.020	<0.03	0.528	0.57	0.9	1.08	<1.0	1.0
1/25/2016	**1/25/2016**	**Base flow**									
11:16	15:25	Spring	0.010	0.022	<0.03	0.565	0.60	0.3	1.27	34.5	1732.9
12:10	15:25	Upstream	0.010	0.022	<0.03	0.068	0.09	1.1	1.52	16.9	290.9
11:00	15:25	Downstream	0.011	0.022	<0.03	0.213	0.24	0.7	1.29	8.6	365.4
10:48	15:25	Left Fork	0.010	0.024	<0.03	0.198	0.25	1.0	1.30	21.1	435.2
11:28	15:25	Ephemeral	0.011	0.030	<0.03	0.762	0.87	9.8	3.10	1.0	816.4
11:42	15:25	House well	0.012	0.020	<0.03	0.602	0.55	0.5	2.36	<1.0	<1
2/10/2016	**2/10/2016**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:25	15:26	Spring	0.007	0.040	<0.03	0.634	0.80	17.7	2.70	1.0	325.5
11:15	15:26	Upstream	0.005	0.016	<0.03	0.048	0.11	0.5	1.11	14.5	178.5
11:04	15:26	Downstream	0.005	0.016	<0.03	0.198	0.24	0.9	0.99	4.1	218.7
11:29	15:26	Left Fork	0.003	0.012	<0.03	0.175	0.24	0.8	1.15	7.4	209.8
12:03	15:26	House well	0.007	0.014	<0.03	0.542	0.56	0.1	0.63	<1.0	<1.0
2/24/2016	**2/24/2016**	**Base flow**									
11:05	14:45	Spring	0.010	0.052	<0.03	1.102	1.46	2.8		209.8	3930.0
12:16	14:45	Upstream	0.014	0.052	<0.03	0.099	0.28	6.1		1203.3	7330.0
10:52	14:45	Downstream	0.015	0.058	<0.03	0.142	0.37	8.3		1986.3	6500.0
10:38	14:45	Left Fork	0.015	0.088	<0.03	0.249	0.63	15.6		2780.0	14390.0
11:15	14:45	Ephemeral	0.010	0.056	<0.03	0.195	0.40	12.8		387.3	4870.0
11:36	14:45	Trench 1	0.005	0.014	<0.03	0.345	0.39	2.1		<1.0	9070.0
11:53	14:45	House well	0.010	0.010	<0.03	0.582	0.55	1.3		<1.0	<1.0

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.
§ N.S. is No Sample.

Nutrients, Sediment, and Bacteria by Date Spring, Upstream, and Downstream Sites

Table 4. Water quality analyses in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application since January 2015, with those collected since the last report noted.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	---------- mg/L ----------							--- MPN/100 mL ---	
1/8/2015									
Upstream	0.009	0.022	<0.03	0.187	0.21	2.3	1.41	30.9	547.5
Downstream	0.011	0.024	<0.03	0.376	0.39	2.5	1.22	42.6	980.4
1/14/2015									
Upstream	0.012	0.032	<0.03	0.135	0.19	1.1	3.02	88.2	727.0
Downstream	0.011	0.020	<0.03	0.388	0.34	1.0	2.03	25.6	613.1
1/21/2015									
Upstream	0.008	0.018	<0.03	0.089	0.12	1.1	0.95	70.3	579.4
Downstream	0.010	0.026	0.06	0.197	0.30	1.1	1.60	37.4	613.1
1/29/2015									
Upstream	0.006	0.060	<0.03	0.065	0.21	47.8	1.71	727.0	1413.6
Downstream	0.009	0.020	0.04	0.168	0.27	1.3	1.50	19.9	1046.2

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
2/3/2015									
Upstream	0.006	0.022	<0.03	0.051	0.28	1.1	2.69	4.1	1203.3
Downstream	0.009	0.018	<0.03	0.140	0.29	4.1	2.66	1.0	547.5
2/10/2015									
Upstream	0.009	0.012	<0.03	0.056	0.09	0.7	1.04	1119.1	2419.2
Downstream	0.011	0.012	<0.03	0.143	0.23	1.0	1.15	7.4	1553.1
2/26/2015									
Upstream	0.006	0.024	<0.03	0.100	0.13	0.6	1.20	47.9	686.7
Downstream	0.008	0.026	0.02	0.200	0.25	0.8	1.17	48.7	866.4
3/3/2015									
Upstream	0.006	0.026	0.02	0.048	0.11	N.D.	1.50	N.S.	N.S.
Downstream	0.007	0.028	<0.03	0.138	0.23	N.D.	1.50	N.S.	N.S.
3/11/2015									
Upstream	0.005	0.026	0.02	0.118	0.16	2.1	3.38	34.5	579.4
Downstream	0.007	0.030	0.02	0.209	0.27	1.8	1.44	66.3	770.1
3/19/2015									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.007	0.024	0.04	0.111	0.20	1.7	2.53	42.6	866.4
Downstream	0.009	0.028	0.04	0.234	0.35	2.8	2.87	71.7	1119.9
3/25/2015									
Upstream	0.006	0.028	0.02	0.056	0.16	2.9	1.36	125.9	2419.2
Downstream	0.008	0.036	0.04	0.162	0.29	5.0	1.41	547.5	3410.0
3/26/2015									
Upstream	0.013	0.076	0.06	0.144	0.41	14.1	3.94	816.4	4960.0
Downstream	0.004	0.026	0.02	0.904	1.00	15.4	0.69	<1.0	1553.1
4/2/2015									
Upstream	0.007	0.040	0.02	0.045	0.14	3.1	3.61	166.9	2419.2
Downstream	0.007	0.042	0.02	0.139	0.22	2.5	2.71	121.1	1986.3
4/9/2015									
Upstream	0.011	0.042	0.04	0.066	0.18	13.1	2.13	86.0	2650.0
Downstream	0.010	0.048	0.03	0.157	0.25	19.7	1.82	47.2	1986.3
4/15/2015									
Upstream	0.007	0.040	0.03	0.090	0.16	3.5	3.24	648.8	4040.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.009	0.048	0.03	0.166	0.26	4.4	2.67	344.8	2920.0
4/23/2015									
Upstream	0.007	0.032	0.03	0.083	0.18	4.0	5.11	104.6	2419.2
Downstream	0.007	0.032	0.03	0.162	0.25	2.6	2.51	65.7	2419.2
4/29/2015									
Upstream	0.010	0.020	0.03	0.082	0.13	2.7	1.58	58.3	1732.4
Downstream	0.012	0.018	0.03	0.189	0.82	2.1	1.64	58.6	1986.3
5/7/2015									
Upstream	0.008	0.032	0.01	0.110	0.16	7.5	10.16	77.6	3280.0
Downstream	0.009	0.034	<0.03	0.267	0.36	4.5	7.70	27.8	2280.0
5/8/2015									
Upstream	0.195	0.544	0.27	0.292	1.20	113.2	7.47	N.S.	N.S.
Downstream	0.005	0.254	0.41	2.287	3.23	127.1	6.45	N.S.	N.S.
5/11/2015									
Upstream	0.004	0.074	0.04	0.004	0.24	4.5	4.31	N.S.	N.S.
Downstream	0.031	0.530	0.11	0.071	1.12	277.5	8.48	N.S.	N.S.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/14/2015									
Upstream	0.011	0.046	0.02	0.177	0.23	2.8	1.35	145.5	2470.0
Downstream	0.015	0.050	0.02	0.326	0.39	6.1	1.16	128.1	4370.0
5/18/2015									
Upstream	0.007	0.034	0.02	0.110	0.15	5.2	1.29	137.6	2419.2
Downstream	0.009	0.040	0.03	0.201	0.25	6.1	1.47	185.0	6770.0
5/26/2015									
Upstream	0.012	0.044	0.04	0.080	0.19	6.4	1.50	N.S.	N.S.
Downstream	0.045	0.200	0.11	0.096	0.56	94.7	4.57	N.S.	N.S.
6/1/2015									
Downstream	0.006	0.050	0.05	0.109	0.25	13.7	1.80	N.S.	N.S.
6/4/2015									
Upstream	0.008	0.026	0.03	0.083	0.11	2.3	2.93	38.6	>2419.2
Downstream	0.009	0.034	<0.03	0.184	0.23	1.7	2.64	24.7	2419.2
6/8/2015									
Upstream	0.010	0.030	0.06	0.058	0.24	4.5	3.63	866.4	2780.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.009	0.022	0.05	0.185	0.27	0.9	2.66	57.4	4640.0
6/17/2015									
Upstream farm	0.009	0.036	0.03	0.050	0.16	3.5	2.83	435.2	13130.0
Downstream	0.007	0.034	0.03	0.106	0.23	2.3	2.92	344.8	20980.0
6/22/2015									
Upstream	0.010	0.030	0.01	0.042	0.05	2.9	0.99	78.0	4960.0
Downstream	0.009	0.032	0.04	0.136	0.16	2.9	1.15	36.8	5040.0
6/29/2015									
Upstream	0.010	0.028	0.14	0.055	0.13	2.7	2.49	117.8	4710
Downstream	0.068	0.748	0.17	0.147	1.88	571	6.57	N.S.	N.S.
7/6/2015									
Downstream	0.275	0.380	0.22	0.204	1.03	19.1	7.91	N.S.	N.S.
7/9/2015									
Upstream	0.013	0.048	0.02	0.087	0.18	6.8	2.75	201.4	10140.0
Downstream	0.014	0.050	0.03	0.117	0.24	8.8	2.32	275.5	10760.0
7/16/2015									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.011	0.030	<0.03	0.195	0.33	0.5	1.35	11.8	6310.0
7/23/2015									
Upstream	0.009	0.026	0.02	0.096	0.18	1.3	0.97	93.3	7490.0
Downstream	0.011	0.028	0.02	0.198	0.31	0.8	1.06	16.8	4870.0
7/30/2015									
Upstream	0.014	0.024	<0.03	0.101	0.15	0.9	1.61	27.2	2880.0
Downstream	0.012	0.022	0.02	0.268	0.38	1.9	2.16	11.9	6500.0
8/6/2015									
Upstream	0.009	0.028	<0.03	0.147	0.24	1.8	3.37	488.4	13540.0
Downstream	0.010	0.028	0.03	0.406	0.52	1.7	3.06	40.2	10390.0
8/13/2015									
Upstream	0.013	0.018	0.04	0.124	0.16	0.3	4.32	13.4	2460.0
Downstream	0.011	0.024	<0.03	0.384	0.50	4.0	3.74	24.0	3310.0
8/20/2015									
Downstream	0.015	0.022	0.03	0.491	0.53	2.2	5.94	39.3	66.3
8/27/2015									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.005	0.028	0.04	0.084	0.28	2.9	4.30	104.6	7710.0
Downstream	0.013	0.024	<0.03	0.450	0.54	2.5	4.43	137.4	5730.0
9/2/2015									
Upstream	0.007	0.042	0.07	0.047	0.39	3.37	5.5	46.4	9070.0
Downstream	0.010	0.020	0.01	0.449	0.55	3.2	4.80	20.3	6630.0
9/10/2015									
Downstream	0.008	0.028	0.02	0.464	0.58	3.96	2.9	66.3	5470.0
9/16/2015									
Upstream	0.004	0.024	<0.03	0.104	0.30	4.62	2.1	50.4	3590.0
Downstream	0.009	0.030	0.01	0.404	0.62	4.59	1.4	6.2	4800.0
9/24/2015									
Upstream	0.006	0.078	<0.03	0.200	0.41	5.92	14.8	17.1	4570.0
Downstream	0.009	0.018	<0.03	0.449	0.56	5.58	1.2	29.9	7540.0
9/30/2015									
Downstream	0.008	0.022	0.01	0.472	0.66	5.43	4.5	31.7	5290.0
10/8/2015									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.005	0.020	0.02	0.517	0.60	1.5	1.62	21.3	12360.0
10/14/2015									
Downstream	0.005	0.020	0.02	0.517	0.60	1.5	1.62	21.3	12360.0
10/14/2015									
Downstream	0.010	0.056	0.03	0.603	0.76	12.4	1.33	7.3	8164.0
10/22/2015									
Downstream	0.008	0.018	0.07	0.548	0.69	2.3	3.64	17.8	3140.0
10/28/2015									
Downstream	0.009	0.032	0.03	0.544	0.78	1.7	3.91	35.0	6700.0
11/4/2015									
Downstream	0.010	0.038	<0.03	0.607	0.76	1.7	3.79	23.1	2880.0
11/12/2015									
Upstream	0.015	0.022	<0.03	0.127	0.22	0.9	2.51	117.8	2620.0
Downstream	0.013	0.044	<0.03	0.439	0.64	6.9	2.14	75.9	>2419.2
11/18/2015									
Upstream	0.013	0.046	0.06	0.229	0.41	4.0	2.55	517.2	5810.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.017	0.050	0.09	0.334	0.56	4.5	2.88	435.2	14550.0
12/2/2015									
Upstream	0.010	0.020	0.03	0.135	0.22	1.4	0.98	55.6	1986.3
Downstream	0.012	0.022	0.02	0.266	0.39	1.6	0.94	48.0	9600.0
Sample analyses since the last quarterly report									
12/14/2015									
Upstream	0.009	0.034	0.05	0.181	0.27	4.1	4.10	410.6	4080.0
Downstream	0.012	0.048	0.07	0.235	0.38	11.2	3.24	325.5	4520.0
12/22/2015									
Upstream	0.010	0.020	<0.03	0.092	0.14	0.4	0.94	50.4	648.8
Downstream	0.011	0.020	<0.03	0.245	0.32	1.0	1.12	31.8	980.4
1/5/2016									
Upstream	0.008	0.026	<0.03	0.158	0.20	0.5	0.95	67.7	648.8
Downstream	0.011	0.026	<0.03	0.419	0.46	0.1	1.13	40.8	648.8
1/25/2016									
Upstream	0.010	0.022	<0.03	0.068	0.09	1.1	1.52	16.9	290.9

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.011	0.022	<0.03	0.213	0.24	0.7	1.29	8.6	365.4
2/10/2016									
Upstream	0.005	0.016	<0.03	0.048	0.11	0.5	1.11	14.5	178.5
Downstream	0.005	0.016	<0.03	0.198	0.24	0.9	0.99	4.1	218.7
2/24/2016									
Upstream	0.014	0.052	<0.03	0.099	0.28	6.1		1203.3	7330.0
Downstream	0.015	0.058	<0.03	0.142	0.37	8.3		1986.3	6500.0

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

§ N.S. is No Sample.

† N.D. is No Data.

Nutrients, Sediment, and Bacteria by Site for Ephemeral Stream, House Well, Trenches, Left Fork and Field Runoff

Table 5. Water quality analyses at the ephemeral stream draining the subwatershed containing the production houses and manure holding ponds, and surface runoff from Fields 1, 5a, and 12 since January, 2015, with those collected since the last report noted.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
Ephemeral stream									
1/8/2015	0.008	0.022	<0.03 ¶	0.448	0.59	2.4	1.73	25.6	1203.3
1/15/2015	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6
1/21/2015	0.005	0.016	<0.03	0.370	0.46	1.0	2.34	155.3	2419.2
2/26/2015	0.006	0.022	<0.03	0.530	0.57	1.3	1.38	16.1	4790.0
3/3/2015	0.006	0.020	<0.03	0.477	0.52	ND	1.84	N.S. §	N.S.
3/11//2015	0.006	0.022	0.04	0.567	0.60	0.5	2.20	6.3	410.0
3/19/2015	0.007	0.018	0.01	0.529	0.63	1.0	4.31	14.6	866.4
3/25/2015	0.007	0.014	0.02	0.462	0.53	1.1	0.64	8.6	344.8
4/2/2015	0.006	0.032	0.02	0.467	0.46	1.8	4.41	5.2	547.5
4/15/2015	0.005	0.026	0.03	0.472	0.56	0.8	1.26	305.0	2430.0
4/23/2015	0.008	0.026	0.03	0.520	0.56	2.0	1.78	12.0	3270.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
4/29/2015	0.012	0.018	0.02	0.569	0.61	3.5	1.98	14.3	4080.0
5/7/2015	0.013	0.066	0.02	0.628	0.71	3.2	16.41	71.7	7170.0
5/8/2015	0.005	0.254	0.41	2.287	3.23	127.1	6.45	5200.0	241920
5/11/2015	0.008	0.146	0.15	0.941	1.80	22.0	8.09	N.S.	N.S.
5/14/2015	0.010	0.022	0.01	0.527	0.50	1.7	0.73	41.3	1986.3
5/18/2015	0.007	0.028	0.03	0.525	0.55	0.7	1.18	90.7	7630.0
5/26/2015	0.017	0.030	0.03	0.514	0.60	0.9	1.12	N.S.	N.S.
6/1/2015	0.002	0.056	0.01	0.851	1.05	18.3	2.46	N.S.	N.S.
6/4/2015	0.010	0.024	0.02	0.572	0.58	0.8	5.35	21.6	3890.0
6/8/2015	0.009	0.020	0.03	0.560	0.62	0.6	2.81	65.7	9870.0
6/17/2015	0.009	0.032	0.04	0.948	1.04	6.7	0.97	770.1	8840.0
6/22/2015	0.011	0.026	0.05	0.563	0.61	1.3	1.21	37.9	2419.2
6/29/2015	0.067	1.268	0.34	0.580	3.42	1366.8	11.04	N.S.	N.S.
7/6/2015	0.063	0.658	0.37	0.717	2.75	567.3	8.52	N.S	N.S.
7/9/2015	0.010	0.034	<0.03	0.569	0.71	4.9	2.56	78.9	5560.0
7/16/2015	0.011	0.046	0.01	0.517	0.61	0.4	2.16	45.7	14830.0
7/23/2015	0.011	0.034	<0.03	0.511	0.68	11.3	0.33	201.4	24950.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
11/18/2015	0.012	0.040	0.07	1.262	1.57	2.7	3.23	325.5	10710
12/2/2015	0.011	0.024	<0.03	0.613	0.89	1.0	1.01	145.0	1986.3
Sample analyses since the last quarterly report									
12/14/2015	0.009	0.030	<0.03	0.364	0.58	3.4	11.89	118.7	2810.0
12/22/2015	0.010	0.016	<0.03	1.452	1.68	0.7	2.41	52.9	1299.7
1/5/2016	0.007	0.018	<0.03	0.883	1.00	1.2	2.15	32.7	686.7
1/25/2016	0.011	0.030	<0.03	0.762	0.87	9.8	3.10	1.0	816.4
2/24/2016	0.010	0.056	<0.03	0.195	0.40	12.8		387.3	4870.0
Interceptor Trench 1 (South)									
1/8/2015	0.005	0.022	<0.03	0.769	0.75	4.7	0.88	1.0	13130.0
1/14/2015	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6
2/26/2015	0.004	0.028	0.01	0.712	0.76	46.0	0.60	1.0	41063.0
3/3/2015	0.003	0.024	<0.03	0.867	0.89	N.D. †	0.95	N.S.	N.S.
3/11/2015	0.003	0.014	0.07	0.989	0.97	0.3	2.00	<1.0	2419.2
3/19/2015	0.003	0.012	0.01	0.849	0.93	<6.58	3.11	1.0	275.5

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/25/2015	0.003	0.008	<0.03	0.838	0.88	0.2	0.59	<1.0	410.6
3/26/2015	0.004	0.026	0.02	0.904	1.00	15.4	0.69	<1.0	1553.1
4/2/2015	0.003	0.028	0.02	0.865	0.87	0.3	3.34	1.1	308.6
4/9/2015	0.006	0.018	<0.03	0.790	0.83	0.8	2.99	<1.0	187.2
4/15/2015	0.003	0.020	<0.03	0.857	0.93	1.3	4.29	<1.0	3180.0
4/23/2015	0.003	0.034	<0.03	0.877	0.97	1.2	1.18	3.1	2690.0
5/11/2015	0.003	0.060	0.02	0.916	0.97	27.6	1.78	N.S.	N.S.
5/14/2015	0.005	0.042	0.02	0.904	0.94	29.9	1.20	81.6	1732.9
5/18/2015	0.002	0.020	<0.03	0.897	0.93	0.3	1.28	32.3	1732.9
5/26/2015	0.007	0.012	0.01	0.752	0.80	1.0	0.78	N.S.	N.S.
6/22/2015	0.005	0.048	0.07	0.653	0.76	47.3	1.86	21.1	1986.3
6/29/2015	0.008	0.022	0.05	0.394	0.42	56.8	4.17	82.3	11450
7/9/2015	0.007	0.030	<0.03	0.520	0.62	7.1	2.52	63.7	12330.0
11/18/2015	0.005	0.030	0.02	0.264	0.52	1.9	1.74	65.7	17930.0
12/2/2015	0.006	0.008	<0.03	0.218	0.33	1.3	1.10	6.3	5810.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Sample analyses since the last quarterly report									
12/14/2015	0.004	0.012	<0.03	0.299	0.36	1.1	3.44	8.4	10460.0
12/22/2015	0.005	0.010	<0.03	0.157	0.20	0.3	0.89	1.0	435.2
1/5/2016	0.003	0.016	<0.03	0.243	0.29	0.9	1.11	1.0	209.8
2/24/2016	0.005	0.014	<0.03	0.345	0.39	2.1		<1.0	9070.0
Interceptor Trench 2 (North)									
3/11/2015	0.003	0.056	0.04	1.443	1.59	1.2	3.51	<1.0	2419.2
3/19/2015	0.004	0.062	0.09	1.036	1.42	1.9	5.12	5.2	2419.2
3/26/2015	0.004	0.126	0.13	0.873	1.44	22.2	4.63	105.4	6950.0
5/11/2015	0.003	0.042	0.05	0.553	0.76	8.8	3.44	N.S.	N.S.
5/14/2015	0.005	0.042	0.02	0.904	0.94	29.9	1.20	81.6	1732.9
5/18/2015	0.002	0.020	<0.03	0.897	0.93	0.3	1.28	32.3	1732.9
5/26/2015	0.007	0.112	0.04	1.190	1.44	131.9	1.23	N.S.	N.S.
Left Fork									
5/14/2015	0.015	0.038	0.02	0.321	0.38	3.3	1.36	83.3	2690.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/18/2015	0.011	0.040	0.04	0.209	0.29	4.1	1.90	167.4	8300.0
5/26/2015	0.014	0.048	0.04	0.139	0.29	6.1	2.41	N.S.	N.S.
6/4/2015	0.008	0.022	<0.03	0.145	0.19	2.1	3.15	38.9	2560.0
6/8/2015	0.006	0.024	0.02	0.102	0.23	1.1	2.78	32.7	4550.0
6/17/2015	0.005	0.026	0.04	0.112	0.22	2.8	1.62	26.2	8550.0
6/22/2015	0.011	0.030	0.02	0.147	0.18	2.5	1.59	35.4	5910.0
6/29/2015	0.010	0.026	0.02	0.189	0.26	2.9	2.80	53.6	10170
7/9/2015	0.015	0.058	0.04	0.138	0.31	11.4	2.67	387.3	12670.0
7/16/2015	0.010	0.042	0.01	0.181	0.28	0.9	1.64	21.6	9330.0
7/23/2015	0.009	0.028	0.04	0.239	0.40	1.4	1.21	35.4	8360.0
7/30/2015	0.008	0.020	0.04	0.221	0.37	2.3	2.60	30.3	8160.0
8/6/2015	0.007	0.026	0.04	0.310	0.47	1.2	3.16	217.8	8130.0
8/13/2015	0.007	0.016	0.03	0.192	0.52	1.4	4.50	13.2	4810.0
8/20/2015	0.009	0.028	0.04	0.306	0.42	2.3	5.12	48.8	3930.0
8/27/2015	0.008	0.024	0.02	0.218	0.33	2.0	3.79	7.4	3010.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
9/2/2015	0.007	0.020	0.03	0.109	0.33	1.67	3.8	26.9	5290.0
9/10/2015	0.006	0.026	<0.03	0.198	0.34	4.09	2.5	21.6	7230.0
9/16/2015	0.006	0.032	<0.03	0.146	0.48	2.49	1.3	38.2	6333.0
9/24/2015	0.007	0.016	0.01	0.098	0.20	3.08	0.6	31.3	3410.0
9/30/2015	0.007	0.018	<0.03	0.082	0.20	4.98	1.2	18.3	5940.0
10/8/2015	0.003	0.020	0.02	0.069	0.15	1.5	1.58	59.8	3640.0
10/14/2015	0.009	0.022	0.01	0.078	0.16	2.2	1.28	9.8	1986.3
10/22/2015	0.008	0.018	<0.03	0.069	0.13	1.9	3.57	3.1	1732.9
10/28/2015	0.007	0.024	0.02	0.060	0.24	1.9	2.90	61.3	3410.0
11/4/2015	0.007	0.018	<0.03	0.072	0.18	0.7	3.98	77.6	>2419.2
11/12/2015	0.005	0.016	<0.03	0.215	0.34	1.1	2.50	25.6	3360.0
11/18/2015	0.020	0.062	0.08	0.432	0.73	7.4	3.72	686.7	23590.0
12/2/2015	0.014	0.024	0.01	0.302	0.43	1.6	1.36	66.9	1986.3
Sample analyses since the last quarterly report									
2/14/2015	0.014	0.056	0.06	0.298	0.50	10.8	3.92	410.6	6010.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
12/22/2015	0.013	0.020	<0.03	0.267	0.35	0.1	1.36	26.5	1299.7
1/5/2016	0.013	0.028	<0.03	0.427	0.48	0.7	1.51	34.1	686.7
1/25/2016	0.010	0.024	<0.03	0.198	0.25	1.0	1.30	21.1	435.2
2/10/2016	0.003	0.012	<0.03	0.175	0.24	0.8	1.15	7.4	209.8
2/24/2016	0.015	0.088	<0.03	0.249	0.63	15.6		2780.0	14390.0
Field 1									
3/26/2015	0.143	0.346	0.41	0.216	2.68	65.5	15.65	N.S.	N.S.
5/8/2015	0.525	0.714	0.16	0.475	2.19	16.9	13.28	N.S.	N.S.
5/11/2015	0.251	0.386	0.09	0.055	0.86	44.4	6.31	N.S.	N.S.
5/18/2015	0.208	0.512	0.54	0.410	3.59	53.7	26.12	N.S.	N.S.
5/26/2015	0.245	0.432	0.20	0.174	1.66	37.8	11.28	N.S.	N.S.
6/29/2015	0.354	0.524	0.37	0.226	1.64	11	11.32	N.S.	N.S.
7/6/2015	0.387	0.444	0.23	0.345	1.30	4.9	8.32	N.S.	N.S.
Field 5a									
3/26/2015	0.813	1.330	0.39	0.225	2.59	72.3	15.95	N.S.	N.S.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/8/2015	0.248	0.968	0.26	0.127	1.50	320.1	8.58	N.S.	N.S.
7/6/2015	0.796	0.910	0.13	0.567	1.58	29.0	7.67	N.S.	N.S.
Field 12									
5/8/2015	0.675	0.956	0.14	0.303	1.82	57.0	16.00	N.S.	N.S.
5/11/2015	0.194	0.364	0.09	0.135	0.83	36.7	7.03	N.S.	N.S.
7/6/2015	0.094	0.448	0.13	0.172	1.01	261.3	4.38	N.S.	N.S.

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.

§ N.S. is No Sample. E. coli and total coliform were not measured on surface runoff samples collected by ISCO samplers when sample holding time exceeded the required 8-hour threshold.

† N.D. is No Data

Temporal Trends in Phosphorus, Nitrogen and Bacteria in Big Creek Above and Below the C&H Farm

The concentration of P, N and bacteria forms in Big Creek above and below the C&H Farm are presented in subsequent figures to show the season / temporal trends in measured concentrations (Figures 2, 3, 4, 5, 6, and 7).

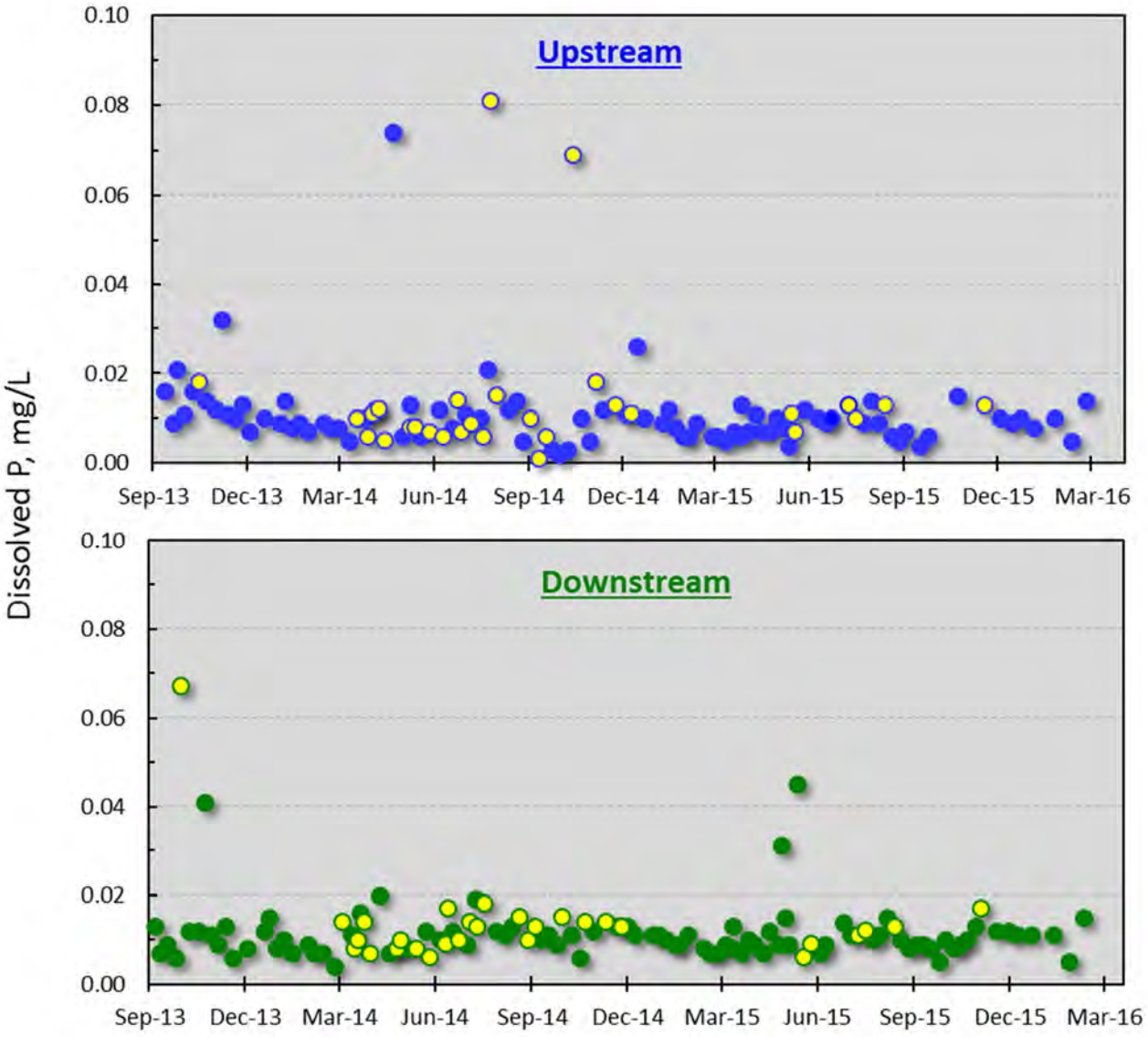

Figure 2. Dissolved P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

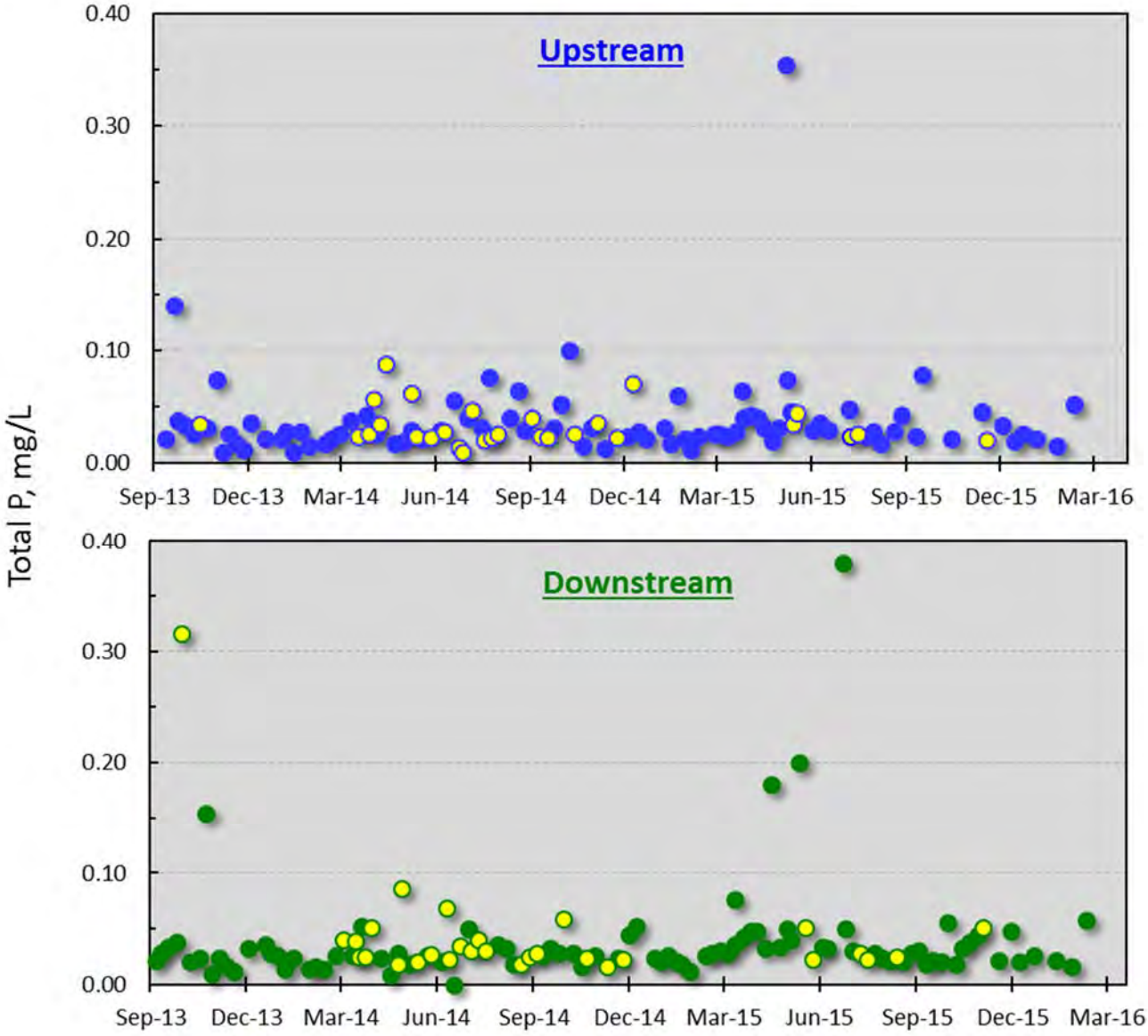

Figure 3. Total P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

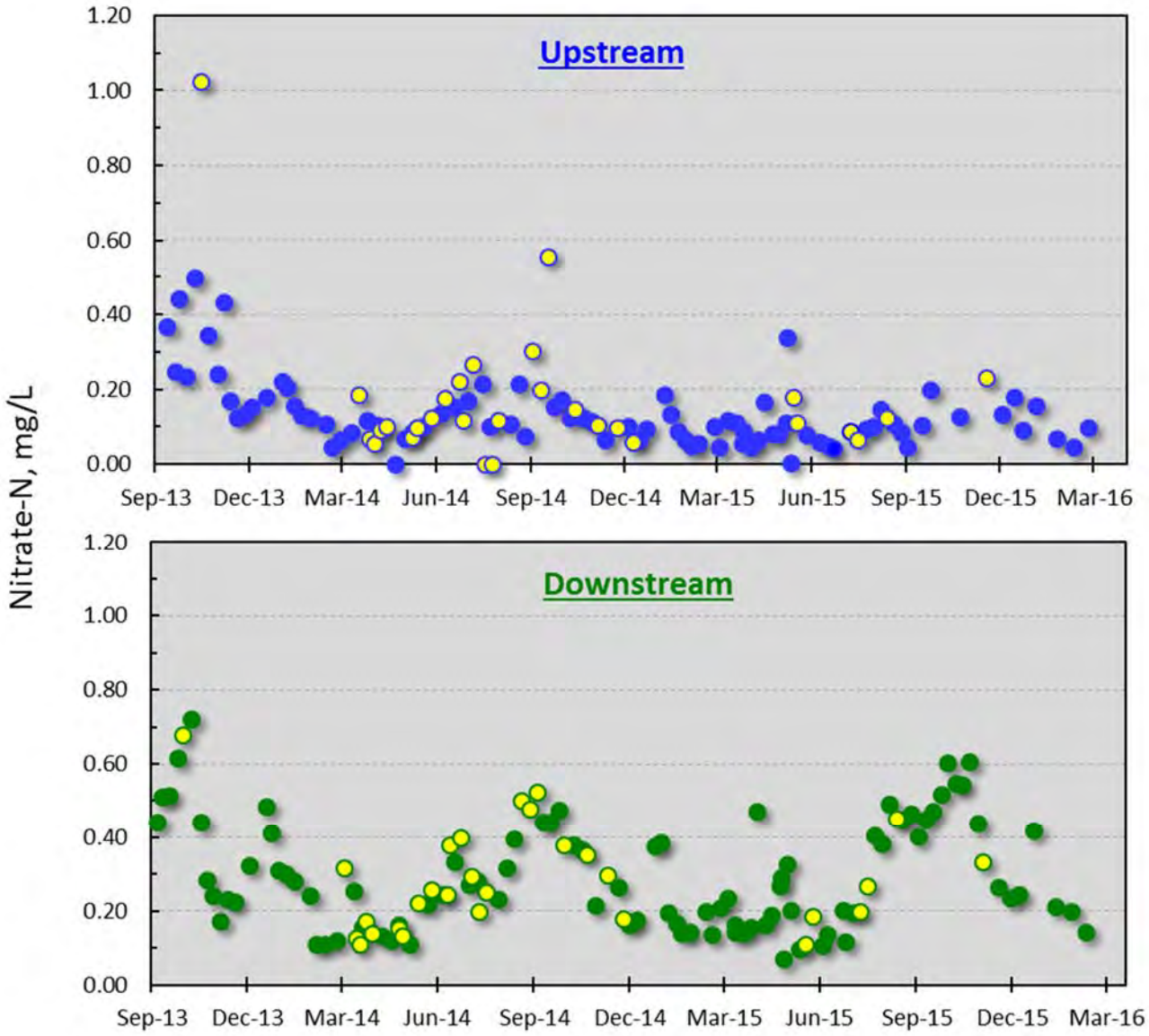

Figure 4. Nitrate-N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

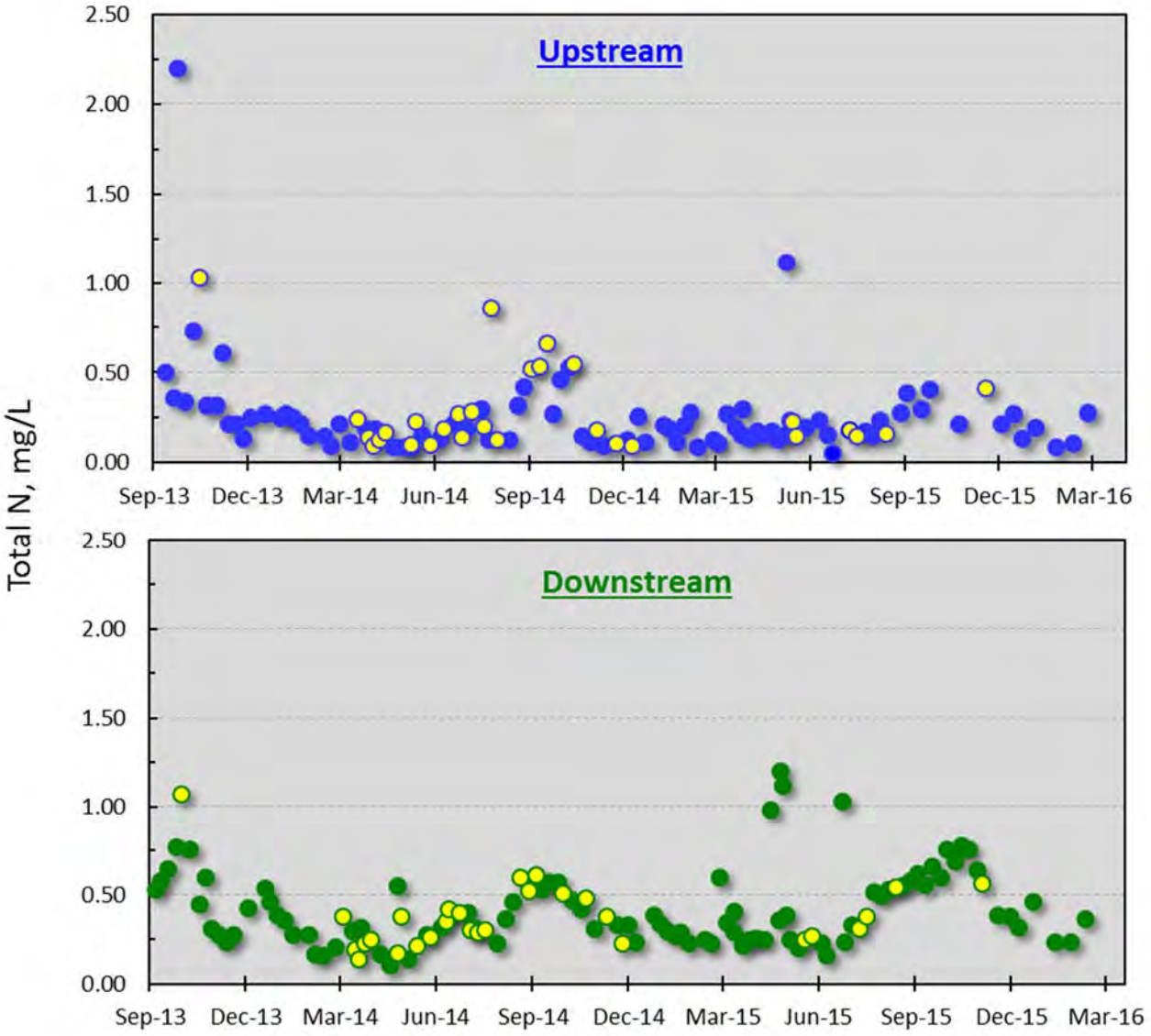

Figure 5. Total N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

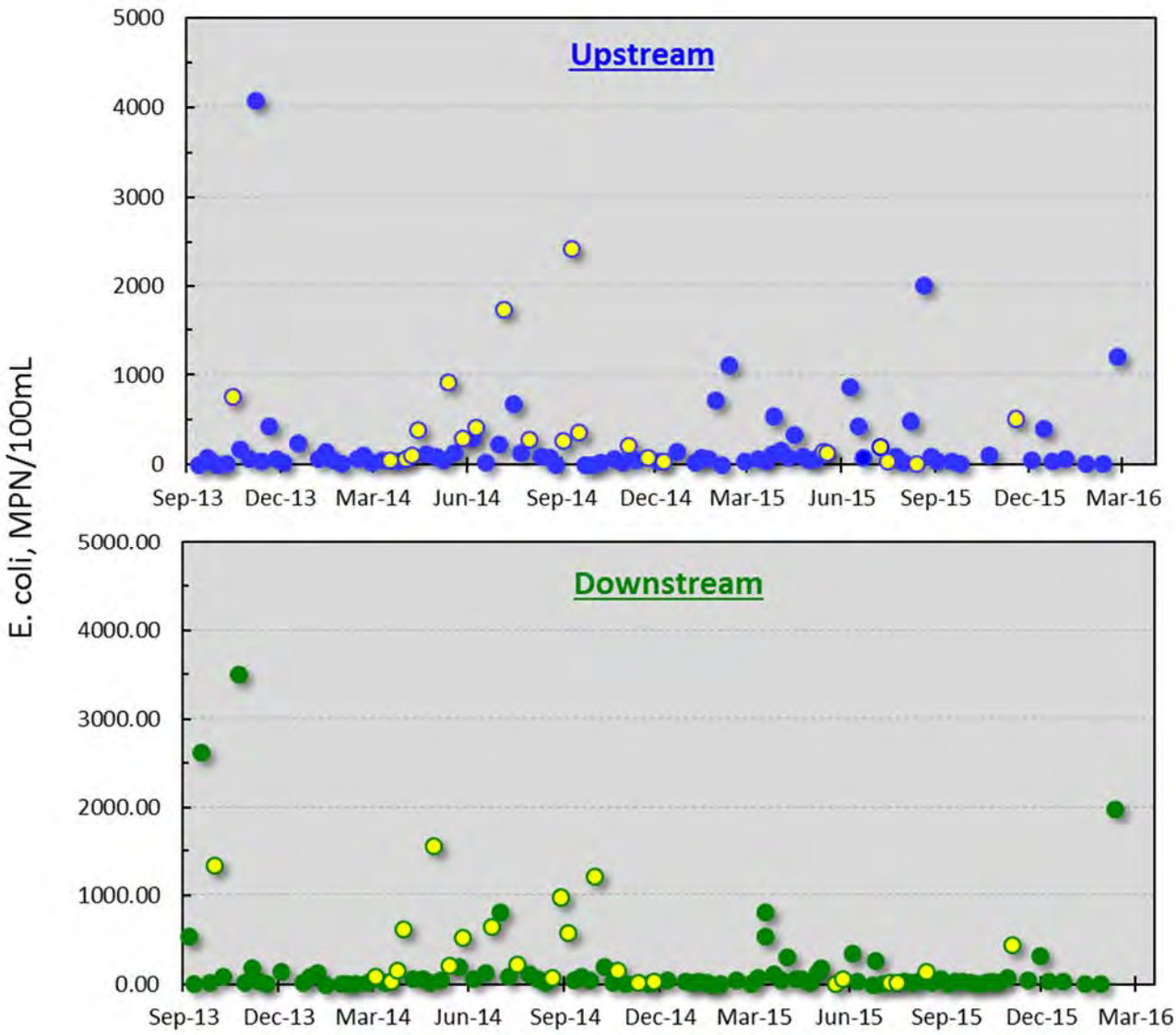

Figure 6. E. coli numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

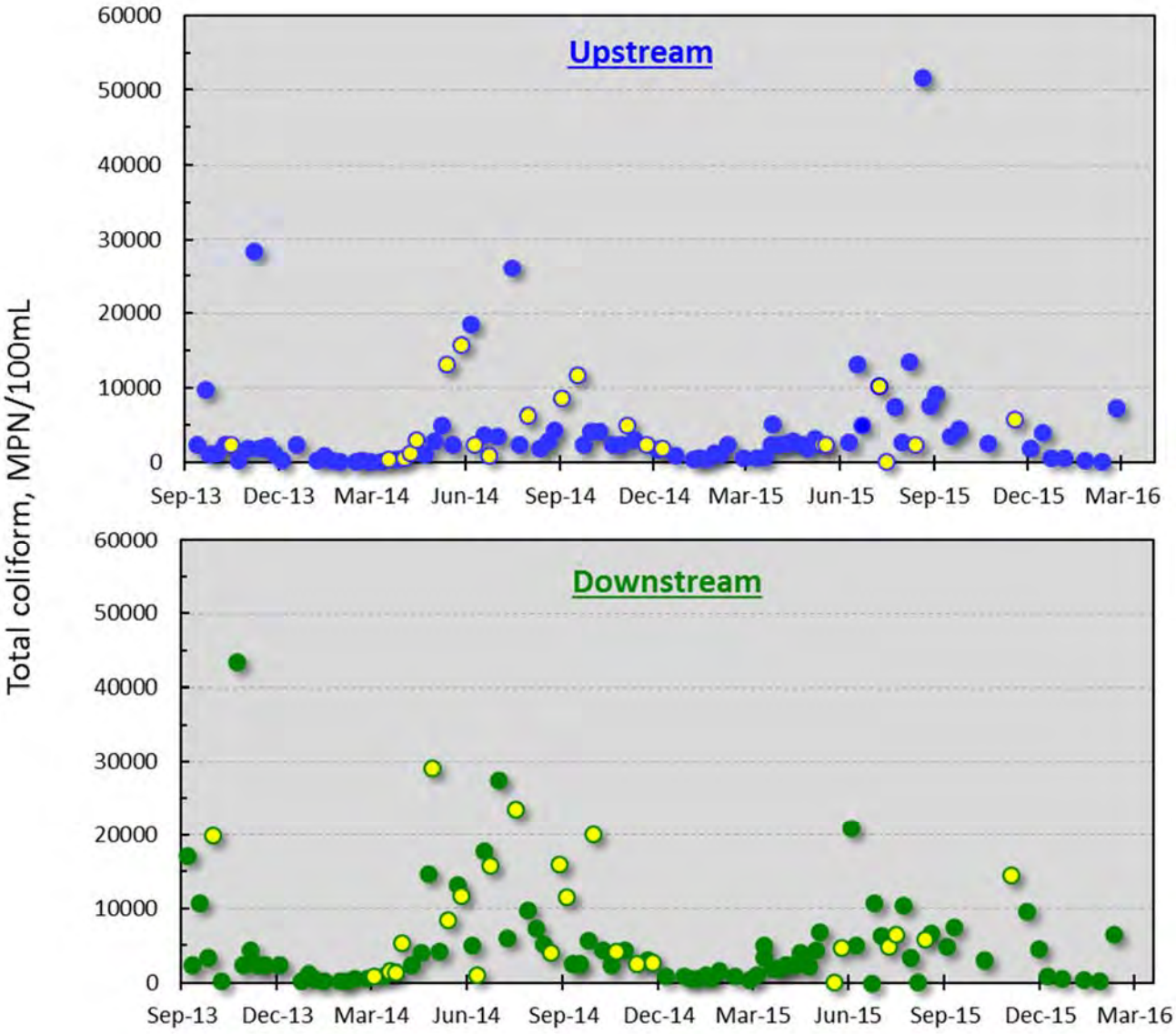

Figure 7. Total coliform numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

Differences in dissolved P, total P, nitrate-N, total P, E. coli, and total coliform concentrations between upstream and downstream sites from the beginning of monitoring (September 2013) to the present time are given in Figures 8, 9, 10, 11, 12, and 13.

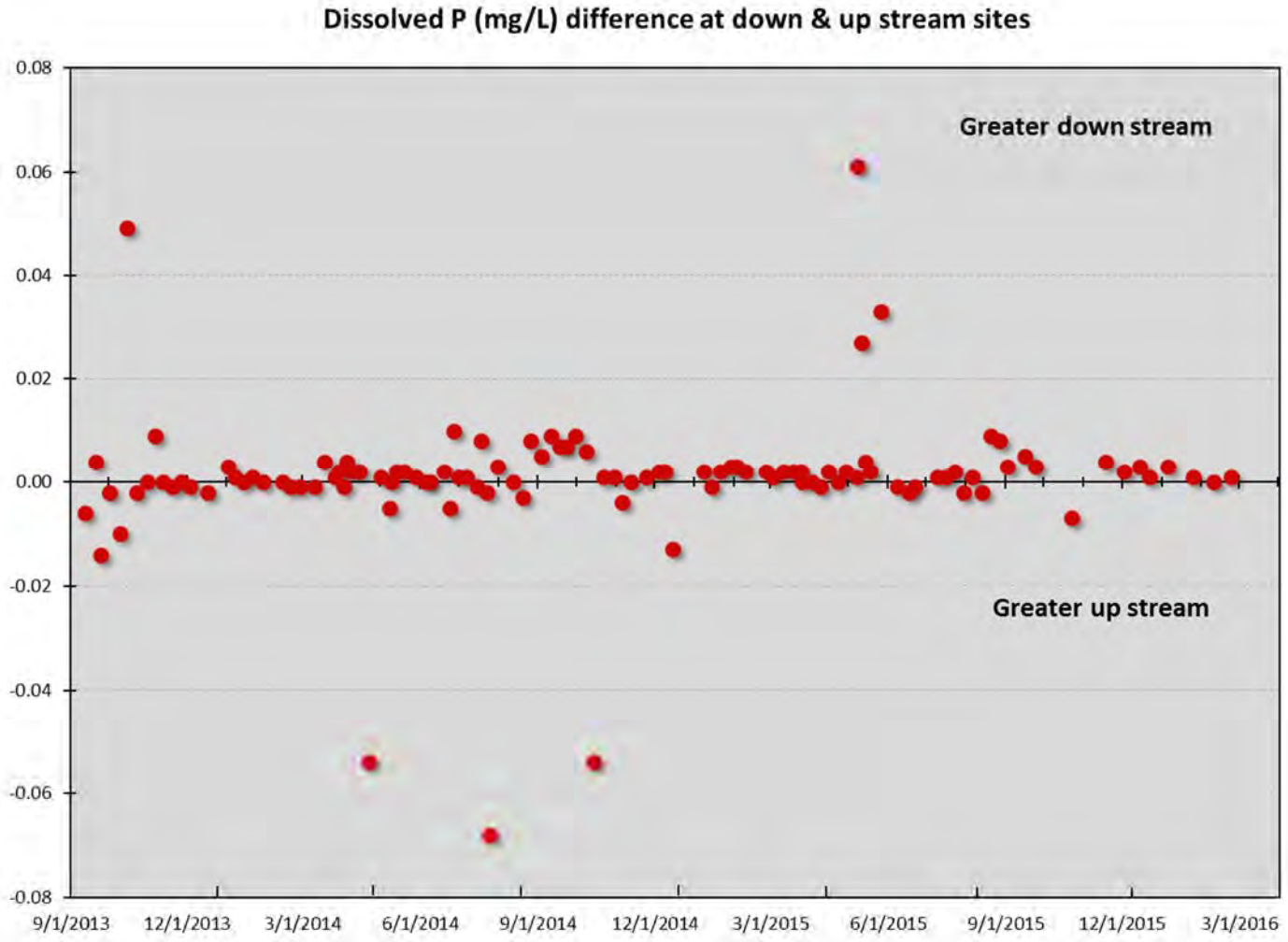

Figure 8. Difference in dissolved P concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

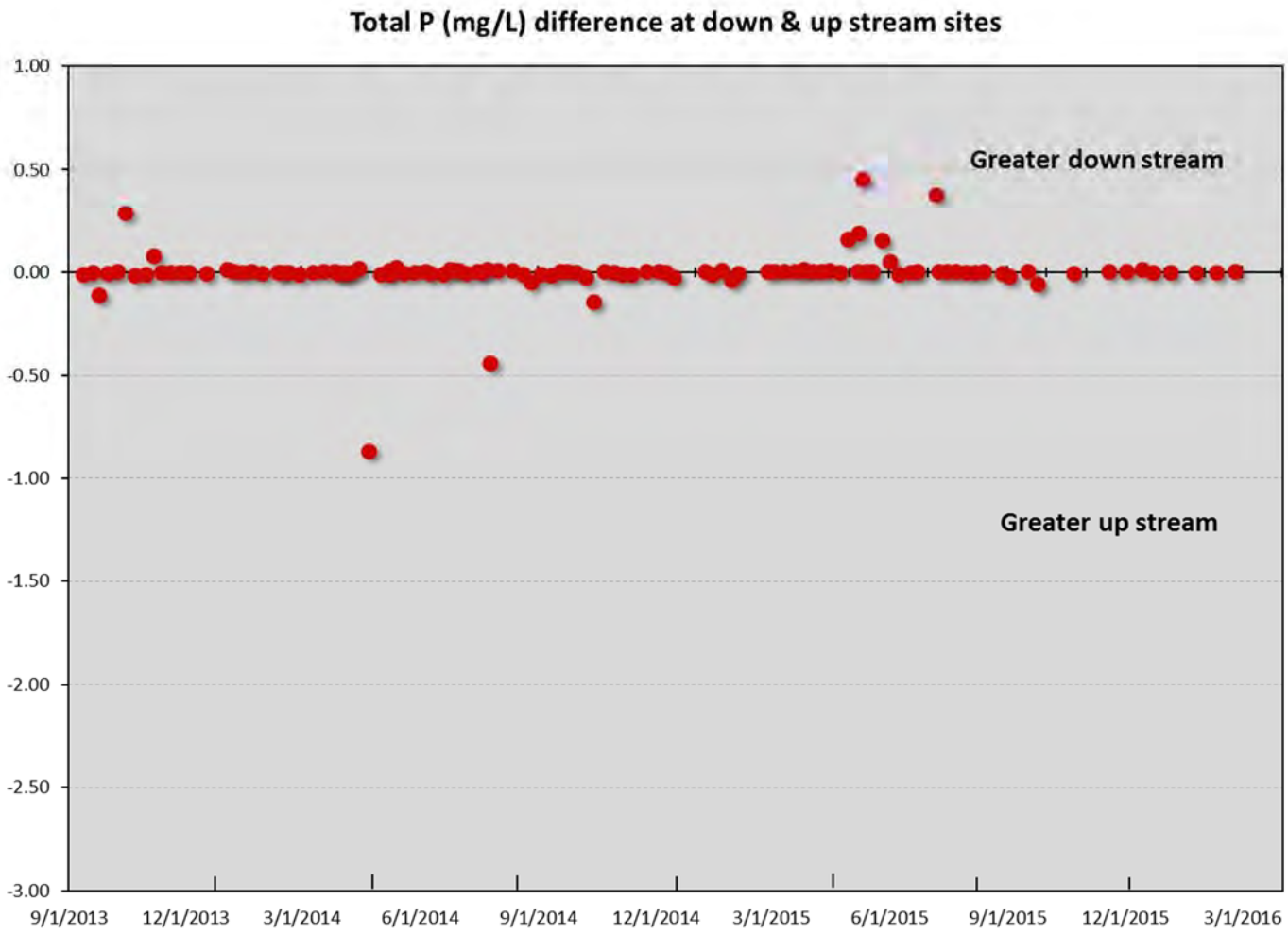

Figure 9. Difference in total P concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

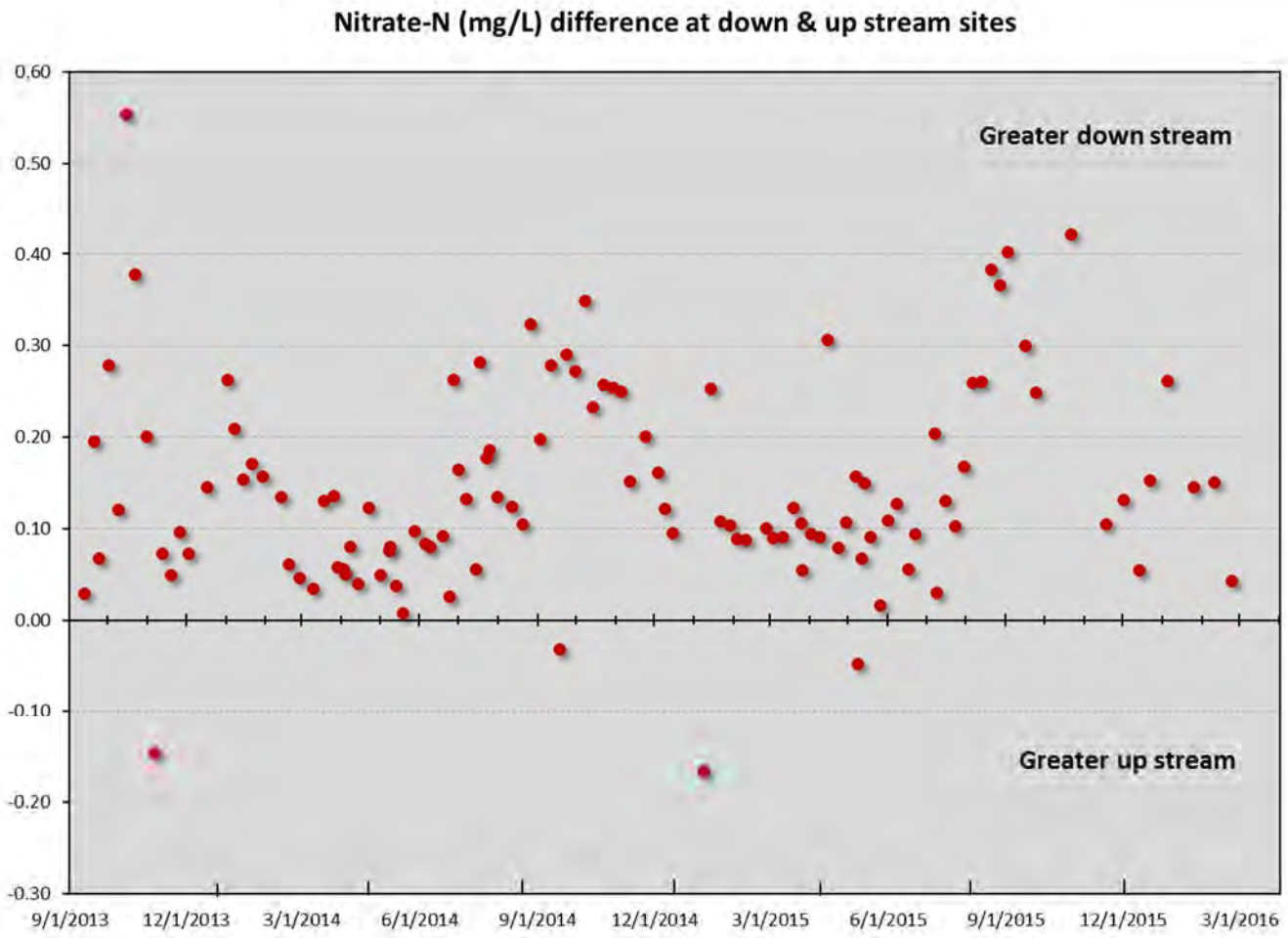

Figure 10. Difference in nitrate-N concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

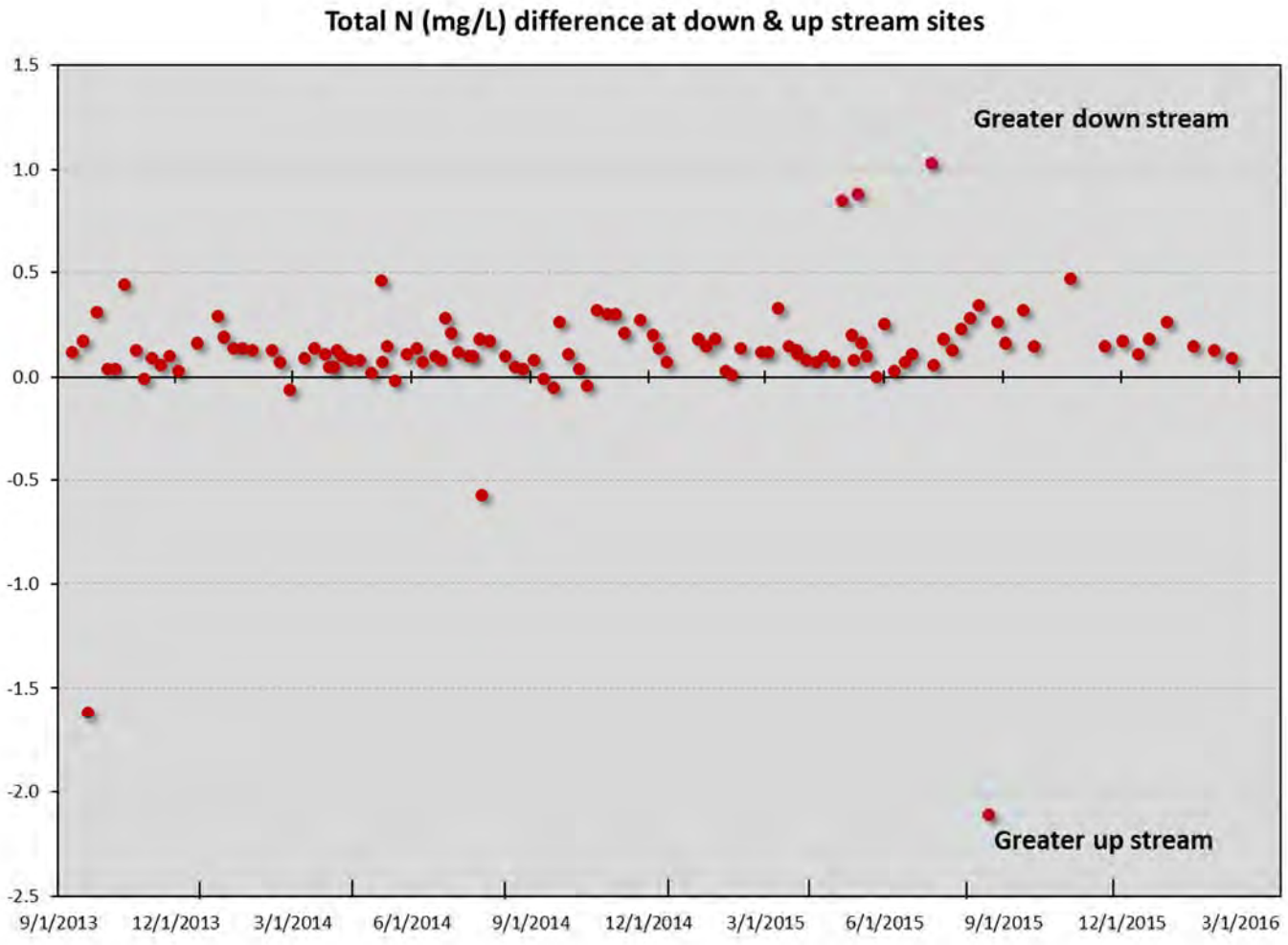

Figure 11. Difference in total N concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

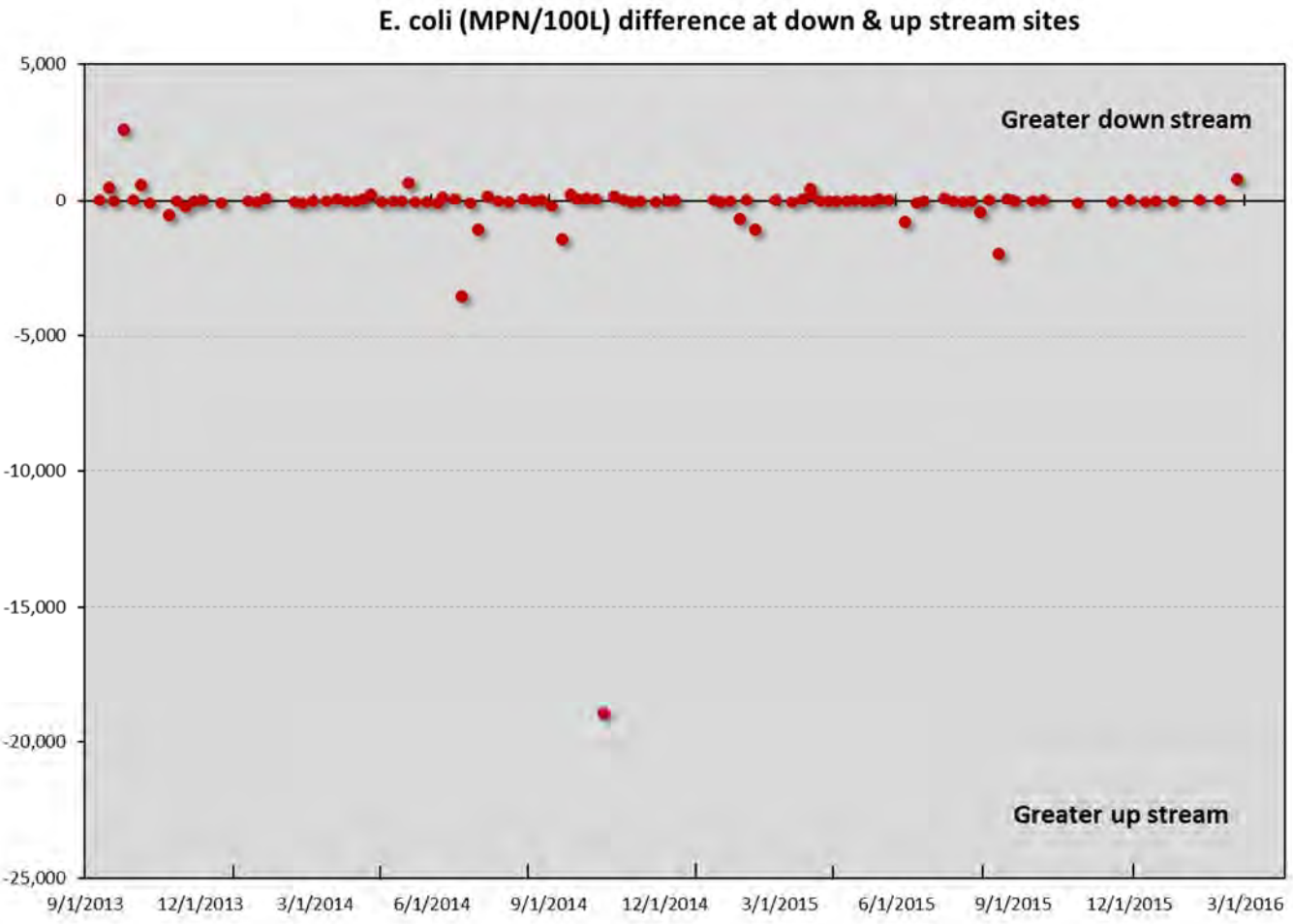

Figure 12. Difference in E. coli concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

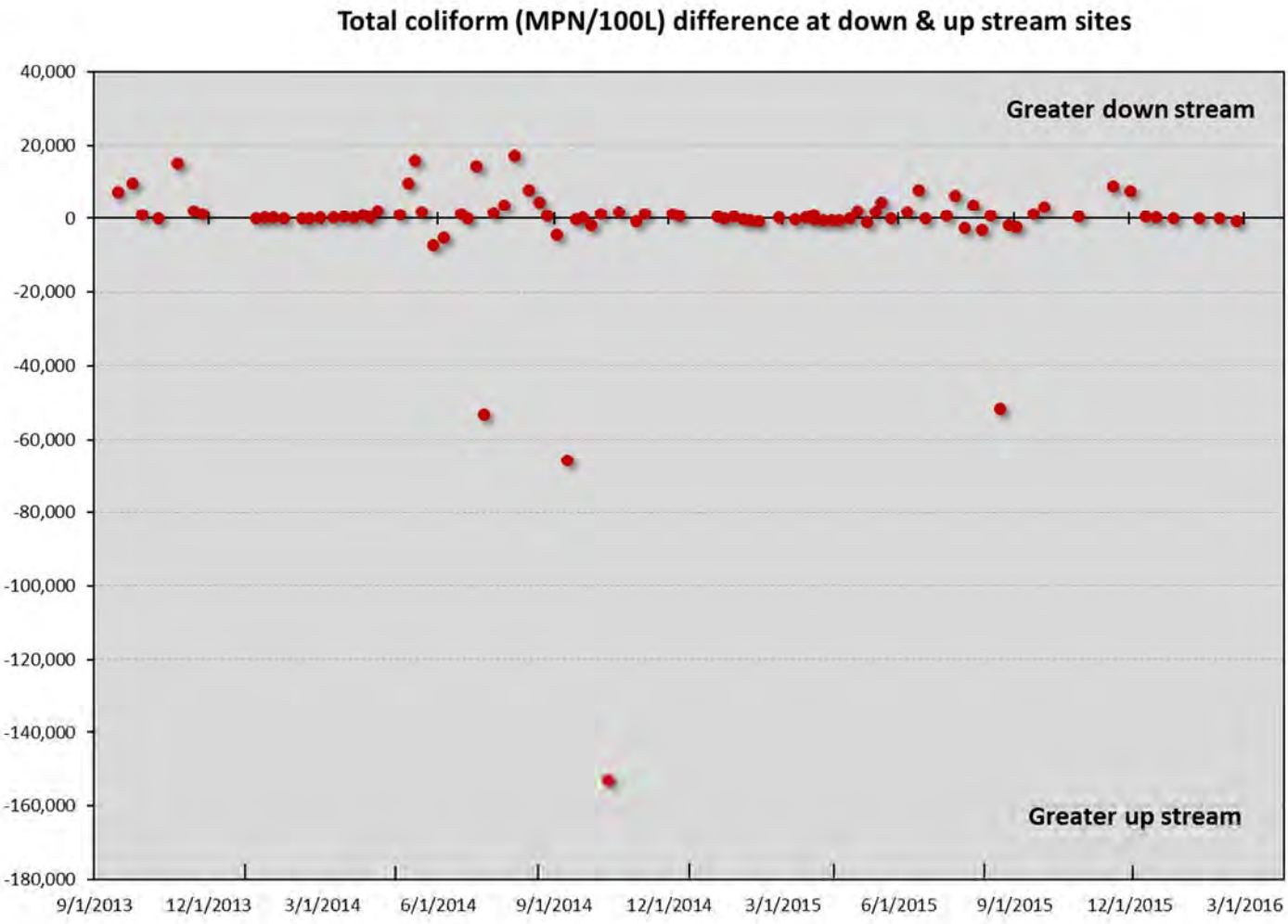

Figure 13. Difference in total coliform concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

Water pH, Alkalinity, Chloride, Electrical Conductivity, and Total Dissolved Solids for Several Big Creek Sites

At the beginning of 2015, the pH, alkalinity, chloride concentration, electrical conductivity and total dissolved solids were determined on water samples collected at the upstream and downstream sites, spring, house well, and trenches, to build a data base that will enable to eventually source track the major water source pathways at these sites. These values are given below in Table 5.

Table 6. The pH, Chloride concentration, electrical conducting, and total solids concentration of water samples collected at upstream, downstream, spring, house well and trench sites, initiated at the beginning of 2015, with those collected since the last report noted.

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
		------- mg/L ------		µS/cm	mg/L
Upstream					
1/8/2015	7.3	36	1.80	90	71.6
1/14/2015			2.09	105	49.1
1/21/2015	7.6	48	1.85	121	71.1
1/29/2015			2.09	140	71.3
2/3/2015	7.7	54	2.40	129	71.1
2/10/2015			2.51	132	67.6
2/26/2015	7.6	40	1.98	107	56.4
3/3/2015			2.08	112	58.9
3/11/2015	7.8	30	1.88	85	269.3
3/19/2015			1.55	98	58.0
3/25/2015	8.0	42	1.77	110	67.6
3/26/2015			1.33	115	64.4
4/2/2015	8.0	42	1.57	110	76.0
4/9/2015			1.73	116	74.9
4/15/2015	7.7	36	1.38	91	63.8
4/23/2015			1.65	95	60.4
4/29/2015	8.1	50	1.56	85	54.3

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
5/7/2015			1.40	123	70.7
5/8/2015			1.80	157	88.4
5/11/2015	7.5	24	1.63	131	110.0
5/14/2015			1.55	143	79.3
5/18/2015			1.20	107	56.2
5/26/2015	7.7	28	1.10	90	58.4
6/4/2015			1.08	78	55.3
6/8/2015	8.2	60	2.03	149	111.3
6/17/2015			1.51	128	70.2
6/22/2015	8.2	40	1.36	114	64.9
6/29/2015			1.74	55	49.8
7/9/2015	7.7	32	1.53	90	64.7
7/16/2015			1.33	161	78.9
7/23/2015	7.9	78	1.63	180	50.2
7/30/2015			1.75	224	113.3
8/6/2015	7.7	100	1.84	218	75.3
8/13/2015			1.91	210	121.6
8/20/2015	7.3	108	2.15	219	120.0
8/27/2015			2.11	240	131.3
9/2/2015	7.1	122	2.50	262	129.3
9/16/2015	7.6	132	3.05	272	151.3
9/24/2015			2.74	271	149.3
11/12/2015	8.0	104	2.13	228	115.0
11/18/2015			1.36	84	55.6
12/2/2015			1.52	83	100.0
Sample analyses since the last quarterly report					

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
12/14/2015	7.5	26	1.21	63	50.0
12/22/2015	8.3	56	1.78	107	50.0
1/5/2016	7.5	40	1.34	102	62.5
1/25/2016	8.2	46	1.50	115	65.0
2/10/2016	8.6	54	1.69	141	60.0
2/24/2016	7.2	66	1.20	102	97.5
Downstream					
1/8/2015	7.6	64	2.02	144	89.3
1/14/2015			2.76	166	79.8
1/21/2015	7.6	84	2.44	191	91.1
1/29/2015			2.51	205	109.1
2/3/2015	7.7	88	2.82	196	103.3
2/10/2015			3.01	204	105.5
2/26/2015	7.8	66	2.27	162	88.0
3/3/2015			2.39	170	80.0
3/11/2015	7.8	52	2.02	128	77.3
3/19/2015			1.75	148	84.9
3/25/2015	7.8	64	2.07	158	88.7
3/26/2015			1.46	83	78.7
4/2/2015	8.1	68	1.95	163	103.0
4/9/2015			2.08	168	100.4
4/15/2015	7.8	56	1.54	130	82.0
4/23/2015			1.81	142	81.0
4/29/2015	8.0	80	2.15	150	97.3
5/7/2015			1.84	185	101.1
5/8/2015			2.50	225	125.8

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
5/11/2015	7.5	36	1.73	149	130.9
5/14/2015			1.06	103	80.2
5/18/2015			1.55	150	58.7
5/26/2015	7.7	46	1.25	137	89.1
6/1/2015			1.20	125	93.3
6/8/2015	8.0	94	1.44	163	86.9
6/17/2015			2.14	216	141.3
6/22/2015	7.9	76	1.76	204	106.5
7/7/2015			1.55	177	79.3
7/9/2015	7.7	50	1.63	116	77.6
7/16/2015			1.50	124	72.2
7/23/2015	7.8	108	1.84	223	111.8
7/30/2015			2.18	248	122.0
8/6/2015	7.6	154	2.31	286	142.9
8/13/2015			2.78	283	159.1
8/20/2015	7.2	142	2.83	287	156.0
8/27/2015			3.01	300	153.3
9/2/2015	7.5	146	3.13	322	159.6
9/10/2015			3.47	309	172.7
9/16/2015	7.4	152	3.87	310	169.3
9/24/201			3.46	308	168.3
9/30/2015	7.6	148	3.98	322	174.5
10/8/2015			3.42	344	179.8
10/14/2015	7.8	16	3.72	362	181.0
10/22/2015			3.45	362	168.8
10/28/2015	7.8	164	3.40	351	168.3
11/4/2015			4.05	358	181.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
11/12/2015	7.9	128	2.80	281	152.0
11/18/2015			1.55	120	77.8
12/2/2015			1.86	127	68.9
Sample analyses since the last quarterly report					
12/14/2015	7.7	38	1.26	93	70.0
12/22/2015	7.7	70	1.99	157	82.5
1/5/2016	7.5	60	2.17	158	92.5
1/25/2016	8.0	80	2.00	191	95.0
2/10/2016	8.0	94	2.36	214	102.5
2/22/2016	7.5	80	1.48	156	110.0
Spring					
1/8/2015			2.27	534	321.1
1/14/2015			2.79	517	310.0
1/21/2015			2.27	553	324.0
2/3/2015			2.20	562	321.8
2/10/2015			2.44	581	314.2
2/26/2015			1.74	491	266.4
3/3/2015			1.57	430	234.9
3/11/2015			1.63	495	54.7
3/19/2015			1.54	474	220.0
3/25/2015			2.08	544	277.6
4/2/2015			1.78	515	289.8
4/9/2015			2.03	509	305.8
4/15/2015			1.76	480	276.9
4/23/2015			1.93	512	297.3
4/29/2015			2.55	564	294.9

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
5/4/2015			1.57	554	251.8
5/7/2015			2.29	623	318.9
5/11/2015			1.11	408	202.0
5/14/2015			1.35	507	259.6
5/18/2015			1.17	508	265.8
5/26/2015			1.08	516	250.4
6/8/2015			1.95	615	341.8
6/17/2015			1.65	532	276.0
6/22/2015			1.79	601	301.1
7/9/2015			1.43	542	266.9
7/16/2015			2.02	629	309.3
7/23/2015			2.17	656	312.0
7/30/2015			2.26	648	334.9
8/6/2015			0.92	606	330.7
8/13/2015			2.71	522	328.0
8/20/2015			2.09	554	330.9
8/27/2015			2.01	575	318.2
9/2/2015			2.08	581	311.1
9/10/2015			1.99	485	254.8
9/16/2015			0.00	557	294.9
9/24/2015			1.95	574	311.5
9/30/2015			2.00	573	321.3
10/8/2015			1.92	581	333.8
10/14/2015			1.94	610	313.0
10/22/2015			1.86	581	273.8
10/28/201			1.81	537	292.3
11/4/2015			2.11	572	299.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
11/12/2015			2.20	565	294.5
11/18/2015			1.80	395	215.6
12/2/2015			4.14	487	302.2
Trench 1					
1/8/2015			2.01	154	103.6
1/14/2015			2.81	166	81.8
2/26/2015			2.08	171	78.4
3/3/2015			2.11	177	86.7
3/11/2015			1.95	193	114.0
3/19/2015			1.70	209	109.3
3/25/2015			2.13	238	105.1
3/26/2015			1.64	209	120.2
4/2/2015			1.94	261	151.3
4/9/2015			1.99	260	154.0
4/15/2015			1.80	260	146.7
4/23/2015			2.06	231	132.7
5/11/2015			2.09	262	126.5
5/14/2015			1.86	299	156.5
5/18/2015			1.57	346	173.1
5/26/2015			1.65	297	146.0
6/22/2015			1.99	341	169.8
6/29/2015			2.63	342	167.8
7/9/2015			2.08	171	78.4
11/18/2015			1.15	152	86.7
12/2/2015			1.47	162	108.9

Sample analyses since the last quarterly report

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
12/14/2015			1.59	157	92.5
12/22/2015			1.70	180	95.0
1/5/2016			1.61	161	82.5
2/24/2016			1.16	162	102.5
Trench 2					
3/11/2015			1.77	159	140.8
3/19/2015			1.04	168	104.9
3/26/2015			0.78	135	160.9
5/11/2015			0.41	165	88.5
5/26/2015			0.93	284	141.3
Sample analyses since the last quarterly report					
12/14/2016			1.00	148	110.0
2/24/2016			0.99	144	122.5

Well Water Analyses

The sample collection point for the house well adjacent to the animal house facilities and slurry holding ponds was reconfigured to exclude any potential sources of sample contamination. It was determined that the risk of contamination was a result of factors such as well-head pump and in-house maintenance, In addition to installing a new well-water sampling site, USGS water quality sampling guidelines were used, which involved collection of a well sample when in-situ field measurement of well water temperature, pH, and electrical conductivity had stabilized. Well water analyses from samples collected after the new sampling port and sampling protocol were in operation are given in Table 6.

Table 7. Water quality analyses for samples collected from the well adjacent to the animal houses and slurry holding ponds following installation of new sampling port at the beginning of October, 2015.

	Dissolved P	Total P	Ammonia -N	Nitrate-N	Total N	Total suspended solids	Dissolved organic C	E. coli	Total coliform	Chloride	Conduct -ivity	Total dissolved Solids
	mg/L							MPN/100 mL		mg/L	µS/cm	mg/L
9/30/2015	0.009	0.016	<0.03	0.499	0.60	4.2	0.5	<1.0	2.0	7.307	446	236.3
10/8/2015	0.008	0.020	0.02	0.518	0.53	0.5	1.54	<1.0	<1	5.782	455	250.3
10/14/2015	0.012	0.020	<0.03	0.490	0.63	0.3	0.94	<1.0	<1	5.235	461	230.0
10/22/2015	0.010	0.014	0.04	0.478	0.50	0.4	1.93	<1.0	2.0	5.845	453	241.0
10/28/2015	0.008	0.016	0.01	0.391	0.54	<6.58	2.40	<1.0	<1	4.837	456	234.0
11/4/2015	0.010	0.016	<0.03	0.468	0.54	<6.58	2.62	<1.0	<1	5.159	455	239.3
11/12/2015	0.009	0.012	<0.03	0.501	0.55	0.3	3.71	<1.0	<1	5.590	458	237.0
11/18/2015	0.009	0.014	<0.03	0.464	0.59	0.4	0.48	<1.0	<1	4.657	458	231.1
12/2/2015	0.011	0.014	0.02	0.480	0.60	0.9	1.38	1.0	1.0	5.557	422	253.3
12/14/2015	0.011	0.010	<0.03	0.545	0.57	0.1	10.15	<1.0	1.0	4.545	460	245.0
12/22/2015	0.010	0.016	<0.03	0.534	0.59	0.3	1.40	<1.0	<1.0	5.455	458	242.5
1/5/2016	0.008	0.020	<0.03	0.528	0.57	0.9	1.08	<1.0	1.0	4.855	439	215.0
1/25/2016	0.012	0.020	<0.03	0.602	0.55	0.5	2.36	<1.0	<1.0	5.300	462	242.5
2/10/2016	0.007	0.014	<0.03	0.542	0.56	0.1	0.63	<1.0	<1.0	5.273	468	215.0
2/24/2016	0.010	0.010	<0.03	0.582	0.55	1.3	2.63	<1.0	<1.0	5.237	447	242.5

The University of Arkansas System Division of Agriculture offers its programs to all eligible persons regardless of race, color, sex, gender identity, sexual orientation, national origin, religion, age, disability, marital or veteran status, genetic information, or any other legally protected status, and is an Affirmative Action/Equal Opportunity Employer.

Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – April 1 to June 30, 2016

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

The mission of the **Division of Agriculture** is to advance the stewardship of natural resources and the environment, cultivate the improvement of agriculture and agribusiness, develop leadership skills and productive citizenship among youth and adults, enhance economic security and financial responsibility among the citizens of the state, ensure a safe, nutritious food supply, improve the quality of life in communities across Arkansas, and strengthen Arkansas families.

Dr. Mark J. Cochran
Vice President for Agriculture

Executive Summary

This is the second Quarterly Report of 2016 for the Big Creek Research and Extension Team that details progress made from April 1 through June 30, 2016.

1. The BCRET serves interests of all people who live, work, and visit the Big Creek Watershed and the larger Buffalo River Watershed, as mandated by the University of Arkansas System Division of Agriculture guidelines. A key component of our mission is "to advance the stewardship of natural resources and the environment, …., improve the quality of life in communities across Arkansas, and strengthen Arkansas families."

2. The nutrient management plan for the C&H Farm is based on using the Phosphorus (P) Loss Risk Assessment Tool, the Phosphorus Index, to determine rates of manure application that will not increase the risk of P runoff to Big Creek. The Arkansas P Index was developed by several members of BCRET. Independent research shows the Arkansas P Index to be one of the most restrictive in terms of determining environmentally acceptable mineral fertilizer and manure applications.

3. We continue to collect weekly base flow and periodic storm flow water samples from Big Creek above and below the C&H Farm, along with water from a spring, ephemeral stream, surface runoff sites on Fields 1, 5a, and 12, two interceptor trenches below the slurry holding ponds, and reconfigured house well for chemical and bacterial analysis.

4. Chemical analysis of water samples collected from the house well, trenches, and ephemeral gully provide three direct methods to determine if manure is leaking from the holding ponds. To date, these analyses do not provide a scientific, weight-of-evidence that there is any massive leakage of material from the manure holding ponds adjacent to the house barns. Concentrations of P, N, chloride (a conservative and effective tracer), and electrical conductivity do not show any elevated values compared with baseline or background values. We will continue to monitor these sites.

5. The Electrical Resistivity Imaging Analysis indicates a differences in electrical resistivity below the surface to a depth of approximately 75 feet, which may result from natural and site properties. BCRET is committed to working with ADEQ in its decision to drill a bore-hole in an agreed location adjacent to the holding ponds to provide information, which will aid defining the cause of the shifts in resistivity.

6. Recent results of BCRET were presented to the Arkansas Pollution Control and Ecology Commission (APC&EC) meeting on June 24th. That presentation is available on the BCRET website at http://www.bigcreekresearch.org/press_release_presentations/Sharpley%20PC-E%20Mtg%206-24-2016.pdf .

Big Creek Research Team

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Brian Breaker, M.Sc., Surface-Water Specialist, stream flow and constituent collection, analysis, and statistical evaluation of trends.

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Ed Gbur, Ph.D., Professor and Director, Agricultural Statistics Laboratory - Experimental design, linear and generalized linear mixed models, regression, agricultural applications of statistics.

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Phil Hays, Ph.D. Ground Water Specialist, U.S. Geological Survey and Research Professor with Geosciences Dept., University of Arkansas, application of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems

Tim Kresse, M.Sc., Water Quality Specialist, U.S. Geological Survey, natural geochemical evolution of groundwater and separating these processes from anthropogenic sources of contamination

Morteza Mozaffari, Ph.D. – Director, Univ. of Arkansas Soil Testing and Research Laboratory, Marianna.

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Thad Scott, Ph.D., Professor - Water quality, transport of contaminants to and within water bodies

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Jun Zhu, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians - The Big Creek Research and Extension Team are ably supported by several outstanding and dedicated Program Technicians based in Fayetteville and Little Rock.

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Nutrient Management Planning Development for the C&H Farm

Development of the Comprehensive Nutrient Management Plan for the C&H Farm is based on the use of the Phosphorus (P) Loss Risk Assessment Tool, the Arkansas Phosphorus Index (API) for pastures (Sharpley et al., 2010 and b). Several members of BCRET were involved in the development, validation, and implementation of the API, which was adopted by the Arkansas Natural Resources Commission in 2010.

As part of the nutrient management planning process, the API is used to determine the rate of manure that can be applied to any given field without an unacceptable risk of P runoff to Big Creek. The API assesses the risk of P loss in runoff from pastures and hayland as a function of source potential (i.e., P from the soil and manure application), transport potential (i.e., risk P movement offsite as affected by runoff and erosion, field slope, grazing intensity and proximity to streams), and any additional conservation practices (CPs) implemented between the application site and potential receiving waters. As a result, for a specific set of field conditions, the API associates a P runoff risk value to a specific manure application rate and determines if the application is environmentally acceptable. If acceptable, the nutrient management plan specifies this application rate as the maximum rate for that field. Lower rates of manure application are generally considered to be associated with lower environmental P runoff risk and, therefore, also acceptable.

Sharpley et al. (2001 and 2003) was instrumental in developing the original framework of the P Index for use in NRCS 590 Nutrient Management Planning (U.S. Department of Agriculture, Natural Resources Conservation Service, 2011). Independent research shows the API to be one of the most restrictive in terms of limiting manure applications. Osmond et al., (2006 and 2012) showed that of 12 P Indices for Southern U.S. States, the Arkansas Index was consistently the most restrictive in terms determining environmentally acceptable manure application.

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Water Sampling and Analytical Methods

Sampling Locations

Water quality monitoring sites are;

Site 1. Edge-of-field monitoring on Field 1 permitted to receive slurry.

Site 2. Edge-of-field monitoring on Field 5a excluded from receiving slurry.

Site 3. Edge-of-field monitoring on Field 12 permitted to receive slurry.

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities.

Site 5. Spring below Field 1.

Site 6. Big Creek upstream of the C&H Farm operation.

Site 7. Big Creak downstream of the C&H Farm operation.

Site 8. Left Fork downstream of the C&H Farm operation.

Site 9. North interceptor trench below the manure holding ponds.

Site 10. South interceptor trench below the manure holding ponds.

Site 11. House well at animal facility.

Table 1. Location of sampling sites on the Big Creek Research and Extension Team project.

Site description	Latitude	Longitude	Elevation, ft
Field 1	35 55’ 06.42”	93 03’ 38.34”	984
Field 5a	35 56’03.01”	93 04’ 25.85”	778
Field 12	35 54’ 13.57”	93 04’ 04.76”	838
Ephemeral stream	35 55’ 25.89”	93 04’ 14.94”	824
Spring	35 54’ 57.06”	90 03’ 34.64”	977
Big Creek upstream of farm	35 53’ 32.28”	93 04’ 06.38”	857

Big Creek downstream of farm	35 56’ 18.98”	93 04’ 21.81”	769
Left Fork	35 5’”48.04”	93 04” 02.02”	760
Trench 1 (south)	35 55’ 19.24”	93 04’ 23.04”	896
Trench 2 (north)	35 55’ 21.39”	93 04’ 19.93”	883
House well	35 55’ 27.02”	93 04’ 22.71”	915

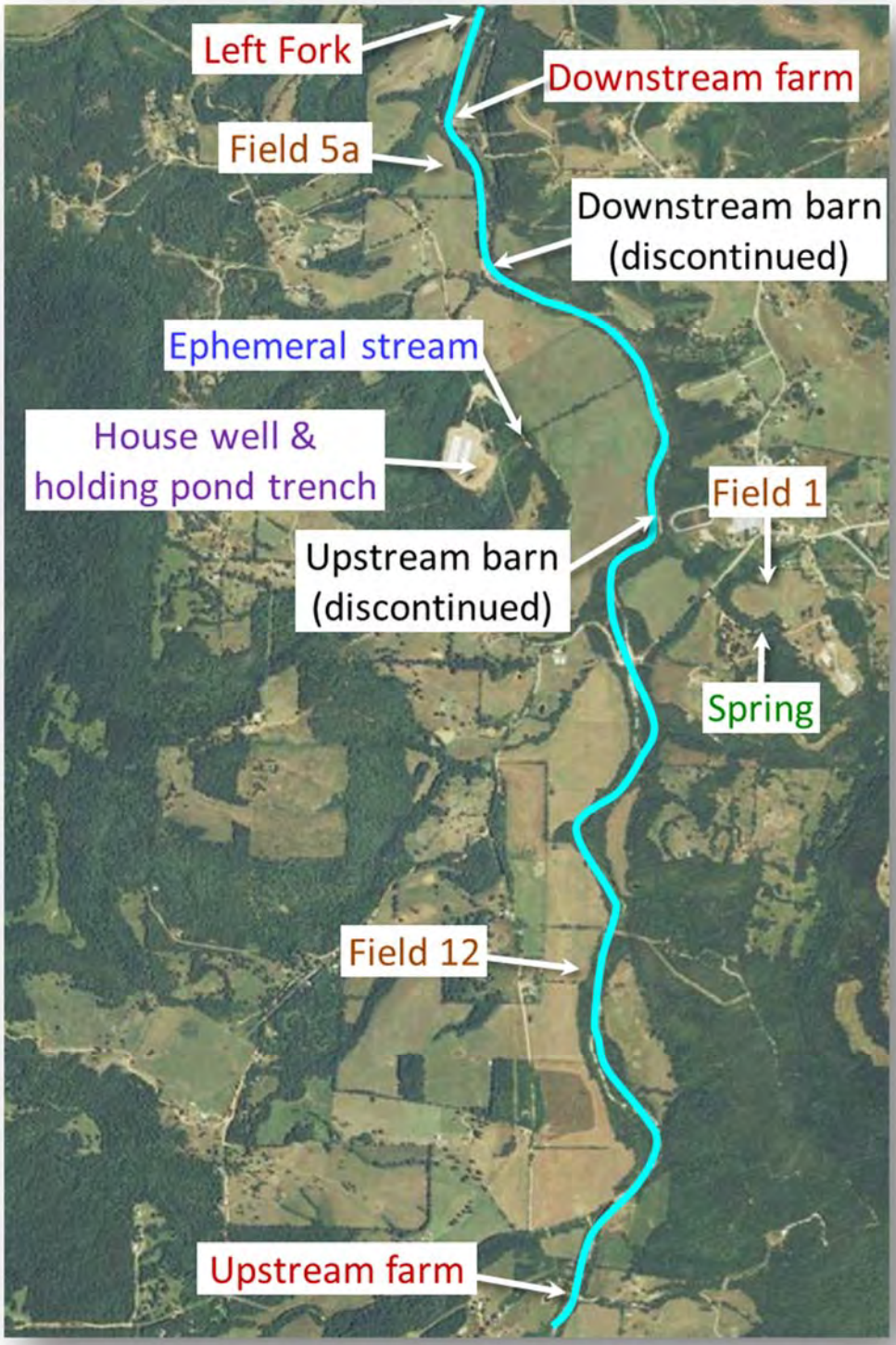

Figure 1. Location of sampling sites for the Big Creek Research and Extension Team project.

Sampling Protocols and Analyses

The following protocols were used to collect, prepare, and analyze all water samples:

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface, where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted, and samples placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
6. Analyses included Alkalinity (APHA 2320-B), Ammonia (EPA 351.2), Chloride (EPA 300.0), Dissolved Phosphorus (EPA 365.2), E. coli (APHA 9223-B), Electrical Conductivity (EPA 120.1), Nitrate (EPA 300.0), pH (EPA 150.1), Total Coliforms (APHA 9223-B), Total Dissolved Solids (EPA 160.1), Total Nitrogen (APHA 4500-P J), Total Phosphorus (APHA 4500-P J), and Total Suspended Solids (EPA 160.2). APHA is American Public Health Association from the Wadeable Streams Assessment, Water Chemistry Laboratory Manual http://www.epa.gov/owow/monitoring/wsa/WRS_lab_manual.pdf
7. Prior to collection of a house well water sample, the well is purged and water temperature, pH, and electrical conductivity measured on-site every 30 seconds until all values stabilize (primarily water temperature). At that point a sample of water is collected in a 1-L acid-washed bottle. This method is taken from USGS and EPA well-water sampling protocols. See USGS methods for sampling at https://water.usgs.gov/owq/FieldManual/chapter4/pdf/Chap4_v2.pdf. Specific and detailed guidance on the collected of water quality data can be found in the USGS National Field Manual at file:///U:/Words/C&H%20Farm/Publications/Planning/USGS%20National%20Field%20Mannual_complete%202015.pdf

   The U.S. EPA also recommend that selected water quality parameters can be monitored during low-rate purging, with stabilization of these parameters indicating when the discharge water represents aquifer water or source well water. See: http://www.csus.edu/indiv/h/hornert/Geol_210_Summer_2012/Week%202%20readings/Puls%20and%20Barcelona%201996%20Low%20flow%20sampling.pdf and https://in-situ.com/wp-content/uploads/2015/01/Low-Flow-Groundwater-Sampling-Techniques-Improve-Sample-Quality-and-Reduce-Monitoring-Program-Costs-Case-Study.pdf
8. Minimum detection limits (MDLs) for each chemical and biological constituent are listed in Table 1. Some constituent concentrations were reported by the laboratory as less than the MDL but greater than zero. Those values are given in subsequent tables but have less confidence in their accuracy than concentrations above the MDL.
9. Chemical and biological analyses of samples collected from the beginning of 2015 to March 31, 2016 are given in Tables 2, 3, and 4.

Table 2. Minimum detection limits (MDLs) for each chemical and biological constituent.

Constituent	Minimum detection limit [1]
Alkalinity, mg/L as $CaCO_3$	2
Chloride, mg/L	0.093
Dissolved P, mg/L	0.002
Conductivity, uS/cm	1
Ammonia-N, mg/L	0.03
Dissolved organic carbon, mg/L	0.18
E. coli, MPN/100 mL	1
Nitrate-N, mg/L	0.004
pH	0.1
Total coliform, MPN/100 mL	1
Total dissolved solids, mg/L	15.22
Total N, mg/L	0.006
Total P, mg/L	0.012
Total suspended solids, mg/L	6.58

[1] MDL the Minimum Detection Limit of an analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. Further information is available at http://water.usgs.gov/owq/OFR_99-193/detection.html

USGS Stations

Big Creek Continuous Flow

We are collaborating with USGS at Big Creek near Mt. Judea (USGS 705579; downstream of the C&H Farm operation) and at Left Fork Big Creek near Vendor (USGS 07055792), to collect base and storm water flows for N, P, and bacteria analysis. The USGS Big Creek site is instrumented with continuous flow gaging equipment and a nitrate sensor, which provides real-time flow, water temperature, nitrate-N, and precipitation data. These data are available on line at the USGS website below.

USGS 07055790 Big Creek near Mt. Judea, AR

http://nwis.waterdata.usgs.gov/ar/nwis/uv/?site_no=07055790&agency_cd=USGS

Big Creek Research and Extension Team Monitoring Data

Nutrients, Sediment, and Bacteria by Date of Sampling

Table 3. Water quality analyses at each sample site since 2015, with those collected since the last report noted. Coliform units are Most Probable Number (MPN) per 100 mL of water.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
			---------- mg/L ----------							-- MPN/100 mL --	
1/8/2015	**1/8/2015**	**Base flow**									
11:05	15:05	Spring	0.010	0.014	<0.03 ¶	0.376	0.56	2.0	3.80	14.8	686.7
11:25	15:05	Upstream farm	0.009	0.022	<0.03	0.187	0.21	2.3	1.41	30.9	547.5
10:53	15:05	Downstream farm	0.011	0.024	<0.03	0.376	0.39	2.5	1.22	42.6	980.4
11:40	15:05	Ephemeral stream	0.008	0.022	<0.03	0.448	0.59	2.4	1.73	25.6	1203.3
12:00	15:05	Trench 1	0.005	0.022	<0.03	0.769	0.75	4.7	0.88	1.0	13130.0
1/14/2015	**1/14/2015**	**Base flow**									
11:30	15:20	Spring	0.010	0.028	<0.03	0.473	0.66	1.1	10.20	21.6	613.1
11:45	15:20	Upstream farm	0.012	0.032	<0.03	0.135	0.19	1.1	3.02	88.2	727.0
11:15	15:20	Downstream farm	0.011	0.020	<0.03	0.388	0.34	1.0	2.03	25.6	613.1
12:00	15:20	Ephemeral stream	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
1/21/2015	**1/21/2015**	**Base flow**									
11:15	15:28	Spring	0.009	0.020	<0.03	0.552	0.69	1.5	2.29	9.8	461.1
11:52	15:28	Upstream farm	0.008	0.018	<0.03	0.089	0.12	1.1	0.95	70.3	579.4
11:05	15:28	Downstream farm	0.010	0.026	0.06	0.197	0.30	1.1	1.60	37.4	613.1
11:25	15:28	Ephemeral stream	0.005	0.016	<0.03	0.370	0.46	1.0	2.34	155.3	2419.2
1/29/2015	**1/29/2015**	**Base flow**									
10:40	15:28	Spring	0.010	0.018	0.03	0.886	0.74	2.3	4.27	1.0	2850.0
11:45	15:28	Upstream farm	0.006	0.060	<0.03	0.065	0.21	47.8	1.71	727.0	1413.6
1:20	15:28	Downstream farm	0.009	0.020	0.04	0.168	0.27	1.3	1.50	19.9	1046.2
2/3/2015	**2/3/2015**	**Base flow**									
11:05	15:40	Spring	0.008	0.018	<0.03	0.691	0.77	3.8	7.64	1.0	461.1
11:40	15:40	Upstream farm	0.006	0.022	<0.03	0.051	0.28	1.1	2.69	4.1	1203.3
10:50	15:40	Downstream farm	0.009	0.018	<0.03	0.140	0.29	4.1	2.66	1.0	547.5
2/10/2015	**2/10/2015**	**Base flow**									
10:38	15:08	Spring	0.010	0.010	<0.03	0.544	0.64	1.9	0.76	2.0	686.7
11:05	15:08	Upstream farm	0.009	0.012	<0.03	0.056	0.09	0.7	1.04	1119.1	2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:25	15:08	Downstream farm	0.011	0.012	<0.03	0.143	0.23	1.0	1.15	7.4	1553.1
2/26/2015	**2/26/2015**	**Base flow**									
10:45	15:30	Spring	0.009	0.042	0.02	0.237	0.38	5.0	3.97	37.3	2419.2
11:36	15:30	Upstream farm	0.006	0.024	<0.03	0.100	0.13	0.6	1.20	47.9	686.7
10:34	15:30	Downstream farm	0.008	0.026	0.02	0.200	0.25	0.8	1.17	48.7	866.4
10:55	15:30	Ephemeral stream	0.006	0.022	<0.03	0.530	0.57	1.3	1.38	16.1	4790.0
11:15	15:30	Trench 1	0.004	0.028	0.01	0.712	0.76	46.0	0.60	1.0	41063.0
3/3/2015	**3/3/2015**	**Base flow**									
11:07	15:33	Spring	0.008	0.052	<0.03	0.124	0.35	13.5	4.90	N.S. §	N.S.
11:50	15:33	Upstream farm	0.006	0.026	0.02	0.048	0.11	2.3	1.50	N.S.	N.S.
10:55	15:33	Downstream farm	0.007	0.028	<0.03	0.138	0.23	1.3	1.50	N.S.	N.S.
11:18	15:33	Ephemeral stream	0.006	0.020	<0.03	0.477	0.52	2.0	1.84	N.S.	N.S.
11:30	15:33	Trench 1	0.003	0.024	<0.03	0.867	0.89	14.9	0.95	N.S.	N.S.
3/11/2015	**3/11/2015**	**Storm Flow**									
11:30	14:58	Spring	0.009	0.030	<0.03	0.242	2.37	5.5	14.79	19.5	111.9

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:30	14:58	Upstream farm	0.005	0.026	0.02	0.118	0.16	2.1	3.38	34.5	579.4
11:20	14:58	Downstream farm	0.007	0.030	0.02	0.209	0.27	1.8	1.44	66.3	770.1
11:45	14:58	Ephemeral stream	0.006	0.022	0.04	0.567	0.60	0.5	2.20	6.3	410.0
12:10	14:58	Trench 1	0.003	0.014	0.07	0.989	0.97	0.3	2.00	<1.0	2419.2
12:15	14:58	Trench 2	0.003	0.056	0.04	1.443	1.59	1.2	3.51	<1.0	2419.2
3/19/2015	**3/19/2015**	**Base flow**									
10:59	15:10	Spring	0.010	0.028	0.03	0.184	0.29	10.6	7.37	38.9	79.4
12:00	15:10	Upstream farm	0.007	0.024	0.04	0.111	0.20	1.7	2.53	42.6	866.4
11:13	15:10	Downstream farm	0.009	0.028	0.04	0.234	0.35	2.8	2.87	71.7	1119.9
11:08	15:10	Ephemeral stream	0.007	0.018	0.01	0.529	0.63	1.0	4.31	14.6	866.4
11:13	15:10	House well	0.009	0.020	0.02	0.467	0.55	1.2	4.93	1.0	31.3
11:30	15:10	Trench 1	0.003	0.012	0.01	0.849	0.93	<6.58	3.11	1.0	275.5
11:35	15:10	Trench 2	0.004	0.062	0.09	1.036	1.42	1.9	5.12	5.2	2419.2
3/25/2015	**3/25/2015**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:45	15:20	Spring	0.006	0.014	0.02	0.197	0.39	1.6	1.45	23.1	275.5
13:30	15:20	Upstream farm	0.006	0.028	0.02	0.056	0.16	2.9	1.36	125.9	2419.2
11:30	15:20	Downstream farm	0.008	0.036	0.04	0.162	0.29	5.0	1.41	547.5	3410.0
12:00	15:20	Ephemeral stream	0.007	0.014	0.02	0.462	0.53	1.1	0.64	8.6	344.8
12:20	15:20	House well	0.007	0.016	<0.03	0.450	0.52	1.9	0.03	18.5	30.1
12:30	15:20	Trench 1	0.003	0.008	<0.03	0.838	0.88	0.2	0.59	<1.0	410.6
3/26/2015	**3/26/2015**	**Storm flow**									
13:10	15:25	Upstream farm	0.013	0.064	0.06	0.090	0.30	11.4	3.71	547.5	5200.0
13:35	15:25	Downstream farm	0.013	0.076	0.06	0.144	0.41	14.1	3.94	816.4	4960.0
12:55	15:25	Trench 1	0.004	0.026	0.02	0.904	1.00	15.4	0.69	<1.0	1553.1
12:50	15:25	Trench 2	0.004	0.126	0.13	0.873	1.44	22.2	4.63	105.4	6950.0
13:20	15:25	Field 1	0.143	0.346	0.41	0.216	2.68	65.5	15.65	N.S.	N.S.
12:30	15:25	Field 5a	0.813	1.330	0.39	0.225	2.59	72.3	15.95	N.S.	N.S.
4/2/2015	**4/2/2015**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:50	15:25	Spring	0.008	0.042	0.04	0.173	0.35	3.5	10.47	248.1	1299.7
12:15	15:25	Upstream farm	0.007	0.040	0.02	0.045	0.14	3.1	3.61	166.9	2419.2
1:30	15:25	Downstream farm	0.007	0.042	0.02	0.139	0.22	2.5	2.71	121.1	1986.3
12:30	15:25	Ephemeral stream	0.006	0.032	0.02	0.467	0.46	1.8	4.41	5.2	547.5
12:48	15:25	House well	0.008	0.030	<0.03	0.477	0.50	0.7	6.05	39.3	9060.0
12:54	15:25	Trench 1	0.003	0.028	0.02	0.865	0.87	0.3	3.34	1.1	308.6
4/9/2015	**4/9/2015**	**Base flow**									
11:45	15:30	Spring	0.011	0.034	0.01	0.257	0.42	4.9	9.11	7380.0	9040.0
12:30	15:30	Upstream farm	0.011	0.042	0.04	0.066	0.18	13.1	2.13	86.0	2650.0
12:50	15:30	Downstream farm	0.010	0.048	0.03	0.157	0.25	19.7	1.82	47.2	1986.3
12:00	15:30	House well	0.011	0.026	<0.03	0.499	0.50	1.5	0.74	4.1	325.5
12:10	15:30	Trench 1	0.006	0.018	<0.03	0.790	0.83	0.8	2.99	<1.0	187.2
4/15/2015	**4/15/2015**	**Storm Flow**									
11:38	14:55	Spring	0.007	0.034	<0.03	0.210	0.39	7.7	4.70	275.5	2280.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:23	14:55	Upstream farm	0.007	0.040	0.03	0.090	0.16	3.5	3.24	648.8	4040.0
12:40	14:55	Downstream farm	0.009	0.048	0.03	0.166	0.26	4.4	2.67	344.8	2920.0
11:48	14:55	Ephemeral stream	0.005	0.026	0.03	0.472	0.56	0.8	1.26	305.0	2430.0
11:58	14:55	House well	0.008	0.022	0.02	0.475	0.60	1.2	3.72	9.6	80.9
12:10	14:55	Trench 1	0.003	0.020	<0.03	0.857	0.93	1.3	4.29	<1.0	3180.0
4/23/2015	**4/23/2015**	**Base Flow**									
12:23	15:30	Spring	0.008	0.034	<0.03	0.264	0.36	7.4	3.64	71.7	648.8
13:00	15:30	Upstream farm	0.007	0.032	0.03	0.083	0.18	4.0	5.11	104.6	2419.2
12:15	15:30	Downstream farm	0.007	0.032	0.03	0.162	0.25	2.6	2.51	65.7	2419.2
11:55	15:30	Ephemeral stream	0.008	0.026	0.03	0.520	0.56	2.0	1.78	12.0	3270.0
11:35	15:30	House well	0.008	0.082	<0.03	0.496	0.53	1.4	1.69	18.5	35.0
11:48	15:30	Trench 1	0.003	0.034	<0.03	0.877	0.97	1.2	1.18	3.1	2690.0
4/29/2015	**4/29/2015**	**Base flow**									
11:25	14:05	Spring	0.010	0.028	<0.03	0.419	0.59	9.0	4.28	25.6	1732.9

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:53	14:05	Upstream farm	0.010	0.020	0.03	0.082	0.13	2.7	1.58	58.3	1732.4
12:13	14:05	Downstream farm	0.012	0.018	0.03	0.189	0.82	2.1	1.64	58.6	1986.3
11:30	14:05	Ephemeral stream	0.012	0.018	0.02	0.569	0.61	3.5	1.98	14.3	4080.0
11:35	14:05	House well	0.010	0.006	<0.03	0.517	0.51	0.7	2.26	248.1	5040.0
5/7/2015	**5/7/2015**	**Base flow**									
11:10	14:10	Spring	0.011	0.036	0.02	0.499	0.58	9.9	44.04	135.4	980.4
11:43	14:10	Upstream farm	0.008	0.032	0.01	0.110	0.16	7.5	10.16	77.6	3280.0
12:05	14:10	Downstream farm	0.009	0.034	<0.03	0.267	0.36	4.5	7.70	27.8	2280.0
11:18	14:10	Ephemeral stream	0.013	0.066	0.02	0.628	0.71	3.2	16.41	71.7	7170.0
11:23	14:10	House well	0.008	0.022	0.01	0.512	0.49	<6.58	28.63	3.1	59.4
5/8/2015	**5/8/2015**	**Storm flow**									
13:25	15:32	Upstream farm	0.134	0.354	0.16	0.340	1.12	51.4	9.30	N.S.	N.S.
13:25	15:32	Downstream farm	0.195	0.544	0.27	0.292	1.20	113.2	7.47	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:43	15:32	Ephemeral stream	0.005	0.254	0.41	2.287	3.23	127.1	6.45	N.S.	N.S.
13:00	15:32	Field 1	0.525	0.714	0.16	0.475	2.19	16.9	13.28	N.S.	N.S.
12:38	15:32	Field 12	0.675	0.956	0.14	0.303	1.82	57.0	16.00	N.S.	N.S.
5/11/2015	**5/12/2015**	**Storm Flow**									
11:35	8:30	Spring	0.008	0.058	0.01	0.339	0.49	8.7	3.67	N.S.	N.S.
11:28	8:30	Upstream farm	0.004	0.074	0.04	0.004	0.24	4.5	4.31	N.S.	N.S.
12:47	8:30	Downstream farm	0.031	0.530	0.11	0.071	1.12	277.5	8.48	N.S.	N.S.
12:05	8:30	Ephemeral stream	0.008	0.146	0.15	0.941	1.80	22.0	8.09	N.S.	N.S.
12:15	8:30	House well	0.009	0.038	0.02	0.541	0.55	4.2	0.89	N.S.	N.S.
12:25	8:30	Trench 1	0.003	0.060	0.02	0.916	0.97	27.6	1.78	N.S.	N.S.
12:35	8:30	Trench 2	0.003	0.042	0.05	0.553	0.76	8.8	3.44	N.S.	N.S.
11:25	8:30	Field 1	0.251	0.386	0.09	0.055	0.86	44.4	6.31	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:40	8:30	Field 5a	0.248	0.968	0.26	0.127	1.50	320.1	8.58	N.S.	N.S.
1:05	8:30	Field 12	0.194	0.364	0.09	0.135	0.83	36.7	7.03	N.S.	N.S.
5/14/2015	**5/14/2015**	**Base flow**									
12:35	15:12	Spring	0.009	0.062	0.02	0.222	0.35	41.5	2.84	121.1	2419.2
12:28	15:12	Upstream farm	0.011	0.046	0.02	0.177	0.23	2.8	1.35	145.5	2470.0
12:47	15:12	Downstream farm	0.015	0.050	0.02	0.326	0.39	6.1	1.16	128.1	4370.0
12:57	15:12	Left Fork	0.015	0.038	0.02	0.321	0.38	3.3	1.36	83.3	2690.0
12:15	15:12	Ephemeral stream	0.010	0.022	0.01	0.527	0.50	1.7	0.73	41.3	1986.3
12:05	15:12	Trench 1	0.005	0.042	0.02	0.904	0.94	29.9	1.20	81.6	1732.9
5/18/2015	**5/18/2015**	**Storm Flow**									
10:45	14:43	Spring	0.005	0.084	0.05	0.209	0.56	114.2	2.79	98.7	1413.6
11:57	14:43	Upstream farm	0.007	0.034	0.02	0.110	0.15	5.2	1.29	137.6	2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:17	14:43	Downstream farm	0.009	0.040	0.03	0.201	0.25	6.1	1.47	185.0	6770.0
12:29	14:43	Left Fork	0.011	0.040	0.04	0.209	0.29	4.1	1.90	167.4	8300.0
11:14	14:43	Ephemeral stream	0.007	0.028	0.03	0.525	0.55	0.7	1.18	90.7	7630.0
11:20	14:43	House well	0.008	0.018	<0.03	0.529	0.53	0.9	0.90	5.2	13.4
12:55	14:43	Trench 1	0.002	0.020	<0.03	0.897	0.93	0.3	1.28	32.3	1732.9
10:58	14:43	Field 1	0.208	0.512	0.54	0.410	3.59	53.7	26.12	N.S.	N.S.
5/26/2015	**5/26/2015**	**Base flow**									
11:49	15:48	Spring	0.021	0.020	<0.03	0.205	0.29	1.2	2.66	N.S.	N.S.
13:20	15:48	Upstream farm	0.012	0.044	0.04	0.080	0.19	6.4	1.50	N.S.	N.S.
13:32	15:48	Downstream farm	0.045	0.200	0.11	0.096	0.56	94.7	4.57	N.S.	N.S.
13:45	15:48	Left Fork	0.014	0.048	0.04	0.139	0.29	6.1	2.41	N.S.	N.S.
13:11	15:48	Ephemeral stream	0.017	0.030	0.03	0.514	0.60	0.9	1.12	N.S.	N.S.
12:43	15:48	House well	0.013	0.020	<0.03	0.514	0.54	2.7	0.87	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:55	15:48	Trench 1	0.007	0.012	0.01	0.752	0.80	1.0	0.78	N.S.	N.S.
1:00	15:48	Trench 2	0.007	0.112	0.04	1.190	1.44	131.9	1.23	N.S.	N.S.
12:09	15:48	Field 1	0.245	0.432	0.20	0.174	1.66	37.8	11.28	N.S.	N.S.
6/1/2015	**6/1/2015**	**Storm Flow**									
13:15	15:20	Downstream farm	0.006	0.050	0.05	0.109	0.25	13.7	1.80	N.S.	N.S.
12:00	15:20	Ephemeral stream	0.002	0.056	0.01	0.851	1.05	18.3	2.46	N.S.	N.S.
6/4/2015	**6/4/2015**	**Base Flow**									
12:50	15:20	Spring	0.010	0.028	<0.03	0.239	0.3	6.2	9.54	44.3	1413.8
12:00	15:20	Upstream farm	0.008	0.026	0.03	0.083	0.11	2.3	2.93	38.6	>2419.2
13:05	15:20	Downstream farm	0.009	0.034	<0.03	0.184	0.23	1.7	2.64	24.7	2419.2
13:13	15:20	Left Fork	0.008	0.022	<0.03	0.145	0.19	2.1	3.15	38.9	2560.0
11:40	15:20	Ephemeral stream	0.010	0.024	0.02	0.572	0.58	0.8	5.35	21.6	3890.0
11:35	15:20	House well	0.012	0.022	0.02	0.561	0.52	1.3	6.07	<1.0	14.6
6/8/2015	**6/8/2015**	**Base flow**									
11:36	15:30	House well	0.008	0.018	0.27	0.475	0.82	0.7	6.67	<1.0	<1.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:45	15:30	Spring	0.011	0.046	0.03	0.322	0.53	12.7	11.18	20.1	1986.3
12:26	15:30	Upstream farm	0.010	0.030	0.06	0.058	0.24	4.5	3.63	866.4	2780.0
13:12	15:30	Downstream farm	0.009	0.022	0.05	0.185	0.27	0.9	2.66	57.4	4640.0
13:25	15:30	Left Fork	0.006	0.024	0.02	0.102	0.23	1.1	2.78	32.7	4550.0
11:51	15:30	Ephemeral stream	0.009	0.020	0.03	0.560	0.62	0.6	2.81	65.7	9870.0
6/17/2015	**6/17/2015**	**Base flow**									
12:08	15:40	Spring	0.009	0.046	0.07	0.224	0.47	9.4	8.92	517.2	24890.0
10:10	15:40	Upstream farm	0.009	0.036	0.03	0.050	0.16	3.5	2.83	435.2	13130.0
12:49	15:40	Downstream farm	0.007	0.034	0.03	0.106	0.23	2.3	2.92	344.8	20980.0
13:01	15:40	Left Fork	0.005	0.026	0.04	0.112	0.22	2.8	1.62	26.2	8550.0
11:50	15:40	Ephemeral stream	0.009	0.032	0.04	0.948	1.04	6.7	0.97	770.1	8840.0
11:47	15:40	House well	0.010	0.028	0.03	0.466	0.52	0.06	3.08	488.4	15390.0
6/22/2015	**6/22/15**	**Storm flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:30	15:55	Spring	0.009	0.032	0.03	0.218	0.26	5.3	3.01	61.3	1413.6
12:15	15:55	Upstream farm	0.010	0.030	0.01	0.042	0.05	2.9	0.99	78.0	4960.0
12:55	15:55	Downstream farm	0.009	0.032	0.04	0.136	0.16	2.9	1.15	36.8	5040.0
13:10	15:55	Left Fork	0.011	0.030	0.02	0.147	0.18	2.5	1.59	35.4	5910.0
10:50	15:55	Ephemeral stream	0.011	0.026	0.05	0.563	0.61	1.3	1.21	37.9	2419.2
10:45	15:55	House well	0.010	0.032	0.02	0.459	0.43	0.4	1.85	27.2	1732.9
10:30	15:55	Trench 1	0.005	0.048	0.07	0.653	0.76	47.3	1.86	21.1	1986.3
6/29/2015	**6/29/2015**	**Storm flow**									
10:47	15:32	Spring	0.013	0.018	0.03	0.235	0.30	1.7	5.26	93.3	2419.2
12:30	15:32	Upstream farm	0.010	0.028	0.14	0.055	0.13	2.7	2.49	117.8	4710
13:22	15:32	Downstream farm	0.068	0.748	0.17	0.147	1.88	571	6.57	135.4	7540
13:30	15:32	Left Fork	0.010	0.026	0.02	0.189	0.26	2.9	2.80	53.6	10170
12:20	15:32	Ephemeral stream	0.067	1.268	0.34	0.580	3.42	1366.8	11.04	69.7	4040
12:15	15:32	Trench 1	0.008	0.022	0.05	0.394	0.42	56.8	4.17	82.3	11450

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:48	15:32	Field 1	0.354	0.524	0.37	0.226	1.64	11	11.32	N.S.	N.S.
7/6/2015	**7/7/2015**	**Storm flow**									
19:45	14:58	Downstream farm	0.275	0.380	0.22	0.204	1.03	19.1	7.91	N.S.	N.S.
17:10	14:58	Ephemeral stream	0.063	0.658	0.37	0.717	2.75	567.3	8.52	N.S	N.S.
13:25	14:58	Field 1	0.387	0.444	0.23	0.345	1.30	4.9	8.32	N.S.	N.S.
16:45	14:58	Field 12	0.796	0.910	0.13	0.567	1.58	29.0	7.67	N.S.	N.S.
18:25	14:58	Field 5a	0.094	0.448	0.13	0.172	1.01	261.3	4.38	N.S.	N.S.
7/9/2015	**7/9/2015**	**Base flow**									
13:37	15:15	Spring	0.011	0.048	0.09	0.144	0.41	4.3	6.47	77.1	3050.0
12:25	15:15	Upstream farm	0.013	0.048	0.02	0.087	0.18	6.8	2.75	201.4	10140.0
12:55	15:15	Downstream farm	0.014	0.050	0.03	0.117	0.24	8.8	2.32	275.5	10760.0
13:15	15:15	Left Fork	0.015	0.058	0.04	0.138	0.31	11.4	2.67	387.3	12670.0
12:12	15:15	Ephemeral stream	0.010	0.034	<0.03	0.569	0.71	4.9	2.56	78.9	5560.0
12:07	15:15	House well	0.011	0.024	0.01	0.423	0.48	2.0	1.69	9.8	4160.0
12:00	15:15	Trench 1	0.007	0.030	<0.03	0.520	0.62	7.1	2.52	63.7	12330.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
7/16/2015	**7/16/2015**	**Base flow**									
12:15	15:10	Upstream farm	0.010	0.024	0.02	0.065	0.15	0.5	1.91	41.3	52.0
12:54	15:10	Downstream farm	0.011	0.030	<0.03	0.195	0.33	0.5	1.35	11.8	6310.0
13:03	15:10	Left Fork	0.010	0.042	0.01	0.181	0.28	0.9	1.64	21.6	9330.0
12:33	15:10	Ephemeral stream	0.011	0.046	0.01	0.517	0.61	0.4	2.16	45.7	14830.0
12:28	15:10	House well	0.012	0.024	0.01	0.471	0.47	0.0	4.00	2.0	727.0
12:42	15:10	Spring	0.010	0.024	0.01	0.303	0.41	5.7	5.54	22.8	1413.6
7/23/2015	**7/23/2015**	**Storm flow**									
10:55	15:20	Spring	0.010	0.026	<0.03	0.436	0.60	2.7	1.12	61.3	1046.2
11:15	15:20	Upstream farm	0.009	0.026	0.02	0.096	0.18	1.3	0.97	93.3	7490.0
12:40	15:20	Downstream farm	0.011	0.028	0.02	0.198	0.31	0.8	1.06	16.8	4870.0
13:02	15:20	Left Fork	0.009	0.028	0.04	0.239	0.40	1.4	1.21	35.4	8360.0
12:00	15:20	Ephemeral stream	0.011	0.034	<0.03	0.511	0.68	11.3	0.33	201.4	24950.0
12:23	15:20	House well	0.015	0.030	<0.03	0.442	0.52	1.0	0.89	8.5	35.0
7/30/2015	**7/30/2015**	**Base flow**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:28	15:20	Spring	0.011	0.026	0.03	0.479	0.65	6.3	4.73	6.3	920.8
12:17	15:20	Upstream farm	0.014	0.024	<0.03	0.101	0.15	0.9	1.61	27.2	2880.0
12:50	15:20	Downstream farm	0.012	0.022	0.02	0.268	0.38	1.9	2.16	11.9	6500.0
13:00	15:20	Left Fork	0.008	0.020	0.04	0.221	0.37	2.3	2.60	30.3	8160.0
11:58	15:20	House well	0.013	0.014	0.02	0.466	0.51	0.3	0.90	1.0	7.4
8/6/2015	**8/6/2015**	**Storm flow**									
12:05	14:50	Spring	0.008	0.240	0.07	0.265	0.97	<6.58	7.10	23.1	48840.0
11:36	14:50	Upstream farm	0.009	0.028	<0.03	0.147	0.24	1.8	3.37	488.4	13540.0
12:22	14:50	Downstream farm	0.010	0.028	0.03	0.406	0.52	1.7	3.06	40.2	10390.0
12:37	14:50	Left Fork	0.007	0.026	0.04	0.310	0.47	1.2	3.16	217.8	8130.0
10:37	14:50	House well	0.010	0.018	0.04	0.482	0.52	0.5	3.33	920.8	21870.0
8/13/2015	**8/13/2015**	**Base flow**									
11:40	15:30	Spring	0.009	0.360	0.15	0.735	1.12	254.9	7.29	21.6	3360.0
12:06	15:30	Upstream farm	0.013	0.018	0.04	0.124	0.16	0.3	4.32	13.4	2460.0
13:01	15:30	Downstream farm	0.011	0.024	<0.03	0.384	0.50	4.0	3.74	24.0	3310.0
13:12	15:30	Left Fork	0.007	0.016	0.03	0.192	0.52	1.4	4.50	13.2	4810.0
11:53	15:30	House well	0.025	0.012	0.03	0.498	0.58	0.5	6.15	4.1	228.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
8/20/2015	**8/20/2015**	**Storm flow**									
11:32	14:05	Spring	0.009	0.276	0.07	0.337	0.89	223.6	17.88	148.3	3270.0
11:49	14:05	Downstream farm	0.015	0.022	0.03	0.491	0.53	2.2	5.94	39.3	66.3
12:04	14:05	Left Fork	0.009	0.028	0.04	0.306	0.42	2.3	5.12	48.8	3930.0
10:52	14:05	House well	0.012	0.018	<0.03	0.545	0.56	0.9	6.63	1.0	29.5
8/27/2015	**8/27/2015**	**Base flow**									
12:48	15:35	Spring	0.007	0.158	0.04	0.329	0.69	103.7	9.07	27.2	7540.0
12:37	15:35	Upstream farm	0.005	0.028	0.04	0.084	0.28	2.9	4.30	104.6	7710.0
1:20	15:35	Downstream farm	0.013	0.024	<0.03	0.450	0.54	2.5	4.43	137.4	5730.0
1:30	15:35	Left Fork	0.008	0.024	0.02	0.218	0.33	2.0	3.79	7.4	3010.0
12:20	15:35	House well	0.012	0.018	<0.03	0.599	0.61	1.6	3.66	1.0	61.3
9/2/2015	**9/2/2015**	**Base flow**									
12:06	14:45	Spring	0.007	0.620	0.10	0.304	1.27	2.47	402.7	155.3	15530.0
11:50	14:45	Upstream farm	0.007	0.042	0.07	0.047	0.39	3.37	5.5	46.4	9070.0
12:19	14:45	Downstream farm	0.010	0.020	0.01	0.449	0.55	3.2	4.80	20.3	6630.0
12:30	14:45	Left Fork	0.010	0.020	0.01	0.449	0.55	3.19	4.8	20.3	6630.0
11:30	14:45	House well	0.007	0.020	0.03	0.109	0.33	1.67	3.8	26.9	5290.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
9/10/2015	**9/10/2015**	**Base flow**									
12:45	15:15	Spring	0.004	0.026	0.02	0.197	0.39	6.50	3.5	980.4	38730.0
12:59	15:15	Downstream farm	0.008	0.028	0.02	0.464	0.58	3.96	2.9	66.3	5470.0
13:10	15:15	Left Fork	0.006	0.026	<0.03	0.198	0.34	4.09	2.5	21.6	7230.0
11:56	15:15	House well	0.010	0.018	<0.03	0.576	0.60	3.21	0.3	8.6	727.0
9/16/2015	**9/16/2015**	**Base flow**									
11:41	14:40	Spring	0.004	0.176	<0.03	0.260	0.70	5.84	111.2	130.9	8330.0
12:06	14:40	Upstream farm	0.004	0.024	<0.03	0.104	0.30	4.62	2.1	50.4	3590.0
12:24	14:40	Downstream farm	0.009	0.030	0.01	0.404	0.62	4.59	1.4	6.2	4800.0
12:36	14:40	Left Fork	0.006	0.032	<0.03	0.146	0.48	2.49	1.3	38.2	6333.0
11:52	14:40	House well	0.009	0.020	<0.03	0.559	0.60	2.58	0.2	1.0	148.3
9/24/2015	**9/24/2015**	**Base flow**									
11:40	14:30	Spring	0.006	0.024	<0.03	0.216	0.42	10.59	12.3	8.6	1119.9
11:30	14:30	Upstream farm	0.006	0.078	<0.03	0.200	0.41	5.92	14.8	17.1	4570.0
12:07	14:30	Downstream farm	0.009	0.018	<0.03	0.449	0.56	5.58	1.2	29.9	7540.0
12:18	14:30	Left Fork	0.007	0.016	0.01	0.098	0.20	3.08	0.6	31.3	3410.0
11:19	14:30	House well	0.009	0.012	<0.03	0.543	0.58	7.72	0.3	<1.0	24.6

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
9/30/2015	**9/30/2015**	**Base flow**									
12:00	15:15	Spring	0.005	0.630	0.11	0.178	1.15	15.88	450.3	137.6	36540.0
11:50	15:15	Downstream farm	0.008	0.022	0.01	0.472	0.66	5.43	4.5	31.7	5290.0
11:42	15:15	Left Fork	0.007	0.018	<0.03	0.082	0.20	4.98	1.2	18.3	5940.0
12:43	15:15	House well	0.009	0.016	<0.03	0.499	0.60	4.20	0.5	<1.0	2.0
10/8/2015	**10/8/2015**	**Base flow**									
11:32	14:05	Spring	0.003	0.018	0.02	0.176	0.27	4.5	2.43	<1.0	686.7
11:20	14:05	Downstream farm	0.005	0.020	0.02	0.517	0.60	1.5	1.62	21.3	12360.0
11:10	14:05	Left Fork	0.003	0.020	0.02	0.069	0.15	1.5	1.58	59.8	3640.0
12:15	14:05	House well	0.008	0.020	0.02	0.518	0.53	0.5	1.54	<1.0	<1
10/14/2015	**10/14/2015**	**Base flow**									
11:42	14:40	Spring	0.008	0.056	0.03	0.193	0.36	27.5	1.50	<1.0	248.1
11:28	14:40	Downstream farm	0.010	0.056	0.03	0.603	0.76	12.4	1.33	7.3	8164.0
11:17	14:40	Left Fork	0.009	0.022	0.01	0.078	0.16	2.2	1.28	9.8	1986.3
12:10	14:40	House well	0.012	0.020	<0.03	0.490	0.63	0.3	0.94	<1.0	<1
10/22/2015	**10/22/2015**	**Base flow**									
12:35	13:45	Spring	0.005	0.028	0.03	0.173	0.33	11.4	6.99	<1.0	307.6

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:15	13:45	Downstream farm	0.008	0.018	0.07	0.548	0.69	2.3	3.64	17.8	3140.0
12:05	13:45	Left Fork	0.008	0.018	<0.03	0.069	0.13	1.9	3.57	3.1	1732.9
13:10	13:45	House well	0.010	0.014	0.04	0.478	0.50	0.4	1.93	<1.0	2.0
10/28/2015	**10/28/2015**	**Base flow**									
12:10	14:25	Spring	0.005	0.112	0.05	0.247	0.55	66.2	4.89	179.3	3950.0
11:56	14:25	Downstream farm	0.009	0.032	0.03	0.544	0.78	1.7	3.91	35.0	6700.0
11:46	14:25	Left Fork	0.007	0.024	0.02	0.060	0.24	1.9	2.90	61.3	3410.0
12:55	14:25	House well	0.008	0.016	0.01	0.391	0.54	<6.58	2.40	<1.0	<1
11/4/2015	**11/4/2015**	**Base flow**									
12:14	14:50	Spring	0.007	0.026	0.07	0.139	0.33	0.7	5.44	8.4	920.8
12:03	14:50	Downstream farm	0.010	0.038	<0.03	0.607	0.76	1.7	3.79	23.1	2880.0
11:54	14:50	Left Fork	0.007	0.018	<0.03	0.072	0.18	0.7	3.98	77.6	>2419.2
12:41	14:50	House well	0.010	0.016	<0.03	0.468	0.54	<6.58	2.62	<1.0	<1
11/12/2015	**11/12/2015**	**Base flow**									
12:15	15:00	Spring	0.007	0.064	<0.03	0.187	0.43	33.6	5.46	72.7	>2419.2
12:26	15:00	Upstream farm	0.015	0.022	<0.03	0.127	0.22	0.9	2.51	117.8	2620.0
12:03	15:00	Downstream farm	0.013	0.044	<0.03	0.439	0.64	6.9	2.14	75.9	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:54	15:00	Left Fork	0.005	0.016	<0.03	0.215	0.34	1.1	2.50	25.6	3360.0
12:42	15:00	House well	0.009	0.012	<0.03	0.501	0.55	0.3	3.71	<1.0	<1
11/18/2015	**11/18/2015**	**Base flow**									
11:37	15:05	Spring	0.011	0.030	0.01	0.168	0.43	1.8	5.47	461.1	13130.0
11:50	15:05	Upstream farm	0.013	0.046	0.06	0.229	0.41	4.0	2.55	517.2	5810.0
11:25	15:05	Downstream farm	0.017	0.050	0.09	0.334	0.56	4.5	2.88	435.2	14550.0
11:15	15:05	Left Fork	0.020	0.062	0.08	0.432	0.73	7.4	3.72	686.7	23590.0
12:15	15:05	Ephemeral stream	0.012	0.040	0.07	1.262	1.57	2.7	3.23	325.5	10710.0
12:28	15:05	Trench 1	0.005	0.030	0.02	0.264	0.52	1.9	1.74	65.7	17930.0
12:50	15:05	House well	0.009	0.014	<0.03	0.464	0.59	0.4	0.48	<1.0	<1
12/2/2015	**12/2/2015**	**Base flow**									
12:15	15:35	Spring	0.011	0.014	<0.03	1.262	1.63	1.9	2.51	109.2	2419.2
13:22	15:35	Upstream farm	0.010	0.020	0.03	0.135	0.22	1.4	0.98	55.6	1986.3
11:57	15:35	Downstream farm	0.012	0.022	0.02	0.266	0.39	1.6	0.94	48.0	9600.0
11:40	15:35	Left Fork	0.014	0.024	0.01	0.302	0.43	1.6	1.36	66.9	1986.3
12:27	15:35	Ephemeral stream	0.011	0.024	<0.03	0.613	0.89	1.0	1.01	145.0	1986.3

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:48	15:35	Trench 1	0.006	0.008	<0.03	0.218	0.33	1.3	1.10	6.3	5810.0
13:38	15:35	House well	0.011	0.014	0.02	0.480	0.60	0.9	1.38	1.0	1.0
12/14/2015	**12/14/2015**	**Base flow**									
12:45	16:00	Spring	0.007	0.024	<0.03	0.744	0.94	0.5	3.86	No Data	3230.0
13:00	16:00	Upstream farm	0.009	0.030	<0.03	0.364	0.58	3.4	11.89	118.7	2810.0
12:30	16:00	Downstream farm	0.009	0.034	0.05	0.181	0.27	4.1	4.10	410.6	4080.0
12:20	16:00	Left Fork	0.012	0.048	0.07	0.235	0.38	11.2	3.24	325.5	4520.0
15:15	16:00	Ephemeral stream	0.014	0.056	0.06	0.298	0.50	10.8	3.92	410.6	6010.0
13:30	16:00	Trench 1	0.004	0.012	<0.03	0.299	0.36	1.1	3.44	8.4	10460.0
13:38	16:00	House well	0.011	0.010	<0.03	0.545	0.57	0.1	10.15	<1.0	1.0
12/22/2015	**12/22/2015**	**Base flow**									
11:35	14:45	Spring	0.008	0.018	<0.03	0.531	0.58	0.7	1.23	146.7	1203.3
12:38	14:45	Upstream	0.010	0.020	<0.03	0.092	0.14	0.4	0.94	50.4	648.8
11:02	14:45	Downstream	0.011	0.020	<0.03	0.245	0.32	1.0	1.12	31.8	980.4
10:48	14:45	Left Fork	0.013	0.020	<0.03	0.267	0.35	0.1	1.36	26.5	1299.7
11:46	14:45	Ephemeral	0.010	0.016	<0.03	1.452	1.68	0.7	2.41	52.9	1299.7
12:14	14:45	Trench 1	0.005	0.010	<0.03	0.157	0.20	0.3	0.89	1.0	435.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:25	14:45	House well	0.010	0.016	<0.03	0.534	0.59	0.3	1.40	<1.0	<1.0
1/5/2016	**1/25/2016**	**Base flow**									
11:52	15:29	Spring	0.007	0.024	<0.03	0.584	0.63	0.7	1.39	16.0	816.4
13:00	15:29	Upstream	0.008	0.026	<0.03	0.158	0.20	0.5	0.95	67.7	648.8
11:40	15:29	Downstream	0.011	0.026	<0.03	0.419	0.46	0.1	1.13	40.8	648.8
11:30	15:29	Left Fork	0.013	0.028	<0.03	0.427	0.48	0.7	1.51	34.1	686.7
12:02	15:29	Ephemeral	0.007	0.018	<0.03	0.883	1.00	1.2	2.15	32.7	686.7
12:13	15:29	Trench 1	0.003	0.016	<0.03	0.243	0.29	0.9	1.11	1.0	209.8
12:44	15:29	House well	0.008	0.020	<0.03	0.528	0.57	0.9	1.08	<1.0	1.0
1/25/2016	**1/25/2016**	**Base flow**									
11:16	15:25	Spring	0.010	0.022	<0.03	0.565	0.60	0.3	1.27	34.5	1732.9
12:10	15:25	Upstream	0.010	0.022	<0.03	0.068	0.09	1.1	1.52	16.9	290.9
11:00	15:25	Downstream	0.011	0.022	<0.03	0.213	0.24	0.7	1.29	8.6	365.4
10:48	15:25	Left Fork	0.010	0.024	<0.03	0.198	0.25	1.0	1.30	21.1	435.2
11:28	15:25	Ephemeral	0.011	0.030	<0.03	0.762	0.87	9.8	3.10	1.0	816.4
11:42	15:25	House well	0.012	0.020	<0.03	0.602	0.55	0.5	2.36	<1.0	<1
2/10/2016	**2/10/2016**	**Base flow**									
12:25	15:26	Spring	0.007	0.040	<0.03	0.634	0.80	17.7	2.70	1.0	325.5

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:15	15:26	Upstream	0.005	0.016	<0.03	0.048	0.11	0.5	1.11	14.5	178.5
11:04	15:26	Downstream	0.005	0.016	<0.03	0.198	0.24	0.9	0.99	4.1	218.7
11:29	15:26	Left Fork	0.003	0.012	<0.03	0.175	0.24	0.8	1.15	7.4	209.8
12:03	15:26	House well	0.007	0.014	<0.03	0.542	0.56	0.1	0.63	<1.0	<1.0
2/24/2016	**2/24/2016**	**Base flow**									
11:05	14:45	Spring	0.010	0.052	<0.03	1.102	1.46	2.8	N.S.	209.8	3930.0
12:16	14:45	Upstream	0.014	0.052	<0.03	0.099	0.28	6.1	N.S.	1203.3	7330.0
10:52	14:45	Downstream	0.015	0.058	<0.03	0.142	0.37	8.3	N.S.	1986.3	6500.0
10:38	14:45	Left Fork	0.015	0.088	<0.03	0.249	0.63	15.6	N.S.	2780.0	14390.0
11:15	14:45	Ephemeral	0.010	0.056	<0.03	0.195	0.40	12.8	N.S.	387.3	4870.0
11:36	14:45	Trench 1	0.005	0.014	<0.03	0.345	0.39	2.1	N.S.	<1.0	9070.0
11:53	14:45	House well	0.010	0.010	<0.03	0.582	0.55	1.3	N.S.	<1.0	<1.0
Samples analyzed since the last quarterly report											
3/10/2016	**3/10/2016**	**Base flow**									
11:04	15:45	Spring	0.012	0.064	0.11	0.104	0.34	9.5	5.38	285.1	3230.0
13:13	15:45	Upstream	0.012	0.048	0.13	0.082	0.20	8.6	2.66	770.1	>2419.2
10:51	15:45	Downstream	0.010	0.044	0.11	0.118	0.25	6.2	2.28	298.7	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:32	15:45	Ephemeral stream	0.006	0.050	0.13	0.918	1.22	26.7	3.12	648.8	8840.0
10:38	15:45	Left Fork	0.013	0.046	0.01	0.154	0.38	8.7	2.64	367.3	2750.0
12:03	15:45	House well	0.011	0.020	0.02	0.562	0.59	0.9	1.19	<1.0	<1.0
11:50	15:45	Trench 1	0.005	0.036	0.10	0.264	0.45	3.5	2.87	2419.2	16690.0
11:46	15:45	Trench 2	0.005	0.054	0.14	1.716	2.35	6.8	6.77	613.1	34480.0
12:41	15:45	Field 12	0.411	0.522	1.17	0.852	4.49	621.5	12.58	410.6	>241920
3/16/2016	**3/16/2016**	**Base flow**									
11:35	15:05	Spring	0.009	0.036	0.01	0.340	0.44	5.7	3.36	75.4	461.1
12:35	15:05	Upstream	0.008	0.034	<0.03	0.060	0.13	0.4	1.10	52.9	579.4
11:23	15:05	Downstream	0.006	0.028	0.01	0.170	0.24	0.9	1.17	81.3	>2419.2
11:50	15:05	Ephemeral stream	0.006	0.022	0.01	0.520	0.54	0.0	1.75	88.0	461.1
11:13	15:05	Left Fork	0.009	0.032	<0.03	0.190	0.26	0.3	1.45	35.9	980.4
12:22	15:05	House well	0.009	0.022	<0.03	0.550	0.55	0.0	1.55	<1.0	<1
12:01	15:05	Trench 1	0.003	0.032	0.02	0.331	0.37	0.0	1.23	101.7	290.9
3/24/2016	**3/24/2016**	**Storm flow**									
11:50	15:10	Spring	0.015	0.046	0.06	0.172	0.42	13.1	4.95	N.S.	N.S.
12:50	15:10	Upstream	0.011	0.032	0.06	0.040	0.14	4.5	1.60	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:35	15:10	Downstream	0.011	0.024	<0.03	0.106	0.20	3.9	1.29	N.S.	N.S.
12:10	15:10	Ephemeral stream	0.010	0.012	<0.03	0.531	0.64	1.3	1.44	N.S.	N.S.
11:25	15:10	Left Fork	0.013	0.048	0.09	0.186	0.39	10.7	2.65	N.S.	N.S.
12:34	15:10	House well	0.012	0.014	<0.03	0.565	0.65	0.2	2.72	N.S.	N.S.
12:20	15:10	Trench 1	0.008	0.016	<0.03	0.208	0.20	2.8	1.33	N.S.	N.S.
3/31/2016	**3/31/3016**	**Base Flow**									
11:06	15:10	Spring	0.011	0.034	<0.03	0.319	0.52	7.4	25.32	71.7	1553.1
12:45	15:10	Upstream	0.008	0.042	0.08	0.100	0.22	6.1	2.49	186.0	>2419.2
10:45	15:10	Downstream	0.011	0.056	0.08	0.156	0.33	12.4	2.67	365.0	>2419.2
11:16	15:10	Ephemeral stream	0.013	0.656	0.68	1.211	3.05	375.0	12.14	16160.0	198630.0
10:33	15:10	Left Fork	0.013	0.056	0.09	0.199	0.40	11.9	2.59	172.0	3640.0
11:49	15:10	House well	0.010	0.018	<0.03	0.556	0.62	0.2	3.93	1.0	26.2
11:40	15:10	Trench 1	0.004	0.018	<0.03	0.347	0.49	5.5	4.76	4.1	2419.2
11:35	15:10	Trench 2	0.006	0.040	0.06	2.800	3.54	20.9	9.29	7.4	10810.0
12:02	15:10	Field 5a	1.154	1.352	0.27	0.302	1.67	26.5	32.74	24890.0	>241920
4/4/2016	**4/4/2016**	**Base Flow**									
11:58	15:20	Spring	0.009	0.028	<0.03	0.324	0.42	7.5	1.57	104.7	866.4

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:50	15:20	Upstream	0.008	0.026	<0.03	0.065	0.08	1.7	0.71	8.3	648.8
11:48	15:20	Downstream	0.010	0.026	<0.03	0.176	0.20	1.9	0.98	77.6	1046.2
12:08	15:20	Ephemeral stream	0.008	0.018	<0.03	0.462	0.48	1.3	1.79	12.0	727.0
11:38	15:20	Left Fork	0.009	0.022	<0.03	0.131	0.17	1.5	0.87	44.8	1119.9
12:35	15:20	House well	0.011	0.018	<0.03	0.466	0.48	0.0	0.94	<1.0	1.0
12:26	15:20	Trench 2	0.004	0.012	<0.03	0.236	0.25	0.0	0.85	1.0	>2419.2
4/20/2016	**4/20/2016**	**Base Flow**									
12:02	15:52	Spring	0.005	0.042	<0.03	0.410	0.55	22.4	1.04	3.1	195.6
13:20	15:52	Upstream	0.003	0.020	<0.03	0.047	0.06	1.9	0.61	185.0	1299.7
11:42	15:52	Downstream	0.004	0.018	<0.03	0.152	0.20	1.2	0.74	38.4	2920.0
12:11	15:52	Ephemeral stream	0.008	0.020	<0.03	0.517	0.66	4.1	0.68	44.3	21430.0
11:30	15:52	Left Fork	0.005	0.020	<0.03	0.157	0.21	2.1	0.84	35.0	6160.0
12:52	15:52	House well	0.005	0.014	<0.03	0.598	0.50	0.5	0.47	1.0	1.0
4/28/2016	**4/28/2016**	**Base Flow**									
11:55	15:17	Spring	0.010	0.024	<0.03	0.455	0.63	12.0	N.S.	25.6	>2419.2
13:00	15:17	Upstream	0.009	0.012	<0.03	0.035	0.12	1.2	N.S.	58.6	648.8
11:30	15:17	Downstream	0.010	0.012	<0.03	0.154	0.27	1.5	N.S.	36.4	2149.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:31	15:17	House well	0.011	0.008	<0.03	0.481	0.57	0.3	N.S.	<1.0	<1.0
11:25	15:17	Dry Creek	0.010	0.012	<0.03	0.152	0.27	1.0	N.S.	14.8	3050.0
5/2/2016	**5/3/2016**	**Base Flow**									
12:25	08:55	Spring	0.008	0.012	<0.03	0.338	0.36	2.2	5.08	88.2	>2419.2
14:29	08:55	Upstream	0.006	0.018	<0.03	0.039	0.10	6.7	1.76	185.0	2419.2
11:43	08:55	Downstream	0.008	0.016	<0.03	0.075	0.16	2.0	1.50	178.9	4720.0
12:38	08:55	Ephemeral stream	0.007	0.016	<0.03	0.468	0.59	1.7	2.56	118.7	5380.0
12:38	08:55	Ephemeral stream	0.008	0.112	0.15	1.794	2.62	61.8	4.07	1046.2	23590.0
11:24	08:55	Left Fork	0.009	0.020	<0.03	0.095	0.20	1.9	2.30	172.6	3640.0
13:27	08:55	House well	0.009	0.016	<0.03	0.551	0.56	0.1	1.94	<1.0	<1
5/10/2016	**5/10/2016**	**Base Flow**									
11:15	15:40	Spring	0.008	0.026	<0.03	0.281	0.45	2.9	7.58	410.6	2780.0
12:50	15:40	Upstream	0.007	0.044	0.01	0.070	0.20	6.1	3.10	613.1	4480.0
10:58	15:40	Downstream	0.011	0.060	0.01	0.101	0.31	11.6	2.95	1203.3	7490.0
11:28	15:40	Ephemeral stream	0.195	0.560	0.32	0.649	4.01	1346.7	11.94	579.4	>2419.2
10:35	15:40	Left Fork	0.011	0.072	0.02	0.121	0.37	17.2	3.35	980.4	8230.0
12:08	15:40	House well	0.009	0.008	<0.03	0.533	0.56	0.5	4.39	<1.0	24.9

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:55	15:40	Trench 1	0.002	0.016	<0.03	0.228	0.30	3.9	2.91	13.9	>2419.2
11:45	15:40	Trench 2	0.002	0.038	<0.03	1.706	2.18	5.2	3.72	38.7	>2419.2
12:26	15:40	Field 5a	1.114	1.458	1.69	2.894	6.35	79.9	12.82	22820.0	>2419.2
13:08	15:40	Field 12	0.370	0.666	0.12	0.062	1.03	96.7	6.92	663.0	>2419.2
5/18/2016	**5/18/2016**	**Base Flow**									
11:29	15:20	Spring	0.009	0.024	0.01	0.320	0.51	8.7	2.20	45.7	1413.6
13:08	15:20	Upstream	0.007	0.016	<0.03	0.043	0.13	1.4	1.00	85.5	1299.7
11:10	15:20	Downstream	0.009	0.020	0.02	0.117	0.25	1.2	0.98	107.1	>2419.2
11:43	15:20	Ephemeral stream	0.008	0.014	<0.03	0.479	0.63	3.0	0.84	34.1	2419.2
10:57	15:20	Left Fork	0.010	0.016	0.01	0.139	0.27	1.4	1.54	60.1	2620.0
12:50	15:20	House well	0.009	0.010	<0.03	0.488	0.64	0.4	0.95	<1.0	<1.0
12:05	15:20	Trench 1	0.006	0.006	<0.03	0.169	0.22	0.1	0.54	2.0	5200.0
5/26/2016	**5/26/2016**	**Base Flow**									
11:45	15:30	Spring	0.008	0.020	<0.03	0.219	0.35	6.2	4.15	344.8	3730.0
13:08	15:30	Upstream	0.007	0.030	<0.03	0.056	0.12	4.2	1.56	238.2	5290.0
11:30	15:30	Downstream	0.009	0.036	<0.03	0.094	0.20	4.6	1.75	547.5	3640.0
12:05	15:30	Ephemeral stream	0.052	0.424	0.39	0.858	2.20	350.6	8.58	22470.0	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:20	15:30	Left Fork	0.010	0.048	0.02	0.123	0.24	10.6	2.66	461.1	6890.0
12:51	15:30	House well	0.009	0.012	<0.03	0.564	0.57	0.7	0.93	1.0	7.4
12:38	15:30	Trench 1	0.008	0.006	<0.03	0.217	0.23	1.4	1.29	1.0	4260.0

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.
§ N.S. is No Sample.

Nutrients, Sediment, and Bacteria by Date Spring, Upstream, and Downstream Sites

Table 4. Water quality analyses in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application since January 2015, with those collected since the last report noted.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
1/8/2015									
Upstream	0.009	0.022	<0.03	0.187	0.21	2.3	1.41	30.9	547.5
Downstream	0.011	0.024	<0.03	0.376	0.39	2.5	1.22	42.6	980.4
1/14/2015									
Upstream	0.012	0.032	<0.03	0.135	0.19	1.1	3.02	88.2	727.0
Downstream	0.011	0.020	<0.03	0.388	0.34	1.0	2.03	25.6	613.1
1/21/2015									
Upstream	0.008	0.018	<0.03	0.089	0.12	1.1	0.95	70.3	579.4
Downstream	0.010	0.026	0.06	0.197	0.30	1.1	1.60	37.4	613.1
1/29/2015									
Upstream	0.006	0.060	<0.03	0.065	0.21	47.8	1.71	727.0	1413.6
Downstream	0.009	0.020	0.04	0.168	0.27	1.3	1.50	19.9	1046.2

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
2/3/2015									
Upstream	0.006	0.022	<0.03	0.051	0.28	1.1	2.69	4.1	1203.3
Downstream	0.009	0.018	<0.03	0.140	0.29	4.1	2.66	1.0	547.5
2/10/2015									
Upstream	0.009	0.012	<0.03	0.056	0.09	0.7	1.04	1119.1	2419.2
Downstream	0.011	0.012	<0.03	0.143	0.23	1.0	1.15	7.4	1553.1
2/26/2015									
Upstream	0.006	0.024	<0.03	0.100	0.13	0.6	1.20	47.9	686.7
Downstream	0.008	0.026	0.02	0.200	0.25	0.8	1.17	48.7	866.4
3/3/2015									
Upstream	0.006	0.026	0.02	0.048	0.11	N.D.	1.50	N.S.	N.S.
Downstream	0.007	0.028	<0.03	0.138	0.23	N.D.	1.50	N.S.	N.S.
3/11/2015									
Upstream	0.005	0.026	0.02	0.118	0.16	2.1	3.38	34.5	579.4
Downstream	0.007	0.030	0.02	0.209	0.27	1.8	1.44	66.3	770.1
3/19/2015									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.007	0.024	0.04	0.111	0.20	1.7	2.53	42.6	866.4
Downstream	0.009	0.028	0.04	0.234	0.35	2.8	2.87	71.7	1119.9
3/25/2015									
Upstream	0.006	0.028	0.02	0.056	0.16	2.9	1.36	125.9	2419.2
Downstream	0.008	0.036	0.04	0.162	0.29	5.0	1.41	547.5	3410.0
3/26/2015									
Upstream	0.013	0.076	0.06	0.144	0.41	14.1	3.94	816.4	4960.0
Downstream	0.004	0.026	0.02	0.904	1.00	15.4	0.69	<1.0	1553.1
4/2/2015									
Upstream	0.007	0.040	0.02	0.045	0.14	3.1	3.61	166.9	2419.2
Downstream	0.007	0.042	0.02	0.139	0.22	2.5	2.71	121.1	1986.3
4/9/2015									
Upstream	0.011	0.042	0.04	0.066	0.18	13.1	2.13	86.0	2650.0
Downstream	0.010	0.048	0.03	0.157	0.25	19.7	1.82	47.2	1986.3
4/15/2015									
Upstream	0.007	0.040	0.03	0.090	0.16	3.5	3.24	648.8	4040.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.009	0.048	0.03	0.166	0.26	4.4	2.67	344.8	2920.0
4/23/2015									
Upstream	0.007	0.032	0.03	0.083	0.18	4.0	5.11	104.6	2419.2
Downstream	0.007	0.032	0.03	0.162	0.25	2.6	2.51	65.7	2419.2
4/29/2015									
Upstream	0.010	0.020	0.03	0.082	0.13	2.7	1.58	58.3	1732.4
Downstream	0.012	0.018	0.03	0.189	0.82	2.1	1.64	58.6	1986.3
5/7/2015									
Upstream	0.008	0.032	0.01	0.110	0.16	7.5	10.16	77.6	3280.0
Downstream	0.009	0.034	<0.03	0.267	0.36	4.5	7.70	27.8	2280.0
5/8/2015									
Upstream	0.195	0.544	0.27	0.292	1.20	113.2	7.47	N.S.	N.S.
Downstream	0.005	0.254	0.41	2.287	3.23	127.1	6.45	N.S.	N.S.
5/11/2015									
Upstream	0.004	0.074	0.04	0.004	0.24	4.5	4.31	N.S.	N.S.
Downstream	0.031	0.530	0.11	0.071	1.12	277.5	8.48	N.S.	N.S.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/14/2015									
Upstream	0.011	0.046	0.02	0.177	0.23	2.8	1.35	145.5	2470.0
Downstream	0.015	0.050	0.02	0.326	0.39	6.1	1.16	128.1	4370.0
5/18/2015									
Upstream	0.007	0.034	0.02	0.110	0.15	5.2	1.29	137.6	2419.2
Downstream	0.009	0.040	0.03	0.201	0.25	6.1	1.47	185.0	6770.0
5/26/2015									
Upstream	0.012	0.044	0.04	0.080	0.19	6.4	1.50	N.S.	N.S.
Downstream	0.045	0.200	0.11	0.096	0.56	94.7	4.57	N.S.	N.S.
6/1/2015									
Downstream	0.006	0.050	0.05	0.109	0.25	13.7	1.80	N.S.	N.S.
6/4/2015									
Upstream	0.008	0.026	0.03	0.083	0.11	2.3	2.93	38.6	>2419.2
Downstream	0.009	0.034	<0.03	0.184	0.23	1.7	2.64	24.7	2419.2
6/8/2015									
Upstream	0.010	0.030	0.06	0.058	0.24	4.5	3.63	866.4	2780.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.009	0.022	0.05	0.185	0.27	0.9	2.66	57.4	4640.0
6/17/2015									
Upstream farm	0.009	0.036	0.03	0.050	0.16	3.5	2.83	435.2	13130.0
Downstream	0.007	0.034	0.03	0.106	0.23	2.3	2.92	344.8	20980.0
6/22/2015									
Upstream	0.010	0.030	0.01	0.042	0.05	2.9	0.99	78.0	4960.0
Downstream	0.009	0.032	0.04	0.136	0.16	2.9	1.15	36.8	5040.0
6/29/2015									
Upstream	0.010	0.028	0.14	0.055	0.13	2.7	2.49	117.8	4710
Downstream	0.068	0.748	0.17	0.147	1.88	571	6.57	N.S.	N.S.
7/6/2015									
Downstream	0.275	0.380	0.22	0.204	1.03	19.1	7.91	N.S.	N.S.
7/9/2015									
Upstream	0.013	0.048	0.02	0.087	0.18	6.8	2.75	201.4	10140.0
Downstream	0.014	0.050	0.03	0.117	0.24	8.8	2.32	275.5	10760.0
7/16/2015									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.011	0.030	<0.03	0.195	0.33	0.5	1.35	11.8	6310.0
7/23/2015									
Upstream	0.009	0.026	0.02	0.096	0.18	1.3	0.97	93.3	7490.0
Downstream	0.011	0.028	0.02	0.198	0.31	0.8	1.06	16.8	4870.0
7/30/2015									
Upstream	0.014	0.024	<0.03	0.101	0.15	0.9	1.61	27.2	2880.0
Downstream	0.012	0.022	0.02	0.268	0.38	1.9	2.16	11.9	6500.0
8/6/2015									
Upstream	0.009	0.028	<0.03	0.147	0.24	1.8	3.37	488.4	13540.0
Downstream	0.010	0.028	0.03	0.406	0.52	1.7	3.06	40.2	10390.0
8/13/2015									
Upstream	0.013	0.018	0.04	0.124	0.16	0.3	4.32	13.4	2460.0
Downstream	0.011	0.024	<0.03	0.384	0.50	4.0	3.74	24.0	3310.0
8/20/2015									
Downstream	0.015	0.022	0.03	0.491	0.53	2.2	5.94	39.3	66.3
8/27/2015									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.005	0.028	0.04	0.084	0.28	2.9	4.30	104.6	7710.0
Downstream	0.013	0.024	<0.03	0.450	0.54	2.5	4.43	137.4	5730.0
9/2/2015									
Upstream	0.007	0.042	0.07	0.047	0.39	3.37	5.5	46.4	9070.0
Downstream	0.010	0.020	0.01	0.449	0.55	3.2	4.80	20.3	6630.0
9/10/2015									
Downstream	0.008	0.028	0.02	0.464	0.58	3.96	2.9	66.3	5470.0
9/16/2015									
Upstream	0.004	0.024	<0.03	0.104	0.30	4.62	2.1	50.4	3590.0
Downstream	0.009	0.030	0.01	0.404	0.62	4.59	1.4	6.2	4800.0
9/24/2015									
Upstream	0.006	0.078	<0.03	0.200	0.41	5.92	14.8	17.1	4570.0
Downstream	0.009	0.018	<0.03	0.449	0.56	5.58	1.2	29.9	7540.0
9/30/2015									
Downstream	0.008	0.022	0.01	0.472	0.66	5.43	4.5	31.7	5290.0
10/8/2015									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.005	0.020	0.02	0.517	0.60	1.5	1.62	21.3	12360.0
10/14/2015									
Downstream	0.005	0.020	0.02	0.517	0.60	1.5	1.62	21.3	12360.0
10/14/2015									
Downstream	0.010	0.056	0.03	0.603	0.76	12.4	1.33	7.3	8164.0
10/22/2015									
Downstream	0.008	0.018	0.07	0.548	0.69	2.3	3.64	17.8	3140.0
10/28/2015									
Downstream	0.009	0.032	0.03	0.544	0.78	1.7	3.91	35.0	6700.0
11/4/2015									
Downstream	0.010	0.038	<0.03	0.607	0.76	1.7	3.79	23.1	2880.0
11/12/2015									
Upstream	0.015	0.022	<0.03	0.127	0.22	0.9	2.51	117.8	2620.0
Downstream	0.013	0.044	<0.03	0.439	0.64	6.9	2.14	75.9	>2419.2
11/18/2015									
Upstream	0.013	0.046	0.06	0.229	0.41	4.0	2.55	517.2	5810.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.017	0.050	0.09	0.334	0.56	4.5	2.88	435.2	14550.0
12/2/2015									
Upstream	0.010	0.020	0.03	0.135	0.22	1.4	0.98	55.6	1986.3
Downstream	0.012	0.022	0.02	0.266	0.39	1.6	0.94	48.0	9600.0
12/14/2015									
Upstream	0.009	0.034	0.05	0.181	0.27	4.1	4.10	410.6	4080.0
Downstream	0.012	0.048	0.07	0.235	0.38	11.2	3.24	325.5	4520.0
12/22/2015									
Upstream	0.010	0.020	<0.03	0.092	0.14	0.4	0.94	50.4	648.8
Downstream	0.011	0.020	<0.03	0.245	0.32	1.0	1.12	31.8	980.4
1/5/2016									
Upstream	0.008	0.026	<0.03	0.158	0.20	0.5	0.95	67.7	648.8
Downstream	0.011	0.026	<0.03	0.419	0.46	0.1	1.13	40.8	648.8
1/25/2016									
Upstream	0.010	0.022	<0.03	0.068	0.09	1.1	1.52	16.9	290.9
Downstream	0.011	0.022	<0.03	0.213	0.24	0.7	1.29	8.6	365.4

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
2/10/2016									
Upstream	0.005	0.016	<0.03	0.048	0.11	0.5	1.11	14.5	178.5
Downstream	0.005	0.016	<0.03	0.198	0.24	0.9	0.99	4.1	218.7
2/24/2016									
Upstream	0.014	0.052	<0.03	0.099	0.28	6.1		1203.3	7330.0
Downstream	0.015	0.058	<0.03	0.142	0.37	8.3		1986.3	6500.0
Samples analyzed since the last quarterly report									
3/10/2016									
Upstream	0.012	0.048	0.13	0.082	0.20	8.6	2.66	770.1	>2419.2
Downstream	0.010	0.044	0.11	0.118	0.25	6.2	2.28	298.7	>2419.2
3/16/2016									
Upstream	0.008	0.034	0.00	0.060	0.13	0.4	1.10	52.9	579.4
Downstream	0.006	0.028	0.01	0.170	0.24	0.9	1.17	81.3	>2419.2
3/24/2016									
Upstream	0.011	0.032	0.06	0.04	0.14	4.5	1.60	N.S.	N.S.
Downstream	0.011	0.024	0.00	0.106	0.20	3.9	1.29	N.S.	N.S.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/31/2016									
Upstream	0.008	0.042	0.08	0.100	0.22	6.1	2.49	186.0	>2419.2
Downstream	0.011	0.056	0.08	0.156	0.33	12.4	2.67	365.0	>2419.2
4/4/2016									
Upstream	0.008	0.026	<0.03	0.065	0.08	1.7	0.71	8.3	648.8
Downstream	0.010	0.026	<0.03	0.176	0.20	1.9	0.98	77.6	1046.2
4/20/2016									
Upstream	0.003	0.020	<0.03	0.047	0.06	1.9	0.61	185.0	1299.7
Downstream	0.004	0.018	<0.03	0.152	0.20	1.2	0.74	38.4	2920.0
4/28/2016									
Upstream	0.009	0.012	<0.03	0.035	0.12	1.2	N.D.	58.6	648.8
Downstream	0.010	0.012	<0.03	0.154	0.27	1.5	N.D.	36.4	2149.2
5/2/2016									
Upstream	0.006	0.018	<0.03	0.039	0.10	6.7	1.76	185.0	2419.2
Downstream	0.008	0.016	<0.03	0.075	0.16	2.0	1.50	178.9	4720.0
5/10/2016									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.007	0.044	0.01	0.070	0.20	6.1	3.10	613.1	4480.0
Downstream	0.011	0.060	0.01	0.101	0.31	11.6	2.95	1203.3	7490.0
5/18/2016									
Upstream	0.007	0.016	<0.03	0.043	0.13	1.4	1.00	85.5	1299.7
Downstream	0.009	0.020	0.02	0.117	0.25	1.2	0.98	107.1	>2419.2
5/26/2016									
Upstream	0.007	0.030	<0.03	0.056	0.12	4.2	1.56	238.2	5290.0
Downstream	0.009	0.036	<0.03	0.094	0.20	4.6	1.75	547.5	3640.0

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

§ N.S. is No Sample.

† N.D. is No Data.

Nutrients, Sediment, and Bacteria by Site for Ephemeral Stream, Trenches, Left Fork and Field Runoff

Table 5. Water quality analyses at the ephemeral stream draining the subwatershed containing the production houses and manure holding ponds, and surface runoff from Fields 1, 5a, and 12 since January, 2015, with those collected since the last report noted.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
Ephemeral stream									
1/8/2015	0.008	0.022	<0.03 ¶	0.448	0.59	2.4	1.73	25.6	1203.3
1/15/2015	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6
1/21/2015	0.005	0.016	<0.03	0.370	0.46	1.0	2.34	155.3	2419.2
2/26/2015	0.006	0.022	<0.03	0.530	0.57	1.3	1.38	16.1	4790.0
3/3/2015	0.006	0.020	<0.03	0.477	0.52	ND	1.84	N.S. §	N.S.
3/11//2015	0.006	0.022	0.04	0.567	0.60	0.5	2.20	6.3	410.0
3/19/2015	0.007	0.018	0.01	0.529	0.63	1.0	4.31	14.6	866.4
3/25/2015	0.007	0.014	0.02	0.462	0.53	1.1	0.64	8.6	344.8
4/2/2015	0.006	0.032	0.02	0.467	0.46	1.8	4.41	5.2	547.5
4/15/2015	0.005	0.026	0.03	0.472	0.56	0.8	1.26	305.0	2430.0
4/23/2015	0.008	0.026	0.03	0.520	0.56	2.0	1.78	12.0	3270.0
4/29/2015	0.012	0.018	0.02	0.569	0.61	3.5	1.98	14.3	4080.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/7/2015	0.013	0.066	0.02	0.628	0.71	3.2	16.41	71.7	7170.0
5/8/2015	0.005	0.254	0.41	2.287	3.23	127.1	6.45	5200.0	241920
5/11/2015	0.008	0.146	0.15	0.941	1.80	22.0	8.09	N.S.	N.S.
5/14/2015	0.010	0.022	0.01	0.527	0.50	1.7	0.73	41.3	1986.3
5/18/2015	0.007	0.028	0.03	0.525	0.55	0.7	1.18	90.7	7630.0
5/26/2015	0.017	0.030	0.03	0.514	0.60	0.9	1.12	N.S.	N.S.
6/1/2015	0.002	0.056	0.01	0.851	1.05	18.3	2.46	N.S.	N.S.
6/4/2015	0.010	0.024	0.02	0.572	0.58	0.8	5.35	21.6	3890.0
6/8/2015	0.009	0.020	0.03	0.560	0.62	0.6	2.81	65.7	9870.0
6/17/2015	0.009	0.032	0.04	0.948	1.04	6.7	0.97	770.1	8840.0
6/22/2015	0.011	0.026	0.05	0.563	0.61	1.3	1.21	37.9	2419.2
6/29/2015	0.067	1.268	0.34	0.580	3.42	1366.8	11.04	N.S.	N.S.
7/6/2015	0.063	0.658	0.37	0.717	2.75	567.3	8.52	N.S	N.S.
7/9/2015	0.010	0.034	<0.03	0.569	0.71	4.9	2.56	78.9	5560.0
7/16/2015	0.011	0.046	0.01	0.517	0.61	0.4	2.16	45.7	14830.0
7/23/2015	0.011	0.034	<0.03	0.511	0.68	11.3	0.33	201.4	24950.0
11/18/2015	0.012	0.040	0.07	1.262	1.57	2.7	3.23	325.5	10710

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
12/2/2015	0.011	0.024	<0.03	0.613	0.89	1.0	1.01	145.0	1986.3
12/14/2015	0.009	0.030	<0.03	0.364	0.58	3.4	11.89	118.7	2810.0
12/22/2015	0.010	0.016	<0.03	1.452	1.68	0.7	2.41	52.9	1299.7
1/5/2016	0.007	0.018	<0.03	0.883	1.00	1.2	2.15	32.7	686.7
1/25/2016	0.011	0.030	<0.03	0.762	0.87	9.8	3.10	1.0	816.4
2/24/2016	0.010	0.056	<0.03	0.195	0.40	12.8		387.3	4870.0
Samples analyzed since the last quarterly report									
3/10/2016	0.006	0.050	0.13	0.918	1.22	26.7	3.12	648.8	8840.0
3/16/2016	0.006	0.022	0.01	0.520	0.54	0.0	1.75	88.0	461.1
3/24/2016	0.010	0.012	<0.03	0.531	0.64	1.3	1.44	N.S.	N.S.
3/31/2016	0.013	0.656	0.68	1.211	3.05	375.0	12.14	16160.0	198630.0
4/4/2016	0.008	0.018	<0.03	0.462	0.48	1.3	1.79	12.0	727.0
4/20/2016	0.008	0.020	<0.03	0.517	0.66	4.1	0.68	44.3	21430.0
5/2/2016	0.007	0.016	<0.03	0.468	0.59	1.7	2.56	118.7	5380.0
5/10/2016	0.195	0.560	0.32	0.649	4.01	1346.7	11.94	579.4	241920.0
5/18/2016	0.008	0.014	<0.03	0.479	0.63	3.0	0.84	34.1	2419.2
5/26/2016	0.052	0.424	0.39	0.858	2.20	350.6	8.58	22470.0	241920..0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Interceptor Trench 1 (South)									
1/8/2015	0.005	0.022	<0.03	0.769	0.75	4.7	0.88	1.0	13130.0
1/14/2015	0.007	0.028	<0.03	0.469	0.55	1.9	0.55	7.4	1413.6
2/26/2015	0.004	0.028	0.01	0.712	0.76	46.0	0.60	1.0	41063.0
3/3/2015	0.003	0.024	<0.03	0.867	0.89	N.D. †	0.95	N.S.	N.S.
3/11/2015	0.003	0.014	0.07	0.989	0.97	0.3	2.00	<1.0	2419.2
3/19/2015	0.003	0.012	0.01	0.849	0.93	<6.58	3.11	1.0	275.5
3/25/2015	0.003	0.008	<0.03	0.838	0.88	0.2	0.59	<1.0	410.6
3/26/2015	0.004	0.026	0.02	0.904	1.00	15.4	0.69	<1.0	1553.1
4/2/2015	0.003	0.028	0.02	0.865	0.87	0.3	3.34	1.1	308.6
4/9/2015	0.006	0.018	<0.03	0.790	0.83	0.8	2.99	<1.0	187.2
4/15/2015	0.003	0.020	<0.03	0.857	0.93	1.3	4.29	<1.0	3180.0
4/23/2015	0.003	0.034	<0.03	0.877	0.97	1.2	1.18	3.1	2690.0
5/11/2015	0.003	0.060	0.02	0.916	0.97	27.6	1.78	N.S.	N.S.
5/14/2015	0.005	0.042	0.02	0.904	0.94	29.9	1.20	81.6	1732.9

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/18/2015	0.002	0.020	<0.03	0.897	0.93	0.3	1.28	32.3	1732.9
5/26/2015	0.007	0.012	0.01	0.752	0.80	1.0	0.78	N.S.	N.S.
6/22/2015	0.005	0.048	0.07	0.653	0.76	47.3	1.86	21.1	1986.3
6/29/2015	0.008	0.022	0.05	0.394	0.42	56.8	4.17	82.3	11450
7/9/2015	0.007	0.030	<0.03	0.520	0.62	7.1	2.52	63.7	12330.0
11/18/2015	0.005	0.030	0.02	0.264	0.52	1.9	1.74	65.7	17930.0
12/2/2015	0.006	0.008	<0.03	0.218	0.33	1.3	1.10	6.3	5810.0
12/14/2015	0.004	0.012	<0.03	0.299	0.36	1.1	3.44	8.4	10460.0
12/22/2015	0.005	0.010	<0.03	0.157	0.20	0.3	0.89	1.0	435.2
1/5/2016	0.003	0.016	<0.03	0.243	0.29	0.9	1.11	1.0	209.8
2/24/2016	0.005	0.014	<0.03	0.345	0.39	2.1		<1.0	9070.0
Samples analyzed since the last quarterly report									
3/10/2016	0.005	0.036	0.10	0.264	0.45	3.5	2.87	2419.2	16690.0
3/16/2016	0.003	0.032	0.02	0.331	0.37	0.0	1.23	101.7	290.9
3/24/2016	0.008	0.016	<0.03	0.208	0.20	2.8	1.33	N.S.	N.S.
3/31/2016	0.004	0.018	<0.03	0.347	0.49	5.5	4.76	4.1	2419.2

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/10/2016	0.002	0.016	<0.03	0.228	0.30	3.9	2.91	13.9	2419.2
5/18/2016	0.006	0.006	<0.03	0.169	0.22	0.1	0.54	2.0	5200.0
5/26/2016	0.008	0.006	<0.03	0.217	0.23	1.4	1.29	1.0	4260.0
Interceptor Trench 2 (North)									
3/11/2015	0.003	0.056	0.04	1.443	1.59	1.2	3.51	<1.0	2419.2
3/19/2015	0.004	0.062	0.09	1.036	1.42	1.9	5.12	5.2	2419.2
3/26/2015	0.004	0.126	0.13	0.873	1.44	22.2	4.63	105.4	6950.0
5/11/2015	0.003	0.042	0.05	0.553	0.76	8.8	3.44	N.S.	N.S.
5/14/2015	0.005	0.042	0.02	0.904	0.94	29.9	1.20	81.6	1732.9
5/18/2015	0.002	0.020	<0.03	0.897	0.93	0.3	1.28	32.3	1732.9
5/26/2015	0.007	0.112	0.04	1.190	1.44	131.9	1.23	N.S.	N.S.
12/14/2016	0.003	0.026	0.10	6.473	7.40	1.6	5.56	33.6	29090.0
2/24/2016	0.005	0.066	0.13	6.298	7.02	9.7	4.27	30.1	18720.0
Samples analyzed since the last quarterly report									
3/10/2016	0.005	0.054	0.14	1.716	2.35	6.8	6.77	613.1	34480.0
3/31/2016	0.006	0.040	0.06	2.800	3.54	20.9	9.29	7.4	10810.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
4/4/2016	0.004	0.012	<0.03	0.236	0.25	0.0	0.85	1.0	2419.2
5/10/2016	0.002	0.038	<0.03	1.706	2.18	5.2	3.72	38.7	1553.0
Left Fork									
5/14/2015	0.015	0.038	0.02	0.321	0.38	3.3	1.36	83.3	2690.0
5/18/2015	0.011	0.040	0.04	0.209	0.29	4.1	1.90	167.4	8300.0
5/26/2015	0.014	0.048	0.04	0.139	0.29	6.1	2.41	N.S.	N.S.
6/4/2015	0.008	0.022	<0.03	0.145	0.19	2.1	3.15	38.9	2560.0
6/8/2015	0.006	0.024	0.02	0.102	0.23	1.1	2.78	32.7	4550.0
6/17/2015	0.005	0.026	0.04	0.112	0.22	2.8	1.62	26.2	8550.0
6/22/2015	0.011	0.030	0.02	0.147	0.18	2.5	1.59	35.4	5910.0
6/29/2015	0.010	0.026	0.02	0.189	0.26	2.9	2.80	53.6	10170
7/9/2015	0.015	0.058	0.04	0.138	0.31	11.4	2.67	387.3	12670.0
7/16/2015	0.010	0.042	0.01	0.181	0.28	0.9	1.64	21.6	9330.0
7/23/2015	0.009	0.028	0.04	0.239	0.40	1.4	1.21	35.4	8360.0
7/30/2015	0.008	0.020	0.04	0.221	0.37	2.3	2.60	30.3	8160.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
8/6/2015	0.007	0.026	0.04	0.310	0.47	1.2	3.16	217.8	8130.0
8/13/2015	0.007	0.016	0.03	0.192	0.52	1.4	4.50	13.2	4810.0
8/20/2015	0.009	0.028	0.04	0.306	0.42	2.3	5.12	48.8	3930.0
8/27/2015	0.008	0.024	0.02	0.218	0.33	2.0	3.79	7.4	3010.0
9/2/2015	0.007	0.020	0.03	0.109	0.33	1.67	3.8	26.9	5290.0
9/10/2015	0.006	0.026	<0.03	0.198	0.34	4.09	2.5	21.6	7230.0
9/16/2015	0.006	0.032	<0.03	0.146	0.48	2.49	1.3	38.2	6333.0
9/24/2015	0.007	0.016	0.01	0.098	0.20	3.08	0.6	31.3	3410.0
9/30/2015	0.007	0.018	<0.03	0.082	0.20	4.98	1.2	18.3	5940.0
10/8/2015	0.003	0.020	0.02	0.069	0.15	1.5	1.58	59.8	3640.0
10/14/2015	0.009	0.022	0.01	0.078	0.16	2.2	1.28	9.8	1986.3
10/22/2015	0.008	0.018	<0.03	0.069	0.13	1.9	3.57	3.1	1732.9
10/28/2015	0.007	0.024	0.02	0.060	0.24	1.9	2.90	61.3	3410.0
11/4/2015	0.007	0.018	<0.03	0.072	0.18	0.7	3.98	77.6	>2419.2
11/12/2015	0.005	0.016	<0.03	0.215	0.34	1.1	2.50	25.6	3360.0
11/18/2015	0.020	0.062	0.08	0.432	0.73	7.4	3.72	686.7	23590.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
12/2/2015	0.014	0.024	0.01	0.302	0.43	1.6	1.36	66.9	1986.3
2/14/2015	0.014	0.056	0.06	0.298	0.50	10.8	3.92	410.6	6010.0
12/22/2015	0.013	0.020	<0.03	0.267	0.35	0.1	1.36	26.5	1299.7
1/5/2016	0.013	0.028	<0.03	0.427	0.48	0.7	1.51	34.1	686.7
1/25/2016	0.010	0.024	<0.03	0.198	0.25	1.0	1.30	21.1	435.2
2/10/2016	0.003	0.012	<0.03	0.175	0.24	0.8	1.15	7.4	209.8
2/24/2016	0.015	0.088	<0.03	0.249	0.63	15.6		2780.0	14390.0
Samples analyzed since the last quarterly report									
3/10/2016	0.013	0.046	0.01	0.154	0.38	8.7	2.64	367.3	2750.0
3/16/2016	0.009	0.032	<0.03	0.190	0.26	0.3	1.45	35.9	980.4
3/24/2016	0.013	0.048	0.09	0.186	0.39	10.7	2.65		
3/31/2016	0.013	0.056	0.09	0.199	0.40	11.9	2.59	172.0	3640.0
4/4/2016	0.009	0.022	<0.03	0.131	0.17	1.5	0.87	44.8	1119.9
4/20/2016	0.005	0.020	<0.03	0.157	0.21	2.1	0.84	35.0	6160.0
5/2/2016	0.009	0.020	<0.03	0.095	0.20	1.9	2.30	172.6	3640.0
5/10/2016	0.011	0.072	0.02	0.121	0.37	17.2	3.35	980.4	8230.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/18/2016	0.010	0.016	0.01	0.139	0.27	1.4	1.54	60.1	2620.0
5/26/2016	0.010	0.048	0.02	0.123	0.24	10.6	2.66	461.1	6890.0
Field 1									
3/26/2015	0.143	0.346	0.41	0.216	2.68	65.5	15.65	N.S.	N.S.
5/8/2015	0.525	0.714	0.16	0.475	2.19	16.9	13.28	N.S.	N.S.
5/11/2015	0.251	0.386	0.09	0.055	0.86	44.4	6.31	N.S.	N.S.
5/18/2015	0.208	0.512	0.54	0.410	3.59	53.7	26.12	N.S.	N.S.
5/26/2015	0.245	0.432	0.20	0.174	1.66	37.8	11.28	N.S.	N.S.
6/29/2015	0.354	0.524	0.37	0.226	1.64	11	11.32	N.S.	N.S.
7/6/2015	0.387	0.444	0.23	0.345	1.30	4.9	8.32	N.S.	N.S.
Field 5a									
3/26/2015	0.813	1.330	0.39	0.225	2.59	72.3	15.95	N.S.	N.S.
5/8/2015	0.248	0.968	0.26	0.127	1.50	320.1	8.58	N.S.	N.S.
7/6/2015	0.796	0.910	0.13	0.567	1.58	29.0	7.67	N.S.	N.S.
Samples analyzed since the last quarterly report									

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/31/2016	1.154	1.352	0.27	0.302	1.67	26.5	32.74	N.S.	N.S.
5/10/2016	1.114	1.458	1.69	2.894	6.35	79.9	12.82	N.S.	N.S.
Field 12									
5/8/2015	0.675	0.956	0.14	0.303	1.82	57.0	16.00	N.S.	N.S.
5/11/2015	0.194	0.364	0.09	0.135	0.83	36.7	7.03	N.S.	N.S.
7/6/2015	0.094	0.448	0.13	0.172	1.01	261.3	4.38	N.S.	N.S.
Samples analyzed since the last quarterly report									
3/10/2016	0.411	0.522	1.17	0.852	4.49	621.5	12.58	N.S.	N.S.
5/10/2016	0.370	0.666	0.12	0.062	1.03	96.7	6.92	N.S.	N.S.

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.

§ N.S. is No Sample. E. coli and total coliform were not measured on surface runoff samples collected by ISCO samplers when sample holding time exceeded the required 8-hour threshold.

† N.D. is No Data.

Temporal Trends in Phosphorus, Nitrogen and Bacteria in Big Creek Above and Below the C&H Farm

The concentration of P, N and bacteria forms in Big Creek above and below the C&H Farm are presented in subsequent figures to show the season / temporal trends in measured concentrations (Figures 2, 3, 4, 5, 6, and 7).

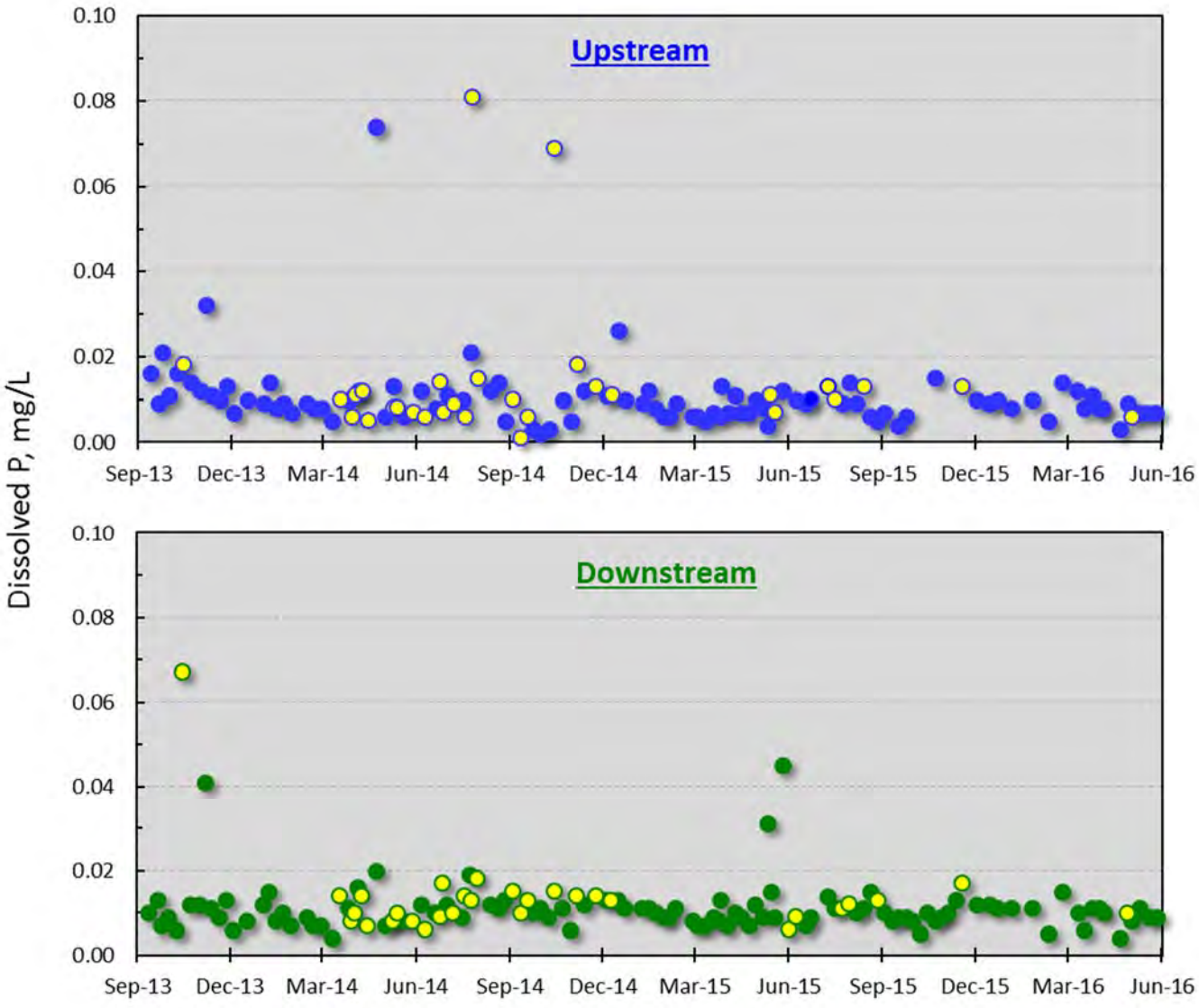

Figure 2. Dissolved P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

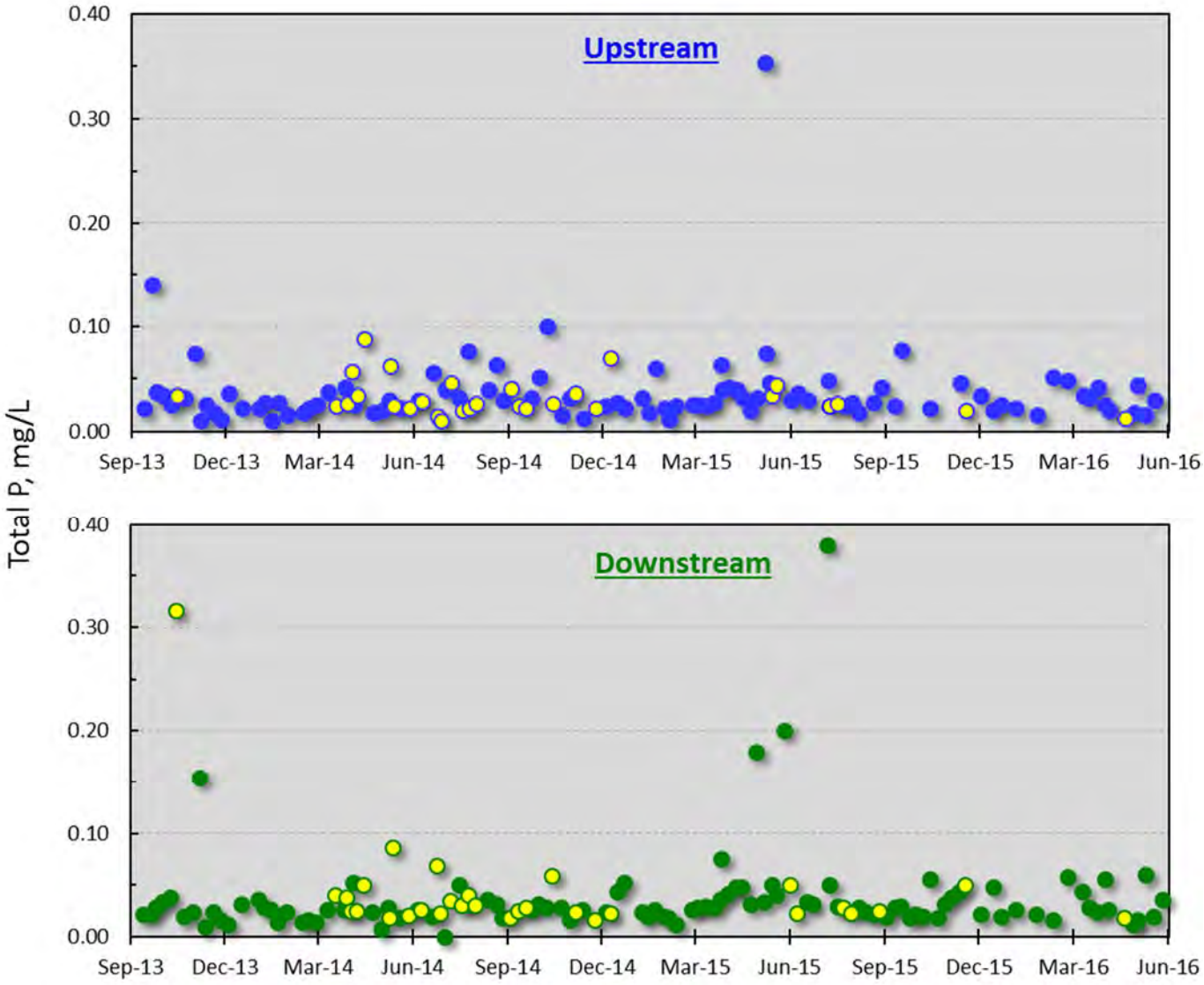

Figure 3. Total P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

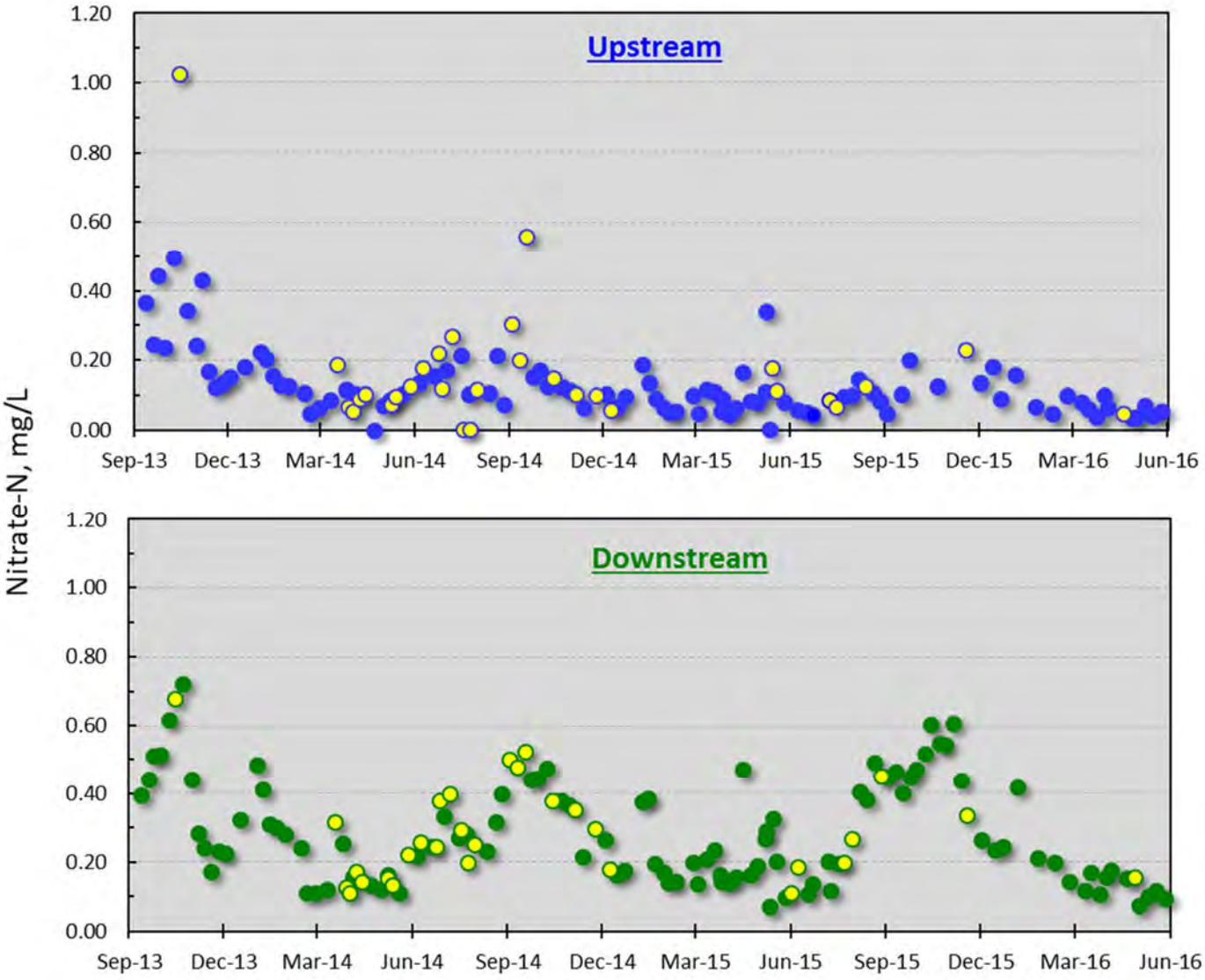

Figure 4. Nitrate-N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

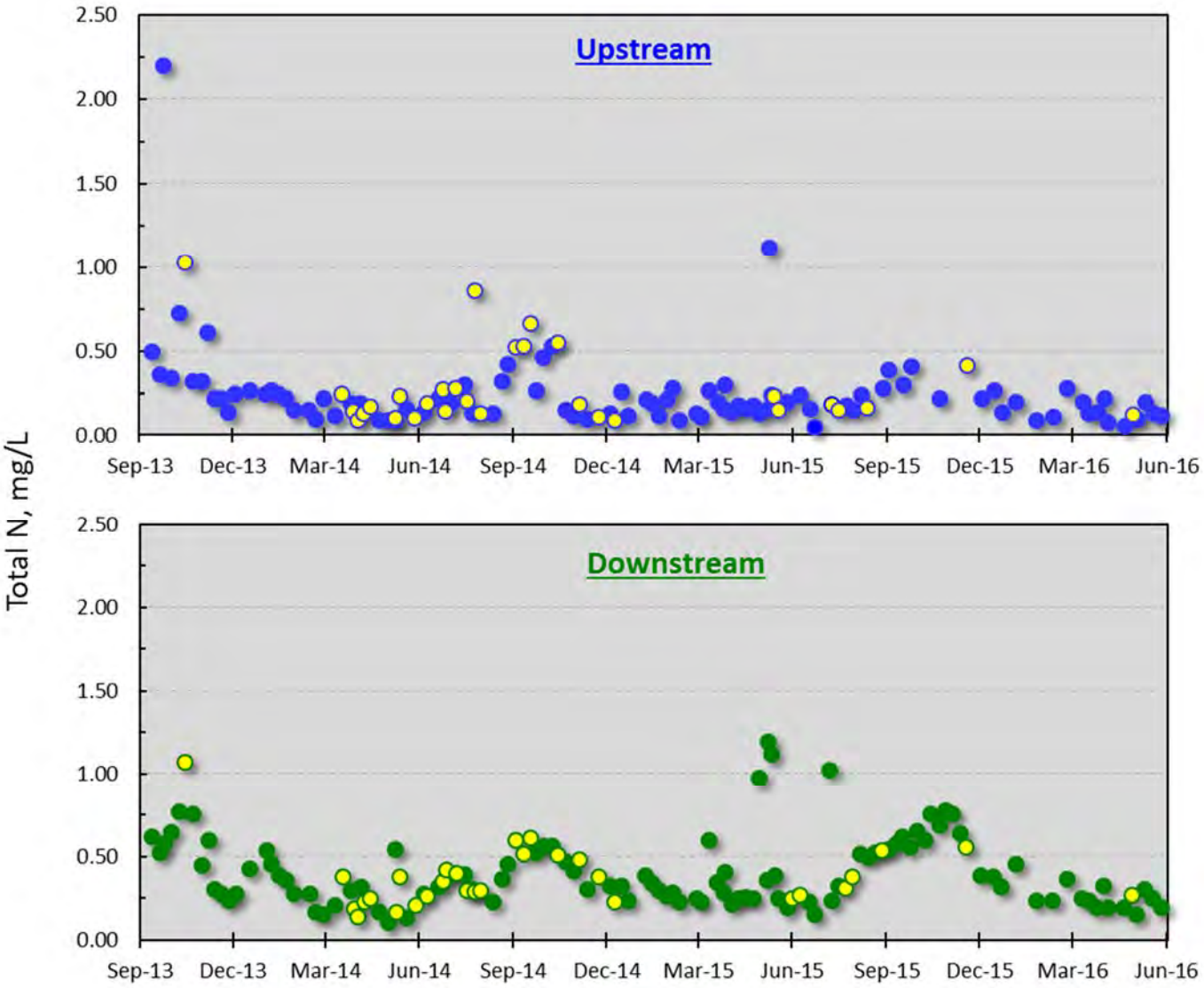

Figure 5. Total N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

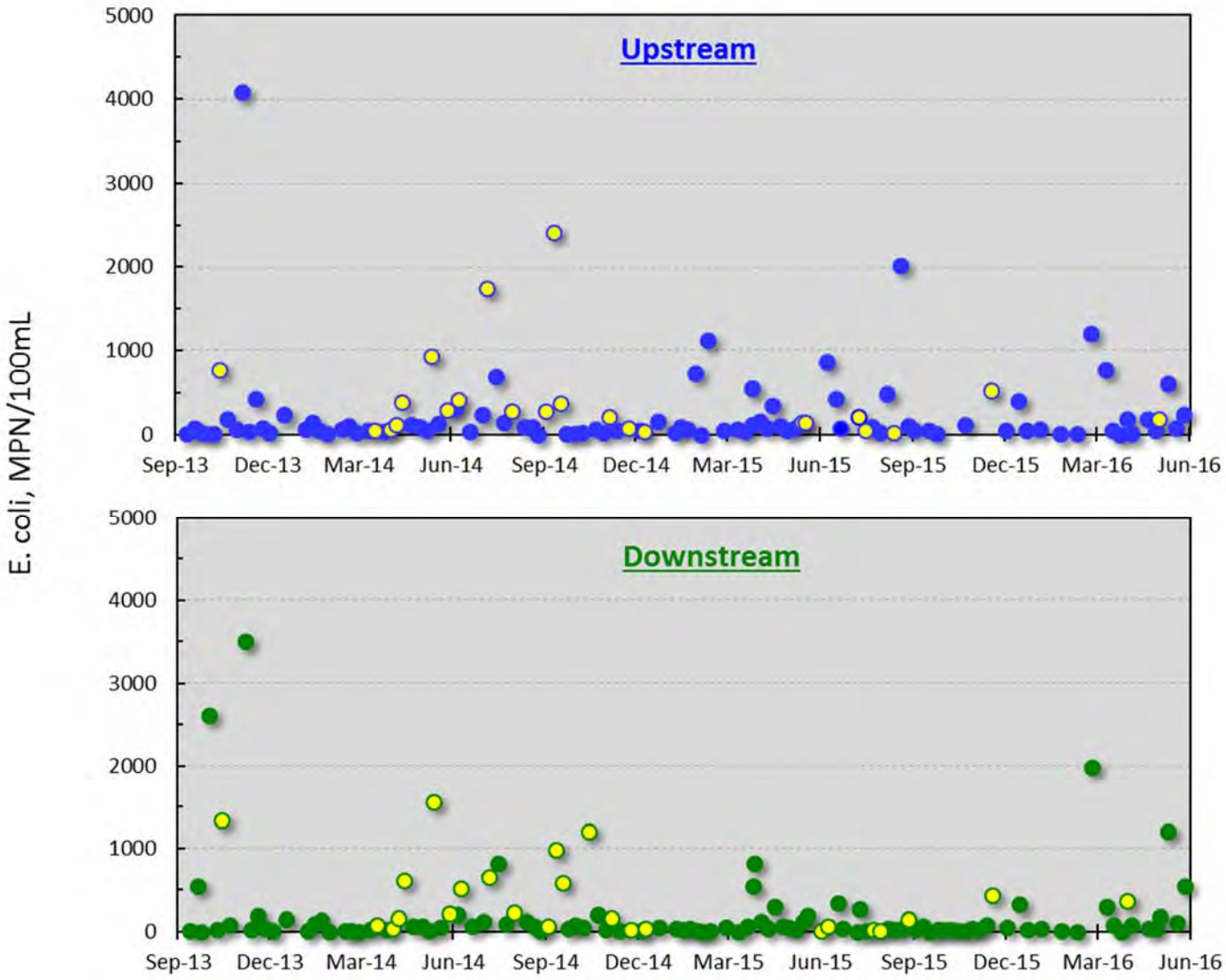

Figure 6. E. coli numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

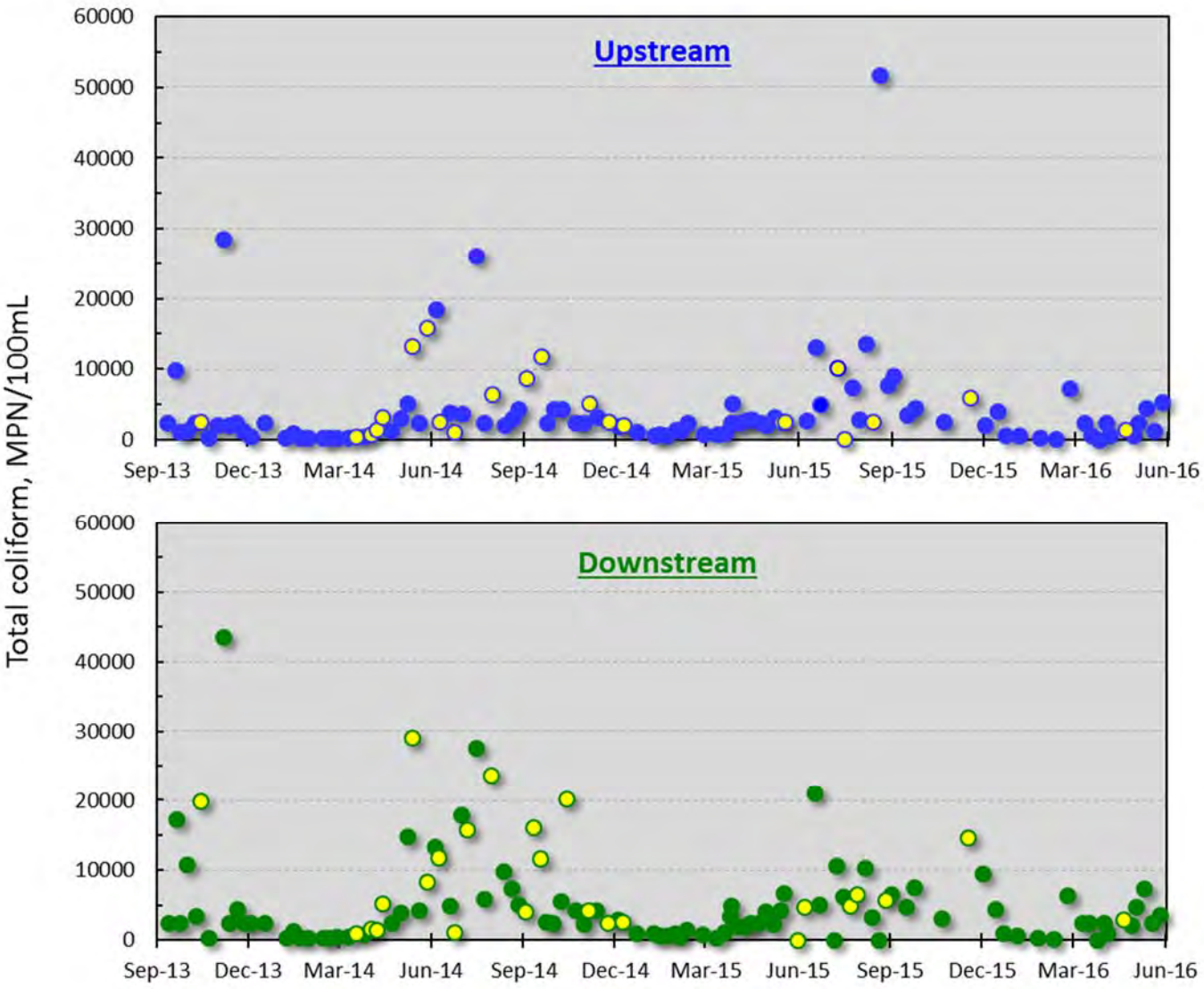

Figure 7. Total coliform numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

Differences in dissolved P, total P, nitrate-N, total P, E. coli, and total coliform concentrations between upstream and downstream sites from the beginning of monitoring (September 2013) to the present time are given in Figures 8, 9, 10, 11, 12, and 13.

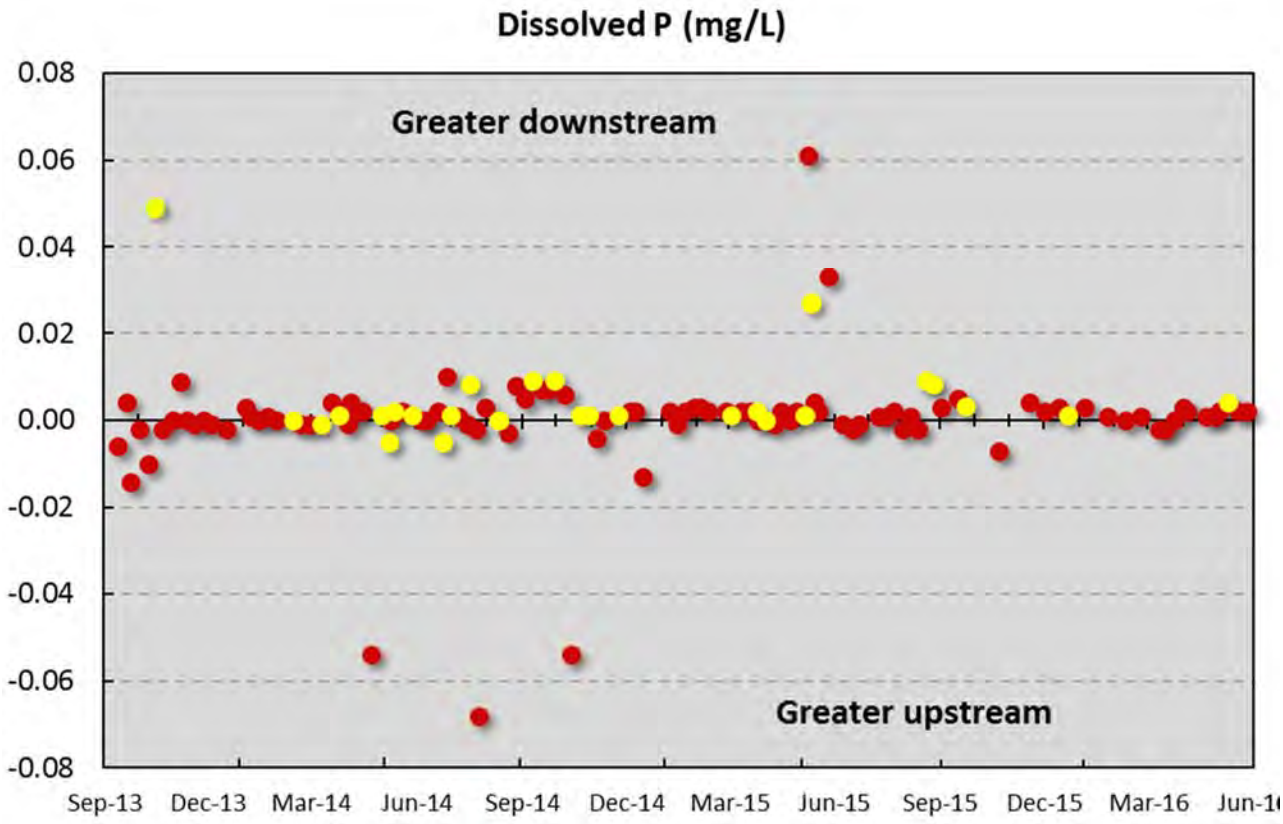

Figure 8. Difference in dissolved P concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

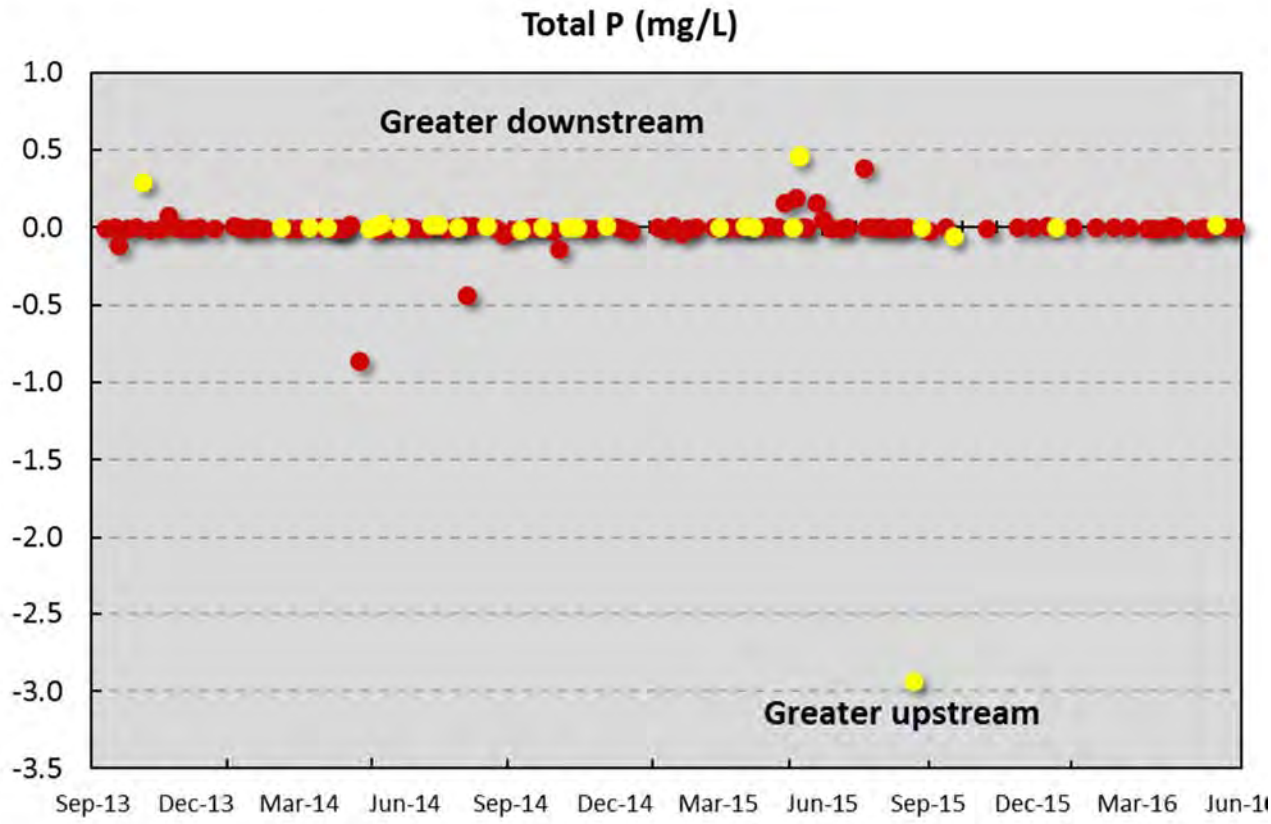

Figure 9. Difference in total P concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

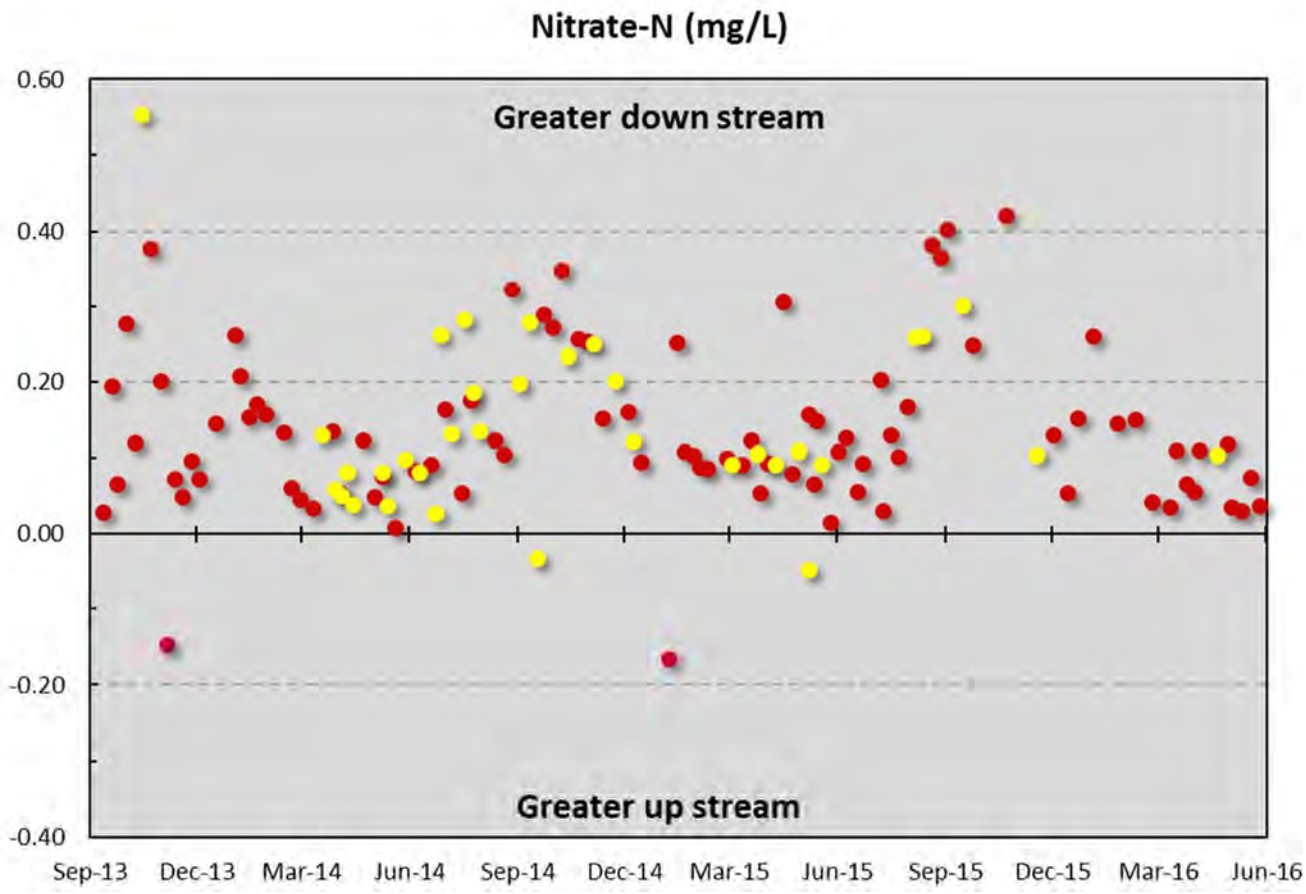

Figure 10. Difference in nitrate-N concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

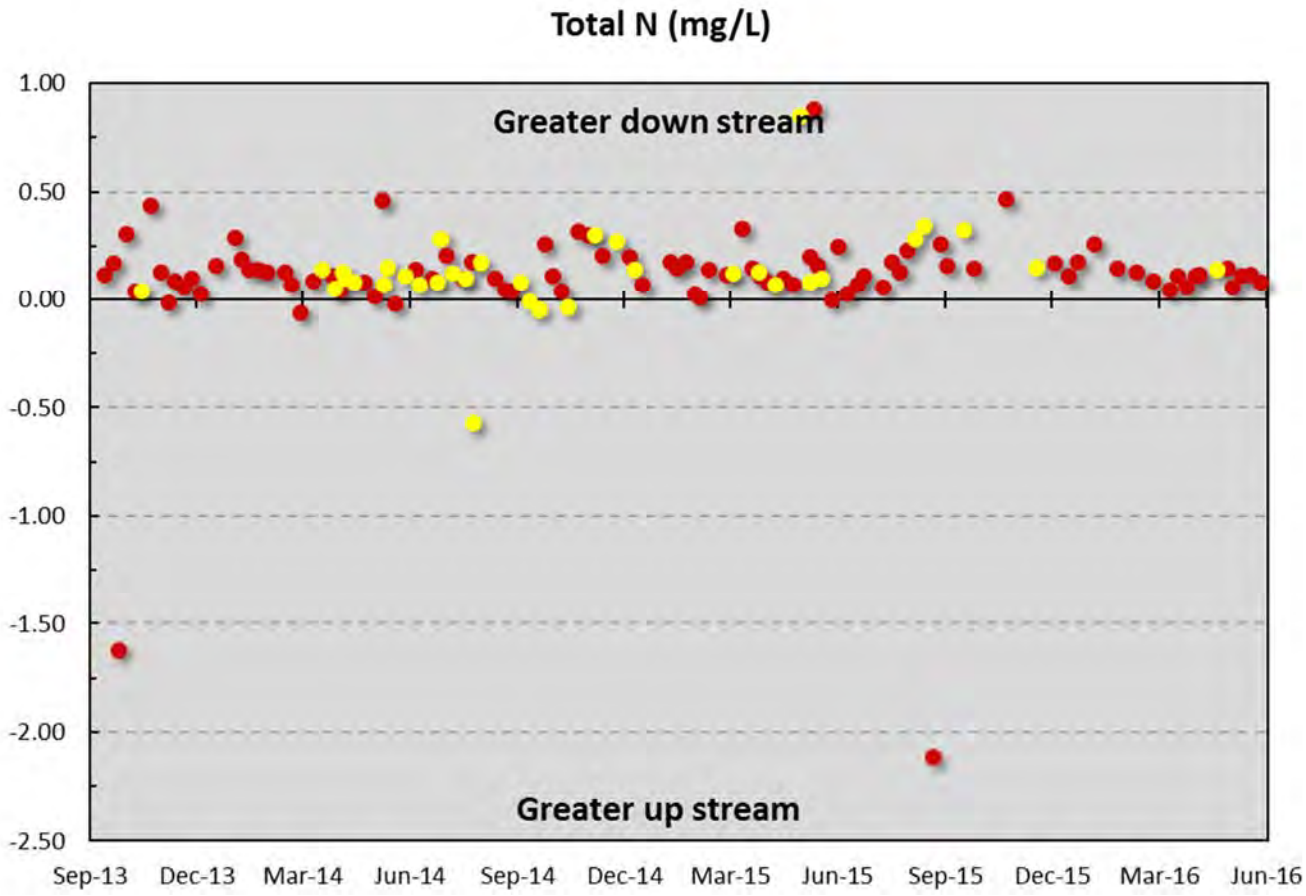

Figure 11. Difference in total N concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

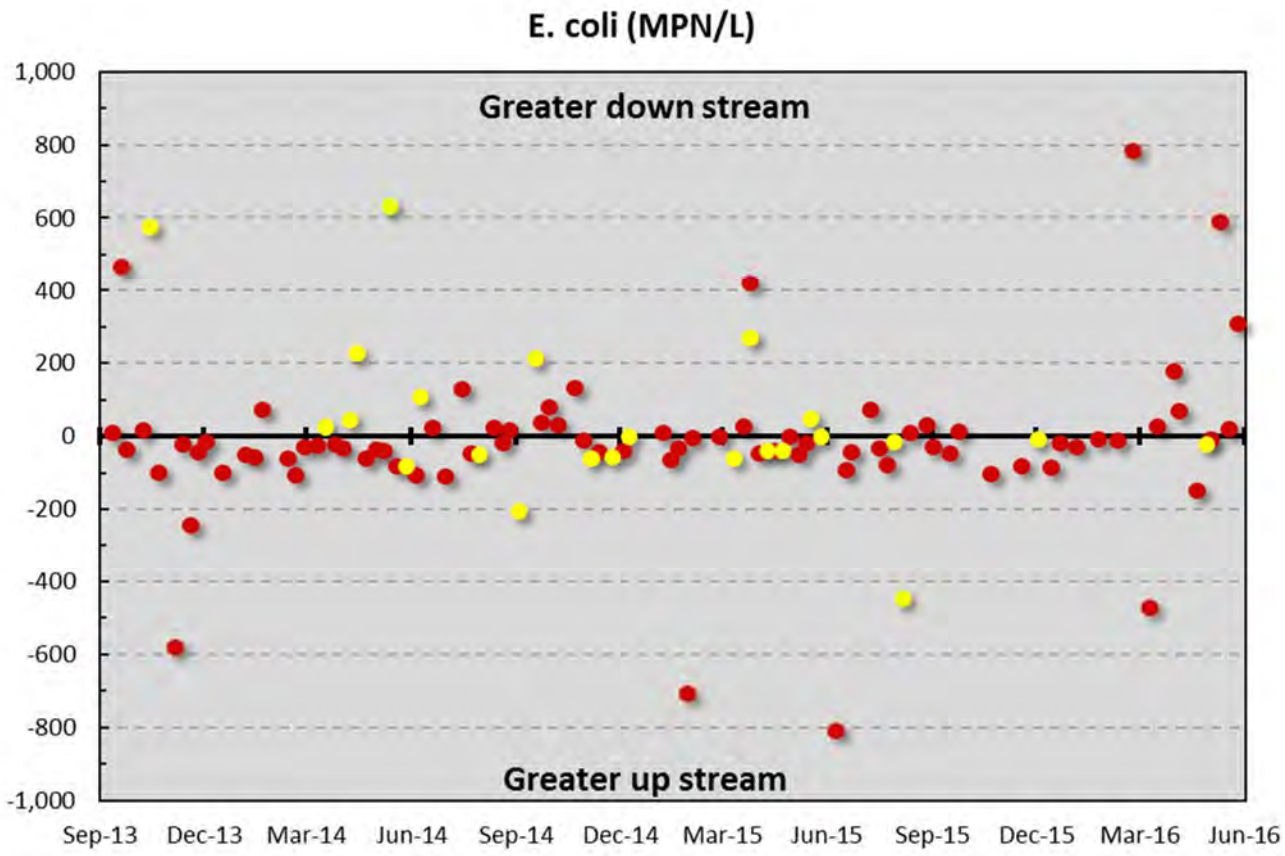

Figure 12. Difference in E. coli concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

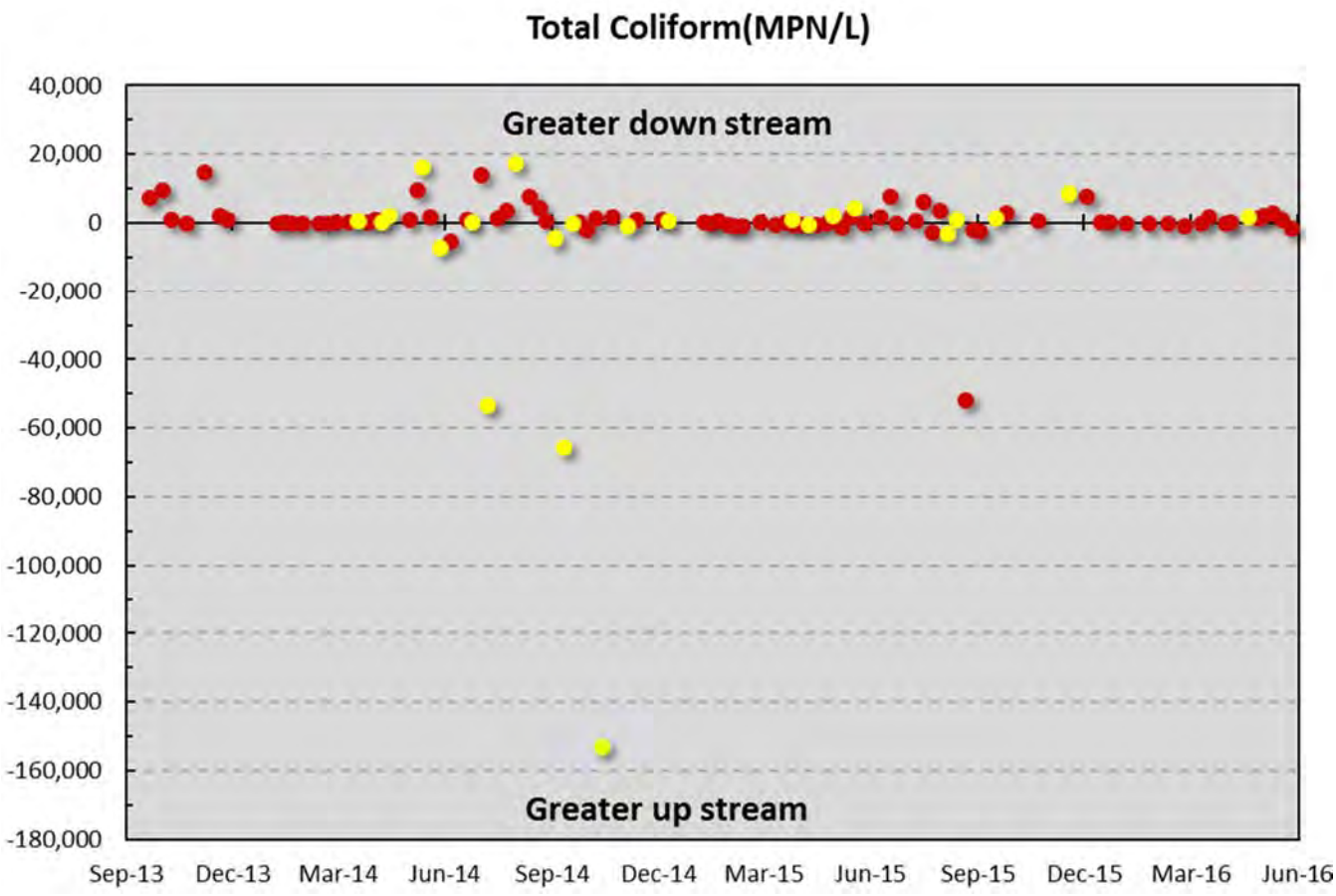

Figure 13. Difference in total coliform concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

Water pH, Alkalinity, Chloride, Electrical Conductivity, and Total Dissolved Solids for Several Big Creek Sites

At the beginning of 2015, the pH, alkalinity, chloride concentration, electrical conductivity and total dissolved solids were determined on water samples collected at the upstream and downstream sites, spring, house well, and trenches, to build a data base that will enable to eventually source track the major water source pathways at these sites. These values are given below in Table 6.

Table 6. The pH, Chloride concentration, electrical conducting, and total solids concentration of water samples collected at upstream, downstream, spring, ephemeral stream, house well and trench sites, initiated at the beginning of 2015, with those collected since the last report noted.

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
		------- mg/L ------		µS/cm	mg/L
Upstream					
1/8/2015	7.3	36	1.80	90	71.6
1/14/2015			2.09	105	49.1
1/21/2015	7.6	48	1.85	121	71.1
1/29/2015			2.09	140	71.3
2/3/2015	7.7	54	2.40	129	71.1
2/10/2015			2.51	132	67.6
2/26/2015	7.6	40	1.98	107	56.4
3/3/2015			2.08	112	58.9
3/11/2015	7.8	30	1.88	85	269.3
3/19/2015			1.55	98	58.0
3/25/2015	8.0	42	1.77	110	67.6
3/26/2015			1.33	115	64.4
4/2/2015	8.0	42	1.57	110	76.0
4/9/2015			1.73	116	74.9
4/15/2015	7.7	36	1.38	91	63.8
4/23/2015			1.65	95	60.4
4/29/2015	8.1	50	1.56	85	54.3

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
5/7/2015			1.40	123	70.7
5/8/2015			1.80	157	88.4
5/11/2015	7.5	24	1.63	131	110.0
5/14/2015			1.55	143	79.3
5/18/2015			1.20	107	56.2
5/26/2015	7.7	28	1.10	90	58.4
6/4/2015			1.08	78	55.3
6/8/2015	8.2	60	2.03	149	111.3
6/17/2015			1.51	128	70.2
6/22/2015	8.2	40	1.36	114	64.9
6/29/2015			1.74	55	49.8
7/9/2015	7.7	32	1.53	90	64.7
7/16/2015			1.33	161	78.9
7/23/2015	7.9	78	1.63	180	50.2
7/30/2015			1.75	224	113.3
8/6/2015	7.7	100	1.84	218	75.3
8/13/2015			1.91	210	121.6
8/20/2015	7.3	108	2.15	219	120.0
8/27/2015			2.11	240	131.3
9/2/2015	7.1	122	2.50	262	129.3
9/16/2015	7.6	132	3.05	272	151.3
9/24/2015			2.74	271	149.3
11/12/2015	8.0	104	2.13	228	115.0
11/18/2015			1.36	84	55.6
12/2/2015			1.52	83	100.0
12/14/2015	7.5	26	1.21	63	50.0
12/22/2015	8.3	56	1.78	107	50.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
1/5/2016	7.5	40	1.34	102	62.5
1/25/2016	8.2	46	1.50	115	65.0
2/10/2016	8.6	54	1.69	141	60.0
2/24/2016	7.2	66	1.20	102	97.5
Samples analyzed since the last quarterly report					
3/10/2016	7.6	38.0	1.268	84.5	60.0
3/16/2016	6.7	38.0	1.252	88.3	52.5
3/24/2016	7.7	46.0	1.825	103.3	56.5
3/31/2016	7.3	30.0	0.933	65.8	235.0
4/4/2016	7.4	40.0	1.163	86.9	55.0
4/20/2016	8.0	58.0	1.405	125.7	65.0
4/29/2016	8.1	66.0	1.373	134.8	72.5
5/3/2016	7.7	38.0	1.150	83.7	52.5
5/10/2016	7.6	32.0	0.914	67.6	57.5
518/2016	8.0	48.0	1.228	102.8	57.5
5/26/2016	7.8	76.0	1.045	78.4	50.0
Downstream					
1/8/2015	7.6	64	2.02	144	89.3
1/14/2015			2.76	166	79.8
1/21/2015	7.6	84	2.44	191	91.1
1/29/2015			2.51	205	109.1
2/3/2015	7.7	88	2.82	196	103.3
2/10/2015			3.01	204	105.5
2/26/2015	7.8	66	2.27	162	88.0
3/3/2015			2.39	170	80.0
3/11/2015	7.8	52	2.02	128	77.3

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
3/19/2015			1.75	148	84.9
3/25/2015	7.8	64	2.07	158	88.7
3/26/2015			1.46	83	78.7
4/2/2015	8.1	68	1.95	163	103.0
4/9/2015			2.08	168	100.4
4/15/2015	7.8	56	1.54	130	82.0
4/23/2015			1.81	142	81.0
4/29/2015	8.0	80	2.15	150	97.3
5/7/2015			1.84	185	101.1
5/8/2015			2.50	225	125.8
5/11/2015	7.5	36	1.73	149	130.9
5/14/2015			1.06	103	80.2
5/18/2015			1.55	150	58.7
5/26/2015	7.7	46	1.25	137	89.1
6/1/2015			1.20	125	93.3
6/8/2015	8.0	94	1.44	163	86.9
6/17/2015			2.14	216	141.3
6/22/2015	7.9	76	1.76	204	106.5
7/7/2015			1.55	177	79.3
7/9/2015	7.7	50	1.63	116	77.6
7/16/2015			1.50	124	72.2
7/23/2015	7.8	108	1.84	223	111.8
7/30/2015			2.18	248	122.0
8/6/2015	7.6	154	2.31	286	142.9
8/13/2015			2.78	283	159.1
8/20/2015	7.2	142	2.83	287	156.0
8/27/2015			3.01	300	153.3

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
9/2/2015	7.5	146	3.13	322	159.6
9/10/2015			3.47	309	172.7
9/16/2015	7.4	152	3.87	310	169.3
9/24/201			3.46	308	168.3
9/30/2015	7.6	148	3.98	322	174.5
10/8/2015			3.42	344	179.8
10/14/2015	7.8	16	3.72	362	181.0
10/22/2015			3.45	362	168.8
10/28/2015	7.8	164	3.40	351	168.3
11/4/2015			4.05	358	181.0
11/12/2015	7.9	128	2.80	281	152.0
11/18/2015			1.55	120	77.8
12/2/2015			1.86	127	68.9
12/14/2015	7.7	38	1.26	93	70.0
12/22/2015	7.7	70	1.99	157	82.5
1/5/2016	7.5	60	2.17	158	92.5
1/25/2016	8.0	80	2.00	191	95.0
2/10/2016	8.0	94	2.36	214	102.5
2/22/2016	7.5	80	1.48	156	110.0
Samples analyzed since the last quarterly report					
3/10/2016	7.3	54.0	1.481	126.1	80.0
3/16/2016	7.1	60.0	1.500	137.6	75.0
3/24/2016	7.3	68.0	1.827	156.8	79.0
3/31/2016	7.3	48.0	1.043	95.9	50.0
4/4/2016	7.4	66.0	1.563	138.6	80.0
4/20/2016	7.3	92.0	1.903	187.0	105.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
4/29/2016	7.7	100.0	2.052	199.1	107.5
5/3/2016	7.8	60.0	1.197	130.5	87.5
5/10/2016	7.6	44.0	0.856	93.5	75.0
518/2016	7.8	74.0	1.482	154.5	82.5
5/26/2016	7.7	34.0	0.941	114.1	72.5
Spring					
1/8/2015			2.27	534	321.1
1/14/2015			2.79	517	310.0
1/21/2015			2.27	553	324.0
2/3/2015			2.20	562	321.8
2/10/2015			2.44	581	314.2
2/26/2015			1.74	491	266.4
3/3/2015			1.57	430	234.9
3/11/2015			1.63	495	54.7
3/19/2015			1.54	474	220.0
3/25/2015			2.08	544	277.6
4/2/2015			1.78	515	289.8
4/9/2015			2.03	509	305.8
4/15/2015			1.76	480	276.9
4/23/2015			1.93	512	297.3
4/29/2015			2.55	564	294.9
5/4/2015			1.57	554	251.8
5/7/2015			2.29	623	318.9
5/11/2015			1.11	408	202.0
5/14/2015			1.35	507	259.6
5/18/2015			1.17	508	265.8

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
5/26/2015			1.08	516	250.4
6/8/2015			1.95	615	341.8
6/17/2015			1.65	532	276.0
6/22/2015			1.79	601	301.1
7/9/2015			1.43	542	266.9
7/16/2015			2.02	629	309.3
7/23/2015			2.17	656	312.0
7/30/2015			2.26	648	334.9
8/6/2015			0.92	606	330.7
8/13/2015			2.71	522	328.0
8/20/2015			2.09	554	330.9
8/27/2015			2.01	575	318.2
9/2/2015			2.08	581	311.1
9/10/2015			1.99	485	254.8
9/16/2015			0.00	557	294.9
9/24/2015			1.95	574	311.5
9/30/2015			2.00	573	321.3
10/8/2015			1.92	581	333.8
10/14/2015			1.94	610	313.0
10/22/2015			1.86	581	273.8
10/28/201			1.81	537	292.3
11/4/2015			2.11	572	299.0
11/12/2015			2.20	565	294.5
11/18/2015			1.80	395	215.6
12/2/2015			4.14	487	302.2
Samples analyzed since the last quarterly report					

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
3/10/2016			1.109	359.0	210.0
3/16/2016			2.038	516.0	250.0
3/24/2016			1.939	446.0	214.0
3/31/2016			1.324	414.0	45.0
4/4/2016			1.971	506.0	272.5
4/20/2016			2.111	554.0	300.0
4/29/2016			2.234	522.0	285.0
5/3/2016			1.879	486.0	275.0
5/10/2016			1.190	417.0	245.0
518/2016			2.206	493.0	275.0
5/26/2016			1.370	450.0	250.0
Ephemeral Stream					
1/5/2016			2.908	368.0	
1/25/2016			3.454	392.0	
2/24/2016			2.427	264.0	
3/10/2016			2.530	288.0	
3/16/2016			2.427	356.0	
3/24/2016			3.467	399.0	
3/31/2016			3.366	153.2	
4/4/2016			2.544	330.0	
4/20/2016			2.758	380.0	
5/2/2016			2.068	329.0	
5/2/2016			2.571	241.0	
5/10/2016			1.617	143.3	
5/18/2016			2.726	360.0	
5/26/2016			2.031	194.5	

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
Trench 1					
1/8/2015			2.01	154	103.6
1/14/2015			2.81	166	81.8
2/26/2015			2.08	171	78.4
3/3/2015			2.11	177	86.7
3/11/2015			1.95	193	114.0
3/19/2015			1.70	209	109.3
3/25/2015			2.13	238	105.1
3/26/2015			1.64	209	120.2
4/2/2015			1.94	261	151.3
4/9/2015			1.99	260	154.0
4/15/2015			1.80	260	146.7
4/23/2015			2.06	231	132.7
5/11/2015			2.09	262	126.5
5/14/2015			1.86	299	156.5
5/18/2015			1.57	346	173.1
5/26/2015			1.65	297	146.0
6/22/2015			1.99	341	169.8
6/29/2015			2.63	342	167.8
7/9/2015			2.08	171	78.4
11/18/2015			1.15	152	86.7
12/2/2015			1.47	162	108.9
12/14/2015			1.59	157	92.5
12/22/2015			1.70	180	95.0
1/5/2016			1.61	161	82.5
2/24/2016			1.16	162	102.5

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
Samples analyzed since the last quarterly report					
3/10/2016			1.019	173.7	117.5
3/16/2016			1.451	226.0	120.0
3/24/2016			1.732	229.0	99.0
3/31/2016			1.280	167.9	100.0
5/10/2016			1.122	226.0	130.0
5/19/2016			0.405	196.5	115.0
5/18/2016			1.653	234.0	125.0
5/262016			1.421	262.0	142.5
Trench 2					
3/11/2015			1.77	159	140.8
3/19/2015			1.04	168	104.9
3/26/2015			0.78	135	160.9
5/11/2015			0.41	165	88.5
5/26/2015			0.93	284	141.3
12/14/2016			1.00	148	110.0
2/24/2016			0.99	144	122.5
Sample analyses since the last quarterly report					
3/10/2016			0.349	106.8	80.0
3/31/2016			0.424	134.5	87.5
4/4/2016			1.4	192.1	107.5

Direct Measurements as Indicators of Potential Holding Pond Leakage

Three direct measurements to monitor possible leakage of manure from the holding ponds are; (a) the interceptor trenches down slope of the ponds, (b) the house well, and (c) the ephemeral stream capturing surface runoff and shallow seepage water from the area around the animal houses and holding ponds. These sites are located on Figure 14.

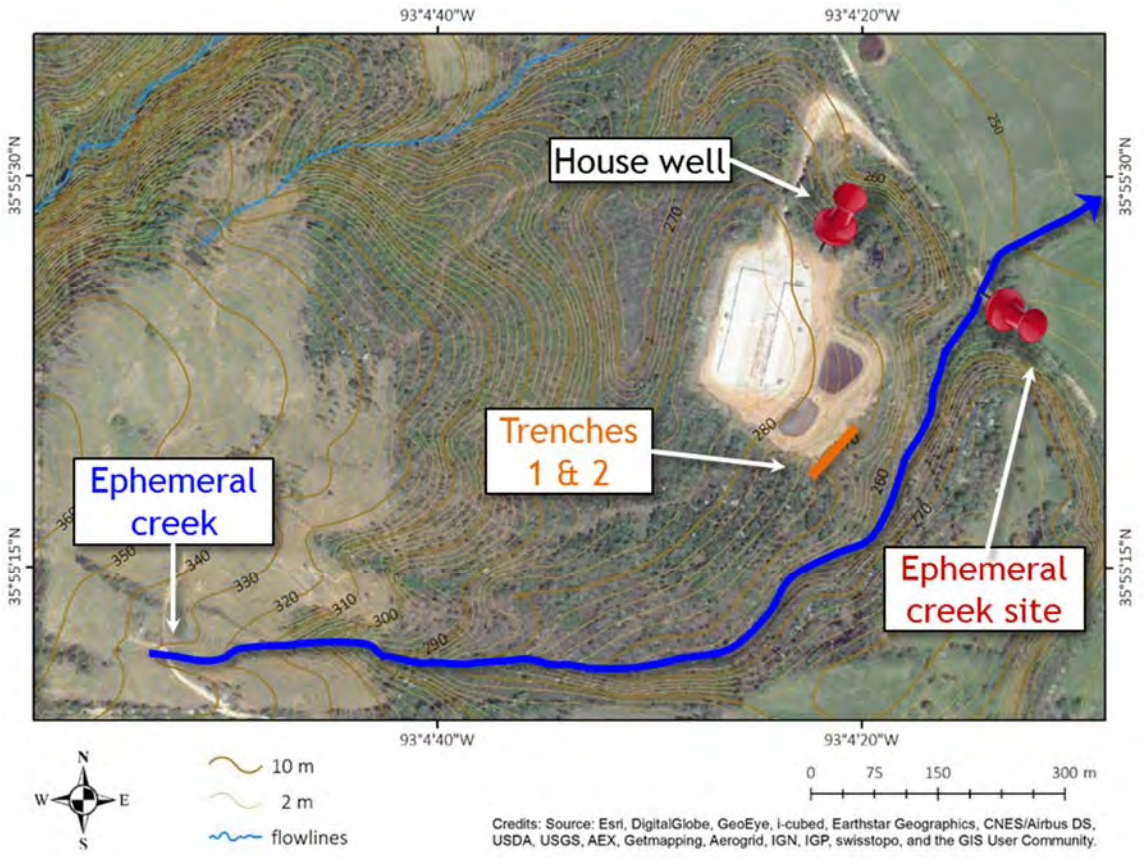

Figure 14. Location of direct measurement sites in the vicinity of the manure holding ponds; the interceptor trenches, house well, and ephemeral stream.

The BCRET are confident that at least one of these direct measurements will capture any potential leakage from the holding ponds where occurring. While these direct measurements are not designed to quantify leakage, they will indicate by increases in indicator constituents any leakage of manure from the storage ponds. This is particularly the case for conservative tracers, such as chloride and electrical conductivity. Chloride is not commonly involved in geochemical reactions nor is it affected by pH and changes in redox and, thus, behaves as a conservative tracer (see http://www.gwadi.org/tools/tracers/chloride). Nitrate is an additional useful tracer, although it can be affected by changes in redox conditions and subject to denitrification. Together, these and other constituents aid in identifying potential leakage from the manure storage ponds.

Manure slurry holding ponds

The physical and chemical properties measurement of slurry composition in the holding ponds have been determined at various times and reported in prior Quarterly Reports. Here, the mean values of constituents measured are given in Table 7 for samples collected on September 24th, 2013; April 10th, 2014; October 28th, 2014; April 16th, 2015; January 15th, 2016; and May 27th, 2016.

Table 7. Mean concentration of constituent property of manure sampled from the top 6 inches, bottom layer, and profile of holding ponds 1 and 2 on the C&H Farm between September, 2013 and May, 2016.

Property	Pond 1			Pond 2		
	Top 6 inches	Bottom layer	Profile	Top 6 inches	Bottom layer	Profile
pH	7.9	7.5	7.7	8.1	7.9	8.0
Conductivity, µS/cm	12610.0	10433.3	12653.3	10275.0	10475.0	8884.0
Solids, %	0.7	9.0	3.7	0.5	4.3	1.8
Chloride	120.0	136.3	65.2	169.0	204.5	74.4
Total N	1382.3	3906.7	2726.7	1212.5	2980.0	1309.8
Ammonium-N	1125.7	1210.3	1172.5	858.5	937.5	703.2
Nitrate-N	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
Total P	164.6	3759.8	1191.6	113.5	457.5	258.0
Water extractable P	81.1	371.7	172.3	79.4	161.5	78.7
TOTAL K	1281.7	1448.3	1333.5	1108.5	1179.5	1032.2
Total Ca	80.1	4355.0	994.8	45.3	409.0	215.7
Total Mg	14.1	974.8	99.0	2.9	88.5	5.9
Total S	31.8	430.2	46.0	11.5	66.5	8.2
Total Fe	8.8	879.0	67.4	6.2	668.0	94.2

Property	Pond 1			Pond 2		
	Top 6 inches	Bottom layer	Profile	Top 6 inches	Bottom layer	Profile
Total Mn	2.4	42.1	3.6	0.0	4.9	0.4
Total Zn	1.5	88.3	8.8	0.1	9.3	0.7
Total Cu	0.3	10.9	1.1	0.0	1.5	0.1
Total Na	113.3	122.7	56.5	123.0	125.0	50.6

Interceptor trenches

The trench approach was selected over a three-dimensional network of shallow observation and sampling wells located below the holding ponds due to the greater probability of the trench intercepting any seepage from the ponds along discrete and preferred pathways. The continuous interception provided by the trench offers a greater probability of capturing any subsurface seepage as compared to a three dimensional grid of discontinuous point observations. Thus, the trench reduces the probability of by-pass flow of any seepage down slope of the ponds (Figure 14). A detailed description of trench construction was provided in the July to September, 2014 Quarterly Report.

Interceptor trenches have been widely used in the Ozark Mountains region to assess if manure holding ponds were leaking and worldwide as a preferred method to determine subsurface lateral flows in hillslopes along areas of differing or contrasting permeabilities. References to some of the relevant studies are given at the end of this section.

House well

The sample collection point for the house well adjacent to the animal house facilities and slurry holding ponds was reconfigured to exclude any potential sources of sample contamination (Figure 14). It was determined that the risk of contamination was a result of factors such as well-head pump and in-house maintenance. In addition to installing a new well-water sampling site, USGS water quality sampling guidelines were used, which involved collection of a well sample when in-situ field measurement of well water temperature, pH, and electrical conductivity had stabilized. Details are given in the October to December, 2015 Quarterly Report. The house well serves to track any potential water-quality changes in the deeper groundwater table.

Ephemeral stream

The ephemeral stream site, where monitoring was initiated in March, 2014, drains a small sub-watershed containing the house barns, manure holding ponds, and interflow partially captured by the

interceptor trenches (Figure 14). The stream will capture surface runoff and shallow interflow, seepage, and spring water from adjacent to and encompassing the animal house barns and holding ponds.

Findings to date from direct measurements

Concentrations of nutrients, bacteria, chloride, and electrical conductivity in samples collected from the direct measurement sites have not shown any consistent elevation or increasing trends over the sampling periods to date (Figures 15, 16, and 17). Sampling of the inceptor trenches was initiated in August 2014, the secure house well in September 2015, and the ephemeral creek in March 2014. For samples collected from Trench 1, nitrate-N and chloride concentrations actually decreased slightly with time, although not significant, and this decrease likely reflects a stabilization of the profile after trench construction.

The mean concentration of nutrients, coliform, chloride, and electrical conductivity are provided in Table 8, along with respective concentrations for manure slurry collected from holding ponds 1 and 2 over the last two years, in addition to concentrations reported in published data for other swine manure holding ponds in Kansas and Manitoba. While there is a wide range in concentrations reported in the literature, the mean values are similar to those of manure collected from holding pond 1 (Table 8). Holding pond 2 has lower nutrient and conductivity values that reflect the accumulation of slurry from which solids of higher nutrient content have settled out in holding pond 1. The mean concentration of dissolved P, total P, total N, chloride, and electrical conductivity are appreciably lower than values measured in manure from holding pond 1 (Table 8).

These findings indicate that at the present time, there is no evidence of major leakage of manure from holding pond 1 or 2. However, we will continue to sample these sites and measure nutrient, bacteria, and conservative tracer concentrations to determine if this situation remains as the same. To provide additional information on interceptor trench flows and chemistry, we are in the process of installing secure sampling sites at trench 1 and 2, which will be equipped with flow monitoring equipment and an ISCO sampler to collected periodic higher flows from the trenches.

Table 8. Mean concentrations of water quality analyses for samples collected from the manure holding ponds, interceptor trenches, house well, ephemeral creek, upstream of farm and downstream of farm.

Source	#	Diss. P	Total P	Nitrate-N	Total N	E. coli	Total Coliform	Chloride	Conductivity
		mg/L				MPN/100 mL		mg/L	µS/cm
Manure pond 1	7	151.8	932.8	N.D.	2,349.6	N.D.	N.D.	391.0	12,780
Manure pond 2	5	78.4	235.7	N.D.	1,297.3	N.D.	N.D.	372.0	8,100
Trench 1 ¶	37	0.004	0.021	0.67	0.74	586.6	9,581	1.75	223
Trench 2 ¶	15	0.004	0.055	2.15	2.70	209.5	13,728	0.82	171
House well §	42	0.010	0.041	0.52	0.57	40.5	1,546	5.29	453
Ephemeral creek †	67	0.014	0.112	0.74	1.20	567.0	16,049	2.61	304
Upstream ‡	129	0.015	0.050	0.14	0.26	439.7	6,831	1.64	126
Downstream ‡	136	0.015	0.047	0.28	0.40	245.9	6,055	2.17	195
Manure from literature - mean *	162	363	579	N.D.	2,460	N.D.	15,280	390	N.D.
Manure from literature – range *	162	50 – 3,810	60 – 1,209	N.D.	610 – 10,140	N.D.	6,840 – 27,200	73 – 1,149	N.D.

N.D. Not determined.
¶ Samples collected since August, 2014.
§ Samples collected from September, 2015.
† Samples collected from March, 2014.
‡ Samples collected from September, 2013.
* Values from published data; DeRouchey et al., 2002 and Malley et al., 2001.

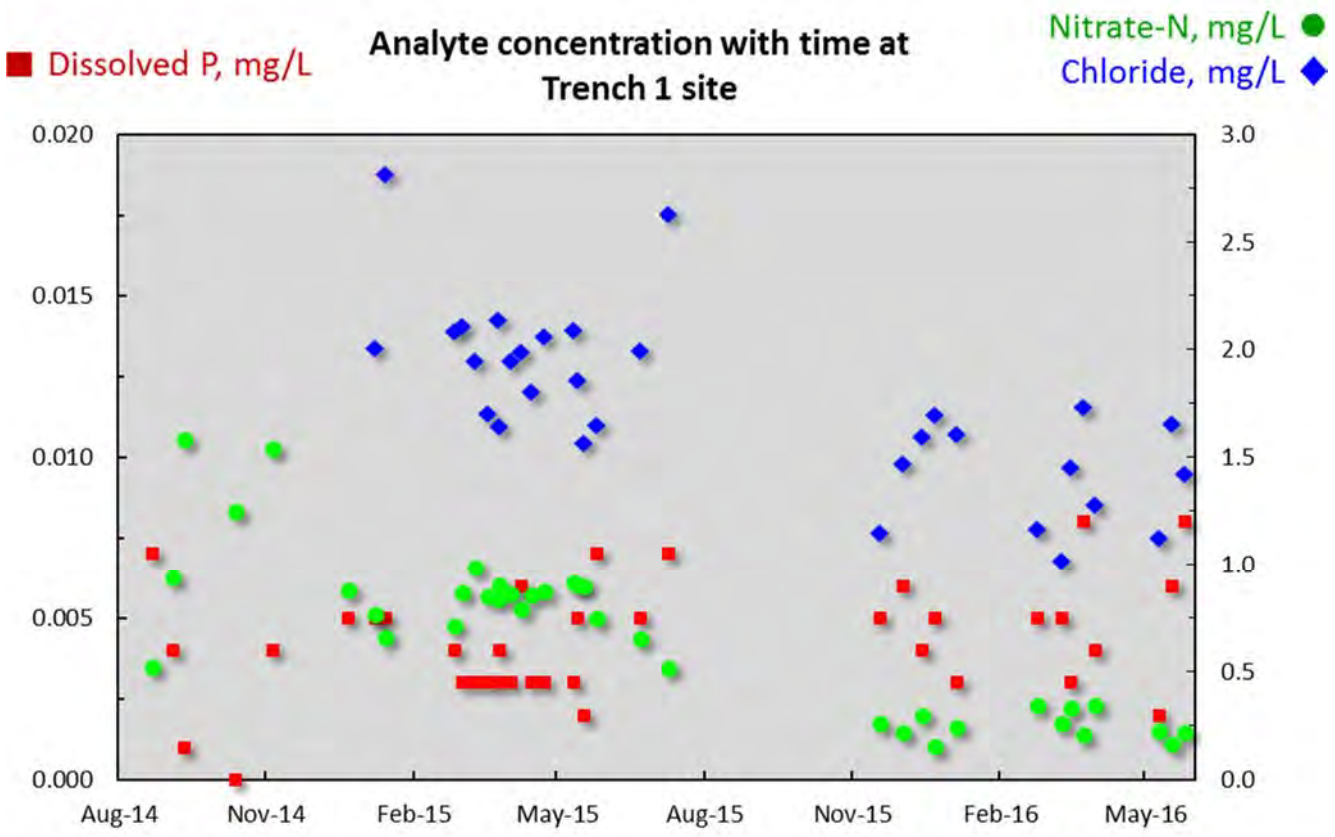

Figure 15. Dissolved P, nitrate-N, and chloride concentrations in Trench 1, since the inception of monitoring in August, 2014.

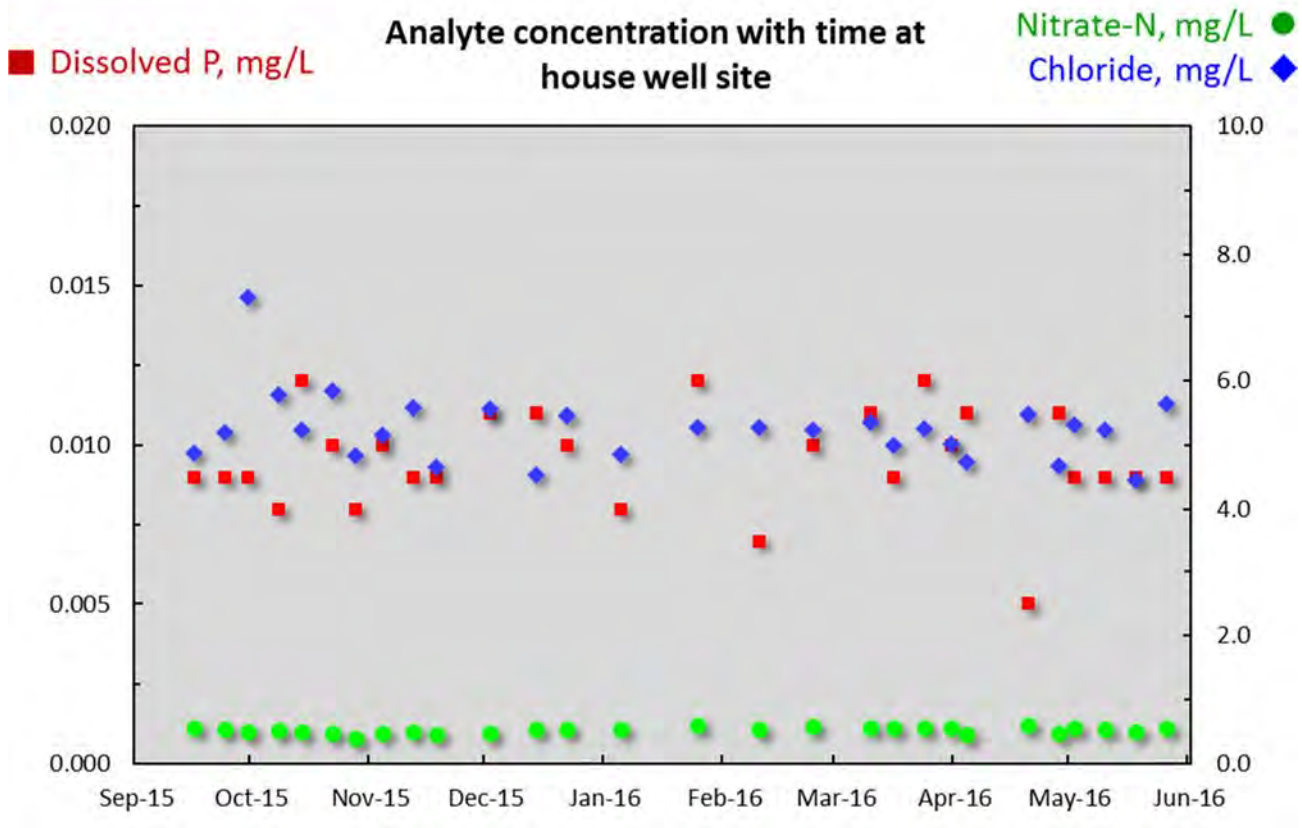

Figure 16. Dissolved P, nitrate-N, and chloride concentrations in the house well, since the inception of protected monitoring port in September, 2015.

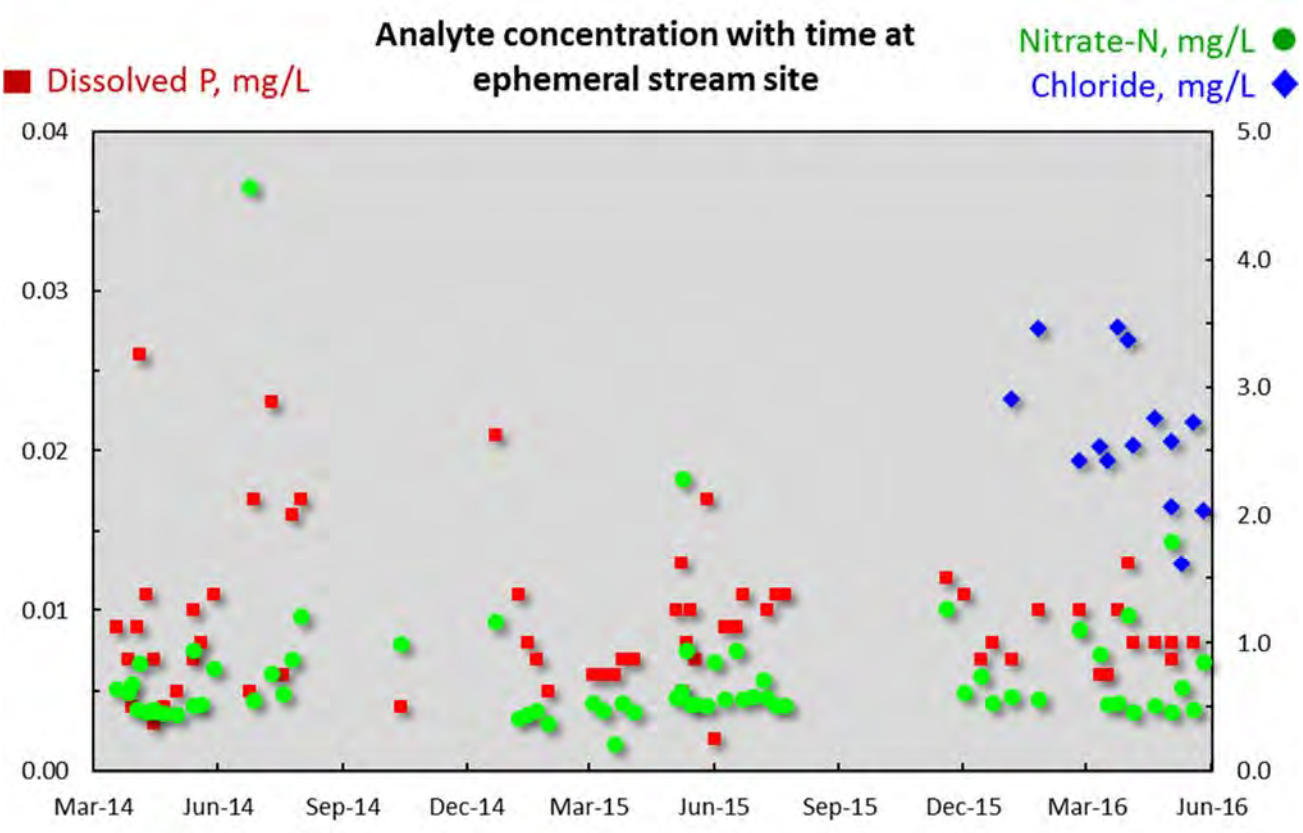

Figure 17. Dissolved P, nitrate-N concentrations in ephemeral stream, since the inception of monitoring in March, 2014.

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Soil Series Map and NRCS Description for Holding Pond Area

Following is the soils map and NRCS official soil series description for the soils in the vicinity of the holding pond area.

Well Log and Geologic Investigations of Holding Pond Area for CNMP

Below in Table 9 is the drilling log for the house well located to the north of the barns, which documents the presence of red clays to a depth of 54 feet below the surface.

Table 9. Drilling log for water well on the C&H Farm.

A

1. Contractor Name & Number: 1077 ARNOLD WELL DRILLING & PUMP SE
2. Driller Name & Number: 2819 JOSHUA ARNOLD
3. Pump Installer Name & Number:
4. Date Well Completed: 02/15/2013 New Well

5. COUNTY : NEWTON (101)
6 FRACTION ¼ of ¼
7 SECTION:
8 TOWNSHIP
9 RANGE

11. LONGITUDE 93-04-23 12. LATITUDE 35-55-27

B

DESCRIPTION OF FORMATION	DEPTHS IN FEET FROM	TO	WATER BEARING	IF YES.. DEPTH
Red Clay	0	54	No	
Gray Limestone	54	310	Yes	145
White Limestone	310	320	No	
Gray Limestone	320	325	No	
			Yes	285
			No	
			Yes	265
			No	

2. TOTAL DEPTH OF WELL 325
3. STATIC WATER LEVEL 138 Ft. below land surface
4. YIELD 30 gallons per
5. DIAMETER OF BORE HOLE 6.06 IN

C PUMP REPORT

1 TYPE PUMP
2 SETTING DEPTH FEET
3 BRAND NAME AND SERIAL NUMBERS:
4 RATED CAPACITY gallons per minute
5 TYPE LUBRICATION
6 DROP PIPE OR COLUMN PIPE SIZE
7 WIRE SIZE
8 PRESSURE TANK:
SIZE: MAKE: MODEL:
9 DATE OF INSTALLATION OR REPAIR
10 Is there an abandoned water well on the property?

FT TO: FT

D

1 LAND OWNER OR OTHER CONTACT PERSON
NAME JASON HENSON (C & H FARM)
STREET ADDRESS HC 72 BOX 10
CITY MT JUDEA

CASING FROM 0 TO 74 W/ 6.25 Inner Diameter
CASING FROM TO W/ Inner Diameter
TYPE CASING STEEL

3. SCREEN
TYPE: DIA SLOT/GA
SET FROM FT TO FT
TYPE: DIA SLOT/GA
SET FROM FT TO FT

4. GRAVEL PACK FROM: FT TO: FT

5. BACK FILLED WITH: CUTTINGS
FROM: 0 FT TO: 69 FT

6. SEALED WITH: BENTONITE
FROM: 69 FT TO: 74 FT
FROM: FT TO: FT

7. DISINFECTED WITH: CHLORINE

8. USE OF WELL:
COMMERCIAL
OTHER

A/C HEATPUMP TYPE WELLS

(For A/C only)Will system also be used for purposes other than Heating and Air Conditioning?
If yes, name use:

(For A/C open-loop only) Into what medium is water returned?

11. REMARKS

12. SIGNED DATE

Below in Table 10 is the drilling log for the second well south of the initial house well, which provides supplemental water for the house operation and documents red clays to a depth of 45 feet below the surface.

Table 10. Drilling log for supplemental water well on the C&H Farm.

A

1. Contractor Name & Number: 1077 ARNOLD WELL DRILLING & PUMP SE
2. Driller Name & Number: 2819 JOSHUA ARNOLD
3. Pump Installer Name & Number:
4. Date Well Completed: 06/12/2015 New Well
5. COUNTY : NEWTON (101)
6 FRACTION ¼ of ¼
7 SECTION:
8 TOWNSHIP
9 RANGE
11. LONGITUDE 93-04-25 12. LATITUDE 35-55-23

B

DESCRIPTION OF FORMATION	DEPTHS IN FEET FROM	TO	WATER BEARING	IF YES.. DEPTH
Red Clay	0	45	No	
Gray Limestone	45	320	Yes	180
White Limestone	320	345	Yes	345
Gray Limestone	345	355	No	
Gray Limestone	355	488	No	
Gray Sand	488	665	Yes	660
			Yes	230
			No	
			No	
			Yes	320

2. TOTAL DEPTH OF WELL 665
3. STATIC WATER LEVEL 120 Ft. below land surface
4. YIELD 30 gallons per
5. DIAMETER OF BORE HOLE 6 IN

C PUMP REPORT

1 TYPE PUMP
2 SETTING DEPTH FEET
3 BRAND NAME AND SERIAL NUMBERS:
4 RATED CAPACITY gallons per minute
5 TYPE LUBRICATION
6 DROP PIPE OR COLUMN PIPE SIZE
7 WIRE SIZE
8 PRESSURE T
SIZE: MAKE: MODEL:
9 DATE OF INSTALLATION OR REPAIR

FT TO: FT

D

1 LAND OWNER OR OTHER CONTACT PERSON
NAME C & H FARMS
STREET ADDRESS HC 72 BOX 10
CITY MT. JUDEA

CASING FROM 0 TO 85 W/ 6.25 Inner Diameter
CASING FROM TO W/ Inner Diameter
TYPE CASING STEEL

3. SCREEN
TYPE: DIA SLOT/GA
SET FROM FT TO FT
TYPE: DIA SLOT/GA
SET FROM FT TO FT

4. GRAVEL PACK FROM: FT TO: FT

5. BACK FILLED WITH: CUTTINGS
FROM: 0 FT TO: 80 FT

6. SEALED WITH: BENTONITE
FROM: 80 FT TO: 85 FT
FROM: FT TO: FT

7. DISINFECTED WITH: CHLORINE

8. USE OF WELL:
COMMERCIAL
OTHER

A/C HEATPUMP TYPE WELLS

(For A/C only)Will system also be used for purposes other than Heating and Air Conditio
If yes, name use:

(For A/C open-loop only) Into what medium is water returned?

11. REMARKS

12. SIGNED

10 Is there an abandoned water well on the property?	

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Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – July 1 to September 30, 2016

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

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Dr. Mark J. Cochran
Vice President for Agriculture

Executive Summary

This is the third Quarterly Report of 2016 for the Big Creek Research and Extension Team that details activities and progress made from July 1 through September 30, 2016.

1. We continue to collect weekly base flow and periodic storm flow water samples from Big Creek above and below the C&H Farm, along with water from a spring, ephemeral stream, surface runoff sites on Fields 1, 5a, and 12, two interceptor trenches below the slurry holding ponds, and house well for chemical and bacterial analysis. Equipment to monitor flow from the interceptor trenches was installed, along with automatic water sampling equipment.

2. Between July 6th and August 16th, the upstream site on Big Creek was not flowing and samples were collected only at the downstream site on Big Creek.

3. Concentrations of P, N, Cl (a conservative and effective tracer), and electrical conductivity continue to show no upward or downward trends for water samples collected during this quarter. We will continue to monitor these sites.

Big Creek Science Team

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Brian Breaker, M.Sc., Surface-Water Specialist, stream flow and constituent collection, analysis, and statistical evaluation of trends.

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Ed Gbur, Ph.D., Professor and Director, Agricultural Statistics Laboratory - Experimental design, linear and generalized linear mixed models, regression, agricultural applications of statistics.

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Phil Hays, Ph.D. Ground Water Specialist, U.S. Geological Survey and Research Professor with Geosciences Dept., University of Arkansas, application of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems

Tim Kresse, M.Sc., Water Quality Specialist, U.S. Geological Survey, natural geochemical evolution of groundwater and separating these processes from anthropogenic sources of contamination

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Jun Zhu, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians - The Big Creek Research and Extension Team are ably supported by several outstanding and dedicated Program Technicians based in Fayetteville and Little Rock.

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Water Sampling and Analytical Methods

Sampling Locations

Water quality monitoring sites are;

Site 1. Edge-of-field monitoring on Field 1 permitted to receive slurry.

Site 2. Edge-of-field monitoring on Field 5a excluded from receiving slurry.

Site 3. Edge-of-field monitoring on Field 12 permitted to receive slurry.

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities.

Site 5. Spring below Field 1.

Site 6. Big Creek upstream of the C&H Farm operation.

Site 7. Big Creak downstream of the C&H Farm operation.

Site 8. Left Fork downstream of the C&H Farm operation.

Site 9. North interceptor trench below the manure holding ponds.

Site 10. South interceptor trench below the manure holding ponds.

Site 11. House well at animal facility.

Table 1. Location of sampling sites on the Big Creek Research and Extension Team project.

Site description	Latitude	Longitude	Elevation, ft
Field 1	35 55’ 06.42”	93 03’ 38.34”	984
Field 5a	35 56’03.01”	93 04’ 25.85”	778
Field 12	35 54’ 13.57”	93 04’ 04.76”	838
Ephemeral stream	35 55’ 25.89”	93 04’ 14.94”	824
Spring	35 54’ 57.06”	93 03’ 34.64”	977
Big Creek upstream of farm	35 53’ 32.28”	93 04’ 06.38”	857
Big Creek downstream of farm	35 56’ 18.98”	93 04’ 21.81”	769
Left Fork	35 5’”48.04”	93 04” 02.02”	760
Trench 1 (south)	35 55’ 19.24”	93 04’ 23.04”	896
Trench 2 (north)	35 55’ 21.39”	93 04’ 19.93”	883
House well	35 55’ 27.02”	93 04’ 22.71”	915

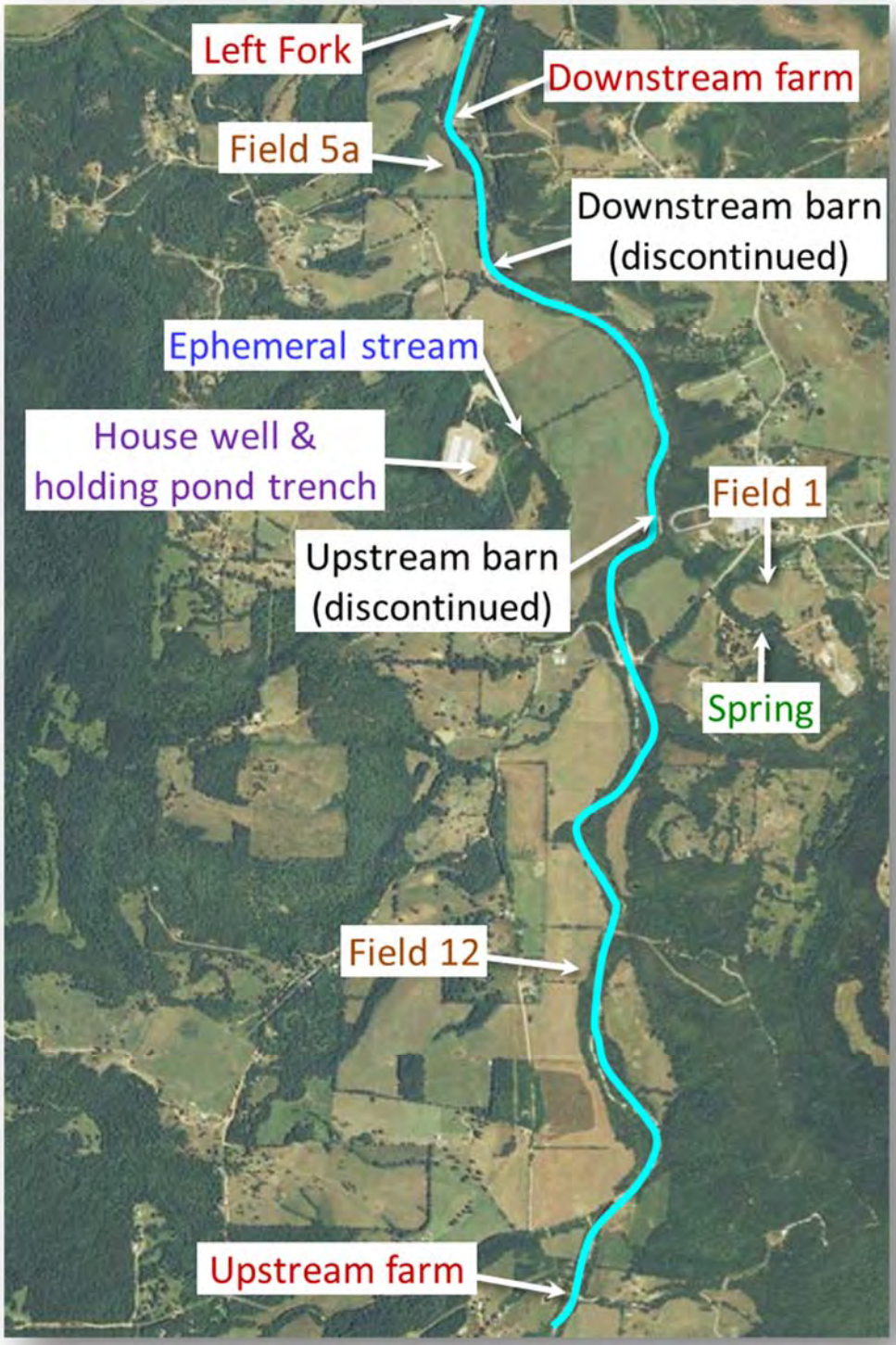

Figure 1. Location of sampling sites for the Big Creek Research and Extension Team project.

Sampling Protocols and Analyses

The following protocols were used to collect, prepare, and analyze all water samples:

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface, where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted, and samples placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
6. Analyses included Alkalinity (APHA 2320-B), Ammonia (EPA 351.2), Chloride (EPA 300.0), Dissolved Phosphorus (EPA 365.2), E. coli (APHA 9223-B), Electrical Conductivity (EPA 120.1), Nitrate (EPA 300.0), pH (EPA 150.1), Total Coliforms (APHA 9223-B), Total Dissolved Solids (EPA 160.1), Total Nitrogen (APHA 4500-P J), Total Phosphorus (APHA 4500-P J), and Total Suspended Solids (EPA 160.2). APHA is American Public Health Association from the Wadeable Streams Assessment, Water Chemistry Laboratory Manual http://www.epa.gov/owow/monitoring/wsa/WRS_lab_manual.pdf
7. Prior to collection of a house well water sample, the well is purged and water temperature, pH, and electrical conductivity measured on-site every 30 seconds until all values stabilize (primarily water temperature). At that point a sample of water is collected in a 1-L acid-washed bottle. This method is taken from USGS and EPA well-water sampling protocols. See USGS methods for sampling at https://water.usgs.gov/owq/FieldManual/chapter4/pdf/Chap4_v2.pdf. Specific and detailed guidance on the collected of water quality data can be found in the USGS National Field Manual at file:///U:/Words/C&H%20Farm/Publications/Planning/USGS%20National%20Field%20Mannual_complete%202015.pdf

   The U.S. EPA also recommend that selected water quality parameters can be monitored during low-rate purging, with stabilization of these parameters indicating when the discharge water represents aquifer water or source well water. See: http://www.csus.edu/indiv/h/hornert/Geol_210_Summer_2012/Week%202%20readings/Puls%20and%20Barcelona%201996%20Low%20flow%20sampling.pdf and https://in-situ.com/wp-content/uploads/2015/01/Low-Flow-Groundwater-Sampling-Techniques-Improve-Sample-Quality-and-Reduce-Monitoring-Program-Costs-Case-Study.pdf
8. Minimum detection limits (MDLs) for each chemical and biological constituent are listed in Table 1. Some constituent concentrations were reported by the laboratory as less than the MDL but greater than zero. Those values are given in subsequent tables but have less confidence in their accuracy than concentrations above the MDL.
9. Chemical and biological analyses of samples collected from the beginning of 2015 to March 31, 2016 are given in Tables 2, 3, and 4.

Table 2. Minimum detection limits (MDLs) for each chemical and biological constituent.

Constituent	Minimum detection limit [1]
Alkalinity, mg/L as $CaCO_3$	2
Chloride, mg/L	0.093
Dissolved P, mg/L	0.002
Conductivity, uS/cm	1
Ammonia-N, mg/L	0.03
Dissolved organic carbon, mg/L	0.18
E. coli, MPN/100 mL	1
Nitrate-N, mg/L	0.004
pH	0.1
Total coliform, MPN/100 mL	1
Total dissolved solids, mg/L	15.22
Total N, mg/L	0.006
Total P, mg/L	0.012
Total suspended solids, mg/L	6.58

[1] MDL the Minimum Detection Limit of an analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. Further information is available at http://water.usgs.gov/owq/OFR_99-193/detection.html

Flow Measurement and Auto-sampling of Interceptor Trenches Drainage

In mid-July installation of a 0.5-foot H flume, tipping bucket water meter, and ISCO automated water sampler was installed at the end of each interceptor trench pipe, below the slurry holding ponds. This equipment was encased in a locked shed. This equipment design allows interceptor trench flow to be recorded and samples of high trench flow collected, in addition to the routine weekly grab samples when flow was present. This also ensured that samples collected were not contaminated by external sources, such as wildlife. Figures 2, 3, and 4 show site configuration.

Flow from the trench pipe was directed into the 0.5' H-flume, which was able to measure flows in excess of 10 mL/second. For smaller flows trench-water exited the flume into a tipping bucket rain gage, which was able to accurately measure low interceptor trench flow (i.e., <~12 mL/second). The ISCO automated water sampler was power by a solar battery and deep-cycle marine battery. This secure location allowed collection of samples of water from the interceptor trenches, which had not been affected by external sources, such as wildlife.

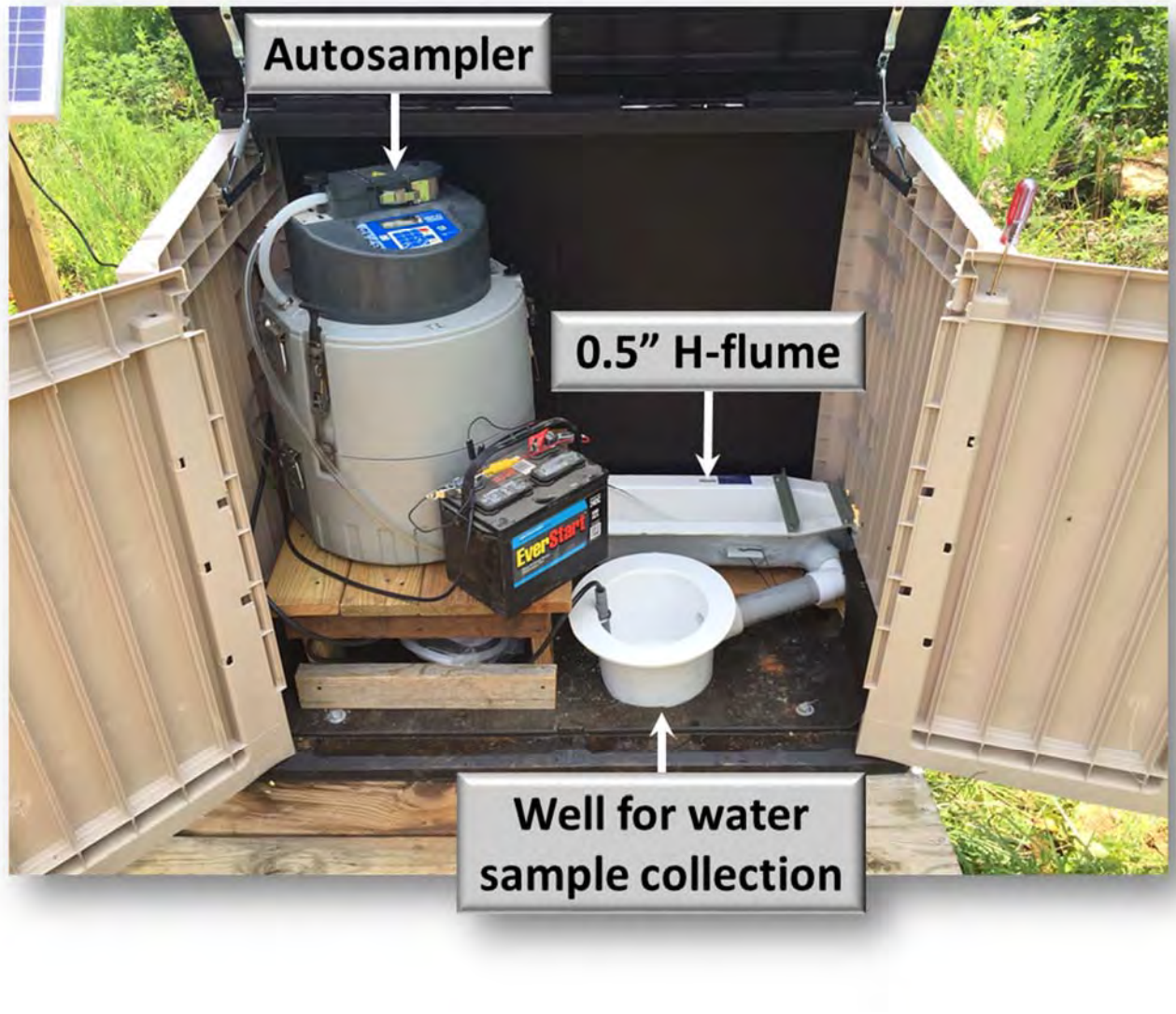

Figure 2. Sampling equipment installed on interceptor trenches.

Figure 3. Tipping bucket rain gage to measure low interceptor trench flow (i.e., <~12 mL/second).

Figure 4. External view of interceptor trench flow monitoring equipment.

Big Creek Research and Extension Team Monitoring Data

Nutrients, Sediment, and Bacteria by Date of Sampling

Table 3. Water quality analyses at each sample site since 2016, with those collected since the last report noted. Coliform units are Most Probable Number (MPN) per 100 mL of water.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
			---------- mg/L ----------							-- MPN/100 mL --	
1/5/2016	**1/25/2016**	**Grab sample**									
11:52	15:29	Spring	0.007	0.024	<0.03	0.584	0.63	0.7	1.39	16.0	816.4
13:00	15:29	Upstream	0.008	0.026	<0.03	0.158	0.20	0.5	0.95	67.7	648.8
11:40	15:29	Downstream	0.011	0.026	<0.03	0.419	0.46	0.1	1.13	40.8	648.8
11:30	15:29	Left Fork	0.013	0.028	<0.03	0.427	0.48	0.7	1.51	34.1	686.7
12:02	15:29	Ephemeral	0.007	0.018	<0.03	0.883	1.00	1.2	2.15	32.7	686.7
12:13	15:29	Trench 1	0.003	0.016	<0.03	0.243	0.29	0.9	1.11	1.0	209.8
12:44	15:29	House well	0.008	0.020	<0.03	0.528	0.57	0.9	1.08	<1.0	1.0
1/25/2016	**1/25/2016**	**Grab sample**									
11:16	15:25	Spring	0.010	0.022	<0.03	0.565	0.60	0.3	1.27	34.5	1732.9
12:10	15:25	Upstream	0.010	0.022	<0.03	0.068	0.09	1.1	1.52	16.9	290.9
11:00	15:25	Downstream	0.011	0.022	<0.03	0.213	0.24	0.7	1.29	8.6	365.4
10:48	15:25	Left Fork	0.010	0.024	<0.03	0.198	0.25	1.0	1.30	21.1	435.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:28	15:25	Ephemeral	0.011	0.030	<0.03	0.762	0.87	9.8	3.10	1.0	816.4
11:42	15:25	House well	0.012	0.020	<0.03	0.602	0.55	0.5	2.36	<1.0	<1
2/10/2016	**2/10/2016**	**Grab sample**									
12:25	15:26	Spring	0.007	0.040	<0.03	0.634	0.80	17.7	2.70	1.0	325.5
11:15	15:26	Upstream	0.005	0.016	<0.03	0.048	0.11	0.5	1.11	14.5	178.5
11:04	15:26	Downstream	0.005	0.016	<0.03	0.198	0.24	0.9	0.99	4.1	218.7
11:29	15:26	Left Fork	0.003	0.012	<0.03	0.175	0.24	0.8	1.15	7.4	209.8
12:03	15:26	House well	0.007	0.014	<0.03	0.542	0.56	0.1	0.63	<1.0	<1.0
2/24/2016	**2/24/2016**	**Grab sample**									
11:05	14:45	Spring	0.010	0.052	<0.03	1.102	1.46	2.8	N.S.	209.8	3930.0
12:16	14:45	Upstream	0.014	0.052	<0.03	0.099	0.28	6.1	N.S.	1203.3	7330.0
10:52	14:45	Downstream	0.015	0.058	<0.03	0.142	0.37	8.3	N.S.	1986.3	6500.0
10:38	14:45	Left Fork	0.015	0.088	<0.03	0.249	0.63	15.6	N.S.	2780.0	14390.0
11:15	14:45	Ephemeral	0.010	0.056	<0.03	0.195	0.40	12.8	N.S.	387.3	4870.0
11:36	14:45	Trench 1	0.005	0.014	<0.03	0.345	0.39	2.1	N.S.	<1.0	9070.0
11:53	14:45	House well	0.010	0.010	<0.03	0.582	0.55	1.3	N.S.	<1.0	<1.0
3/10/2016	**3/10/2016**	**Grab sample**									
11:04	15:45	Spring	0.012	0.064	0.11	0.104	0.34	9.5	5.38	285.1	3230.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
13:13	15:45	Upstream	0.012	0.048	0.13	0.082	0.20	8.6	2.66	770.1	>2419.2
10:51	15:45	Downstream	0.010	0.044	0.11	0.118	0.25	6.2	2.28	298.7	>2419.2
11:32	15:45	Ephemeral stream	0.006	0.050	0.13	0.918	1.22	26.7	3.12	648.8	8840.0
10:38	15:45	Left Fork	0.013	0.046	0.01	0.154	0.38	8.7	2.64	367.3	2750.0
12:03	15:45	House well	0.011	0.020	0.02	0.562	0.59	0.9	1.19	<1.0	<1.0
11:50	15:45	Trench 1	0.005	0.036	0.10	0.264	0.45	3.5	2.87	2419.2	16690.0
11:46	15:45	Trench 2	0.005	0.054	0.14	1.716	2.35	6.8	6.77	613.1	34480.0
12:41	15:45	Field 12	0.411	0.522	1.17	0.852	4.49	621.5	12.58	410.6	>241920
3/16/2016	**3/16/2016**	**Grab sample**									
11:35	15:05	Spring	0.009	0.036	0.01	0.340	0.44	5.7	3.36	75.4	461.1
12:35	15:05	Upstream	0.008	0.034	<0.03	0.060	0.13	0.4	1.10	52.9	579.4
11:23	15:05	Downstream	0.006	0.028	0.01	0.170	0.24	0.9	1.17	81.3	>2419.2
11:50	15:05	Ephemeral stream	0.006	0.022	0.01	0.520	0.54	0.0	1.75	88.0	461.1
11:13	15:05	Left Fork	0.009	0.032	<0.03	0.190	0.26	0.3	1.45	35.9	980.4
12:22	15:05	House well	0.009	0.022	<0.03	0.550	0.55	0.0	1.55	<1.0	<1
12:01	15:05	Trench 1	0.003	0.032	0.02	0.331	0.37	0.0	1.23	101.7	290.9
3/24/2016	**3/24/2016**	**Storm sample**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:50	15:10	Spring	0.015	0.046	0.06	0.172	0.42	13.1	4.95	N.S.	N.S.
12:50	15:10	Upstream	0.011	0.032	0.06	0.040	0.14	4.5	1.60	N.S.	N.S.
11:35	15:10	Downstream	0.011	0.024	<0.03	0.106	0.20	3.9	1.29	N.S.	N.S.
12:10	15:10	Ephemeral stream	0.010	0.012	<0.03	0.531	0.64	1.3	1.44	N.S.	N.S.
11:25	15:10	Left Fork	0.013	0.048	0.09	0.186	0.39	10.7	2.65	N.S.	N.S.
12:34	15:10	House well	0.012	0.014	<0.03	0.565	0.65	0.2	2.72	N.S.	N.S.
12:20	15:10	Trench 1	0.008	0.016	<0.03	0.208	0.20	2.8	1.33	N.S.	N.S.
3/31/2016	**3/31/3016**	**Grab sample**									
11:06	15:10	Spring	0.011	0.034	<0.03	0.319	0.52	7.4	25.32	71.7	1553.1
12:45	15:10	Upstream	0.008	0.042	0.08	0.100	0.22	6.1	2.49	186.0	>2419.2
10:45	15:10	Downstream	0.011	0.056	0.08	0.156	0.33	12.4	2.67	365.0	>2419.2
11:16	15:10	Ephemeral stream	0.013	0.656	0.68	1.211	3.05	375.0	12.14	16160.0	198630.0
10:33	15:10	Left Fork	0.013	0.056	0.09	0.199	0.40	11.9	2.59	172.0	3640.0
11:49	15:10	House well	0.010	0.018	<0.03	0.556	0.62	0.2	3.93	1.0	26.2
11:40	15:10	Trench 1	0.004	0.018	<0.03	0.347	0.49	5.5	4.76	4.1	2419.2
11:35	15:10	Trench 2	0.006	0.040	0.06	2.800	3.54	20.9	9.29	7.4	10810.0
12:02	15:10	Field 5a	1.154	1.352	0.27	0.302	1.67	26.5	32.74	24890.0	>241920

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
4/4/2016	**4/4/2016**	**Grab sample**									
11:58	15:20	Spring	0.009	0.028	<0.03	0.324	0.42	7.5	1.57	104.7	866.4
12:50	15:20	Upstream	0.008	0.026	<0.03	0.065	0.08	1.7	0.71	8.3	648.8
11:48	15:20	Downstream	0.010	0.026	<0.03	0.176	0.20	1.9	0.98	77.6	1046.2
12:08	15:20	Ephemeral stream	0.008	0.018	<0.03	0.462	0.48	1.3	1.79	12.0	727.0
11:38	15:20	Left Fork	0.009	0.022	<0.03	0.131	0.17	1.5	0.87	44.8	1119.9
12:35	15:20	House well	0.011	0.018	<0.03	0.466	0.48	0.0	0.94	<1.0	1.0
12:26	15:20	Trench 2	0.004	0.012	<0.03	0.236	0.25	0.0	0.85	1.0	>2419.2
4/20/2016	**4/20/2016**	**Grab sample**									
12:02	15:52	Spring	0.005	0.042	<0.03	0.410	0.55	22.4	1.04	3.1	195.6
13:20	15:52	Upstream	0.003	0.020	<0.03	0.047	0.06	1.9	0.61	185.0	1299.7
11:42	15:52	Downstream	0.004	0.018	<0.03	0.152	0.20	1.2	0.74	38.4	2920.0
12:11	15:52	Ephemeral stream	0.008	0.020	<0.03	0.517	0.66	4.1	0.68	44.3	21430.0
11:30	15:52	Left Fork	0.005	0.020	<0.03	0.157	0.21	2.1	0.84	35.0	6160.0
12:52	15:52	House well	0.005	0.014	<0.03	0.598	0.50	0.5	0.47	1.0	1.0
4/28/2016	**4/28/2016**	**Grab sample**									
11:55	15:17	Spring	0.010	0.024	<0.03	0.455	0.63	12.0	N.S.	25.6	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
13:00	15:17	Upstream	0.009	0.012	<0.03	0.035	0.12	1.2	N.S.	58.6	648.8
11:30	15:17	Downstream	0.010	0.012	<0.03	0.154	0.27	1.5	N.S.	36.4	2149.2
12:31	15:17	House well	0.011	0.008	<0.03	0.481	0.57	0.3	N.S.	<1.0	<1.0
11:25	15:17	Dry Creek	0.010	0.012	<0.03	0.152	0.27	1.0	N.S.	14.8	3050.0
5/2/2016	**5/3/2016**	**Grab sample**									
12:25	08:55	Spring	0.008	0.012	<0.03	0.338	0.36	2.2	5.08	88.2	>2419.2
14:29	08:55	Upstream	0.006	0.018	<0.03	0.039	0.10	6.7	1.76	185.0	2419.2
11:43	08:55	Downstream	0.008	0.016	<0.03	0.075	0.16	2.0	1.50	178.9	4720.0
12:38	08:55	Ephemeral stream	0.007	0.016	<0.03	0.468	0.59	1.7	2.56	118.7	5380.0
12:38	08:55	Ephemeral stream	0.008	0.112	0.15	1.794	2.62	61.8	4.07	1046.2	23590.0
11:24	08:55	Left Fork	0.009	0.020	<0.03	0.095	0.20	1.9	2.30	172.6	3640.0
13:27	08:55	House well	0.009	0.016	<0.03	0.551	0.56	0.1	1.94	<1.0	<1
5/10/2016	**5/10/2016**	**Grab sample**									
11:15	15:40	Spring	0.008	0.026	<0.03	0.281	0.45	2.9	7.58	410.6	2780.0
12:50	15:40	Upstream	0.007	0.044	0.01	0.070	0.20	6.1	3.10	613.1	4480.0
10:58	15:40	Downstream	0.011	0.060	0.01	0.101	0.31	11.6	2.95	1203.3	7490.0
11:28	15:40	Ephemeral stream	0.195	0.560	0.32	0.649	4.01	1346.7	11.94	579.4	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:35	15:40	Left Fork	0.011	0.072	0.02	0.121	0.37	17.2	3.35	980.4	8230.0
12:08	15:40	House well	0.009	0.008	<0.03	0.533	0.56	0.5	4.39	<1.0	24.9
11:55	15:40	Trench 1	0.002	0.016	<0.03	0.228	0.30	3.9	2.91	13.9	>2419.2
11:45	15:40	Trench 2	0.002	0.038	<0.03	1.706	2.18	5.2	3.72	38.7	>2419.2
12:26	15:40	Field 5a	1.114	1.458	1.69	2.894	6.35	79.9	12.82	22820.0	>2419.2
13:08	15:40	Field 12	0.370	0.666	0.12	0.062	1.03	96.7	6.92	663.0	>2419.2
5/18/2016	**5/18/2016**	**Grab sample**									
11:29	15:20	Spring	0.009	0.024	0.01	0.320	0.51	8.7	2.20	45.7	1413.6
13:08	15:20	Upstream	0.007	0.016	<0.03	0.043	0.13	1.4	1.00	85.5	1299.7
11:10	15:20	Downstream	0.009	0.020	0.02	0.117	0.25	1.2	0.98	107.1	>2419.2
11:43	15:20	Ephemeral stream	0.008	0.014	<0.03	0.479	0.63	3.0	0.84	34.1	2419.2
10:57	15:20	Left Fork	0.010	0.016	0.01	0.139	0.27	1.4	1.54	60.1	2620.0
12:50	15:20	House well	0.009	0.010	<0.03	0.488	0.64	0.4	0.95	<1.0	<1.0
12:05	15:20	Trench 1	0.006	0.006	<0.03	0.169	0.22	0.1	0.54	2.0	5200.0
5/26/2016	**5/26/2016**	**Grab sample**									
11:45	15:30	Spring	0.008	0.020	<0.03	0.219	0.35	6.2	4.15	344.8	3730.0
13:08	15:30	Upstream	0.007	0.030	<0.03	0.056	0.12	4.2	1.56	238.2	5290.0
11:30	15:30	Downstream	0.009	0.036	<0.03	0.094	0.20	4.6	1.75	547.5	3640.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:05	15:30	Ephemeral stream	0.052	0.424	0.39	0.858	2.20	350.6	8.58	22470.0	>2419.2
11:20	15:30	Left Fork	0.010	0.048	0.02	0.123	0.24	10.6	2.66	461.1	6890.0
12:51	15:30	House well	0.009	0.012	<0.03	0.564	0.57	0.7	0.93	1.0	7.4
12:38	15:30	Trench 1	0.008	0.006	<0.03	0.217	0.23	1.4	1.29	1.0	4260.0
Samples analyzed since the last quarterly report											
6/2/2016	**6/2/2016**	**Grab sample**									
11:15	14:40	Spring	0.007	0.032	<0.03	0.330	0.47	10.8	2.38	64.1	1986.3
12:26	14:40	Upstream farm	0.007	0.018	<0.03	0.046	0.13	4.1	1.8	224.7	1986.3
11:04	14:40	Downstream farm	0.006	0.018	<0.03	0.106	0.20	1.4	1.8	104.6	3410
11:26	14:40	Ephemeral stream	0.008	0.022	<0.03	0.494	0.63	3.6	2.15	770.1	1986.3
10:52	14:40	Left Fork	0.007	0.022	<0.03	0.117	0.22	1.4	1.40	44.1	1986.3
12:06	14:40	House well	0.008	0.018	<0.03	0.597	0.62	0.7	0.99	<1.0	<1.0
11:35	14:40	Trench 1	0.002	0.018	<0.03	0.124	0.30	8.8	3.01	26.5	393.0
6/7/2016	**6/7/2016**	**Grab sample**									
11:25	14:30	Spring	0.011	0.026	<0.03	0.327	0.46	4.6	6.06	140.1	2460.0
12:16	14:30	Upstream farm	0.013	0.018	0.06	0.131	0.14	1.3	2.8	120.1	2720.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:10	14:30	Downstream farm	0.012	0.018	0.04	0.123	0.19	1.5	1.94	73.8	2980.0
11:37	14:30	Ephemeral stream	0.012	0.024	0.01	0.503	0.65	6.9	3.89	2419.2	7980.0
10:50	14:30	Left Fork	0.009	0.016	0.04	0.124	0.19	0.8	2.08	31.8	3180.0
12:00	14:30	House well	0.011	0.014	0.03	0.500	0.58	0.1	3.06	<1.0	<1.0
6/15/2016	**6/15/2016**	**Grab sample**									
11:40	15:00	Spring	0.010	0.016	0.03	0.466	0.65	4.2	0.00	153.9	1553.1
12:40	15:00	Upstream farm	0.007	0.010	<0.03	0.097	0.15	1.6	0.02	69.1	2310.0
11:25	15:00	Downstream farm	0.008	0.050	0.05	0.181	0.42	25.4	0.38	33.2	4740.0
11:15	15:00	Left Fork	0.009	0.012	0.01	0.198	0.29	2.0	0.94	63.1	8860.0
12:15	15:00	House well	0.008	0.008	<0.03	0.506	0.59	0.7	0.00	<1.0	<1.0
6/22/2016	**6/22/2016**	**Grab sample**									
10:40	14:35	Spring	0.008	0.012	<0.03	0.532	0.60	1.0	0.00	38.2	1413.6
12:20	14:35	Upstream farm	0.008	0.016	0.02	0.237	0.33	2.3	0.20	455.0	547.5
10:23	14:35	Downstream farm	0.015	0.028	0.04	0.327	0.44	14.9	0.00	46.4	4570.0
10:08	14:35	Left Fork	0.008	0.018	0.05	0.220	0.37	2.1	0.70	37.9	676.0
11:38	14:35	House well	0.009	0.008	<0.03	0.545	0.58	0.5	0.00	<1.0	<1.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
6/29/2016	**6/29/2016**	**Grab sample**									
10:53	14:00	Spring	0.009	0.083	0.02	0.487	0.73	43.4	1.10	5.2	648.8
11:37	14:00	Upstream farm	0.006	0.029	0.06	0.186	0.34	4.6	0.92	55.4	9888.0
10:41	14:00	Downstream farm	0.010	0.021	0.03	0.395	0.47	2.5	0.46	41.3	6310.0
10:25	14:00	Left Fork	0.006	0.023	0.03	0.251	0.35	2.0	0.94	23.5	5200.0
11:12	14:00	House well	0.008	0.014	<0.03	0.569	0.56	0.0	0.23	<1.0	<1.0
7/6/2016	**7/6/2016**	**Grab sample**									
6:44	10:16	Spring	0.011	0.027	<0.03	0.465	0.53	9.8	1.15	25.3	4430
7:41	10:16	Upstream farm	0.009	0.023	<0.03	0.221	0.27	5.9	0.66	387.3	12230.0
6:26	10:16	Downstream farm	0.010	0.023	0.01	0.461	0.43	2.1	0.47	39.3	8570.0
6:08	10:16	Left Fork	0.006	0.020	0.04	0.271	0.36	2.7	0.96	248.1	12590.0
7:18	10:16	House well	0.009	0.013	<0.03	0.874	0.96	1.0	0.73	<1.0	13.5
7/13/2016	**7/13/2016**	**Grab sample**									
7:53	12:30	Spring	0.003	0.023	<0.03	0.355	0.42	12.3	0.90	71.7	2920
7:33	12:30	Downstream farm	0.006	0.017	<0.03	0.365	0.43	4.3	1.12	129.6	8390.0
7:15	12:30	Left Fork	0.005	0.017	<0.03	0.172	0.29	1.9	0.85	95.9	12360.0
8:34	12:30	House well	0.005	0.011	<0.03	0.627	0.63	0.5	0.09	<1.0	<1.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
7/20/2016	**7/20/2016**	**Grab sample**									
7:56	12:05	Spring	0.006	0.024	<0.03	0.298	0.35	9.4	0.55	N.S.	N.S.
7:39	12:05	Downstream farm	0.005	0.024	<0.03	0.356	0.44	5.1	3.93	N.S	N.S.
7:25	12:05	Left Fork	0.005	0.013	<0.03	0.197	0.76	2.3	2.21	N.S.	N.S.
8:30	12:05	House well	0.007	0.009	0.02	0.594	0.70	0.1	0.14	N.S.	N.S.
7/27/2016	**7/27/2016**	**Grab sample**									
7:38	14:15	Spring	0.001	0.043	<0.03	0.375	0.46	17.6	2.64	55.6	980.4
7:21	14:15	Downstream farm	0.007	0.027	<0.03	0.423	0.47	2.3	1.62	140.8	17260.0
7:02	14:15	Left Fork	0.004	0.021	<0.03	0.255	0.35	3.6	1.79	920.8	15000.0
8:14	14:15	House well	0.006	0.010	<0.03	0.650	0.67	0.1	1.41	<1.0	<1.0
8/3/2016	**8/3/2016**	**Grab sample**									
8:03	12:10	Spring	0.006	0.104	<0.03	0.201	0.49	64.8	7.41	65.7	2920
7:43	12:10	Downstream farm	0.013	0.014	<0.03	0.221	0.29	3.2	3.46	115.3	9320.0
7:28	12:10	Left Fork	0.007	0.016	<0.03	0.212	0.32	2.4	2.21	101.4	7430.0
8/16/2016	**8/16/2016**	**Grab sample**									
10:58	14:50	Spring	0.007	0.027	0.02	0.223	0.39	7.7	9.89	88.2	5380.0
12:16	14:50	Upstream farm	0.009	0.031	0.03	0.089	0.23	4.6	3.14	248.9	9330.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:41	14:50	Downstream farm	0.011	0.039	0.03	0.161	0.33	8.1	2.94	178.2	17820.0
11:25	14:50	Ephemeral stream	0.011	0.023	0.01	1.365	1.59	2.6	2.47	137.6	154945.0
10:28	14:50	Left Fork	0.012	0.082	0.07	0.118	0.30	19.5	3.64	201.4	14550.0
11:40	14:50	Trench 1	0.005	0.006	0.02	0.130	0.17	0.2	2.14	93.4	48840.0
11:50	14:50	Trench 2	0.004	0.036	0.05	0.344	0.99	1.5	8.98	290.9	198630.0
8/24/2016	**8/24/2016**	**Grab sample**									
11:29	15:30	Spring	0.004	0.046	<0.03	0.477	0.97	29.9	2.99	27.8	5630
12:40	15:30	Upstream farm	0.004	0.014	0.03	0.046	0.14	2.0	1.08	72.3	2620.0
10:53	15:30	Downstream farm	0.005	0.016	<0.03	0.122	0.22	3.2	0.85	72.8	7030.0
10:40	15:30	Left Fork	0.004	0.013	0.00	0.045	0.13	1.5	1.62	43.5	6690.0
8/24/2016	**8/24/2016**	**Storm sample**									
11:03	15:30	Downstream farm	<0.002	0.109	0.01	0.002	0.42	66.9	5.89	N.S.	N.S.
12:05	15:30	Trench 1	<0.002	0.019	0.03	0.033	0.30	8.3	1.99	21.8	3450.0
8/30/2016	**8/30/2016**	**Grab sample**									
11:24	14:55	Spring	0.003	0.020	<0.03	0.501	0.58	2.9	3.28	195.6	9090.0
12:35	14:55	Upstream farm	0.003	0.020	<0.03	0.042	0.13	1.7	1.37	102.5	5210.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:10	14:55	Downstream farm	0.004	0.020	<0.03	0.116	0.21	1.7	1.19	30.1	5200.0
11:00	14:55	Left Fork	0.005	0.021	0.02	0.157	0.28	2.7	2.00	111.2	17850.0

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.
§ N.S. is No Sample.

Nutrients, Sediment, and Bacteria by Date Spring, Upstream, and Downstream Sites

Table 4. Water quality analyses in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application since January 2016, with those collected since the last report noted.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
1/5/2016									
Upstream	0.008	0.026	<0.03	0.158	0.20	0.5	0.95	67.7	648.8
Downstream	0.011	0.026	<0.03	0.419	0.46	0.1	1.13	40.8	648.8
1/25/2016									
Upstream	0.010	0.022	<0.03	0.068	0.09	1.1	1.52	16.9	290.9
Downstream	0.011	0.022	<0.03	0.213	0.24	0.7	1.29	8.6	365.4
2/10/2016									
Upstream	0.005	0.016	<0.03	0.048	0.11	0.5	1.11	14.5	178.5
Downstream	0.005	0.016	<0.03	0.198	0.24	0.9	0.99	4.1	218.7
2/24/2016									
Upstream	0.014	0.052	<0.03	0.099	0.28	6.1		1203.3	7330.0
Downstream	0.015	0.058	<0.03	0.142	0.37	8.3		1986.3	6500.0
3/10/2016									
Upstream	0.012	0.048	0.13	0.082	0.20	8.6	2.66	770.1	>2419.2
Downstream	0.010	0.044	0.11	0.118	0.25	6.2	2.28	298.7	>2419.2

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/16/2016									
Upstream	0.008	0.034	0.00	0.060	0.13	0.4	1.10	52.9	579.4
Downstream	0.006	0.028	0.01	0.170	0.24	0.9	1.17	81.3	>2419.2
3/24/2016									
Upstream	0.011	0.032	0.06	0.04	0.14	4.5	1.60	N.S.	N.S.
Downstream	0.011	0.024	0.00	0.106	0.20	3.9	1.29	N.S.	N.S.
3/31/2016									
Upstream	0.008	0.042	0.08	0.100	0.22	6.1	2.49	186.0	>2419.2
Downstream	0.011	0.056	0.08	0.156	0.33	12.4	2.67	365.0	>2419.2
4/4/2016									
Upstream	0.008	0.026	<0.03	0.065	0.08	1.7	0.71	8.3	648.8
Downstream	0.010	0.026	<0.03	0.176	0.20	1.9	0.98	77.6	1046.2
4/20/2016									
Upstream	0.003	0.020	<0.03	0.047	0.06	1.9	0.61	185.0	1299.7
Downstream	0.004	0.018	<0.03	0.152	0.20	1.2	0.74	38.4	2920.0
4/28/2016									
Upstream	0.009	0.012	<0.03	0.035	0.12	1.2	N.D.	58.6	648.8
Downstream	0.010	0.012	<0.03	0.154	0.27	1.5	N.D.	36.4	2149.2

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/2/2016									
Upstream	0.006	0.018	<0.03	0.039	0.10	6.7	1.76	185.0	2419.2
Downstream	0.008	0.016	<0.03	0.075	0.16	2.0	1.50	178.9	4720.0
5/10/2016									
Upstream	0.007	0.044	0.01	0.070	0.20	6.1	3.10	613.1	4480.0
Downstream	0.011	0.060	0.01	0.101	0.31	11.6	2.95	1203.3	7490.0
5/18/2016									
Upstream	0.007	0.016	<0.03	0.043	0.13	1.4	1.00	85.5	1299.7
Downstream	0.009	0.020	0.02	0.117	0.25	1.2	0.98	107.1	>2419.2
5/26/2016									
Upstream	0.007	0.030	<0.03	0.056	0.12	4.2	1.56	238.2	5290.0
Downstream	0.009	0.036	<0.03	0.094	0.20	4.6	1.75	547.5	3640.0
Samples analyzed since the last Quarterly Report									
6/12/2016									
Upstream	0.007	0.018	0.00	0.046	0.13	4.1	1.8	224.7	1986.3
Downstream	0.006	0.018	0.00	0.106	0.20	1.4	1.8	104.6	3410.0
6/7/2016									
Upstream	0.013	0.018	0.06	0.131	0.14	1.3	2.8	120.1	2720.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.012	0.018	0.04	0.123	0.19	1.5	1.94	73.8	2980.0
6/15/2016									
Upstream	0.007	0.010	0.00	0.097	0.15	1.6	0.02	69.1	2310.0
Downstream	0.008	0.050	0.05	0.181	0.42	25.4	0.38	33.2	4740.0
6/22/2016									
Upstream	0.008	0.016	0.02	0.237	0.33	2.3	0.20	455.0	547.5
Downstream	0.015	0.028	0.04	0.327	0.44	14.9	0.00	46.4	4570.0
6/29/2016									
Upstream	0.006	0.029	0.06	0.186	0.34	4.6	0.92	55.4	9888.0
Downstream	0.010	0.021	0.03	0.395	0.47	2.5	0.46	41.3	6310.0
7/6/2016									
Upstream	0.009	0.023	0.00	0.221	0.27	5.9	0.66	387.3	12230.0
Downstream	0.010	0.023	0.01	0.461	0.43	2.1	0.47	39.3	8570.0
8/16/2016									
Upstream	0.009	0.031	0.03	0.089	0.23	4.6	3.14	248.9	9330.0
Downstream	0.011	0.039	0.03	0.161	0.33	8.1	2.94	178.2	17820.0
8/24/2016									
Upstream	0.004	0.014	0.03	0.046	0.14	2.0	1.08	72.3	2620.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.005	0.016	0.00	0.122	0.22	3.2	0.85	72.8	7030.0
8/30/2016									
Upstream	0.003	0.020	0.00	0.042	0.13	1.7	1.37	102.5	5210.0
Downstream	0.004	0.020	0.00	0.116	0.21	1.7	1.19	30.1	5200.0
9/7/2016									
Upstream	0.007	0.020	0.01	0.113	0.21	1.9	1.89	195.6	5380.0
Downstream	0.008	0.059	0.01	0.265	0.46	25.4	1.39	30.9	4790.0

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

§ N.S. is No Sample.

† N.D. is No Data.

Nutrients, Sediment, and Bacteria by Site for Ephemeral Stream, Trenches, Left Fork and Field Runoff

Table 5. Water quality analyses at the ephemeral stream draining the subwatershed containing the production houses and manure holding ponds, and surface runoff from Fields 1, 5a, and 12 since January, 2015, with those collected since the last report noted.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
Ephemeral stream									
1/5/2016	0.007	0.018	<0.03	0.883	1.00	1.2	2.15	32.7	686.7
1/25/2016	0.011	0.030	<0.03	0.762	0.87	9.8	3.10	1.0	816.4
2/24/2016	0.010	0.056	<0.03	0.195	0.40	12.8		387.3	4870.0
3/10/2016	0.006	0.050	0.13	0.918	1.22	26.7	3.12	648.8	8840.0
3/16/2016	0.006	0.022	0.01	0.520	0.54	0.0	1.75	88.0	461.1
3/24/2016	0.010	0.012	<0.03	0.531	0.64	1.3	1.44	N.S.	N.S.
3/31/2016	0.013	0.656	0.68	1.211	3.05	375.0	12.14	16160.0	198630.0
4/4/2016	0.008	0.018	<0.03	0.462	0.48	1.3	1.79	12.0	727.0
4/20/2016	0.008	0.020	<0.03	0.517	0.66	4.1	0.68	44.3	21430.0
5/2/2016	0.007	0.016	<0.03	0.468	0.59	1.7	2.56	118.7	5380.0
5/10/2016	0.195	0.560	0.32	0.649	4.01	1346.7	11.94	579.4	241920.0
5/18/2016	0.008	0.014	<0.03	0.479	0.63	3.0	0.84	34.1	2419.2

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/26/2016	0.052	0.424	0.39	0.858	2.20	350.6	8.58	22470.0	241920..0
Samples analyzed since the last quarterly report									
6/2/2016	0.008	0.022	0.03	0.494	0.63	3.6	2.15	770.1	1986.3
6/7/2016	0.012	0.024	0.01	0.5	0.7	6.9	3.89	2419.2	7980
8/16/2016	0.011	0.023	0.01	1.365	1.59	2.6	2.47	137.6	154945.0
Interceptor Trench 1 (South)									
1/5/2016	0.003	0.016	<0.03	0.243	0.29	0.9	1.11	1.0	209.8
2/24/2016	0.005	0.014	<0.03	0.345	0.39	2.1		<1.0	9070.0
3/10/2016	0.005	0.036	0.10	0.264	0.45	3.5	2.87	2419.2	16690.0
3/16/2016	0.003	0.032	0.02	0.331	0.37	0.0	1.23	101.7	290.9
3/24/2016	0.008	0.016	<0.03	0.208	0.20	2.8	1.33	N.S.	N.S.
3/31/2016	0.004	0.018	<0.03	0.347	0.49	5.5	4.76	4.1	2419.2
5/10/2016	0.002	0.016	<0.03	0.228	0.30	3.9	2.91	13.9	2419.2
5/18/2016	0.006	0.006	<0.03	0.169	0.22	0.1	0.54	2.0	5200.0
5/26/2016	0.008	0.006	<0.03	0.217	0.23	1.4	1.29	1.0	4260.0
Samples analyzed since the last quarterly report									
6/2/2016	0.002	0.018	0.00	0.124	0.30	8.8	3.01	26.5	393.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
8/16/2016	0.005	0.006	0.02	0.130	0.17	0.2	2.14	93.4	48840.0
8/24/2016	0.000	0.019	0.03	0.033	0.30	8.3	1.99	21.8	3450.0
Interceptor Trench 2 (North)									
2/24/2016	0.005	0.066	0.13	6.298	7.02	9.7	4.27	30.1	18720.0
3/10/2016	0.005	0.054	0.14	1.716	2.35	6.8	6.77	613.1	34480.0
3/31/2016	0.006	0.040	0.06	2.800	3.54	20.9	9.29	7.4	10810.0
4/4/2016	0.004	0.012	<0.03	0.236	0.25	0.0	0.85	1.0	2419.2
5/10/2016	0.002	0.038	<0.03	1.706	2.18	5.2	3.72	38.7	1553.0
Samples analyzed since the last quarterly report									
8/16/2016	0.004	0.036	0.05	0.344	0.99	1.5	8.98	290.9	198630.0
Left Fork									
1/5/2016	0.013	0.028	<0.03	0.427	0.48	0.7	1.51	34.1	686.7
1/25/2016	0.010	0.024	<0.03	0.198	0.25	1.0	1.30	21.1	435.2
2/10/2016	0.003	0.012	<0.03	0.175	0.24	0.8	1.15	7.4	209.8
2/24/2016	0.015	0.088	<0.03	0.249	0.63	15.6		2780.0	14390.0
3/10/2016	0.013	0.046	0.01	0.154	0.38	8.7	2.64	367.3	2750.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
3/16/2016	0.009	0.032	<0.03	0.190	0.26	0.3	1.45	35.9	980.4
3/24/2016	0.013	0.048	0.09	0.186	0.39	10.7	2.65		
3/31/2016	0.013	0.056	0.09	0.199	0.40	11.9	2.59	172.0	3640.0
4/4/2016	0.009	0.022	<0.03	0.131	0.17	1.5	0.87	44.8	1119.9
4/20/2016	0.005	0.020	<0.03	0.157	0.21	2.1	0.84	35.0	6160.0
5/2/2016	0.009	0.020	<0.03	0.095	0.20	1.9	2.30	172.6	3640.0
5/10/2016	0.011	0.072	0.02	0.121	0.37	17.2	3.35	980.4	8230.0
5/18/2016	0.010	0.016	0.01	0.139	0.27	1.4	1.54	60.1	2620.0
5/26/2016	0.010	0.048	0.02	0.123	0.24	10.6	2.66	461.1	6890.0
Samples analyzed since the last quarterly report									
6/2/2016	0.007	0.022	0.00	0.117	0.22	1.4	1.40	44.1	1986.3
6/7/2016	0.009	0.016	0.04	0.124	0.19	0.8	2.08	31.8	3180.0
6/15/2016	0.009	0.012	0.01	0.198	0.29	2.0	0.94	63.1	8860.0
6/22/2016	0.008	0.018	0.05	0.220	0.37	2.1	0.70	37.9	676.0
6/29/2016	0.006	0.023	0.03	0.251	0.35	2.0	0.94	23.5	5200.0
7/6/2016	0.006	0.02	0.04	0.271	0.36	2.7	0.96	248.1	12590.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
7/13/2016	0.005	0.017	0.00	0.172	0.29	1.9	0.85	95.9	12360.0
7/20/2016	0.005	0.013	0.00	0.197	0.76	2.3	2.21		
7/27/2016	0.004	0.021	0.00	0.255	0.35	3.6	1.79	920.8	15000.0
8/3/2016	0.007	0.016	0.00	0.212	0.32	2.4	2.21	101.4	7430.0
8/16/2016	0.012	0.082	0.07	0.118	0.30	19.5	3.64	201.4	14550.0
8/24/2016	0.004	0.013	0.00	0.045	0.13	1.5	1.62	43.5	6690.0
8/30/2016	0.005	0.021	0.02	0.157	0.28	2.7	2.00	111.2	17850.0
9/7/2016	0.006	0.021	0.00	0.151	0.24	2.8	1.58	27.5	10170.0
Field 1									
No samples collected and analyzed for 2016									
Field 5a									
3/31/2016	1.154	1.352	0.27	0.302	1.67	26.5	32.74	N.S.	N.S.
5/10/2016	1.114	1.458	1.69	2.894	6.35	79.9	12.82	N.S.	N.S.
No samples analyzed since the last quarterly report									
Field 12									
3/10/2016	0.411	0.522	1.17	0.852	4.49	621.5	12.58	N.S.	N.S.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/10/2016	0.370	0.666	0.12	0.062	1.03	96.7	6.92	N.S.	N.S.
No samples analyzed since the last quarterly report									

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.

§ N.S. is No Sample. E. coli and total coliform were not measured on surface runoff samples collected by ISCO samplers when sample holding time exceeded the required 8-hour threshold.

† N.D. is No Data.

Temporal Trends in Phosphorus, Nitrogen and Bacteria in Big Creek Above and Below the C&H Farm

The concentration of dissolved P, total P, nitrate-N, total N, bacteria and chloride in Big Creek above and below the C&H Farm are presented in subsequent figures to show the season / temporal trends in measured concentrations (Figures 5, 6, 7, 8, 9, 10, and 11).

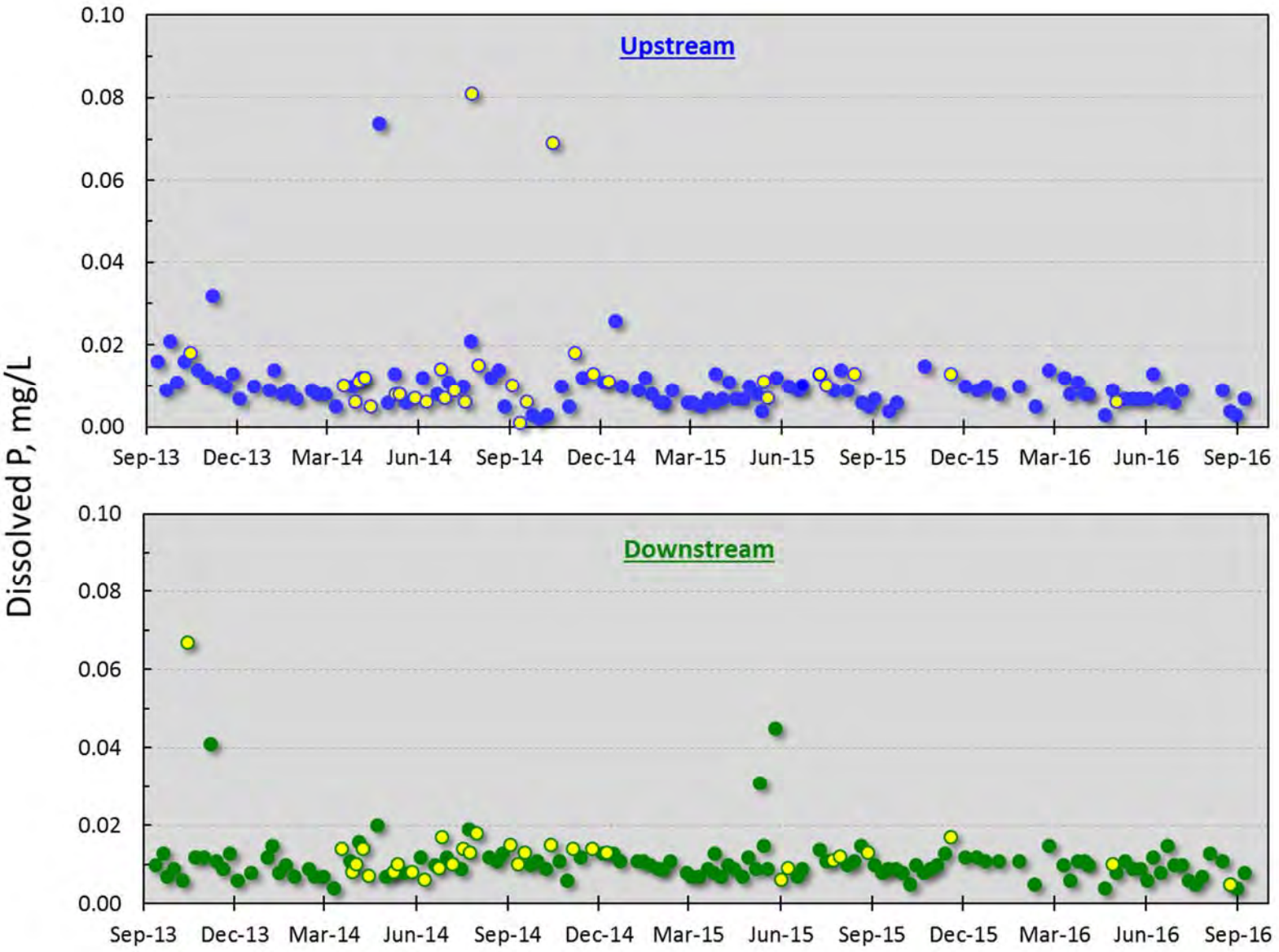

Figure 5. Dissolved P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

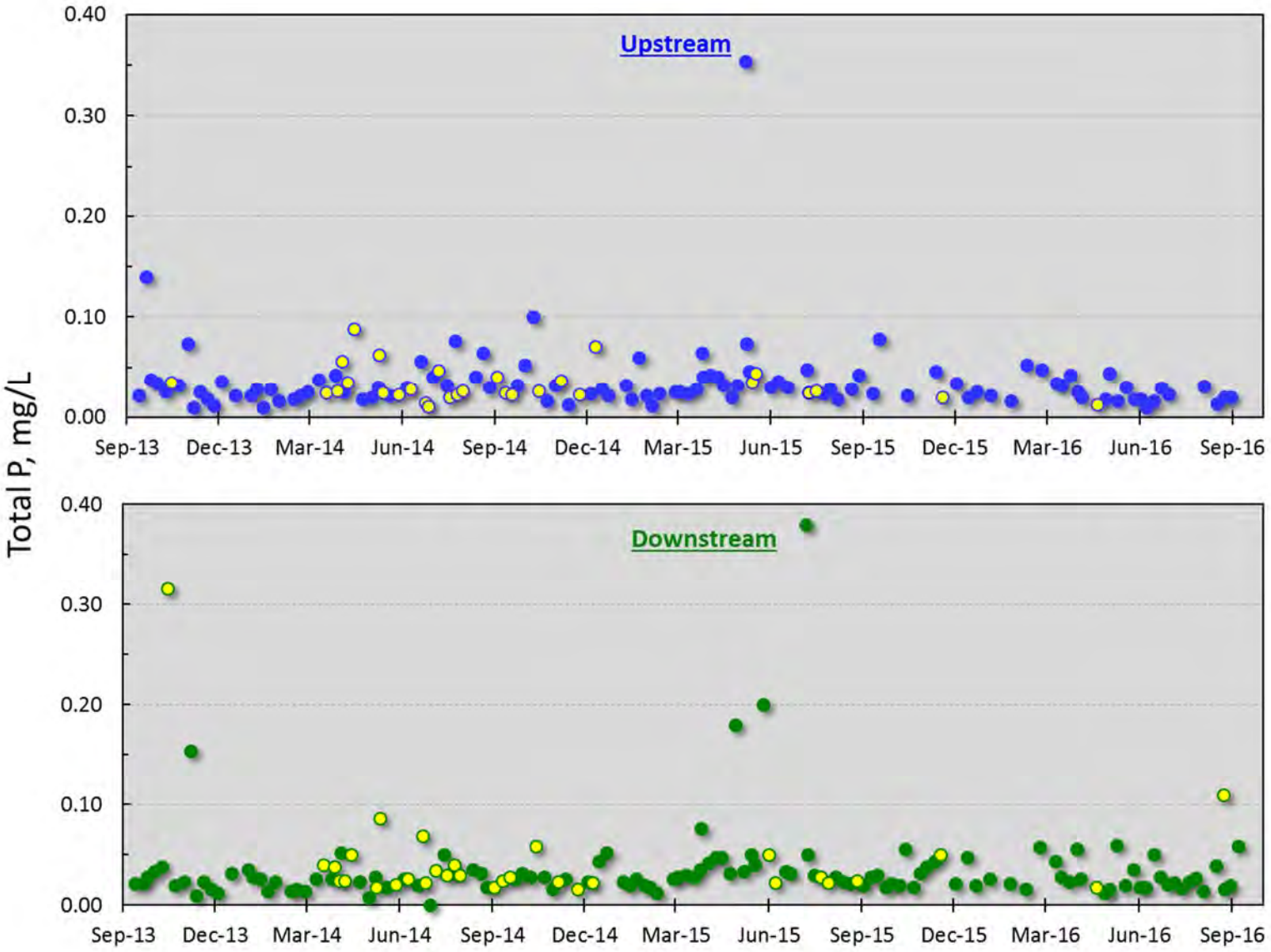

Figure 6. Total P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

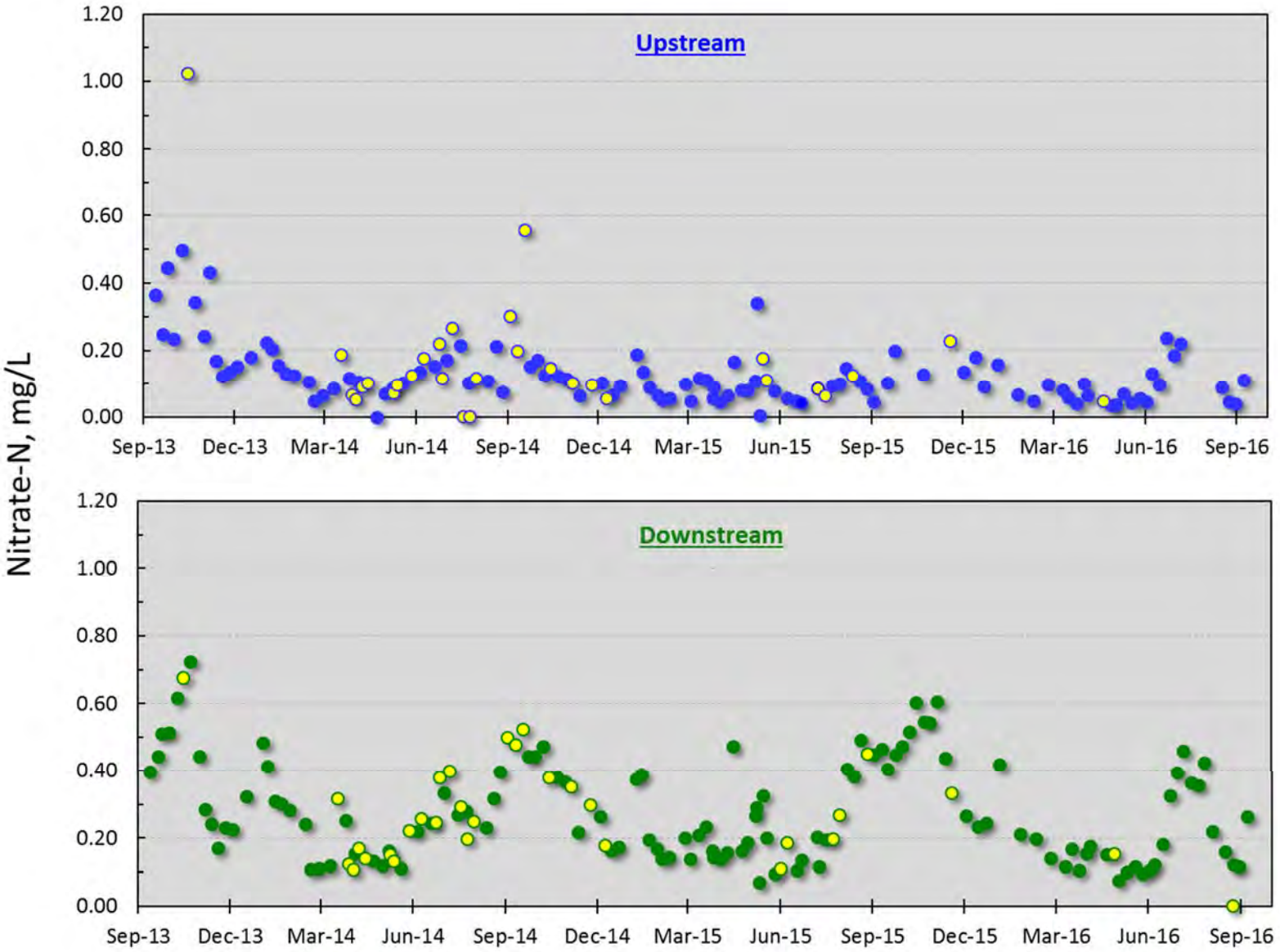

Figure 7. Nitrate-N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

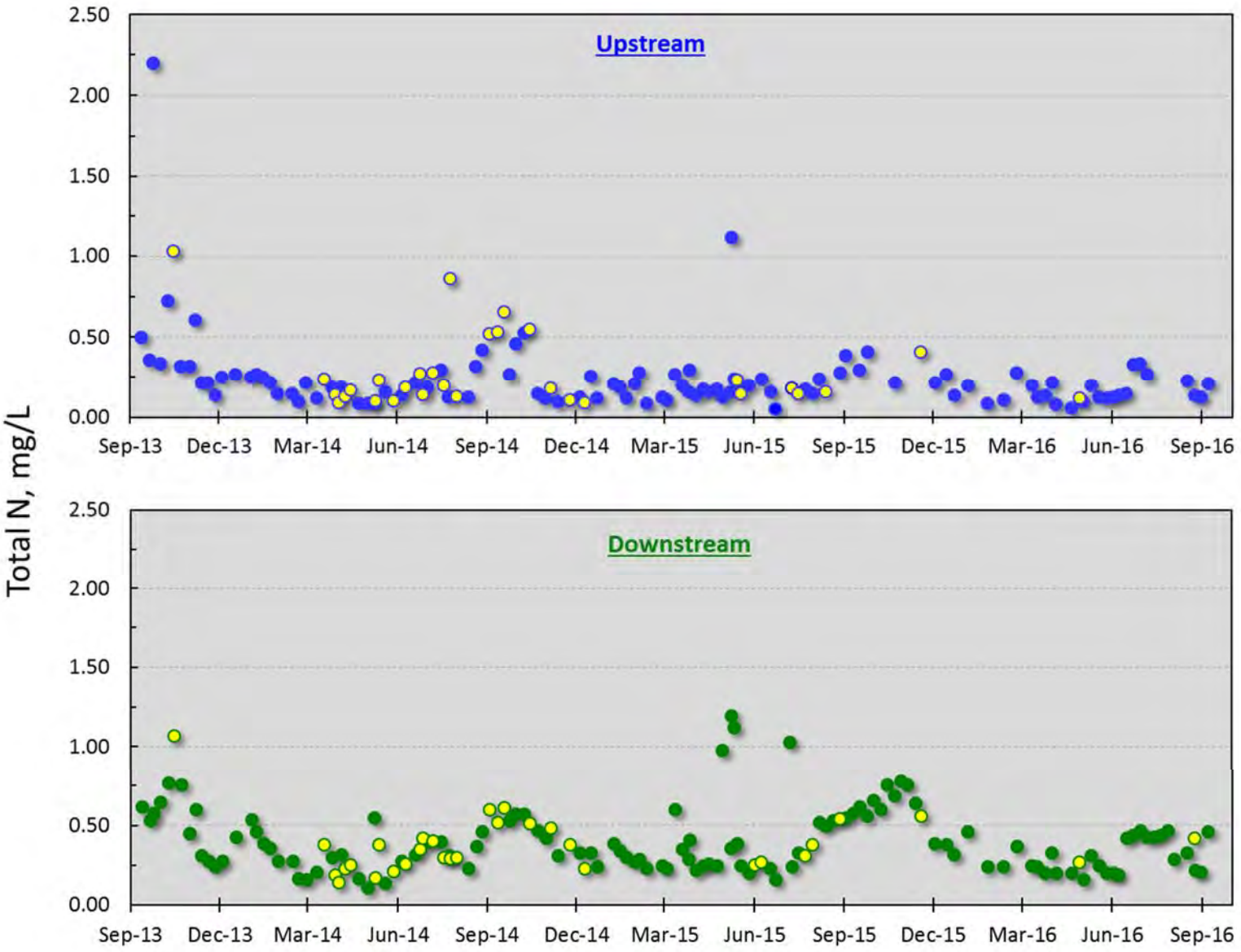

Figure 8. Total N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

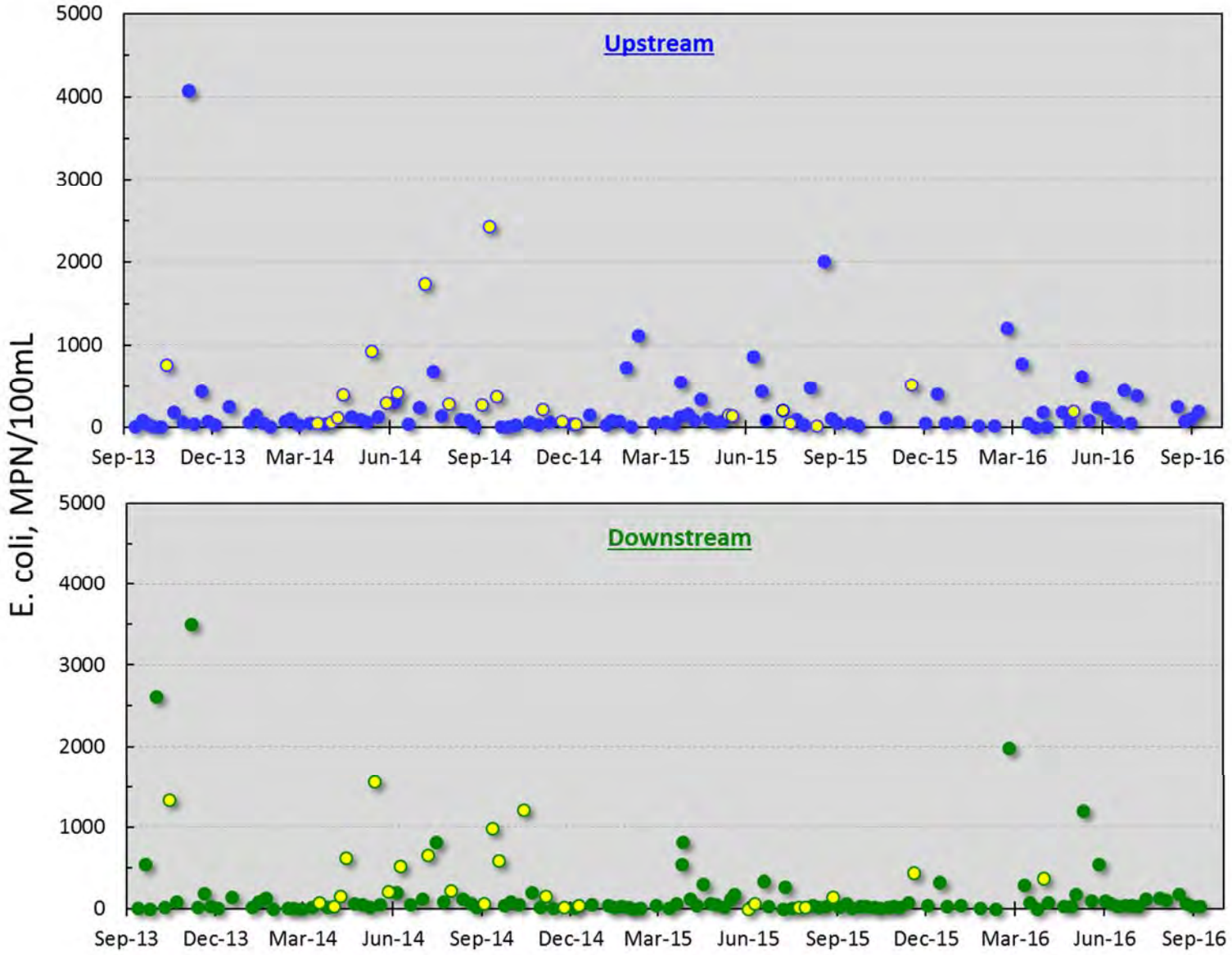

Figure 9. E. coli numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

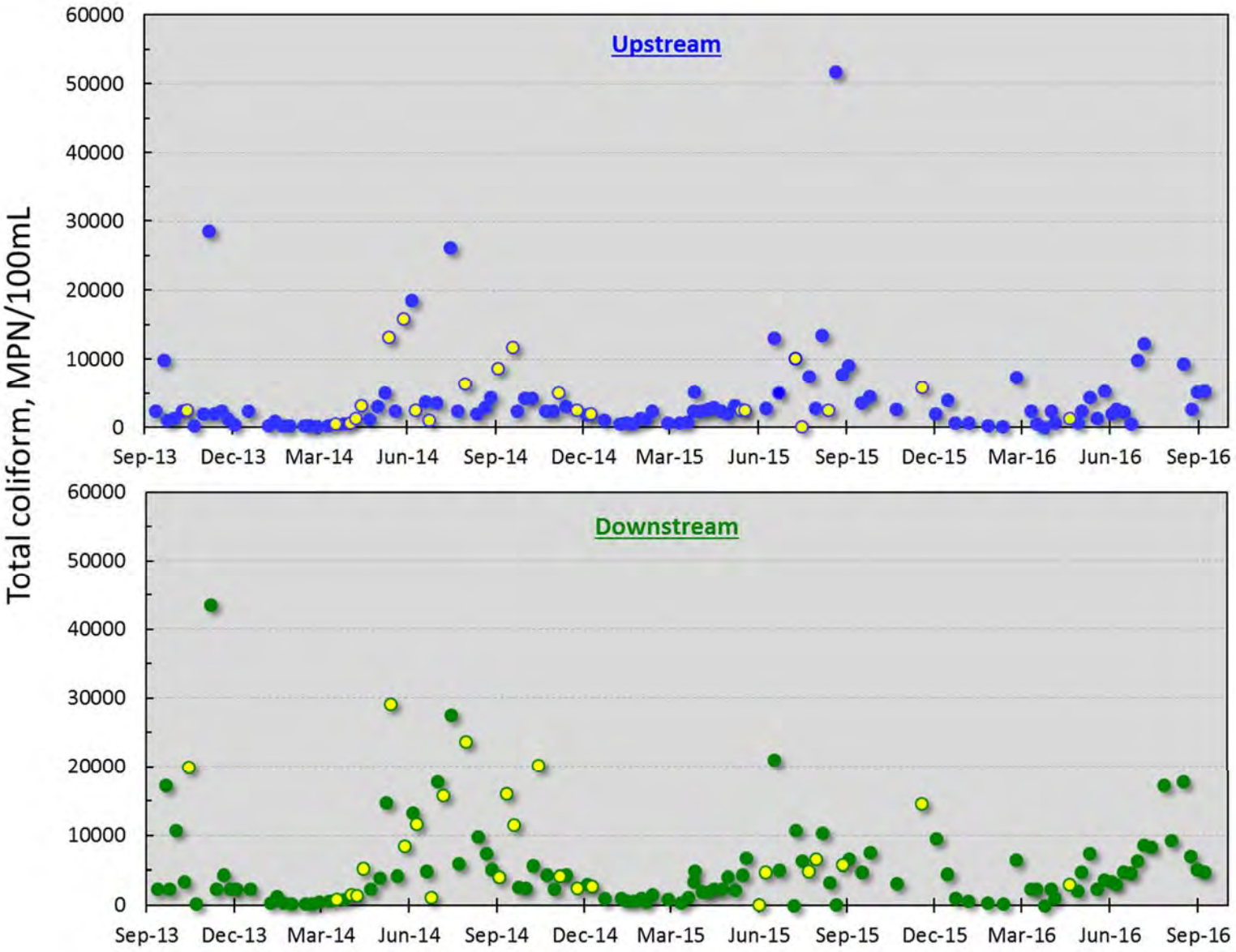

Figure 10. Total coliform numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

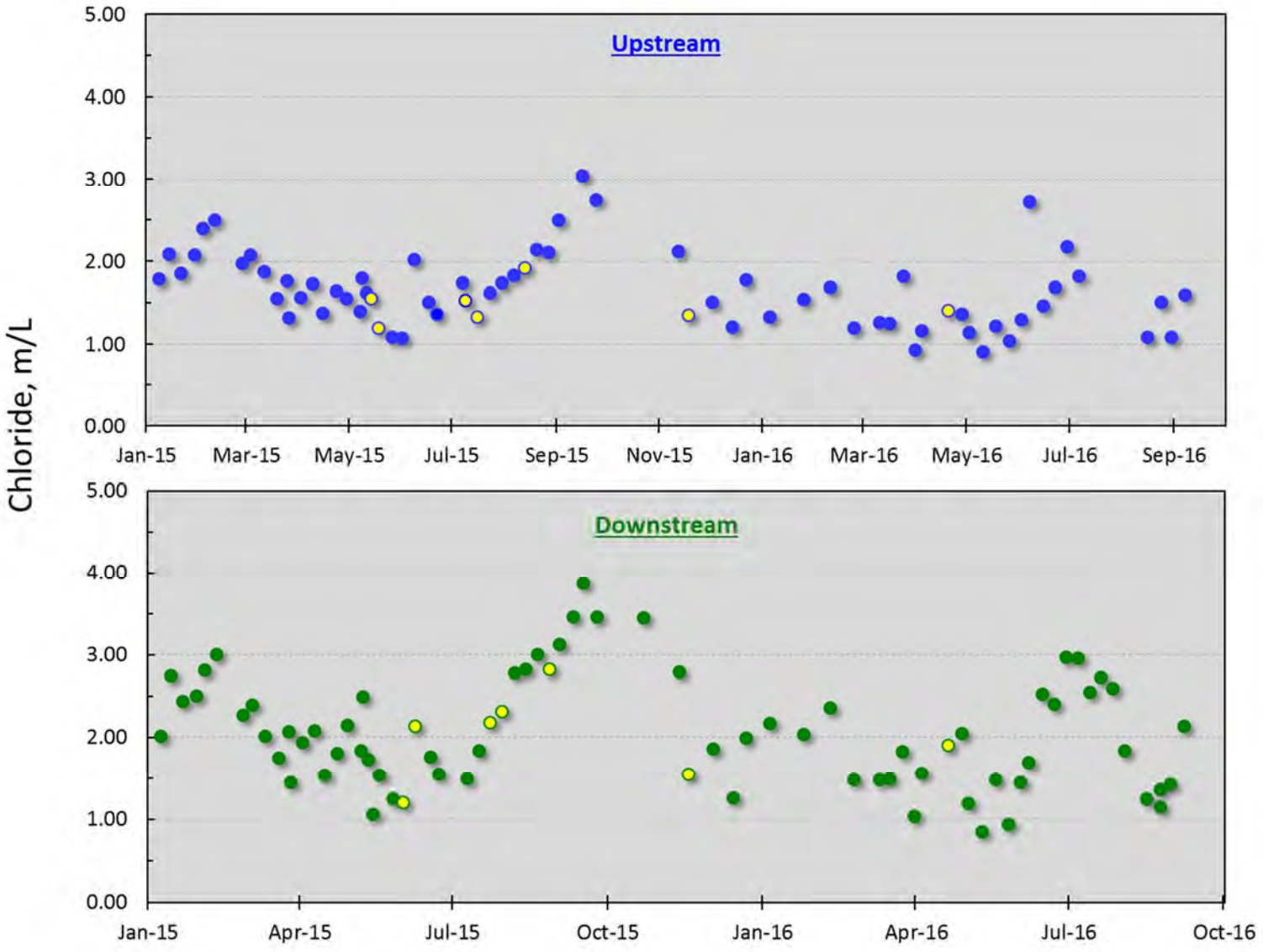

Figure 11. Chloride concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

Differences in dissolved P, total P, nitrate-N, total P, E. coli, total coliform and chloride between upstream and downstream sites from the beginning of monitoring (September 2013) to the present time are given in Figures 12, 13, 14, 15, 16, 17, and 18.

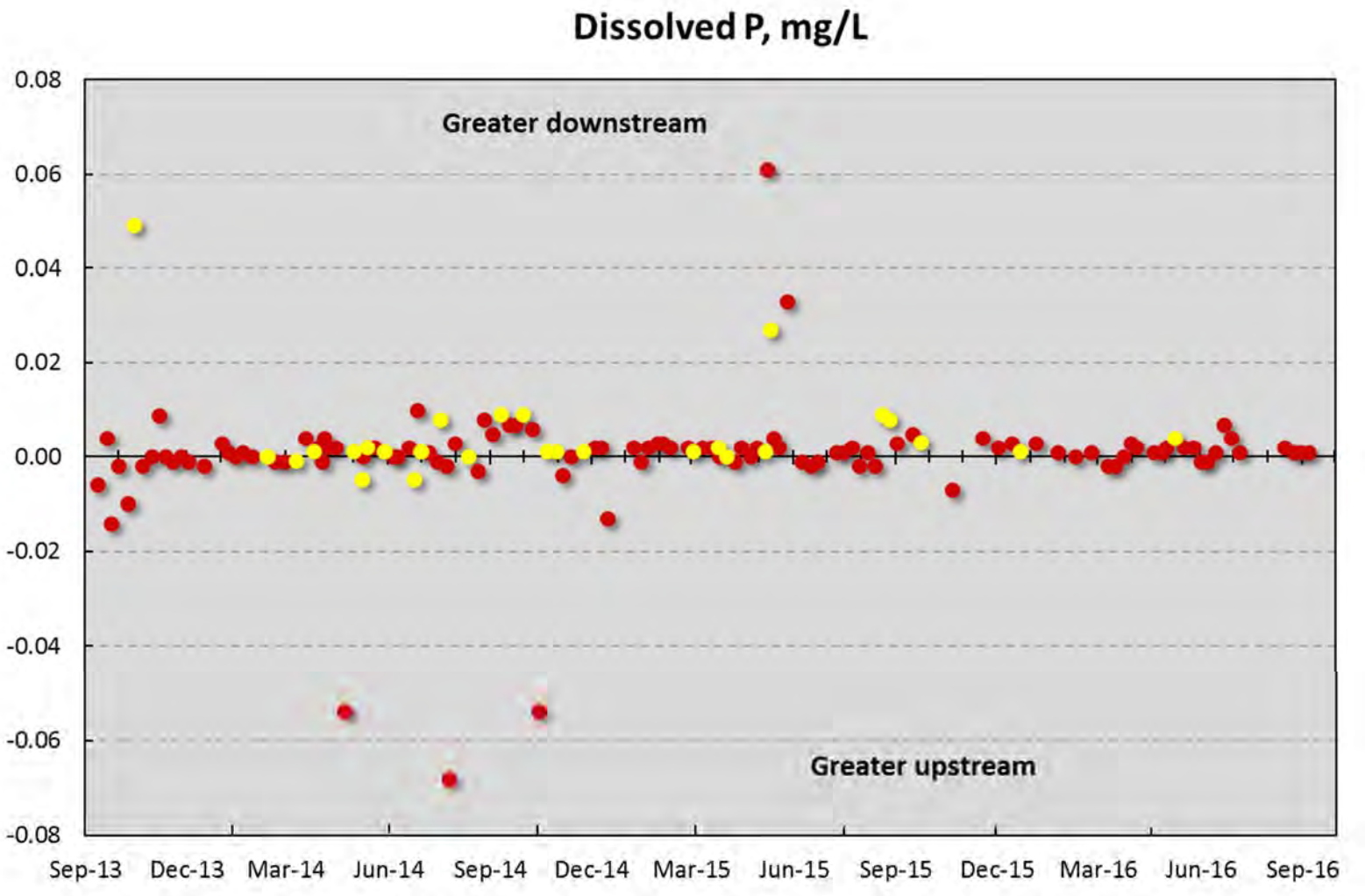

Figure 12. Difference in dissolved P concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

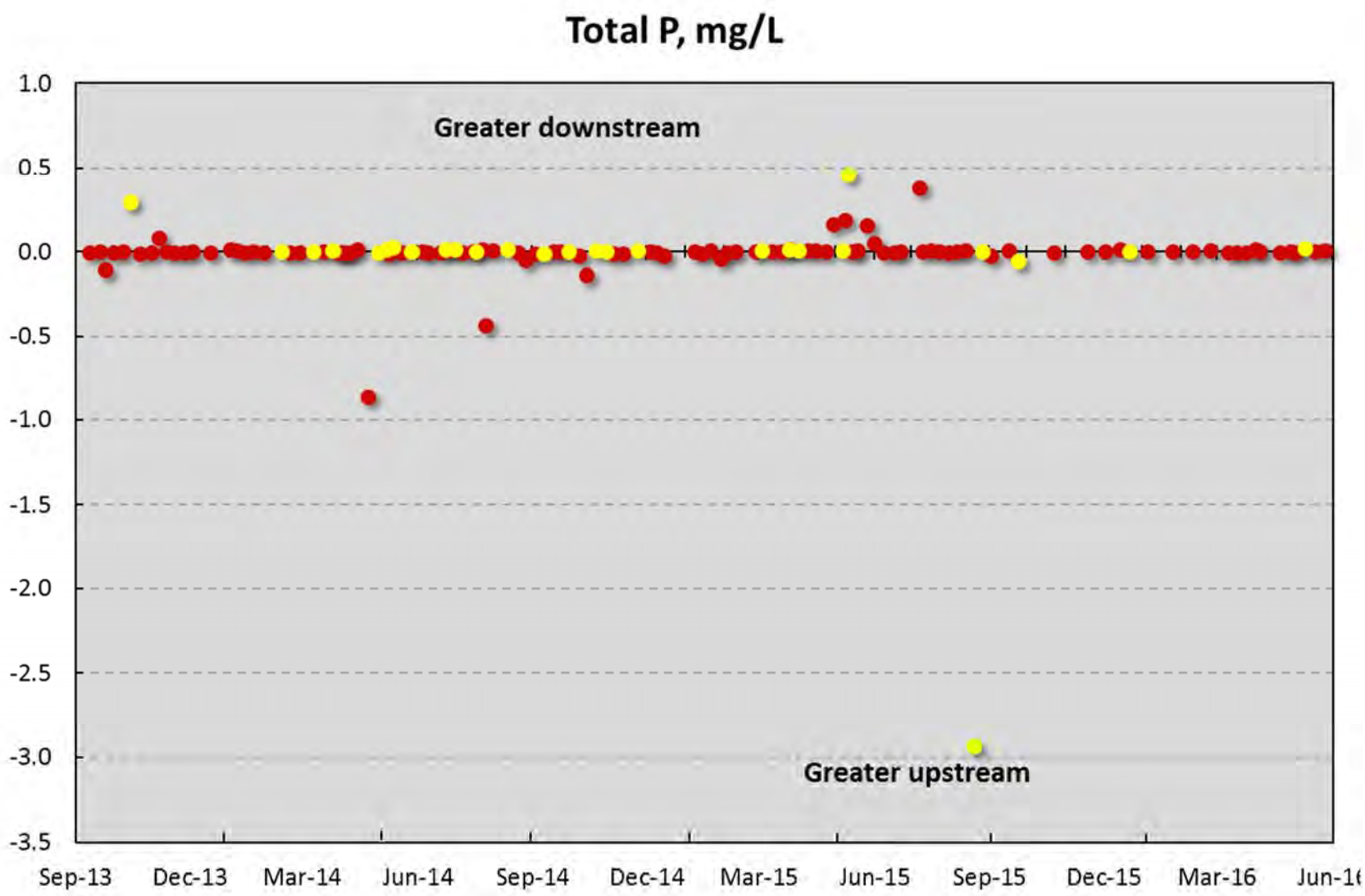

Figure 13. Difference in total P concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

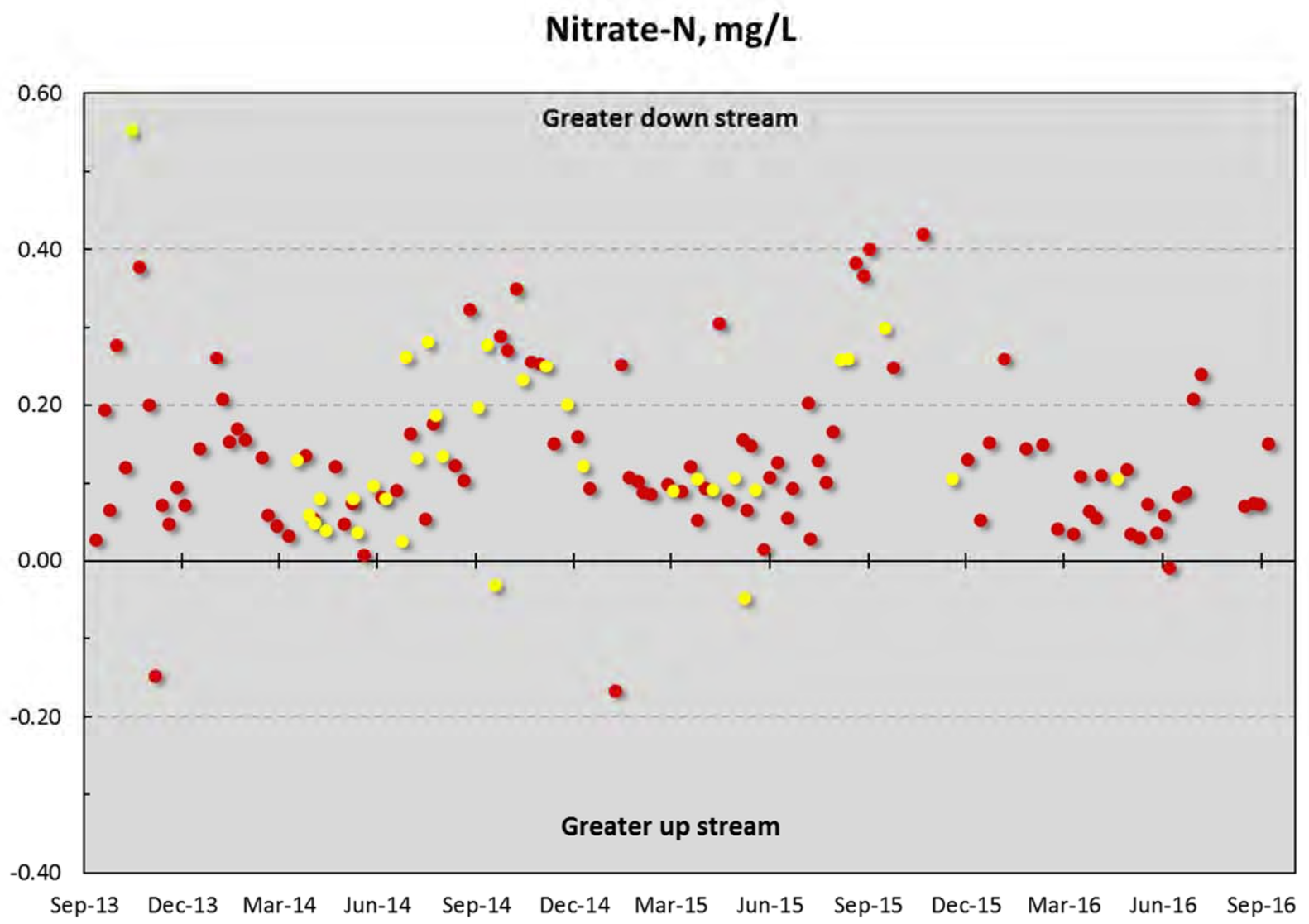

Figure 14. Difference in nitrate-N concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

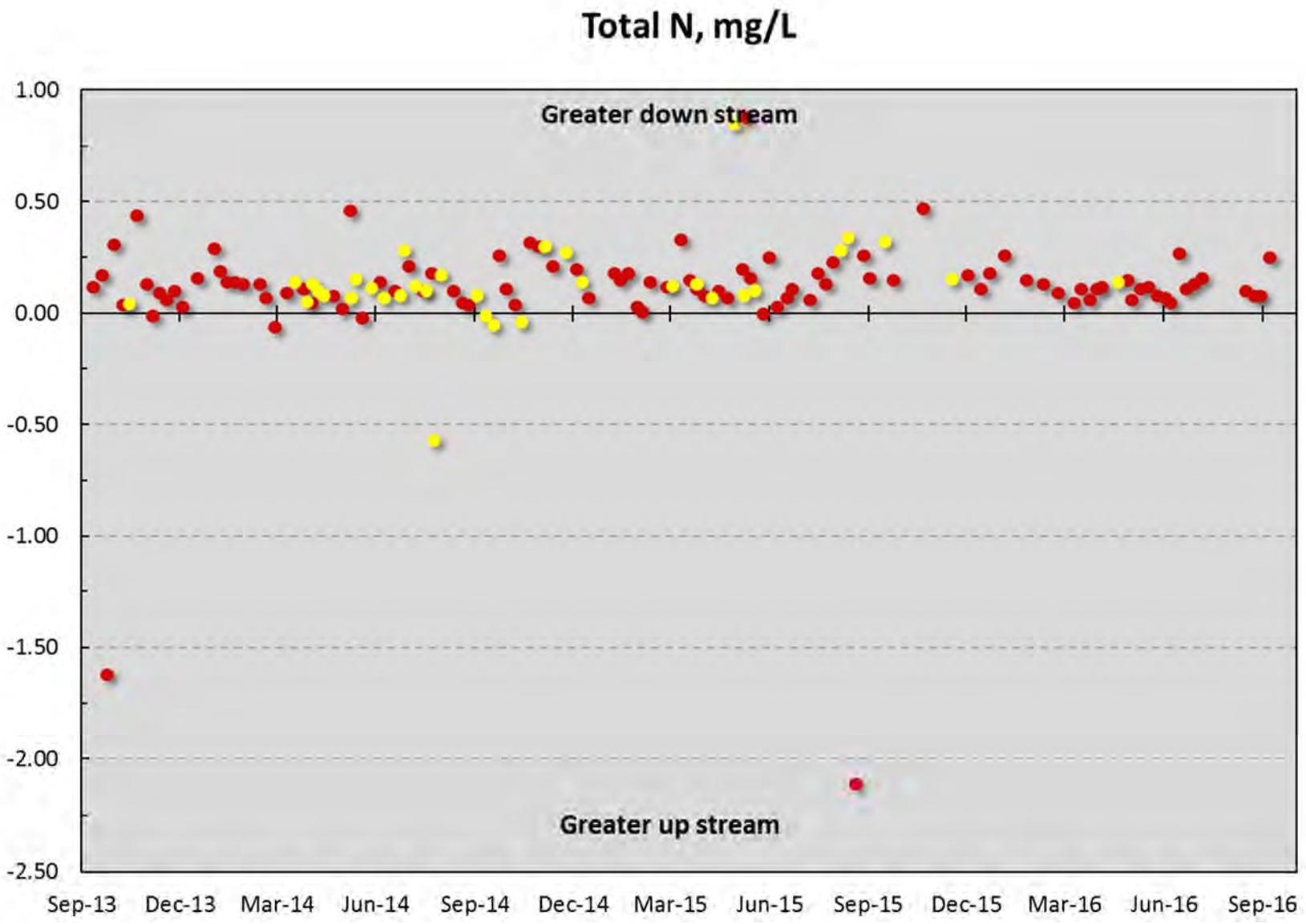

Figure 15. Difference in total N concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

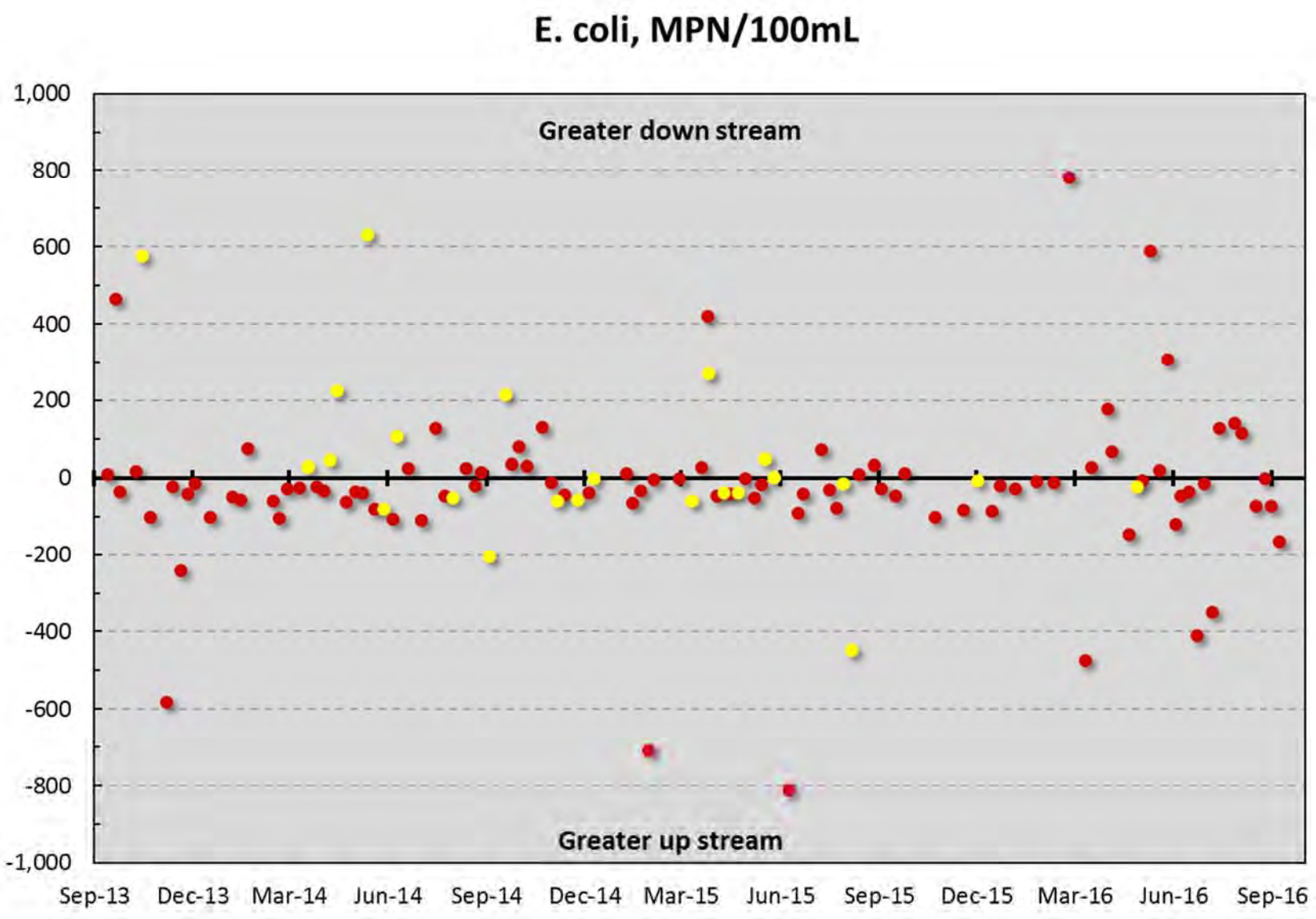

Figure 16. Difference in E. coli numbers in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

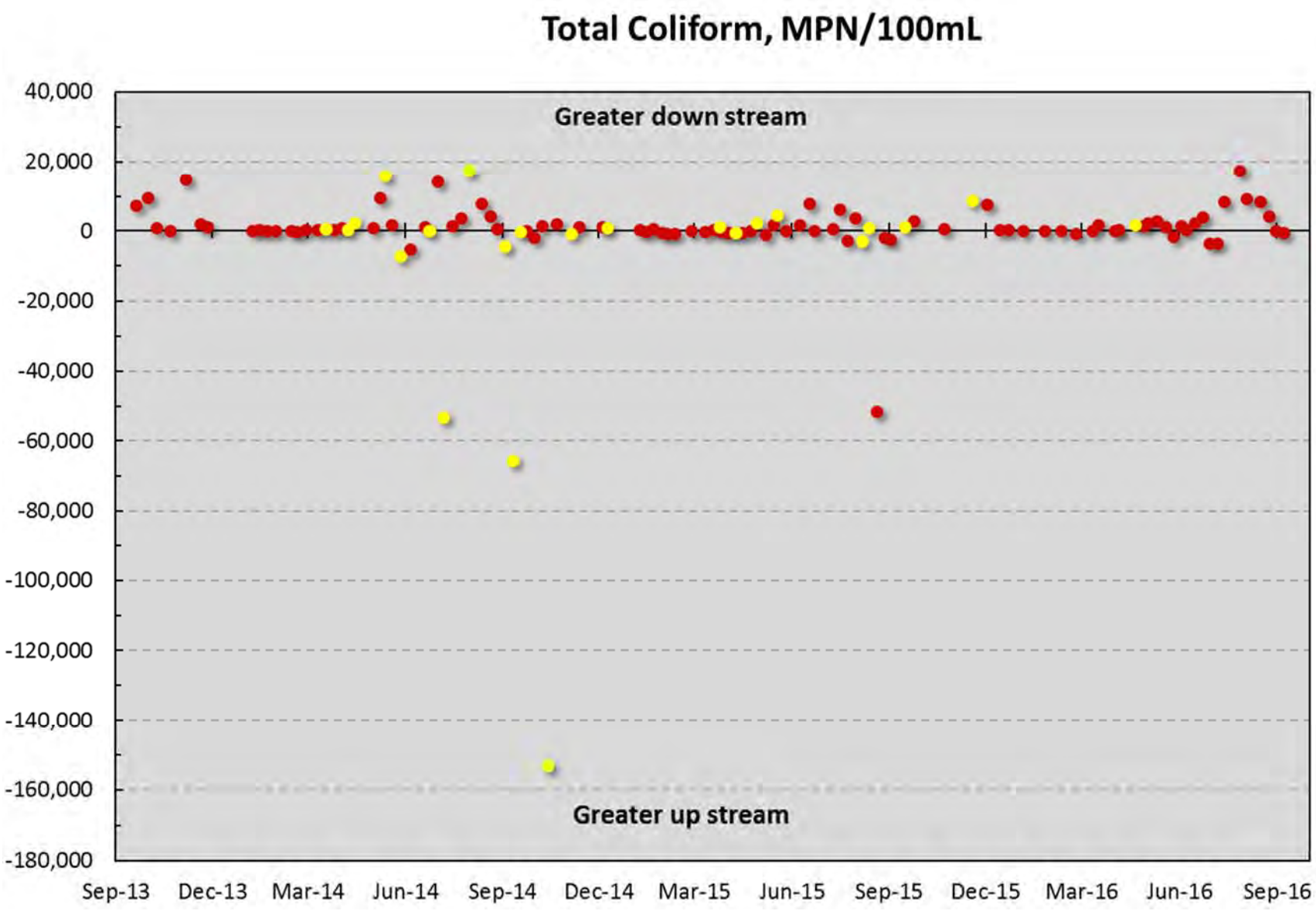

Figure 17. Difference in total coliform numbers in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

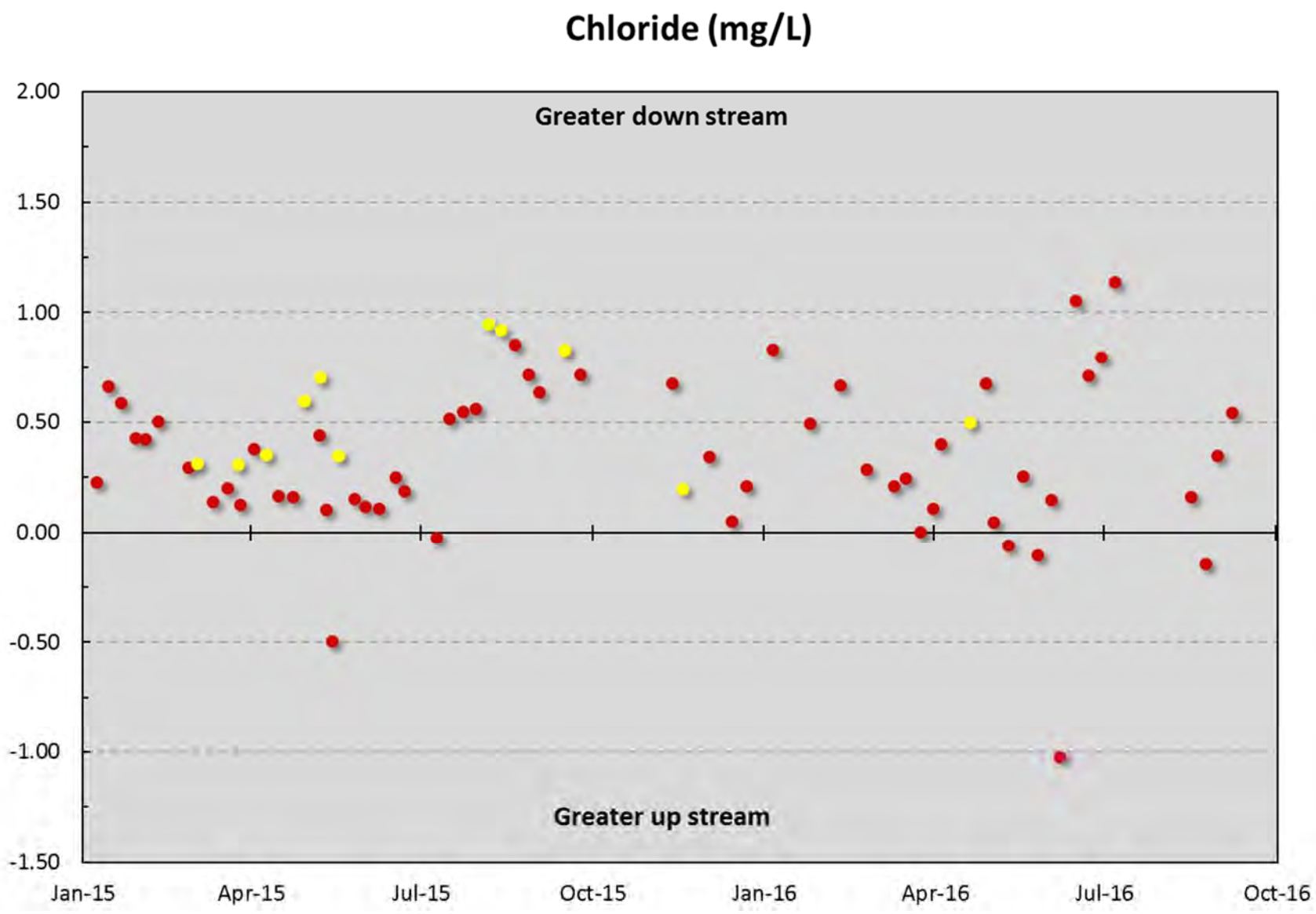

Figure 18. Difference in chloride concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

Water pH, Alkalinity, Chloride, Electrical Conductivity, and Total Dissolved Solids for Several Big Creek Sites

At the beginning of 2015, the pH, alkalinity, chloride concentration, electrical conductivity and total dissolved solids were determined on water samples collected at the upstream and downstream sites, spring, house well, and trenches, to build a data base that will enable to eventually source track the major water source pathways at these sites. These values are given below in Table 6.

Table 6. The pH, Chloride concentration, electrical conducting, and total solids concentration of water samples collected at upstream, downstream, spring, ephemeral stream, house well and trench sites, initiated at the beginning of 2015, with those collected since the last report noted.

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
		------- mg/L ------		µS/cm	mg/L
Upstream					
1/5/2016	7.5	40	1.34	102	62.5
1/25/2016	8.2	46	1.50	115	65.0
2/10/2016	8.6	54	1.69	141	60.0
2/24/2016	7.2	66	1.20	102	97.5
3/10/2016	7.6	38.0	1.268	84.5	60.0
3/16/2016	6.7	38.0	1.252	88.3	52.5
3/24/2016	7.7	46.0	1.825	103.3	56.5
3/31/2016	7.3	30.0	0.933	65.8	235.0
4/4/2016	7.4	40.0	1.163	86.9	55.0
4/20/2016	8.0	58.0	1.405	125.7	65.0
4/29/2016	8.1	66.0	1.373	134.8	72.5
5/3/2016	7.7	38.0	1.150	83.7	52.5
5/10/2016	7.6	32.0	0.914	67.6	57.5
518/2016	8.0	48.0	1.228	102.8	57.5
5/26/2016	7.8	76.0	1.045	78.4	50.0
Samples analyzed since the last quarterly report					
6/2/2016	7.9	68.0	1.298	105.4	75.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
6/7/2016	8.1	58.0	2.722	128.3	77.5
6/15/2016	8.3	72.0	1.471	150.3	77.5
6/22/2016	8.1	88.0	1.695	182.3	112.5
6/29/2016	7.4	110.0	2.176	203.0	112.5
7/6/2016	7.5	106.0	1.821	212.0	117.5
8/16/2016	7.7	40.0	1.092	88.1	60.0
8/24/2016	8.3	54.0	1.513	121.7	95.0
8/30/2016	8.2	64.0	1.088	143.3	70.0
9/7/2016	7.9	82.0	1.601	176.0	97.5
Downstream					
1/5/2016	7.5	60	2.17	158	92.5
1/25/2016	8.0	80	2.00	191	95.0
2/10/2016	8.0	94	2.36	214	102.5
2/22/2016	7.5	80	1.48	156	110.0
3/10/2016	7.3	54.0	1.481	126.1	80.0
3/16/2016	7.1	60.0	1.500	137.6	75.0
3/24/2016	7.3	68.0	1.827	156.8	79.0
3/31/2016	7.3	48.0	1.043	95.9	50.0
4/4/2016	7.4	66.0	1.563	138.6	80.0
4/20/2016	7.3	92.0	1.903	187.0	105.0
4/29/2016	7.7	100.0	2.052	199.1	107.5
5/3/2016	7.8	60.0	1.197	130.5	87.5
5/10/2016	7.6	44.0	0.856	93.5	75.0
518/2016	7.8	74.0	1.482	154.5	82.5
5/26/2016	7.7	34.0	0.941	114.1	72.5
Samples analyzed since the last quarterly report					

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
6/2/2016	8.0	48.0	1.447	154.8	100.0
6/7/2016	7.8	88.0	1.698	176.8	97.5
6/15/2016	7.9	108.0	2.525	205.0	115.0
6/22/2016	7.8	120.0	2.406	230.0	145.0
6/29/2016	7.5	132.0	2.971	259.0	322.5
7/6/2016	7.4	136.0	2.960	262.0	157.5
7/13/2016	7.4	130.0	2.549	289.0	137.5
7/20/2016	7.7	138.0	2.726	305.0	145.0
7/27/2016	7.5	134.0	2.599	286.0	150.0
8/3/2016	7.9	144.0	1.845	258.0	137.5
8/16/2016	7.7	60.0	1.255	128.9	82.5
8/24/2016	7.8	84.0	1.368	174.8	97.5
8/24/2016			1.152	122.8	97.5
8/30/2016	7.8	88.0	1.435	193.5	97.5
9/7/2016	7.9	112.0	2.143	240.0	125.0
Spring					
3/10/2016			1.109	359.0	210.0
3/16/2016			2.038	516.0	250.0
3/24/2016			1.939	446.0	214.0
3/31/2016			1.324	414.0	45.0
4/4/2016			1.971	506.0	272.5
4/20/2016			2.111	554.0	300.0
4/29/2016			2.234	522.0	285.0
5/3/2016			1.879	486.0	275.0
5/10/2016			1.190	417.0	245.0
518/2016			2.206	493.0	275.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
5/26/2016			1.370	450.0	250.0
Samples analyzed since the last quarterly report					
6/2/2016			2.111	512.0	285.0
6/7/2016			2.348	503.0	280.0
6/15/2016			2.523	526.0	305.0
6/22/2016			2.659	543.0	322.5
6/29/2016			2.864	545.0	322.5
7/6/2016			2.749	533.0	267.5
7/13/2016			2.661	272.0	292.5
7/20/2016			2.271	594.0	292.5
7/27/2016			2.424	593.0	297.5
8/3/2016			2.151	541.0	280
8/16/2016			1.435	434.0	242.5
8/24/2016			2.644	556.0	312.5
8/30/2016			2.710	604.0	310.0
9/7/2016			2.822	598.0	322.5
Ephemeral Stream					
1/5/2016			2.908	368.0	
1/25/2016			3.454	392.0	
2/24/2016			2.427	264.0	
3/10/2016			2.530	288.0	
3/16/2016			2.427	356.0	
3/24/2016			3.467	399.0	
3/31/2016			3.366	153.2	
4/4/2016			2.544	330.0	
4/20/2016			2.758	380.0	

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
5/2/2016			2.068	329.0	
5/2/2016			2.571	241.0	
5/10/2016			1.617	143.3	
5/18/2016			2.726	360.0	
5/26/2016			2.031	194.5	
Samples analyzed since the last quarterly report					
6/2/2016			2.733	359.0	
6/7/2016			2.930	344.0	
8/16/2016			3.309	357.0	
Trench 1					
1/5/2016			1.61	161	82.5
2/24/2016			1.16	162	102.5
3/10/2016			1.019	173.7	117.5
3/16/2016			1.451	226.0	120.0
3/24/2016			1.732	229.0	99.0
3/31/2016			1.280	167.9	100.0
5/10/2016			1.122	226.0	130.0
5/19/2016			0.405	196.5	115.0
5/18/2016			1.653	234.0	125.0
5/262016			1.421	262.0	142.5
Samples analyzed since the last quarterly report					
6/2/2016			1.229	320	192.5
8/16/2016			2.051	293	130.0
8/24/2016			1.259	318	170.0
Trench 2					
2/24/2016			0.99	144	122.5

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
3/10/2016			0.349	106.8	80.0
3/31/2016			0.424	134.5	87.5
4/4/2016			1.4	192.1	107.5
Sample analyses since the last quarterly report					
8/16/2016			0.597	219	117.5

The University of Arkansas System Division of Agriculture offers its programs to all eligible persons regardless of race, color, sex, gender identity, sexual orientation, national origin, religion, age, disability, marital or veteran status, genetic information, or any other legally protected status, and is an Affirmative Action/Equal Opportunity Employer.

Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – October 1 to December 31, 2016

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

The mission of the **Division of Agriculture** is to advance the stewardship of natural resources and the environment, cultivate the improvement of agriculture and agribusiness, develop leadership skills and productive citizenship among youth and adults, enhance economic security and financial responsibility among the citizens of the state, ensure a safe, nutritious food supply, improve the quality of life in communities across Arkansas, and strengthen Arkansas families.

Dr. Mark J. Cochran
Vice President for Agriculture

Executive Summary

This is the fourth Quarterly Report of 2016 for the Big Creek Research and Extension Team that details activities and progress made from October 1 through December 31, 2016.

1. We continue to collect weekly base flow and periodic stormflow water samples from Big Creek above and below the C&H Farm, along with water from a spring, ephemeral stream, surface runoff sites on Fields 1, 5a, and 12, two interceptor trenches below the slurry holding ponds, and house well for chemical and bacterial analysis.

2. We continue to monitor concentrations of P, N, bacteria, Cl, and electrical conductivity at all sites. This quarter was a comparatively dry period, with only one field runoff sample collected (Field 1; October 13th) and no interceptor trench flow recorded or sampled.

3. Core samples collected by Harbor Environmental and Safety adjacent to the swine slurry holding ponds were split and analyzed by Arkansas Analytical, Little Rock and by the Soil Testing Laboratory, UA System Division of Agriculture. Results of physical, chemical and biological analyses conducted by the Soil Testing Laboratory are presented in this report and do not indicate leakage of slurry from the ponds at the present time. Concentrations of P, N, bacteria, Cl (a conservative and effective tracer), and electrical conductivity showed no increasing trends at the house well. Due to low rainfall during the 4th quarter of 2016, only one flow event occurred at the ephemeral stream, which was sampled (i.e., October 13th).

4. Results of grid-soil sampling of monitored application Fields 1, 5a and 12, which were completed in 2016, are given and compared with results from the similar sampling conducted in 2014. It is evident from the Mehlich-3 P spatial distribution maps that some accumulation of P occurs in certain areas within the surface 0 - 4 inch depth of Fields 1 and 12. These areas are generally located around trees on Fields 1 and 12 (northern boundary of this field), where grazing cattle congregate for shade. In addition, there is an accumulation of Mehlich-3 P (0 – 4 inch depth) in the southwest corner of Field 12 at the gated entrance to the field, where cattle are routinely fed hay. This accumulation was present with the 2014 soil sampling, which was completed prior to any application of swine slurry to the field. Median Mehlich-3 P concentrations for Field 1 were similar for 2014 and 2016 (59 and 57 mg/L, respectively); for 5a decreased from 2014 to 2016 (71 and 37 mg/L, respectively); and increased for Field 12 (50 and 97 mg/L, respectively).

5. Median values of measured physical and chemical properties of the manure slurry in the holding ponds are updated and presented for samples collected between September 2013 and July 2016. Relationships between N, P, and K concentrations and total solids are presented. In addition, the total N:P_2O_5 concentration ratio exponentially decreased with increasing percent soils content. These trends reflect the variation in manure nutrient concentrations between ponds and depth within the ponds. C&H management is aware of these variations and the nutrient management opportunities they present when making decisions regarding: which pond to pump from; whether the pond will be agitated; the depth at which to pump from; and on which field to make the application.

Big Creek Science Team

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Brian Breaker, M.Sc., Surface-Water Specialist, stream flow and constituent collection, analysis, and statistical evaluation of trends.

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Ed Gbur, Ph.D., Professor and Director, Agricultural Statistics Laboratory - Experimental design, linear and generalized linear mixed models, regression, agricultural applications of statistics.

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Phil Hays, Ph.D. Ground Water Specialist, U.S. Geological Survey and Research Professor with Geosciences Dept., University of Arkansas, application of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems

Tim Kresse, M.Sc., Water Quality Specialist, U.S. Geological Survey, natural geochemical evolution of groundwater and separating these processes from anthropogenic sources of contamination

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Jun Zhu, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians - The Big Creek Research and Extension Team are ably supported by several outstanding and dedicated Program Technicians based in Fayetteville and Little Rock.

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Water Sampling and Analytical Methods

Sampling Locations

Water quality monitoring sites are;

Site 1. Edge-of-field monitoring on Field 1 permitted to receive slurry.

Site 2. Edge-of-field monitoring on Field 5a excluded from receiving slurry.

Site 3. Edge-of-field monitoring on Field 12 permitted to receive slurry.

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities.

Site 5. Spring below Field 1.

Site 6. Big Creek upstream of the C&H Farm operation.

Site 7. Big Creak downstream of the C&H Farm operation.

Site 8. Left Fork downstream of the C&H Farm operation.

Site 9. North interceptor trench below the manure holding ponds.

Site 10. South interceptor trench below the manure holding ponds.

Site 11. House well at animal facility.

Table 1. Location of sampling sites on the Big Creek Research and Extension Team project.

Site description	Latitude	Longitude	Elevation, ft
Field 1	35 55’ 06.42”	93 03’ 38.34”	984
Field 5a	35 56’03.01”	93 04’ 25.85”	778
Field 12	35 54’ 13.57”	93 04’ 04.76”	838
Ephemeral stream	35 55’ 25.89”	93 04’ 14.94”	824
Spring	35 54’ 57.06”	93 03’ 34.64”	977
Big Creek upstream of farm	35 53’ 32.28”	93 04’ 06.38”	857
Big Creek downstream of farm	35 56’ 18.98”	93 04’ 21.81”	769
Left Fork	35 5’”48.04”	93 04” 02.02”	760
Trench 1 (south)	35 55’ 19.24”	93 04’ 23.04”	896
Trench 2 (north)	35 55’ 21.39”	93 04’ 19.93”	883
House well	35 55’ 27.02”	93 04’ 22.71”	915

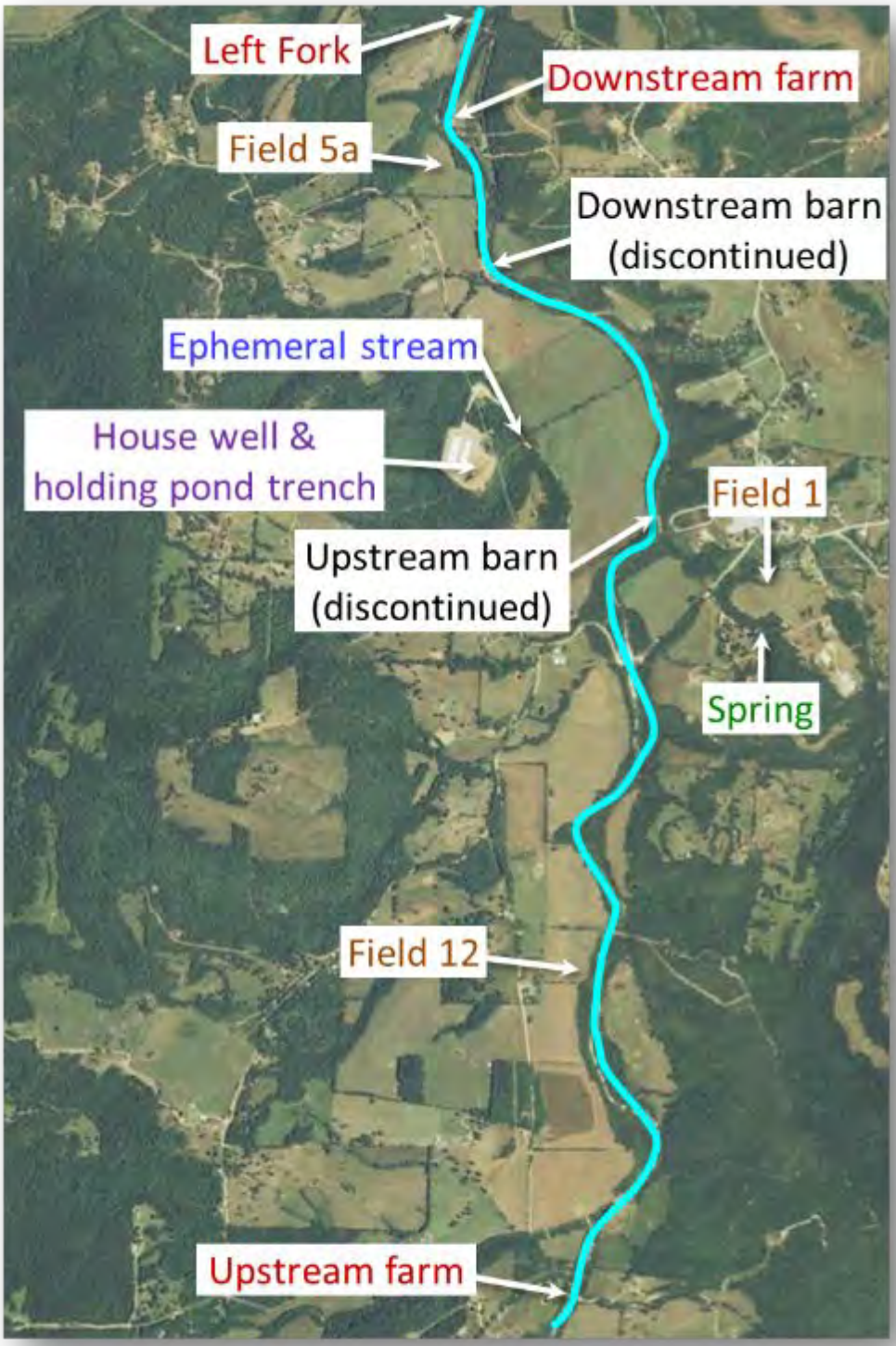


Figure 1. Location of sampling sites for the Big Creek Research and Extension Team project.

Sampling Protocols and Analyses

The following protocols were used to collect, prepare, and analyze all water samples:

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface, where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted, and samples placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
6. Analyses included Alkalinity (APHA 2320-B), Ammonia (EPA 351.2), Chloride (EPA 300.0), Dissolved Phosphorus (EPA 365.2), E. coli (APHA 9223-B), Electrical Conductivity (EPA 120.1), Nitrate (EPA 300.0), pH (EPA 150.1), Total Coliforms (APHA 9223-B), Total Dissolved Solids (EPA 160.1), Total Nitrogen (APHA 4500-P J), Total Phosphorus (APHA 4500-P J), and Total Suspended Solids (EPA 160.2). APHA is American Public Health Association from the Wadeable Streams Assessment, Water Chemistry Laboratory Manual http://www.epa.gov/owow/monitoring/wsa/WRS_lab_manual.pdf
7. Prior to collection of a house well water sample, the well is purged and water temperature, pH, and electrical conductivity measured on-site every 30 seconds until all values stabilize (primarily water temperature). At that point a sample of water is collected in a 1-L acid-washed bottle. This method is taken from USGS and EPA well-water sampling protocols. See USGS methods for sampling at https://water.usgs.gov/owq/FieldManual/chapter4/pdf/Chap4_v2.pdf. Specific and detailed guidance on the collected of water quality data can be found in the USGS National Field Manual at file:///U:/Words/C&H%20Farm/Publications/Planning/USGS%20National%20Field%20Mannual_complete%202015.pdf

   The U.S. EPA also recommend that selected water quality parameters can be monitored during low-rate purging, with stabilization of these parameters indicating when the discharge water represents aquifer water or source well water. See: http://www.csus.edu/indiv/h/hornert/Geol_210_Summer_2012/Week%202%20readings/Puls%20and%20Barcelona%201996%20Low%20flow%20sampling.pdf and https://in-situ.com/wp-content/uploads/2015/01/Low-Flow-Groundwater-Sampling-Techniques-Improve-Sample-Quality-and-Reduce-Monitoring-Program-Costs-Case-Study.pdf
8. Minimum detection limits (MDLs) for each chemical and biological constituent are listed in Table 1. Some constituent concentrations were reported by the laboratory as less than the MDL but greater than zero. Those values are given in subsequent tables but have less confidence in their accuracy than concentrations above the MDL.
9. Chemical and biological analyses of samples collected from the beginning of 2015 to March 31, 2016 are given in Tables 2, 3, and 4.

Table 2. Minimum detection limits (MDLs) for each chemical and biological constituent.

Constituent	Minimum detection limit [1]
Alkalinity, mg/L as $CaCO_3$	2
Chloride, mg/L	0.093
Dissolved P, mg/L	0.002
Conductivity, uS/cm	1
Ammonia-N, mg/L	0.03
Dissolved organic carbon, mg/L	0.18
E. coli, MPN/100 mL	1
Nitrate-N, mg/L	0.004
pH	0.1
Total coliform, MPN/100 mL	1
Total dissolved solids, mg/L	15.22
Total N, mg/L	0.006
Total P, mg/L	0.012
Total suspended solids, mg/L	6.58

[1] MDL the Minimum Detection Limit of an analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. Further information is available at http://water.usgs.gov/owq/OFR_99-193/detection.html

Big Creek Research and Extension Team Monitoring Data

Nutrients, Sediment, and Bacteria by Date of Sampling

Table 3. Water quality analyses at each sample site since 2016, with those collected since the last report noted. Coliform units are Most Probable Number (MPN) per 100 mL of water.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
			---------- mg/L ----------							-- MPN/100 mL --	
1/5/2016	**1/5/2016**	**Grab sample**									
11:52	15:29	Spring	0.007	0.024	<0.03	0.584	0.63	0.7	1.39	16.0	816.4
13:00	15:29	Upstream	0.008	0.026	<0.03	0.158	0.20	0.5	0.95	67.7	648.8
11:40	15:29	Downstream	0.011	0.026	<0.03	0.419	0.46	0.1	1.13	40.8	648.8
11:30	15:29	Left Fork	0.013	0.028	<0.03	0.427	0.48	0.7	1.51	34.1	686.7
12:02	15:29	Ephemeral	0.007	0.018	<0.03	0.883	1.00	1.2	2.15	32.7	686.7
12:13	15:29	Trench 1	0.003	0.016	<0.03	0.243	0.29	0.9	1.11	1.0	209.8
12:44	15:29	House well	0.008	0.020	<0.03	0.528	0.57	0.9	1.08	<1.0	1.0
1/25/2016	**1/25/2016**	**Grab sample**									
11:16	15:25	Spring	0.010	0.022	<0.03	0.565	0.60	0.3	1.27	34.5	1732.9
12:10	15:25	Upstream	0.010	0.022	<0.03	0.068	0.09	1.1	1.52	16.9	290.9
11:00	15:25	Downstream	0.011	0.022	<0.03	0.213	0.24	0.7	1.29	8.6	365.4
10:48	15:25	Left Fork	0.010	0.024	<0.03	0.198	0.25	1.0	1.30	21.1	435.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:28	15:25	Ephemeral	0.011	0.030	<0.03	0.762	0.87	9.8	3.10	1.0	816.4
11:42	15:25	House well	0.012	0.020	<0.03	0.602	0.55	0.5	2.36	<1.0	<1
2/10/2016	**2/10/2016**	**Grab sample**									
12:25	15:26	Spring	0.007	0.040	<0.03	0.634	0.80	17.7	2.70	1.0	325.5
11:15	15:26	Upstream	0.005	0.016	<0.03	0.048	0.11	0.5	1.11	14.5	178.5
11:04	15:26	Downstream	0.005	0.016	<0.03	0.198	0.24	0.9	0.99	4.1	218.7
11:29	15:26	Left Fork	0.003	0.012	<0.03	0.175	0.24	0.8	1.15	7.4	209.8
12:03	15:26	House well	0.007	0.014	<0.03	0.542	0.56	0.1	0.63	<1.0	<1.0
2/24/2016	**2/24/2016**	**Grab sample**									
11:05	14:45	Spring	0.010	0.052	<0.03	1.102	1.46	2.8	N.S.	209.8	3930.0
12:16	14:45	Upstream	0.014	0.052	<0.03	0.099	0.28	6.1	N.S.	1203.3	7330.0
10:52	14:45	Downstream	0.015	0.058	<0.03	0.142	0.37	8.3	N.S.	1986.3	6500.0
10:38	14:45	Left Fork	0.015	0.088	<0.03	0.249	0.63	15.6	N.S.	2780.0	14390.0
11:15	14:45	Ephemeral	0.010	0.056	<0.03	0.195	0.40	12.8	N.S.	387.3	4870.0
11:36	14:45	Trench 1	0.005	0.014	<0.03	0.345	0.39	2.1	N.S.	<1.0	9070.0
11:53	14:45	House well	0.010	0.010	<0.03	0.582	0.55	1.3	N.S.	<1.0	<1.0
3/10/2016	**3/10/2016**	**Grab sample**									
11:04	15:45	Spring	0.012	0.064	0.11	0.104	0.34	9.5	5.38	285.1	3230.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
13:13	15:45	Upstream	0.012	0.048	0.13	0.082	0.20	8.6	2.66	770.1	>2419.2
10:51	15:45	Downstream	0.010	0.044	0.11	0.118	0.25	6.2	2.28	298.7	>2419.2
11:32	15:45	Ephemeral stream	0.006	0.050	0.13	0.918	1.22	26.7	3.12	648.8	8840.0
10:38	15:45	Left Fork	0.013	0.046	0.01	0.154	0.38	8.7	2.64	367.3	2750.0
12:03	15:45	House well	0.011	0.020	0.02	0.562	0.59	0.9	1.19	<1.0	<1.0
11:50	15:45	Trench 1	0.005	0.036	0.10	0.264	0.45	3.5	2.87	2419.2	16690.0
11:46	15:45	Trench 2	0.005	0.054	0.14	1.716	2.35	6.8	6.77	613.1	34480.0
12:41	15:45	Field 12	0.411	0.522	1.17	0.852	4.49	621.5	12.58	410.6	>241920
3/16/2016	**3/16/2016**	**Grab sample**									
11:35	15:05	Spring	0.009	0.036	0.01	0.340	0.44	5.7	3.36	75.4	461.1
12:35	15:05	Upstream	0.008	0.034	<0.03	0.060	0.13	0.4	1.10	52.9	579.4
11:23	15:05	Downstream	0.006	0.028	0.01	0.170	0.24	0.9	1.17	81.3	>2419.2
11:50	15:05	Ephemeral stream	0.006	0.022	0.01	0.520	0.54	0.0	1.75	88.0	461.1
11:13	15:05	Left Fork	0.009	0.032	<0.03	0.190	0.26	0.3	1.45	35.9	980.4
12:22	15:05	House well	0.009	0.022	<0.03	0.550	0.55	0.0	1.55	<1.0	<1
12:01	15:05	Trench 1	0.003	0.032	0.02	0.331	0.37	0.0	1.23	101.7	290.9
3/24/2016	**3/24/2016**	**Storm sample**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:50	15:10	Spring	0.015	0.046	0.06	0.172	0.42	13.1	4.95	N.S.	N.S.
12:50	15:10	Upstream	0.011	0.032	0.06	0.040	0.14	4.5	1.60	N.S.	N.S.
11:35	15:10	Downstream	0.011	0.024	<0.03	0.106	0.20	3.9	1.29	N.S.	N.S.
12:10	15:10	Ephemeral stream	0.010	0.012	<0.03	0.531	0.64	1.3	1.44	N.S.	N.S.
11:25	15:10	Left Fork	0.013	0.048	0.09	0.186	0.39	10.7	2.65	N.S.	N.S.
12:34	15:10	House well	0.012	0.014	<0.03	0.565	0.65	0.2	2.72	N.S.	N.S.
12:20	15:10	Trench 1	0.008	0.016	<0.03	0.208	0.20	2.8	1.33	N.S.	N.S.
3/31/2016	**3/31/3016**	**Grab sample**									
11:06	15:10	Spring	0.011	0.034	<0.03	0.319	0.52	7.4	25.32	71.7	1553.1
12:45	15:10	Upstream	0.008	0.042	0.08	0.100	0.22	6.1	2.49	186.0	>2419.2
10:45	15:10	Downstream	0.011	0.056	0.08	0.156	0.33	12.4	2.67	365.0	>2419.2
11:16	15:10	Ephemeral stream	0.013	0.656	0.68	1.211	3.05	375.0	12.14	16160.0	198630.0
10:33	15:10	Left Fork	0.013	0.056	0.09	0.199	0.40	11.9	2.59	172.0	3640.0
11:49	15:10	House well	0.010	0.018	<0.03	0.556	0.62	0.2	3.93	1.0	26.2
11:40	15:10	Trench 1	0.004	0.018	<0.03	0.347	0.49	5.5	4.76	4.1	2419.2
11:35	15:10	Trench 2	0.006	0.040	0.06	2.800	3.54	20.9	9.29	7.4	10810.0
12:02	15:10	Field 5a	1.154	1.352	0.27	0.302	1.67	26.5	32.74	24890.0	>241920

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
4/4/2016	**4/4/2016**	**Grab sample**									
11:58	15:20	Spring	0.009	0.028	<0.03	0.324	0.42	7.5	1.57	104.7	866.4
12:50	15:20	Upstream	0.008	0.026	<0.03	0.065	0.08	1.7	0.71	8.3	648.8
11:48	15:20	Downstream	0.010	0.026	<0.03	0.176	0.20	1.9	0.98	77.6	1046.2
12:08	15:20	Ephemeral stream	0.008	0.018	<0.03	0.462	0.48	1.3	1.79	12.0	727.0
11:38	15:20	Left Fork	0.009	0.022	<0.03	0.131	0.17	1.5	0.87	44.8	1119.9
12:35	15:20	House well	0.011	0.018	<0.03	0.466	0.48	0.0	0.94	<1.0	1.0
12:26	15:20	Trench 2	0.004	0.012	<0.03	0.236	0.25	0.0	0.85	1.0	>2419.2
4/20/2016	**4/20/2016**	**Grab sample**									
12:02	15:52	Spring	0.005	0.042	<0.03	0.410	0.55	22.4	1.04	3.1	195.6
13:20	15:52	Upstream	0.003	0.020	<0.03	0.047	0.06	1.9	0.61	185.0	1299.7
11:42	15:52	Downstream	0.004	0.018	<0.03	0.152	0.20	1.2	0.74	38.4	2920.0
12:11	15:52	Ephemeral stream	0.008	0.020	<0.03	0.517	0.66	4.1	0.68	44.3	21430.0
11:30	15:52	Left Fork	0.005	0.020	<0.03	0.157	0.21	2.1	0.84	35.0	6160.0
12:52	15:52	House well	0.005	0.014	<0.03	0.598	0.50	0.5	0.47	1.0	1.0
4/28/2016	**4/28/2016**	**Grab sample**									
11:55	15:17	Spring	0.010	0.024	<0.03	0.455	0.63	12.0	N.S.	25.6	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
13:00	15:17	Upstream	0.009	0.012	<0.03	0.035	0.12	1.2	N.S.	58.6	648.8
11:30	15:17	Downstream	0.010	0.012	<0.03	0.154	0.27	1.5	N.S.	36.4	2149.2
12:31	15:17	House well	0.011	0.008	<0.03	0.481	0.57	0.3	N.S.	<1.0	<1.0
11:25	15:17	Dry Creek	0.010	0.012	<0.03	0.152	0.27	1.0	N.S.	14.8	3050.0
5/2/2016	**5/3/2016**	**Grab sample**									
12:25	08:55	Spring	0.008	0.012	<0.03	0.338	0.36	2.2	5.08	88.2	>2419.2
14:29	08:55	Upstream	0.006	0.018	<0.03	0.039	0.10	6.7	1.76	185.0	2419.2
11:43	08:55	Downstream	0.008	0.016	<0.03	0.075	0.16	2.0	1.50	178.9	4720.0
12:38	08:55	Ephemeral stream	0.007	0.016	<0.03	0.468	0.59	1.7	2.56	118.7	5380.0
12:38	08:55	Ephemeral stream	0.008	0.112	0.15	1.794	2.62	61.8	4.07	1046.2	23590.0
11:24	08:55	Left Fork	0.009	0.020	<0.03	0.095	0.20	1.9	2.30	172.6	3640.0
13:27	08:55	House well	0.009	0.016	<0.03	0.551	0.56	0.1	1.94	<1.0	<1
5/10/2016	**5/10/2016**	**Grab sample**									
11:15	15:40	Spring	0.008	0.026	<0.03	0.281	0.45	2.9	7.58	410.6	2780.0
12:50	15:40	Upstream	0.007	0.044	0.01	0.070	0.20	6.1	3.10	613.1	4480.0
10:58	15:40	Downstream	0.011	0.060	0.01	0.101	0.31	11.6	2.95	1203.3	7490.0
11:28	15:40	Ephemeral stream	0.195	0.560	0.32	0.649	4.01	1346.7	11.94	579.4	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:35	15:40	Left Fork	0.011	0.072	0.02	0.121	0.37	17.2	3.35	980.4	8230.0
12:08	15:40	House well	0.009	0.008	<0.03	0.533	0.56	0.5	4.39	<1.0	24.9
11:55	15:40	Trench 1	0.002	0.016	<0.03	0.228	0.30	3.9	2.91	13.9	>2419.2
11:45	15:40	Trench 2	0.002	0.038	<0.03	1.706	2.18	5.2	3.72	38.7	>2419.2
12:26	15:40	Field 5a	1.114	1.458	1.69	2.894	6.35	79.9	12.82	22820.0	>2419.2
13:08	15:40	Field 12	0.370	0.666	0.12	0.062	1.03	96.7	6.92	663.0	>2419.2
5/18/2016	**5/18/2016**	**Grab sample**									
11:29	15:20	Spring	0.009	0.024	0.01	0.320	0.51	8.7	2.20	45.7	1413.6
13:08	15:20	Upstream	0.007	0.016	<0.03	0.043	0.13	1.4	1.00	85.5	1299.7
11:10	15:20	Downstream	0.009	0.020	0.02	0.117	0.25	1.2	0.98	107.1	>2419.2
11:43	15:20	Ephemeral stream	0.008	0.014	<0.03	0.479	0.63	3.0	0.84	34.1	2419.2
10:57	15:20	Left Fork	0.010	0.016	0.01	0.139	0.27	1.4	1.54	60.1	2620.0
12:50	15:20	House well	0.009	0.010	<0.03	0.488	0.64	0.4	0.95	<1.0	<1.0
12:05	15:20	Trench 1	0.006	0.006	<0.03	0.169	0.22	0.1	0.54	2.0	5200.0
5/26/2016	**5/26/2016**	**Grab sample**									
11:45	15:30	Spring	0.008	0.020	<0.03	0.219	0.35	6.2	4.15	344.8	3730.0
13:08	15:30	Upstream	0.007	0.030	<0.03	0.056	0.12	4.2	1.56	238.2	5290.0
11:30	15:30	Downstream	0.009	0.036	<0.03	0.094	0.20	4.6	1.75	547.5	3640.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:05	15:30	Ephemeral stream	0.052	0.424	0.39	0.858	2.20	350.6	8.58	22470.0	>2419.2
11:20	15:30	Left Fork	0.010	0.048	0.02	0.123	0.24	10.6	2.66	461.1	6890.0
12:51	15:30	House well	0.009	0.012	<0.03	0.564	0.57	0.7	0.93	1.0	7.4
12:38	15:30	Trench 1	0.008	0.006	<0.03	0.217	0.23	1.4	1.29	1.0	4260.0
6/2/2016	**6/2/2016**	**Grab sample**									
11:15	14:40	Spring	0.007	0.032	<0.03	0.330	0.47	10.8	2.38	64.1	1986.3
12:26	14:40	Upstream farm	0.007	0.018	<0.03	0.046	0.13	4.1	1.8	224.7	1986.3
11:04	14:40	Downstream farm	0.006	0.018	<0.03	0.106	0.20	1.4	1.8	104.6	3410
11:26	14:40	Ephemeral stream	0.008	0.022	<0.03	0.494	0.63	3.6	2.15	770.1	1986.3
10:52	14:40	Left Fork	0.007	0.022	<0.03	0.117	0.22	1.4	1.40	44.1	1986.3
12:06	14:40	House well	0.008	0.018	<0.03	0.597	0.62	0.7	0.99	<1.0	<1.0
11:35	14:40	Trench 1	0.002	0.018	<0.03	0.124	0.30	8.8	3.01	26.5	393.0
6/7/2016	**6/7/2016**	**Grab sample**									
11:25	14:30	Spring	0.011	0.026	<0.03	0.327	0.46	4.6	6.06	140.1	2460.0
12:16	14:30	Upstream farm	0.013	0.018	0.06	0.131	0.14	1.3	2.8	120.1	2720.0
11:10	14:30	Downstream farm	0.012	0.018	0.04	0.123	0.19	1.5	1.94	73.8	2980.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:37	14:30	Ephemeral stream	0.012	0.024	0.01	0.503	0.65	6.9	3.89	2419.2	7980.0
10:50	14:30	Left Fork	0.009	0.016	0.04	0.124	0.19	0.8	2.08	31.8	3180.0
12:00	14:30	House well	0.011	0.014	0.03	0.500	0.58	0.1	3.06	<1.0	<1.0
6/15/2016	**6/15/2016**	**Grab sample**									
11:40	15:00	Spring	0.010	0.016	0.03	0.466	0.65	4.2	0.00	153.9	1553.1
12:40	15:00	Upstream farm	0.007	0.010	<0.03	0.097	0.15	1.6	0.02	69.1	2310.0
11:25	15:00	Downstream farm	0.008	0.050	0.05	0.181	0.42	25.4	0.38	33.2	4740.0
11:15	15:00	Left Fork	0.009	0.012	0.01	0.198	0.29	2.0	0.94	63.1	8860.0
12:15	15:00	House well	0.008	0.008	<0.03	0.506	0.59	0.7	0.00	<1.0	<1.0
6/22/2016	**6/22/2016**	**Grab sample**									
10:40	14:35	Spring	0.008	0.012	<0.03	0.532	0.60	1.0	0.00	38.2	1413.6
12:20	14:35	Upstream farm	0.008	0.016	0.02	0.237	0.33	2.3	0.20	455.0	547.5
10:23	14:35	Downstream farm	0.015	0.028	0.04	0.327	0.44	14.9	0.00	46.4	4570.0
10:08	14:35	Left Fork	0.008	0.018	0.05	0.220	0.37	2.1	0.70	37.9	676.0
11:38	14:35	House well	0.009	0.008	<0.03	0.545	0.58	0.5	0.00	<1.0	<1.0
6/29/2016	**6/29/2016**	**Grab sample**									
10:53	14:00	Spring	0.009	0.083	0.02	0.487	0.73	43.4	1.10	5.2	648.8

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:37	14:00	Upstream farm	0.006	0.029	0.06	0.186	0.34	4.6	0.92	55.4	9888.0
10:41	14:00	Downstream farm	0.010	0.021	0.03	0.395	0.47	2.5	0.46	41.3	6310.0
10:25	14:00	Left Fork	0.006	0.023	0.03	0.251	0.35	2.0	0.94	23.5	5200.0
11:12	14:00	House well	0.008	0.014	<0.03	0.569	0.56	0.0	0.23	<1.0	<1.0
7/6/2016	**7/6/2016**	**Grab sample**									
6:44	10:16	Spring	0.011	0.027	<0.03	0.465	0.53	9.8	1.15	25.3	4430
7:41	10:16	Upstream farm	0.009	0.023	<0.03	0.221	0.27	5.9	0.66	387.3	12230.0
6:26	10:16	Downstream farm	0.010	0.023	0.01	0.461	0.43	2.1	0.47	39.3	8570.0
6:08	10:16	Left Fork	0.006	0.020	0.04	0.271	0.36	2.7	0.96	248.1	12590.0
7:18	10:16	House well	0.009	0.013	<0.03	0.874	0.96	1.0	0.73	<1.0	13.5
7/13/2016	**7/13/2016**	**Grab sample**									
7:53	12:30	Spring	0.003	0.023	<0.03	0.355	0.42	12.3	0.90	71.7	2920
7:33	12:30	Downstream farm	0.006	0.017	<0.03	0.365	0.43	4.3	1.12	129.6	8390.0
7:15	12:30	Left Fork	0.005	0.017	<0.03	0.172	0.29	1.9	0.85	95.9	12360.0
8:34	12:30	House well	0.005	0.011	<0.03	0.627	0.63	0.5	0.09	<1.0	<1.0
7/20/2016	**7/20/2016**	**Grab sample**									
7:56	12:05	Spring	0.006	0.024	<0.03	0.298	0.35	9.4	0.55	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
7:39	12:05	Downstream farm	0.005	0.024	<0.03	0.356	0.44	5.1	3.93	N.S	N.S.
7:25	12:05	Left Fork	0.005	0.013	<0.03	0.197	0.76	2.3	2.21	N.S.	N.S.
8:30	12:05	House well	0.007	0.009	0.02	0.594	0.70	0.1	0.14	N.S.	N.S.
7/27/2016	**7/27/2016**	**Grab sample**									
7:38	14:15	Spring	0.001	0.043	<0.03	0.375	0.46	17.6	2.64	55.6	980.4
7:21	14:15	Downstream farm	0.007	0.027	<0.03	0.423	0.47	2.3	1.62	140.8	17260.0
7:02	14:15	Left Fork	0.004	0.021	<0.03	0.255	0.35	3.6	1.79	920.8	15000.0
8:14	14:15	House well	0.006	0.010	<0.03	0.650	0.67	0.1	1.41	<1.0	<1.0
8/3/2016	**8/3/2016**	**Grab sample**									
8:03	12:10	Spring	0.006	0.104	<0.03	0.201	0.49	64.8	7.41	65.7	2920
7:43	12:10	Downstream farm	0.013	0.014	<0.03	0.221	0.29	3.2	3.46	115.3	9320.0
7:28	12:10	Left Fork	0.007	0.016	<0.03	0.212	0.32	2.4	2.21	101.4	7430.0
8/16/2016	**8/16/2016**	**Grab sample**									
10:58	14:50	Spring	0.007	0.027	0.02	0.223	0.39	7.7	9.89	88.2	5380.0
12:16	14:50	Upstream farm	0.009	0.031	0.03	0.089	0.23	4.6	3.14	248.9	9330.0
10:41	14:50	Downstream farm	0.011	0.039	0.03	0.161	0.33	8.1	2.94	178.2	17820.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:25	14:50	Ephemeral stream	0.011	0.023	0.01	1.365	1.59	2.6	2.47	137.6	154945.0
10:28	14:50	Left Fork	0.012	0.082	0.07	0.118	0.30	19.5	3.64	201.4	14550.0
11:40	14:50	Trench 1	0.005	0.006	0.02	0.130	0.17	0.2	2.14	93.4	48840.0
11:50	14:50	Trench 2	0.004	0.036	0.05	0.344	0.99	1.5	8.98	290.9	198630.0
8/24/2016	**8/24/2016**	**Grab sample**									
11:29	15:30	Spring	0.004	0.046	<0.03	0.477	0.97	29.9	2.99	27.8	5630
12:40	15:30	Upstream farm	0.004	0.014	0.03	0.046	0.14	2.0	1.08	72.3	2620.0
10:53	15:30	Downstream farm	0.005	0.016	<0.03	0.122	0.22	3.2	0.85	72.8	7030.0
10:40	15:30	Left Fork	0.004	0.013	0.00	0.045	0.13	1.5	1.62	43.5	6690.0
8/24/2016	**8/24/2016**	**Storm sample**									
11:03	15:30	Downstream farm	<0.002	0.109	0.01	0.002	0.42	66.9	5.89	156.5	38730.0
12:05	15:30	Trench 1	<0.002	0.019	0.03	0.033	0.30	8.3	1.99	21.8	3450.0
8/30/2016	**8/30/2016**	**Grab sample**									
11:24	14:55	Spring	0.003	0.020	<0.03	0.501	0.58	2.9	3.28	195.6	9090.0
12:35	14:55	Upstream farm	0.003	0.020	<0.03	0.042	0.13	1.7	1.37	102.5	5210.0
11:10	14:55	Downstream farm	0.004	0.020	<0.03	0.116	0.21	1.7	1.19	30.1	5200.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:00	14:55	Left Fork	0.005	0.021	0.02	0.157	0.28	2.7	2.00	111.2	17850.0
Samples analyzed since the last quarterly report											
9/7/2016	**9/7/2016**	**Grab sample**									
7:58	12:25	Spring	0.003	0.219	0.05	0.514	0.92	142.1	5.37	31.8	18500.0
9:03	12:25	Upstream farm	0.007	0.020	0.01	0.113	0.21	1.9	1.89	195.6	5380.0
7:38	12:25	Downstream farm	0.008	0.059	0.01	0.265	0.46	25.4	1.39	30.9	4790.0
7:23	12:25	Left Fork	0.006	0.021	0.00	0.151	0.24	2.8	1.58	27.5	10170.0
9/15/2016	**9/15/2016**	**Grab sample**									
11:00	14:00	Spring	0.009	0.273	0.00	0.345	0.83	190.9	13.99	ND	ND
11:20	14:00	Upstream farm	0.012	0.011	0.00	0.119	0.21	3.2	6.12	ND	ND
10:45	14:00	Downstream farm	0.014	0.016	0.01	0.312	0.42	2.9	5.38	ND	ND
10:32	14:00	Left Fork	0.011	0.014	0.01	0.132	0.25	2.2	5.35	ND	ND
9/28/2016	**9/28/2016**	**Grab sample**									
11:25	14:25	Spring	0.005	0.043	0.01	0.427	0.62	22.0	2.70	7540.0	7590.0
12:26	14:25	Upstream farm	0.008	0.016	0.01	0.128	0.21	1.0	1.33	9330.0	2310.0
11:12	14:25	Downstream farm	0.011	0.017	0.01	0.293	0.42	1.6	2.15	7120.0	5210.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:00	14:25	Left Fork	0.006	0.011	0.02	0.101	0.22	1.8	1.31	2530.0	3410.0
10/5/2016	**10/5/2016**	**Grab sample**									
10:29	15:40	Spring	0.006	0.513	0.01	0.502	1.40	334.8	4.66	36.8	241920.0
12:01	15:40	Upstream farm	0.009	0.020	0.00	0.120	0.25	2.1	2.85	770.1	13170.0
10:07	15:40	Downstream farm	0.014	0.043	0.02	0.413	0.58	29.3	3.00	547.1	11690.0
9:54	15:40	Left Fork	0.009	0.023	0.01	0.130	0.29	2.8	2.38	285.1	17820.0
10/13/2016	**10/13/2016**	**Grab sample**									
10:46	15:45	Spring	0.018	0.272	0.05	0.623	1.36	148.0	6.09	>2419.2	28090.0
12:46	15:45	Upstream farm	0.015	0.026	0.00	0.147	0.28	2.7	2.32	3590.0	46110.0
10:29	15:45	Downstream farm	0.033	0.066	0.02	0.614	0.88	9.6	3.90	4640.0	129970.0
11:03	15:45	Ephemeral stream	0.018	0.047	0.03	1.760	1.97	9.7	5.17	>2419.2	21430.0
10:16	15:45	Left Fork	0.091	0.203	0.04	1.071	1.74	24.2	9.30	14010.0	>241920
12:30	15:45	House well	0.008	0.010	0.01	1.166	1.23	0.6	1.35	<1.0	23.3
10/13/2016	**10/13/2016**	**Storm sample**									
11:15	15:45	Ephemeral stream	0.067	0.213	0.12	2.732	3.83	61.7	11.10	ND	ND
13:10	15:45	Field 1	0.940	1.231	0.13	0.335	2.36	59.0	16.67	ND	ND

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10/20/2016	**10/20/2016**	**Grab sample**									
11:05	15:05	Spring	0.010	0.044	0.00	0.414	0.56	18.9	11.91	461.1	30760.0
12:03	15:05	Upstream farm	0.010	0.021	0.00	0.076	0.13	1.1	4.43	3730.0	16640.0
10:48	15:05	Downstream farm	0.014	0.030	0.03	0.327	0.39	2.1	3.11	387.3	5690.0
10:20	15:05	Left Fork	0.008	0.026	0.01	0.146	0.27	1.3	3.95	33.5	17890.0
11:38	15:05	House well	0.009	0.020	0.02	0.739	0.79	0.1	4.56	<1.0	19.7
10/27/2016	**10/27/2016**	**Grab sample**									
11:05	15:25	Spring	0.007	0.253	0.03	0.265	0.88	161.1	14.84	61.7	13960.0
11:50	15:25	Upstream farm	0.010	0.021	0.00	0.046	0.14	1.1	5.87	517.2	5450.0
10:42	15:25	Downstream farm	0.014	0.021	0.01	0.291	0.36	2.1	7.91	45.5	6440.0
10:27	15:25	Left Fork	0.008	0.016	0.02	0.132	0.26	1.9	7.76	48.8	9340.0
11:30	15:25	House well	0.009	0.010	0.01	0.664	0.74	0.9	8.95	<1.0	5.2
11/03/2016	**11/03/2016**	**Grab sample**									
9:55	14:20	Spring	0.001	0.483	0.03	0.235	0.89	281.7	15.21	3.1	2419.2
11:10	14:20	Upstream farm	0.003	0.031	0.01	0.071	0.20	2.1	6.81	22.6	3010.0
9:36	14:20	Downstream farm	0.008	0.022	0.03	0.388	0.47	1.7	6.07	1732.9	5200.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
9:14	14:20	Left Fork	0.004	0.026	0.03	0.117	0.26	1.5	9.24	33.1	7380.0
10:38	14:20	House well	0.004	0.010	0.02	0.719	0.75	0.4	9.48	1.0	2.0
11/10/2016	**11/10/2016**	**Grab sample**									
10:56	14:00	Spring	0.003	0.104	0.00	0.255	0.50	53.0	3.30	17.1	13760.0
11:33	14:00	Upstream farm	0.011	0.013	0.01	0.073	0.12	1.0	2.29	53.7	>2419.2
10:38	14:00	Downstream farm	0.011	0.021	0.02	0.419	0.48	0.7	2.15	22.6	5040.0
10:18	14:00	Left Fork	0.005	0.013	0.01	0.161	0.23	4.1	2.07	7.4	2560.0
11:10	14:00	House well	0.005	0.009	0.00	0.574	0.68	0.1	2.16	<1.0	1.0
11/17/2016	**11/17/2016**	**Grab sample**									
11:00	13:45	Spring	0.001	0.021	0.00	0.209	0.32	4.9	2.42	2.0	574.8
11:40	13:45	Upstream farm	0.009	0.020	0.00	0.057	0.13	0.6	1.84	58.1	3270.0
10:43	13:45	Downstream farm	0.011	0.020	0.01	0.412	0.49	2.5	1.37	18.5	>2419.2
10:20	13:45	Left Fork	0.005	0.011	0.00	0.195	0.26	0.5	1.77	15.8	2400.0
11:10	13:45	House well	0.006	0.010	0.01	0.660	0.71	0.3	1.57	<1.0	1.0
11/21/2016	**11/21/2016**	**Grab sample**									
10:24	14:15	Spring	0.010	0.313	0.04	0.239	0.87	210.2	4.99	135.4	6770.0
11:15	14:15	Upstream farm	0.010	0.019	0.00	0.125	0.17	1.3	0.68	178.9	3840.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:05	14:15	Downstream farm	0.012	0.021	0.01	0.466	0.52	1.3	1.23	26.9	>2419.2
9:40	14:15	Left Fork	0.004	0.011	0.01	0.239	0.31	0.4	3.35	11.9	2419.2
10:40	14:15	House well	0.007	0.011	0.00	0.675	0.75	0.4	1.37	<1.0	<1.0
11/29/2016	**11/29/2016**	**Grab sample**									
11:42	15:15	Spring	0.009	0.100	0.00	0.329	0.68	45.0	8.06	1046.2	13360.0
12:48	15:15	Upstream farm	0.008	0.026	0.01	0.063	0.12	2.1	2.38	235.9	3790.0
11:30	15:15	Downstream farm	0.007	0.027	0.00	0.146	0.23	4.4	2.11	387.3	7380.0
11:20	15:15	Left Fork	0.004	0.014	0.00	0.191	0.28	1.1	1.97	57.6	>2419.2
12:36	15:15	House well	0.004	0.011	0.00	0.598	0.68	0.4	2.67	<1.0	<1.0

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.
§ N.S. is No Sample.

Nutrients, Sediment, and Bacteria by Date Spring, Upstream, and Downstream Sites

Table 4. Water quality analyses in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application since January 2016, with those collected since the last report noted.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
1/5/2016									
Upstream	0.008	0.026	<0.03	0.158	0.20	0.5	0.95	67.7	648.8
Downstream	0.011	0.026	<0.03	0.419	0.46	0.1	1.13	40.8	648.8
1/25/2016									
Upstream	0.010	0.022	<0.03	0.068	0.09	1.1	1.52	16.9	290.9
Downstream	0.011	0.022	<0.03	0.213	0.24	0.7	1.29	8.6	365.4
2/10/2016									
Upstream	0.005	0.016	<0.03	0.048	0.11	0.5	1.11	14.5	178.5
Downstream	0.005	0.016	<0.03	0.198	0.24	0.9	0.99	4.1	218.7
2/24/2016									
Upstream	0.014	0.052	<0.03	0.099	0.28	6.1		1203.3	7330.0
Downstream	0.015	0.058	<0.03	0.142	0.37	8.3		1986.3	6500.0
3/10/2016									
Upstream	0.012	0.048	0.13	0.082	0.20	8.6	2.66	770.1	>2419.2
Downstream	0.010	0.044	0.11	0.118	0.25	6.2	2.28	298.7	>2419.2
3/16/2016									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.008	0.034	0.00	0.060	0.13	0.4	1.10	52.9	579.4
Downstream	0.006	0.028	0.01	0.170	0.24	0.9	1.17	81.3	>2419.2
3/24/2016									
Upstream	0.011	0.032	0.06	0.04	0.14	4.5	1.60	N.S.	N.S.
Downstream	0.011	0.024	0.00	0.106	0.20	3.9	1.29	N.S.	N.S.
3/31/2016									
Upstream	0.008	0.042	0.08	0.100	0.22	6.1	2.49	186.0	>2419.2
Downstream	0.011	0.056	0.08	0.156	0.33	12.4	2.67	365.0	>2419.2
4/4/2016									
Upstream	0.008	0.026	<0.03	0.065	0.08	1.7	0.71	8.3	648.8
Downstream	0.010	0.026	<0.03	0.176	0.20	1.9	0.98	77.6	1046.2
4/20/2016									
Upstream	0.003	0.020	<0.03	0.047	0.06	1.9	0.61	185.0	1299.7
Downstream	0.004	0.018	<0.03	0.152	0.20	1.2	0.74	38.4	2920.0
4/28/2016									
Upstream	0.009	0.012	<0.03	0.035	0.12	1.2	N.D.	58.6	648.8
Downstream	0.010	0.012	<0.03	0.154	0.27	1.5	N.D.	36.4	2149.2
5/2/2016									
Upstream	0.006	0.018	<0.03	0.039	0.10	6.7	1.76	185.0	2419.2
Downstream	0.008	0.016	<0.03	0.075	0.16	2.0	1.50	178.9	4720.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/10/2016									
Upstream	0.007	0.044	0.01	0.070	0.20	6.1	3.10	613.1	4480.0
Downstream	0.011	0.060	0.01	0.101	0.31	11.6	2.95	1203.3	7490.0
5/18/2016									
Upstream	0.007	0.016	<0.03	0.043	0.13	1.4	1.00	85.5	1299.7
Downstream	0.009	0.020	0.02	0.117	0.25	1.2	0.98	107.1	>2419.2
5/26/2016									
Upstream	0.007	0.030	<0.03	0.056	0.12	4.2	1.56	238.2	5290.0
Downstream	0.009	0.036	<0.03	0.094	0.20	4.6	1.75	547.5	3640.0
6/12/2016									
Upstream	0.007	0.018	0.00	0.046	0.13	4.1	1.8	224.7	1986.3
Downstream	0.006	0.018	0.00	0.106	0.20	1.4	1.8	104.6	3410.0
6/7/2016									
Upstream	0.013	0.018	0.06	0.131	0.14	1.3	2.8	120.1	2720.0
Downstream	0.012	0.018	0.04	0.123	0.19	1.5	1.94	73.8	2980.0
6/15/2016									
Upstream	0.007	0.010	0.00	0.097	0.15	1.6	0.02	69.1	2310.0
Downstream	0.008	0.050	0.05	0.181	0.42	25.4	0.38	33.2	4740.0
6/22/2016									
Upstream	0.008	0.016	0.02	0.237	0.33	2.3	0.20	455.0	547.5

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.015	0.028	0.04	0.327	0.44	14.9	0.00	46.4	4570.0
6/29/2016									
Upstream	0.006	0.029	0.06	0.186	0.34	4.6	0.92	55.4	9888.0
Downstream	0.010	0.021	0.03	0.395	0.47	2.5	0.46	41.3	6310.0
7/6/2016									
Upstream	0.009	0.023	0.00	0.221	0.27	5.9	0.66	387.3	12230.0
Downstream	0.010	0.023	0.01	0.461	0.43	2.1	0.47	39.3	8570.0
8/16/2016									
Upstream	0.009	0.031	0.03	0.089	0.23	4.6	3.14	248.9	9330.0
Downstream	0.011	0.039	0.03	0.161	0.33	8.1	2.94	178.2	17820.0
8/24/2016									
Upstream	0.004	0.014	0.03	0.046	0.14	2.0	1.08	72.3	2620.0
Downstream	0.005	0.016	0.00	0.122	0.22	3.2	0.85	72.8	7030.0
8/30/2016									
Upstream	0.003	0.020	0.00	0.042	0.13	1.7	1.37	102.5	5210.0
Downstream	0.004	0.020	0.00	0.116	0.21	1.7	1.19	30.1	5200.0
9/7/2016									
Upstream	0.007	0.020	0.01	0.113	0.21	1.9	1.89	195.6	5380.0
Downstream	0.008	0.059	0.01	0.265	0.46	25.4	1.39	30.9	4790.0
Samples analyzed since the last Quarterly Report									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
9/15/2016									
Upstream	0.012	0.011	0.00	0.119	0.21	3.2	6.12	ND	ND
Downstream	0.014	0.016	0.01	0.312	0.42	2.9	5.38	ND	ND
9/28/2016									
Upstream	0.008	0.016	0.01	0.128	0.21	1.0	1.33	9330.0	2310.0
Downstream	0.011	0.017	0.01	0.293	0.42	1.6	2.15	7120.0	5210.0
10/5/2016									
Upstream	0.009	0.020	0.00	0.120	0.25	2.1	2.85	770.1	13170.0
Downstream	0.014	0.043	0.02	0.413	0.58	29.3	3.00	547.1	11690.0
10/13/2016									
Upstream	0.015	0.026	0.00	0.147	0.28	2.7	2.32	3590.0	46110.0
Downstream	0.033	0.066	0.02	0.614	0.88	9.6	3.90	4640.0	129970.0
10/20/2016									
Upstream	0.010	0.021	0.00	0.076	0.13	1.1	4.43	3730.0	16640.0
Downstream	0.014	0.030	0.03	0.327	0.39	2.1	3.11	387.3	5690.0
10/27/2016									
Upstream	0.010	0.021	0.00	0.046	0.14	1.1	5.87	517.2	5450.0
Downstream	0.014	0.021	0.01	0.291	0.36	2.1	7.91	45.5	6440.0
11/3/2016									
Upstream	0.003	0.031	0.01	0.071	0.20	2.1	6.81	22.6	3010.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.008	0.022	0.03	0.388	0.47	1.7	6.07	1732.9	5200.0
11/10/2016									
Upstream	0.011	0.013	0.01	0.073	0.12	1.0	2.29	53.7	>2419.2
Downstream	0.011	0.021	0.02	0.419	0.48	0.7	2.15	22.6	5040.0
11/17/2016									
Upstream	0.009	0.020	0.00	0.057	0.13	0.6	1.84	58.1	3270.0
Downstream	0.012	0.020	0.01	0.412	0.49	2.5	1.37	18.5	>2419.2
11/21/2016									
Upstream	0.010	0.019	0.00	0.125	0.17	1.3	0.68	178.9	3840.0
Downstream	0.012	0.021	0.01	0.466	0.52	1.3	1.23	26.9	>2419.2
11/29/2016									
Upstream	0.008	0.026	0.01	0.063	0.12	2.1	2.38	235.9	3790.0
Downstream	0.007	0.027	0.00	0.146	0.23	4.4	2.11	387.3	7380.0

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

§ N.S. is No Sample.

† N.D. is No Data.

Nutrients, Sediment, and Bacteria by Site for Ephemeral Stream, Trenches, Left Fork and Field Runoff

Table 5. Water quality analyses at the ephemeral stream draining the subwatershed containing the production houses and manure holding ponds, and surface runoff from Fields 1, 5a, and 12 since January, 2015, with those collected since the last report noted.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
Ephemeral stream									
1/5/2016	0.007	0.018	<0.03	0.883	1.00	1.2	2.15	32.7	686.7
1/25/2016	0.011	0.030	<0.03	0.762	0.87	9.8	3.10	1.0	816.4
2/24/2016	0.010	0.056	<0.03	0.195	0.40	12.8		387.3	4870.0
3/10/2016	0.006	0.050	0.13	0.918	1.22	26.7	3.12	648.8	8840.0
3/16/2016	0.006	0.022	0.01	0.520	0.54	0.0	1.75	88.0	461.1
3/24/2016	0.010	0.012	<0.03	0.531	0.64	1.3	1.44	N.S.	N.S.
3/31/2016	0.013	0.656	0.68	1.211	3.05	375.0	12.14	16160.0	198630.0
4/4/2016	0.008	0.018	<0.03	0.462	0.48	1.3	1.79	12.0	727.0
4/20/2016	0.008	0.020	<0.03	0.517	0.66	4.1	0.68	44.3	21430.0
5/2/2016	0.007	0.016	<0.03	0.468	0.59	1.7	2.56	118.7	5380.0
5/10/2016	0.195	0.560	0.32	0.649	4.01	1346.7	11.94	579.4	241920.0
5/18/2016	0.008	0.014	<0.03	0.479	0.63	3.0	0.84	34.1	2419.2
5/26/2016	0.052	0.424	0.39	0.858	2.20	350.6	8.58	22470.0	241920..0
6/2/2016	0.008	0.022	0.03	0.494	0.63	3.6	2.15	770.1	1986.3

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
6/7/2016	0.012	0.024	0.01	0.5	0.7	6.9	3.89	2419.2	7980
8/16/2016	0.011	0.023	0.01	1.365	1.59	2.6	2.47	137.6	154945.0
Samples analyzed since the last quarterly report									
10/13/2016 (grab sample)	0.018	0.047	0.03	1.760	1.97	9.7	5.17	>2419.2	21430.0
10/13/2016 (storm sample)	0.067	0.213	0.12	2.732	3.83	61.7	11.10	ND	ND
House well									
1/5/2016	0.008	0.020	<0.03	0.528	0.57	0.9	1.08	<1.0	1.0
1/25/2016	0.012	0.020	<0.03	0.602	0.55	0.5	2.36	<1.0	<1
2/10/2016	0.007	0.014	<0.03	0.542	0.56	0.1	0.63	<1.0	<1.0
2/24/2016	0.010	0.010	<0.03	0.582	0.55	1.3	N.S.	<1.0	<1.0
3/10/2016	0.011	0.020	0.02	0.562	0.59	0.9	1.19	<1.0	<1.0
3/16/2016	0.009	0.022	<0.03	0.550	0.55	0.0	1.55	<1.0	<1
3/24/2016	0.012	0.014	<0.03	0.565	0.65	0.2	2.72	N.S.	N.S.
3/31/2016	0.010	0.018	<0.03	0.556	0.62	0.2	3.93	1.0	26.2
4/4/2016	0.011	0.018	<0.03	0.466	0.48	0.0	0.94	<1.0	1.0
4/20/2016	0.005	0.014	<0.03	0.598	0.50	0.5	0.47	1.0	1.0
4/28/2016	0.011	0.008	<0.03	0.481	0.57	0.3	N.S.	<1.0	<1.0
5/2/2016	0.009	0.016	<0.03	0.551	0.56	0.1	1.94	<1.0	<1

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/10/2016	0.009	0.008	<0.03	0.533	0.56	0.5	4.39	<1.0	24.9
5/18/2016	0.009	0.010	<0.03	0.488	0.64	0.4	0.95	<1.0	<1.0
5/26/2016	0.009	0.012	<0.03	0.564	0.57	0.7	0.93	1.0	7.4
6/2/2016	0.008	0.018	<0.03	0.597	0.62	0.7	0.99	<1.0	<1.0
6/7/2016	0.011	0.014	0.03	0.500	0.58	0.1	3.06	<1.0	<1.0
6/15/2016	0.008	0.008	<0.03	0.506	0.59	0.7	0.00	<1.0	<1.0
6/22/2016	0.009	0.008	<0.03	0.545	0.58	0.5	0.00	<1.0	<1.0
6/29/2016	0.008	0.014	<0.03	0.569	0.56	0.0	0.23	<1.0	<1.0
7/6/2016	0.009	0.013	<0.03	0.874	0.96	1.0	0.73	<1.0	13.5
7/13/2016	0.005	0.011	<0.03	0.627	0.63	0.5	0.09	<1.0	<1.0
7/20/2016	0.007	0.009	0.02	0.594	0.70	0.1	0.14	N.S.	N.S.
7/27/2016	0.006	0.010	<0.03	0.650	0.67	0.1	1.41	<1.0	<1.0
Samples analyzed since the last quarterly report									
10/13/2016	0.008	0.010	0.01	1.166	1.23	0.6	1.35	<1.0	23.3
10/13/2016	0.009	0.020	0.02	0.739	0.79	0.1	4.56	<1.0	19.7
10/27/2016	0.009	0.010	0.01	0.664	0.74	0.9	8.95	<1.0	5.2
11/03/2016	0.004	0.010	0.02	0.719	0.75	0.4	9.48	1.0	2.0
11/10/2016	0.005	0.009	0.00	0.574	0.68	0.1	2.16	<1.0	1.0
11/17/2016	0.006	0.010	0.01	0.660	0.71	0.3	1.57	<1.0	1.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
11/21/2016	0.007	0.011	0.00	0.675	0.75	0.4	1.37	<1.0	<1.0
11/29/2016	0.004	0.011	0.00	0.598	0.68	0.4	2.67	<1.0	<1.0
Interceptor Trench 1 (South)									
1/5/2016	0.003	0.016	<0.03	0.243	0.29	0.9	1.11	1.0	209.8
2/24/2016	0.005	0.014	<0.03	0.345	0.39	2.1		<1.0	9070.0
3/10/2016	0.005	0.036	0.10	0.264	0.45	3.5	2.87	2419.2	16690.0
3/16/2016	0.003	0.032	0.02	0.331	0.37	0.0	1.23	101.7	290.9
3/24/2016	0.008	0.016	<0.03	0.208	0.20	2.8	1.33	N.S.	N.S.
3/31/2016	0.004	0.018	<0.03	0.347	0.49	5.5	4.76	4.1	2419.2
5/10/2016	0.002	0.016	<0.03	0.228	0.30	3.9	2.91	13.9	2419.2
5/18/2016	0.006	0.006	<0.03	0.169	0.22	0.1	0.54	2.0	5200.0
5/26/2016	0.008	0.006	<0.03	0.217	0.23	1.4	1.29	1.0	4260.0
6/2/2016	0.002	0.018	0.00	0.124	0.30	8.8	3.01	26.5	393.0
8/16/2016	0.005	0.006	0.02	0.130	0.17	0.2	2.14	93.4	48840.0
8/24/2016	<0.002	0.019	0.03	0.033	0.30	8.3	1.99	21.8	3450.0
Samples analyzed since the last quarterly report									
No flow									
Interceptor Trench 2 (North)									

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
2/24/2016	0.005	0.066	0.13	6.298	7.02	9.7	4.27	30.1	18720.0
3/10/2016	0.005	0.054	0.14	1.716	2.35	6.8	6.77	613.1	34480.0
3/31/2016	0.006	0.040	0.06	2.800	3.54	20.9	9.29	7.4	10810.0
4/4/2016	0.004	0.012	<0.03	0.236	0.25	0.0	0.85	1.0	2419.2
5/10/2016	0.002	0.038	<0.03	1.706	2.18	5.2	3.72	38.7	1553.0
8/16/2016	0.004	0.036	0.05	0.344	0.99	1.5	8.98	290.9	198630.0
Samples analyzed since the last quarterly report									
No flow									
Left Fork									
1/5/2016	0.013	0.028	<0.03	0.427	0.48	0.7	1.51	34.1	686.7
1/25/2016	0.010	0.024	<0.03	0.198	0.25	1.0	1.30	21.1	435.2
2/10/2016	0.003	0.012	<0.03	0.175	0.24	0.8	1.15	7.4	209.8
2/24/2016	0.015	0.088	<0.03	0.249	0.63	15.6		2780.0	14390.0
3/10/2016	0.013	0.046	0.01	0.154	0.38	8.7	2.64	367.3	2750.0
3/16/2016	0.009	0.032	<0.03	0.190	0.26	0.3	1.45	35.9	980.4
3/24/2016	0.013	0.048	0.09	0.186	0.39	10.7	2.65		
3/31/2016	0.013	0.056	0.09	0.199	0.40	11.9	2.59	172.0	3640.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
4/4/2016	0.009	0.022	<0.03	0.131	0.17	1.5	0.87	44.8	1119.9
4/20/2016	0.005	0.020	<0.03	0.157	0.21	2.1	0.84	35.0	6160.0
5/2/2016	0.009	0.020	<0.03	0.095	0.20	1.9	2.30	172.6	3640.0
5/10/2016	0.011	0.072	0.02	0.121	0.37	17.2	3.35	980.4	8230.0
5/18/2016	0.010	0.016	0.01	0.139	0.27	1.4	1.54	60.1	2620.0
5/26/2016	0.010	0.048	0.02	0.123	0.24	10.6	2.66	461.1	6890.0
6/2/2016	0.007	0.022	0.00	0.117	0.22	1.4	1.40	44.1	1986.3
6/7/2016	0.009	0.016	0.04	0.124	0.19	0.8	2.08	31.8	3180.0
6/15/2016	0.009	0.012	0.01	0.198	0.29	2.0	0.94	63.1	8860.0
6/22/2016	0.008	0.018	0.05	0.220	0.37	2.1	0.70	37.9	676.0
6/29/2016	0.006	0.023	0.03	0.251	0.35	2.0	0.94	23.5	5200.0
7/6/2016	0.006	0.02	0.04	0.271	0.36	2.7	0.96	248.1	12590.0
7/13/2016	0.005	0.017	0.00	0.172	0.29	1.9	0.85	95.9	12360.0
7/20/2016	0.005	0.013	0.00	0.197	0.76	2.3	2.21		
7/27/2016	0.004	0.021	0.00	0.255	0.35	3.6	1.79	920.8	15000.0
8/3/2016	0.007	0.016	0.00	0.212	0.32	2.4	2.21	101.4	7430.0
8/16/2016	0.012	0.082	0.07	0.118	0.30	19.5	3.64	201.4	14550.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
8/24/2016	0.004	0.013	0.00	0.045	0.13	1.5	1.62	43.5	6690.0
8/30/2016	0.005	0.021	0.02	0.157	0.28	2.7	2.00	111.2	17850.0
9/7/2016	0.006	0.021	0.00	0.151	0.24	2.8	1.58	27.5	10170.0
Samples analyzed since the last quarterly report									
9/15/2016	0.011	0.014	0.01	0.132	0.25	2.2	5.35	ND	ND
9/28/2016	0.006	0.011	0.02	0.101	0.22	1.8	1.31	2530.0	3410.0
10/5/2016	0.009	0.023	0.01	0.130	0.29	2.8	2.38	285.1	17820.0
10/13/2016	0.091	0.203	0.04	1.071	1.74	24.2	9.30	14010.0	>241920
10/20/2016	0.008	0.026	0.01	0.146	0.27	1.3	3.95	33.5	17890.0
10/27/2016	0.008	0.016	0.02	0.132	0.26	1.9	7.76	48.8	9340.0
11/03/2016	0.004	0.026	0.03	0.117	0.26	1.5	9.24	33.1	7380.0
11/10/2016	0.005	0.013	0.01	0.161	0.23	4.1	2.07	7.4	2560.0
11/17/2016	0.005	0.011	0.00	0.195	0.26	0.5	1.77	15.8	2400.0
11/21/2016	0.004	0.011	0.01	0.239	0.31	0.4	3.35	11.9	2419.2
11/29/2016	0.004	0.014	0.00	0.191	0.28	1.1	1.97	57.6	>2419.2
Field 1									

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
10/13/2016	0.940	1.231	0.13	0.335	2.36	59.0	16.67	ND	ND
Field 5a									
3/31/2016	1.154	1.352	0.27	0.302	1.67	26.5	32.74	N.S.	N.S.
5/10/2016	1.114	1.458	1.69	2.894	6.35	79.9	12.82	N.S.	N.S.
No samples analyzed since the last quarterly report									
Field 12									
3/10/2016	0.411	0.522	1.17	0.852	4.49	621.5	12.58	N.S.	N.S.
5/10/2016	0.370	0.666	0.12	0.062	1.03	96.7	6.92	N.S.	N.S.
No samples analyzed since the last quarterly report									

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.

§ N.S. is No Sample. E. coli and total coliform were not measured on surface runoff samples collected by ISCO samplers when sample holding time exceeded the required 8-hour threshold.

† N.D. is No Data.

Water pH, Alkalinity, Chloride, Electrical Conductivity, and Total Dissolved Solids for Several Big Creek Sites

At the beginning of 2015, the pH, alkalinity, chloride concentration, electrical conductivity and total dissolved solids were determined on water samples collected at the upstream and downstream sites, spring, house well, and trenches, to build a data base that will enable to eventually source track the major water source pathways at these sites. These values are given below in Table 6.

Table 6. The pH, Chloride concentration, electrical conducting, and total solids concentration of water samples collected at upstream, downstream, spring, ephemeral stream, house well and trench sites, initiated at the beginning of 2015, with those collected since the last report noted.

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
		------- mg/L ------		µS/cm	mg/L
Upstream					
1/5/2016	7.5	40	1.34	102	62.5
1/25/2016	8.2	46	1.50	115	65.0
2/10/2016	8.6	54	1.69	141	60.0
2/24/2016	7.2	66	1.20	102	97.5
3/10/2016	7.6	38.0	1.268	84.5	60.0
3/16/2016	6.7	38.0	1.252	88.3	52.5
3/24/2016	7.7	46.0	1.825	103.3	56.5
3/31/2016	7.3	30.0	0.933	65.8	235.0
4/4/2016	7.4	40.0	1.163	86.9	55.0
4/20/2016	8.0	58.0	1.405	125.7	65.0
4/29/2016	8.1	66.0	1.373	134.8	72.5
5/3/2016	7.7	38.0	1.150	83.7	52.5
5/10/2016	7.6	32.0	0.914	67.6	57.5
518/2016	8.0	48.0	1.228	102.8	57.5
5/26/2016	7.8	76.0	1.045	78.4	50.0
6/2/2016	7.9	68.0	1.298	105.4	75.0
6/7/2016	8.1	58.0	2.722	128.3	77.5

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
6/15/2016	8.3	72.0	1.471	150.3	77.5
6/22/2016	8.1	88.0	1.695	182.3	112.5
6/29/2016	7.4	110.0	2.176	203.0	112.5
7/6/2016	7.5	106.0	1.821	212.0	117.5
8/16/2016	7.7	40.0	1.092	88.1	60.0
8/24/2016	8.3	54.0	1.513	121.7	95.0
8/30/2016	8.2	64.0	1.088	143.3	70.0
9/7/2016	7.9	82.0	1.601	176.0	97.5
Samples analyzed since the last quarterly report					
9/15/2016	8.0	98.0	1.287	206.0	111.1
9/28/2016	8.1	84.0	1.804	217.0	113.3
10/5/2016	7.9	94.0	1.831	230.0	110.0
10/13/2016	7.8		2.540	225.0	242.5
10/20/2016	7.9		2.017	235.0	117.8
10/27/2016	8.0		2.139	299.0	117.5
11/3/2016	7.6		2.330	260.0	
11/10/2016	8.0		2.446	233.0	
11/17/2016	8.0		2.455	272.0	
11/21/2016	8.0		2.314	101.0	
11/29/2016			2.087		
Downstream					
1/5/2016	7.5	60	2.17	158	92.5
1/25/2016	8.0	80	2.00	191	95.0
2/10/2016	8.0	94	2.36	214	102.5
2/22/2016	7.5	80	1.48	156	110.0
3/10/2016	7.3	54.0	1.481	126.1	80.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
3/16/2016	7.1	60.0	1.500	137.6	75.0
3/24/2016	7.3	68.0	1.827	156.8	79.0
3/31/2016	7.3	48.0	1.043	95.9	50.0
4/4/2016	7.4	66.0	1.563	138.6	80.0
4/20/2016	7.3	92.0	1.903	187.0	105.0
4/29/2016	7.7	100.0	2.052	199.1	107.5
5/3/2016	7.8	60.0	1.197	130.5	87.5
5/10/2016	7.6	44.0	0.856	93.5	75.0
518/2016	7.8	74.0	1.482	154.5	82.5
5/26/2016	7.7	34.0	0.941	114.1	72.5
6/2/2016	8.0	48.0	1.447	154.8	100.0
6/7/2016	7.8	88.0	1.698	176.8	97.5
6/15/2016	7.9	108.0	2.525	205.0	115.0
6/22/2016	7.8	120.0	2.406	230.0	145.0
6/29/2016	7.5	132.0	2.971	259.0	322.5
7/6/2016	7.4	136.0	2.960	262.0	157.5
7/13/2016	7.4	130.0	2.549	289.0	137.5
7/20/2016	7.7	138.0	2.726	305.0	145.0
7/27/2016	7.5	134.0	2.599	286.0	150.0
8/3/2016	7.9	144.0	1.845	258.0	137.5
8/16/2016	7.7	60.0	1.255	128.9	82.5
8/24/2016	7.8	84.0	1.368	174.8	97.5
8/24/2016			1.152	122.8	97.5
8/30/2016	7.8	88.0	1.435	193.5	97.5
9/7/2016	7.9	112.0	2.143	240.0	125.0
Samples analyzed since the last quarterly report					
9/15/2016	7.9	126.0	1.918	265.0	137.8

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
9/28/2016	7.8	124.0	2.272	281.0	142.2
10/5/2016	7.8	122.0	2.708	288.0	140.0
10/13/2016	7.6		2.799	264.0	152.5
10/20/2016	7.2		2.791	314.0	157.8
10/27/2016	7.6		2.805	304.0	150.0
11/3/2016	7.2		3.074	313.0	
11/10/2016	7.8		3.330	311.0	
11/17/2016	7.8		3.203	366.0	
11/21/2016	7.8		3.272	139.0	
11/29/2016			2.481		
Spring					
3/10/2016			1.109	359.0	210.0
3/16/2016			2.038	516.0	250.0
3/24/2016			1.939	446.0	214.0
3/31/2016			1.324	414.0	45.0
4/4/2016			1.971	506.0	272.5
4/20/2016			2.111	554.0	300.0
4/29/2016			2.234	522.0	285.0
5/3/2016			1.879	486.0	275.0
5/10/2016			1.190	417.0	245.0
5/18/2016			2.206	493.0	275.0
5/26/2016			1.370	450.0	250.0
6/2/2016			2.111	512.0	285.0
6/7/2016			2.348	503.0	280.0
6/15/2016			2.523	526.0	305.0
6/22/2016			2.659	543.0	322.5

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
6/29/2016			2.864	545.0	322.5
7/6/2016			2.749	533.0	267.5
7/13/2016			2.661	272.0	292.5
7/20/2016			2.271	594.0	292.5
7/27/2016			2.424	593.0	297.5
8/3/2016			2.151	541.0	280
8/16/2016			1.435	434.0	242.5
8/24/2016			2.644	556.0	312.5
8/30/2016			2.710	604.0	310.0
9/7/2016			2.822	598.0	322.5
Samples analyzed since the last quarterly report					
9/15/2016			2.040	590.0	322.2
9/28/2016			2.785	652.0	328.9
10/5/2016			2.272	644.0	315.0
10/13/2016			1.899	455.0	127.5
10/20/2016	6.9		2.528	674.0	331.1
10/27/2016	7.2		2.525	637.0	315.0
11/3/2016	6.9		2.361	619.0	
11/10/2016	7.2		2.402	605.0	
11/17/2016	7.1		2.367	695.0	
11/21/2016	7.0		2.433	259.0	
11/29/2016			2.472		
Ephemeral Stream					
1/5/2016			2.908	368.0	
1/25/2016			3.454	392.0	
2/24/2016			2.427	264.0	

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
3/10/2016			2.530	288.0	
3/16/2016			2.427	356.0	
3/24/2016			3.467	399.0	
3/31/2016			3.366	153.2	
4/4/2016			2.544	330.0	
4/20/2016			2.758	380.0	
5/2/2016			2.068	329.0	
5/2/2016			2.571	241.0	
5/10/2016			1.617	143.3	
5/18/2016			2.726	360.0	
5/26/2016			2.031	194.5	
6/2/2016			2.733	359.0	
6/7/2016			2.930	344.0	
8/16/2016			3.309	357.0	
Samples analyzed since the last quarterly report					
10/13/2016	7.2		3.546	393.0	225.0
House well					
1/5/2016			4.855	439	215.0
1/25/2016			5.278	462	242.5
2/10/2016			5.273	468	215.0
2/24/2016			5.237	447	242.5
3/10/2016			5.366	458	237.5
3/16/2016			4.993	482	240.0
3/24/2016			5.265	484	219.0
3/31/2016			5.023	409	220.0
4/4/2016			4.735	414	210.0
4/20/2016			5.475	417	227.5

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
4/28/2016			4.671	417	247.5
5/2/2016			5.316	441	237.5
5/10/2016			5.234	411	237.5
5/18/2016			4.450	420	232.5
5/26/2016			5.649	426	220.0
6/2/2016			5.450	409	182.5
6/7/2016			4.670	416	220.0
6/15/2016			4.394	414	242.5
6/22/2016			5.173	424	260.0
6/29/2016			5.557	432	172.5
7/6/2016			5.811	391	237.5
7/13/2016			5.021	561	220.0
7/20/2016			5.561	447	230.0
7/27/2016			5.230	467	227.5
Samples analyzed since the last quarterly report					
10/13/2016			6.988	476.	245.0
10/20/2016		7.6	6.421	495	244.4
10/27/2016		7.9	6.132	501	142.5
11/3/2016		7.6	5.560	479	
11/10/2016		7.6	5.858	473	
11/17/2016		7.6	5.655	544	
11/21/2016		7.5	5.576	209	
11/29/2016			5.721		
12/14/2016		7.4		411	
Trench 1					
1/5/2016			1.61	161	82.5

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
2/24/2016			1.16	162	102.5
3/10/2016			1.019	173.7	117.5
3/16/2016			1.451	226.0	120.0
3/24/2016			1.732	229.0	99.0
3/31/2016			1.280	167.9	100.0
5/10/2016			1.122	226.0	130.0
5/19/2016			0.405	196.5	115.0
5/18/2016			1.653	234.0	125.0
5/26/2016			1.421	262.0	142.5
6/2/2016			1.229	320	192.5
8/16/2016			2.051	293	130.0
8/24/2016			1.259	318	170.0
Trench 2					
3/11/2015			1.77	159	140.8
3/19/2015			1.04	168	104.9
3/26/2015			0.78	135	160.9
5/11/2015			0.41	165	88.5
5/26/2015			0.93	284	141.3
12/14/2016			1.00	148	110.0
2/24/2016			0.99	144	122.5
3/10/2016			0.349	106.8	80.0
3/31/2016			0.424	134.5	87.5
4/4/2016			1.4	192.1	107.5
8/16/2016			0.597	219	117.5

Temporal Trends in Phosphorus, Nitrogen, Bacteria, and Chloride in Big Creek Above and Below the C&H Farm

The concentration of dissolved P, total P, nitrate-N, total N, bacteria and chloride in Big Creek above and below the C&H Farm are presented in subsequent figures to show the season / temporal trends in measured concentrations (Figures 5, 6, 7, 8, 9, 10, and 11).

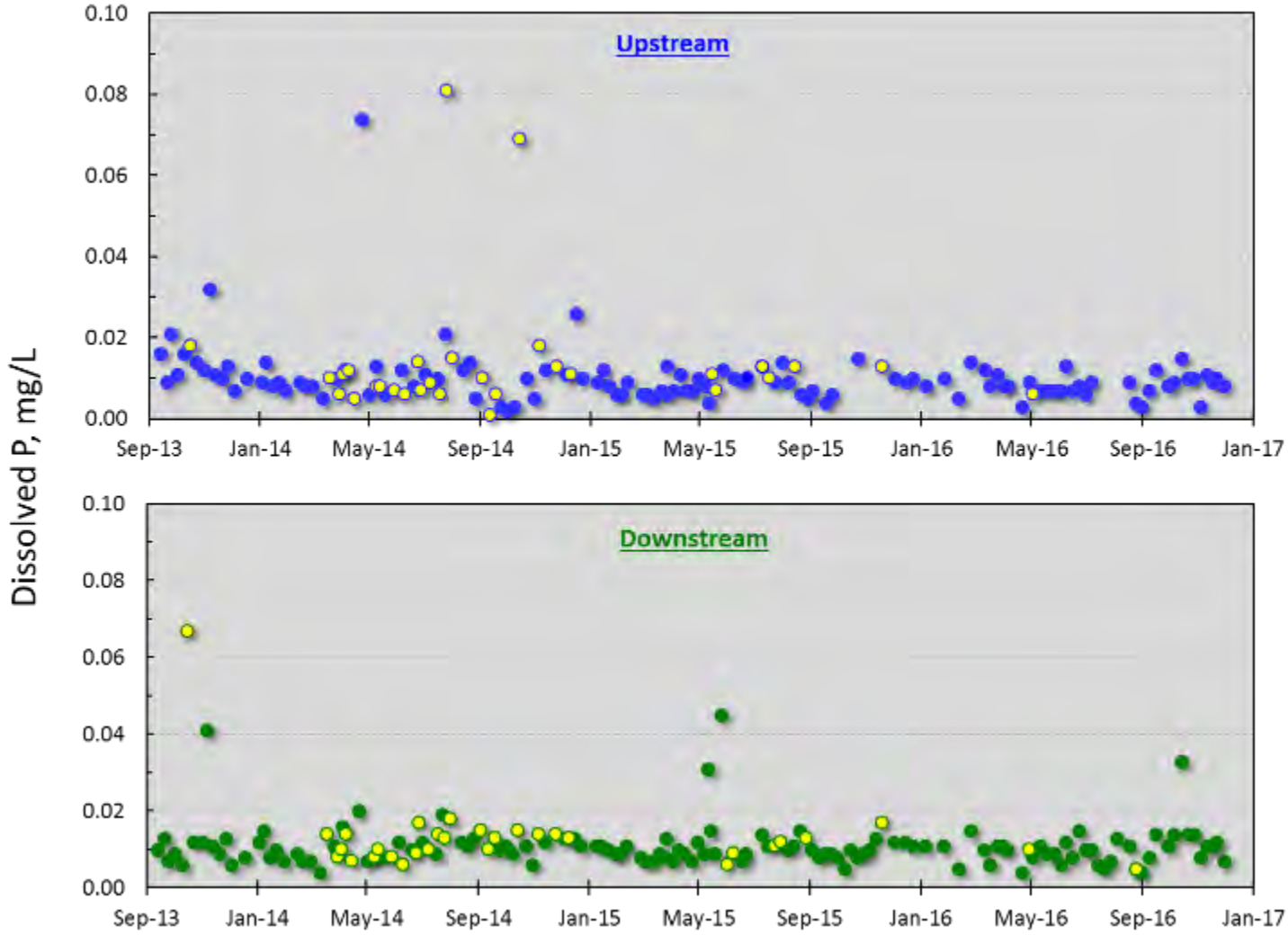


Figure 2. Dissolved P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

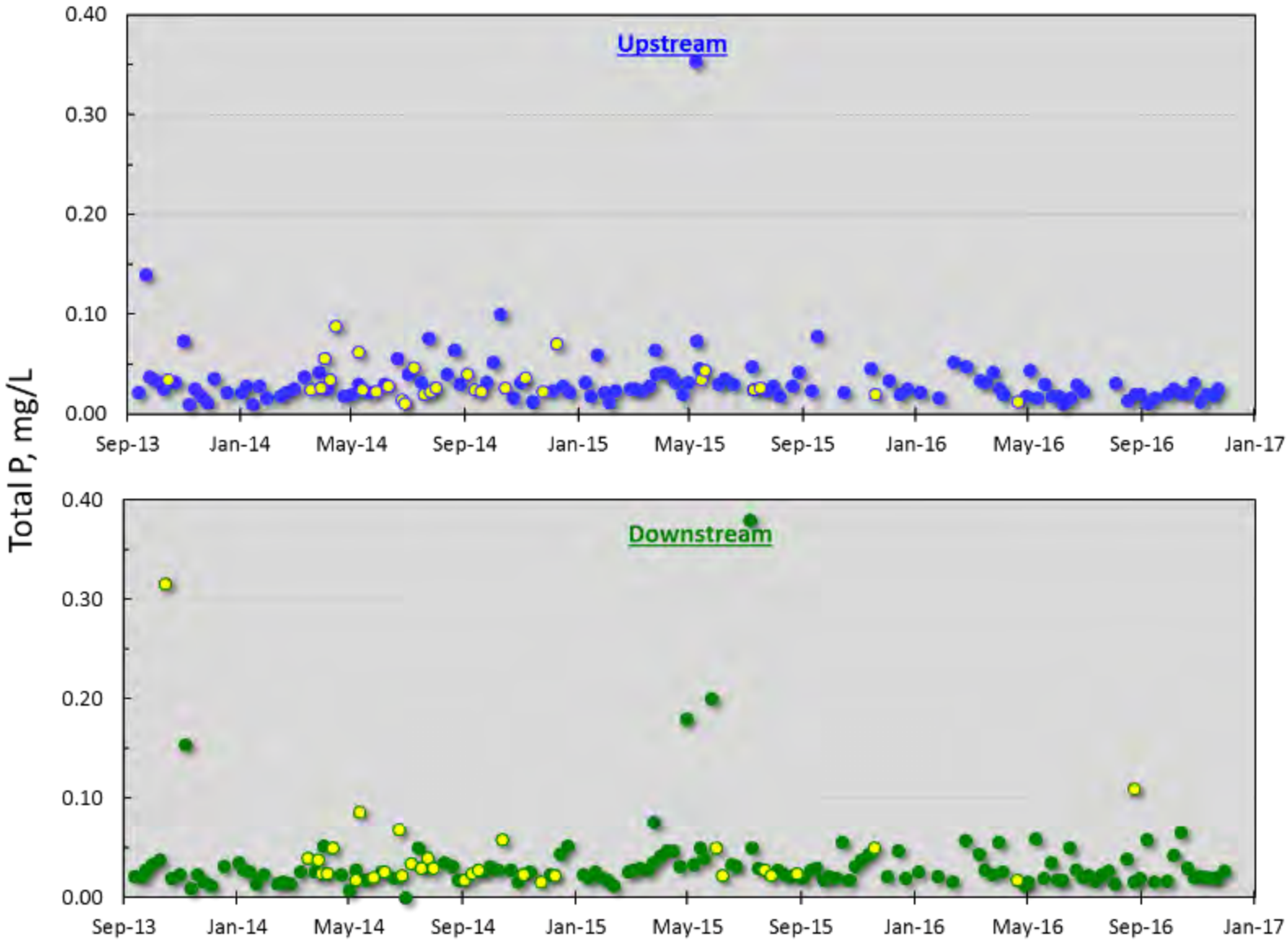


Figure 3. Total P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

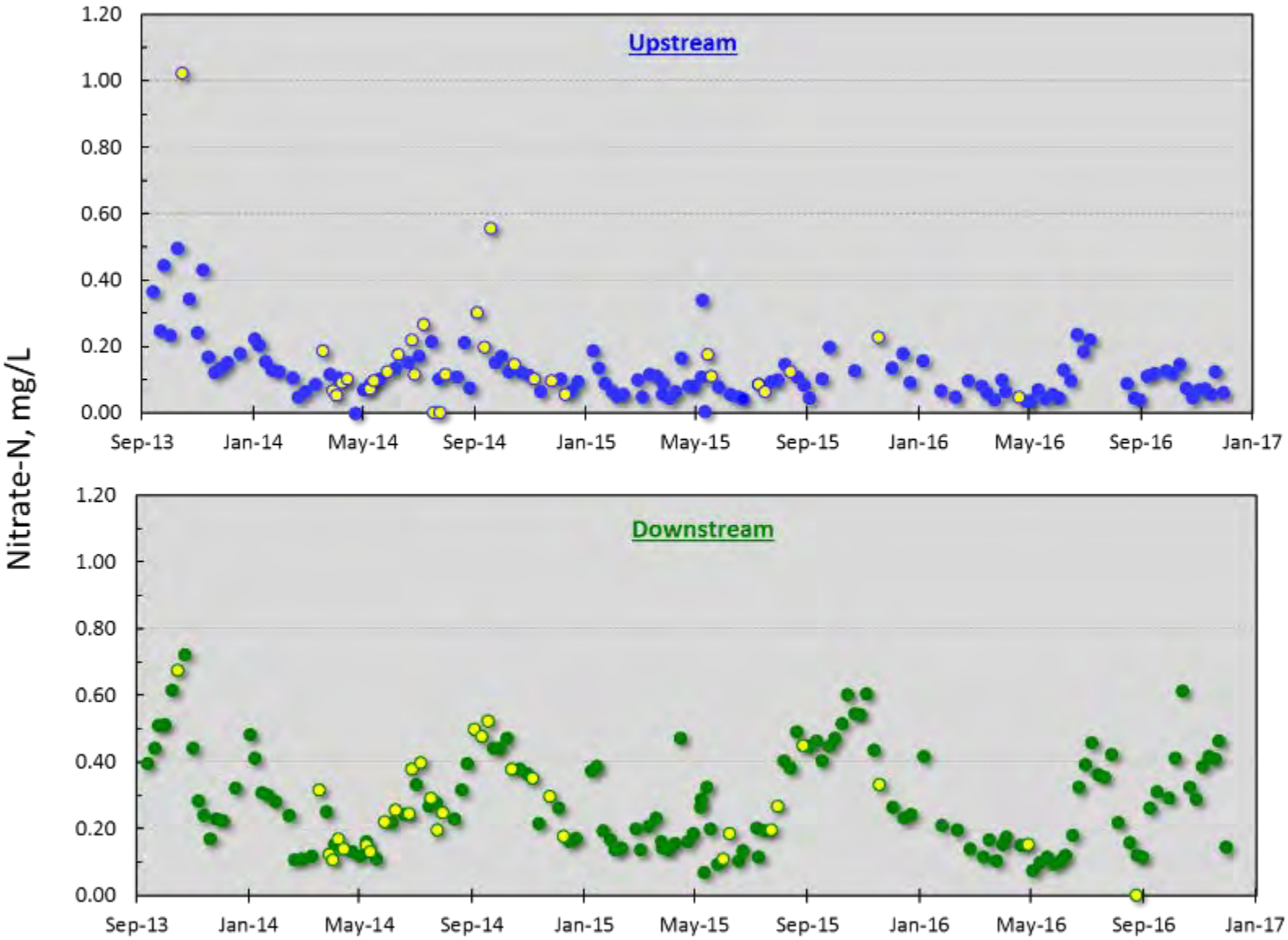


Figure 4. Nitrate-N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

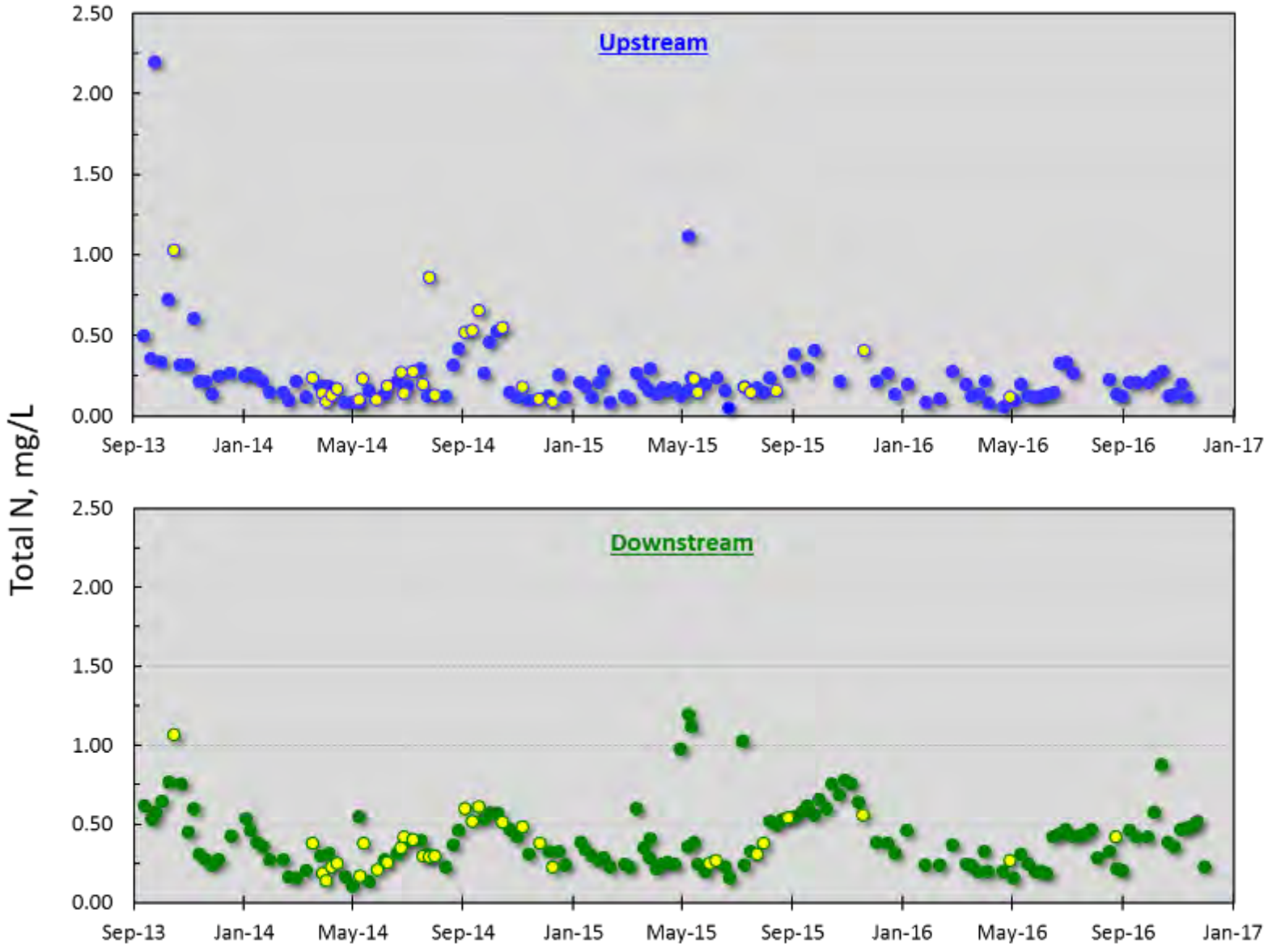


Figure 5. Total N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

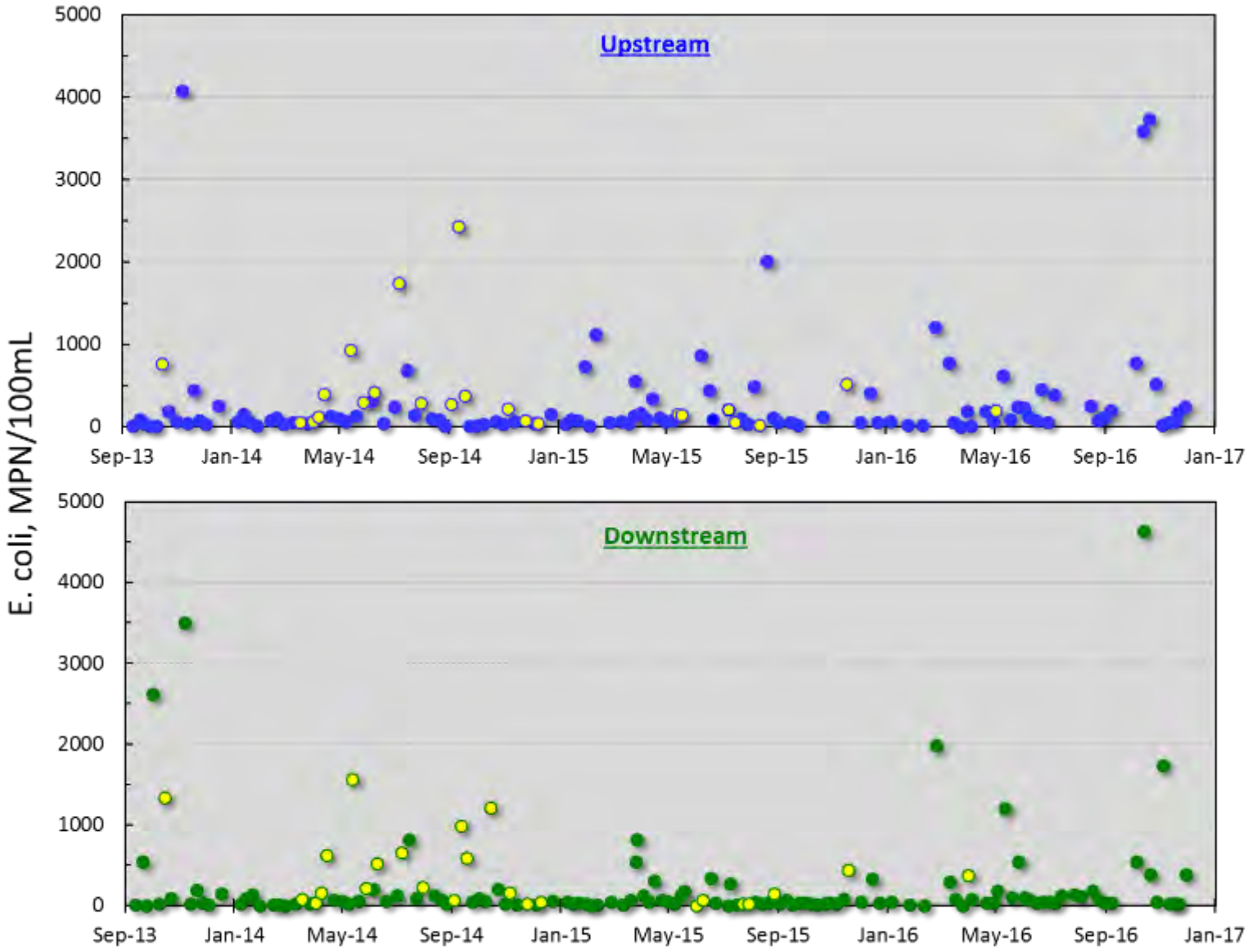


Figure 6. E. coli numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

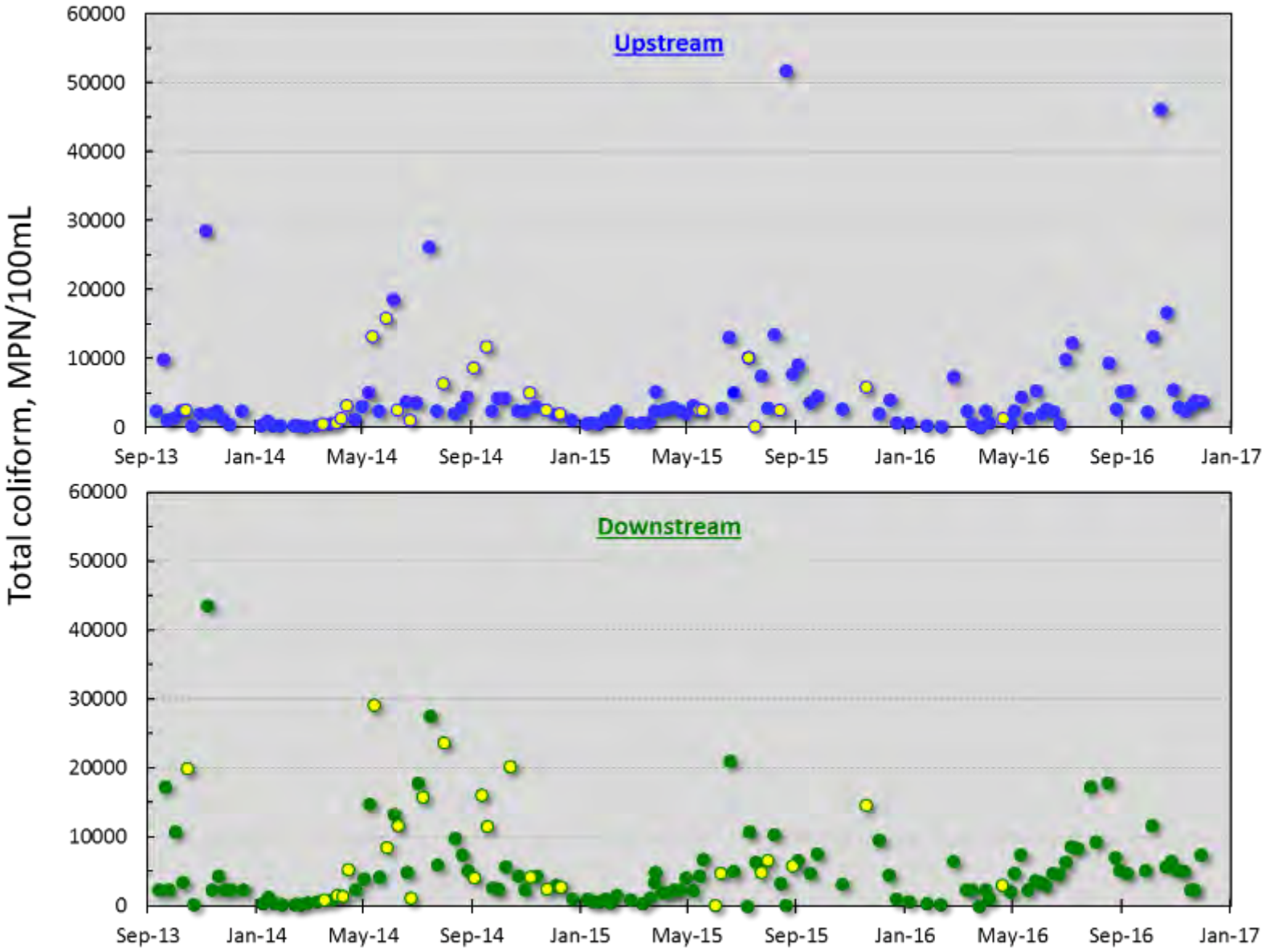


Figure 7. Total coliform numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

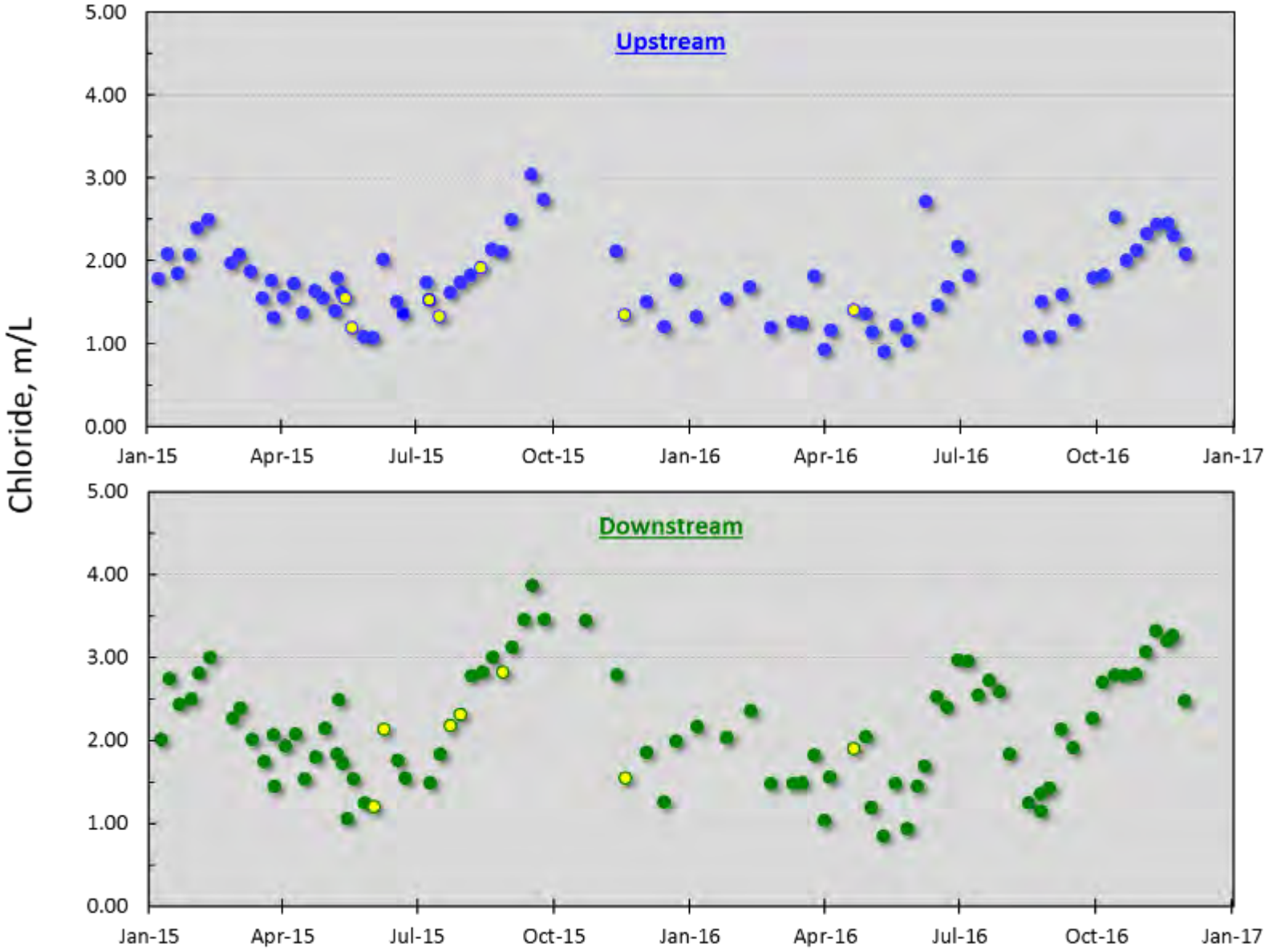


Figure 8. Chloride concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

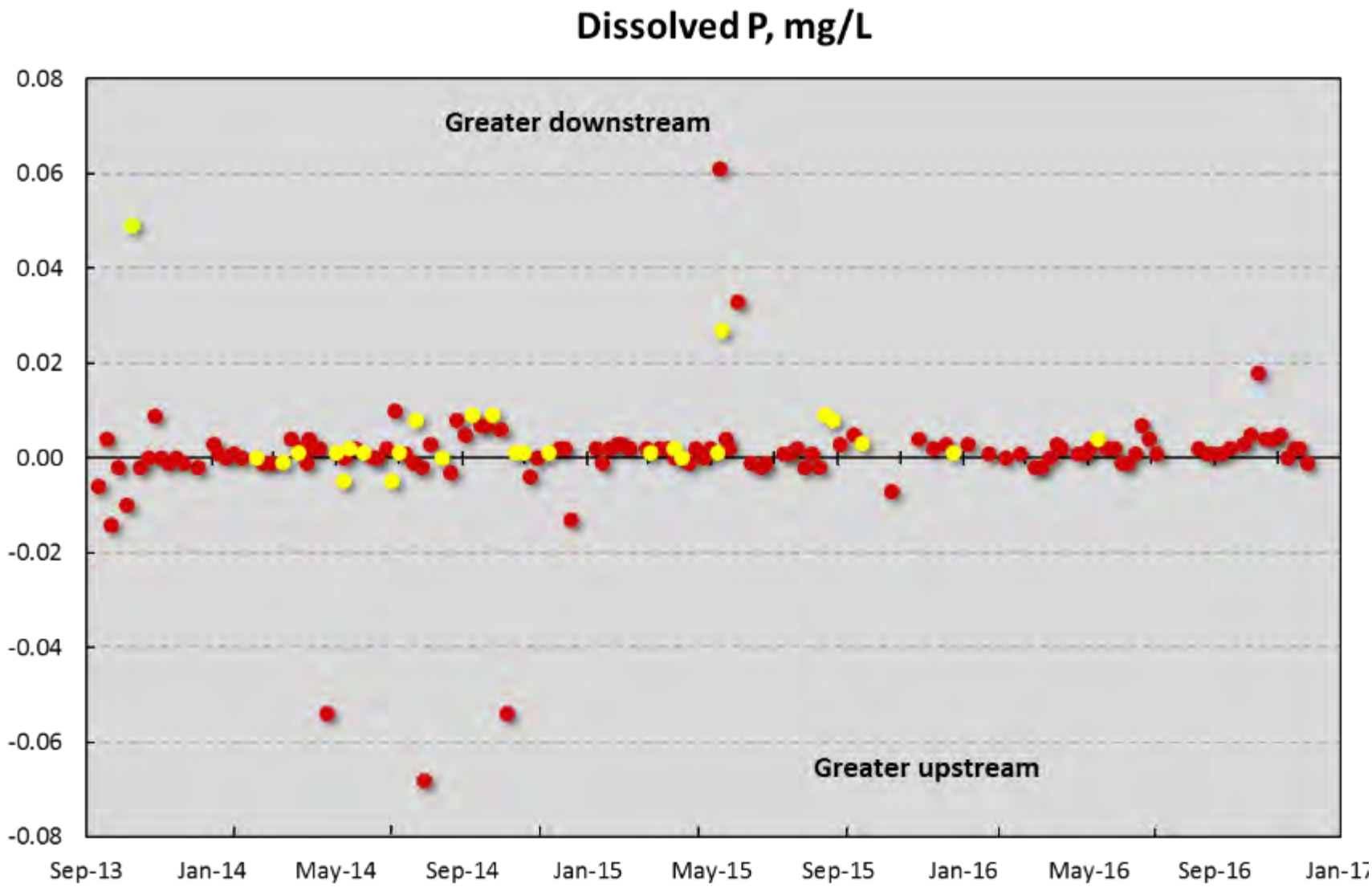


Figure 9. Difference in dissolved P concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

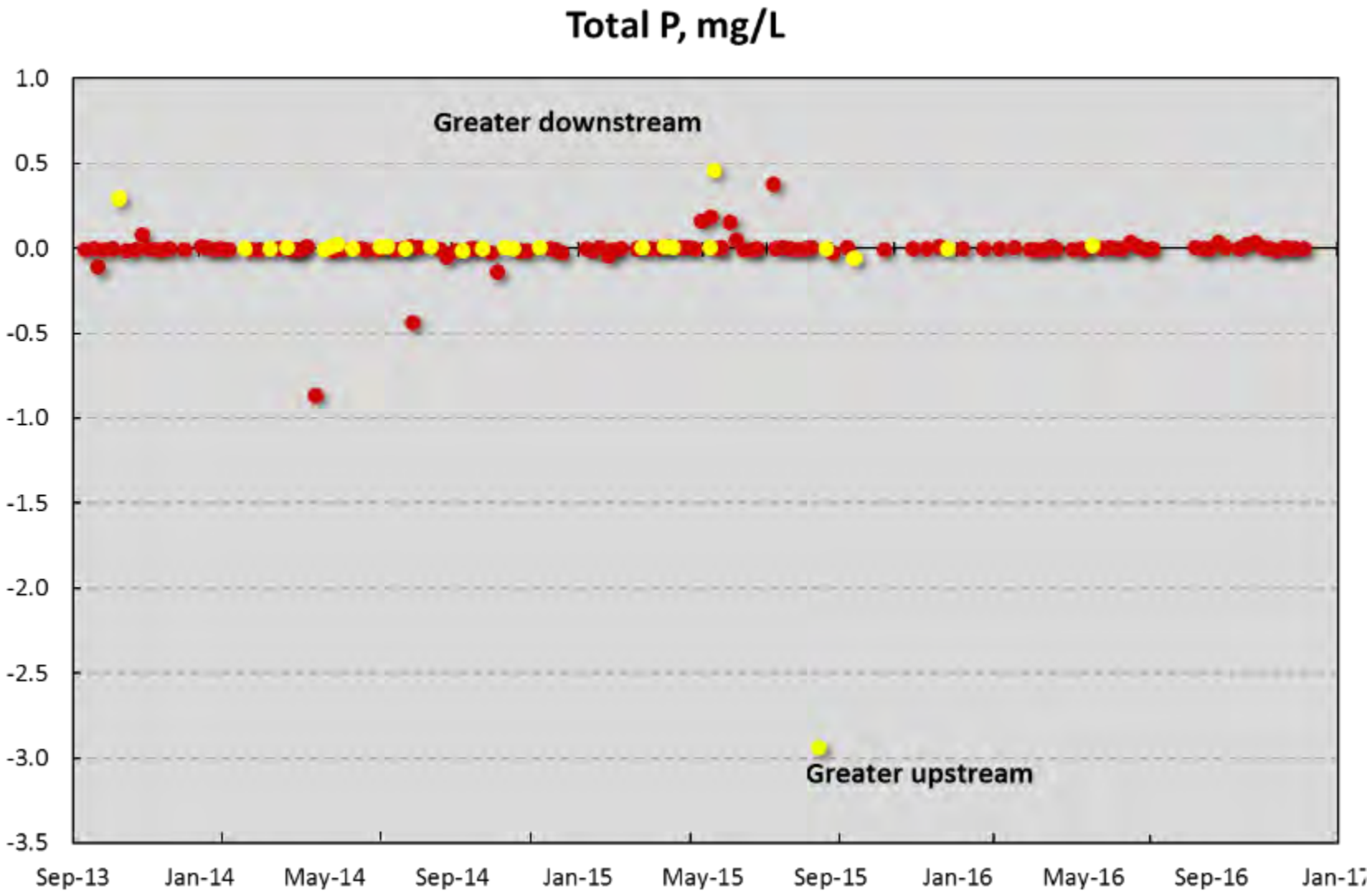


Figure 10. Difference in total P concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

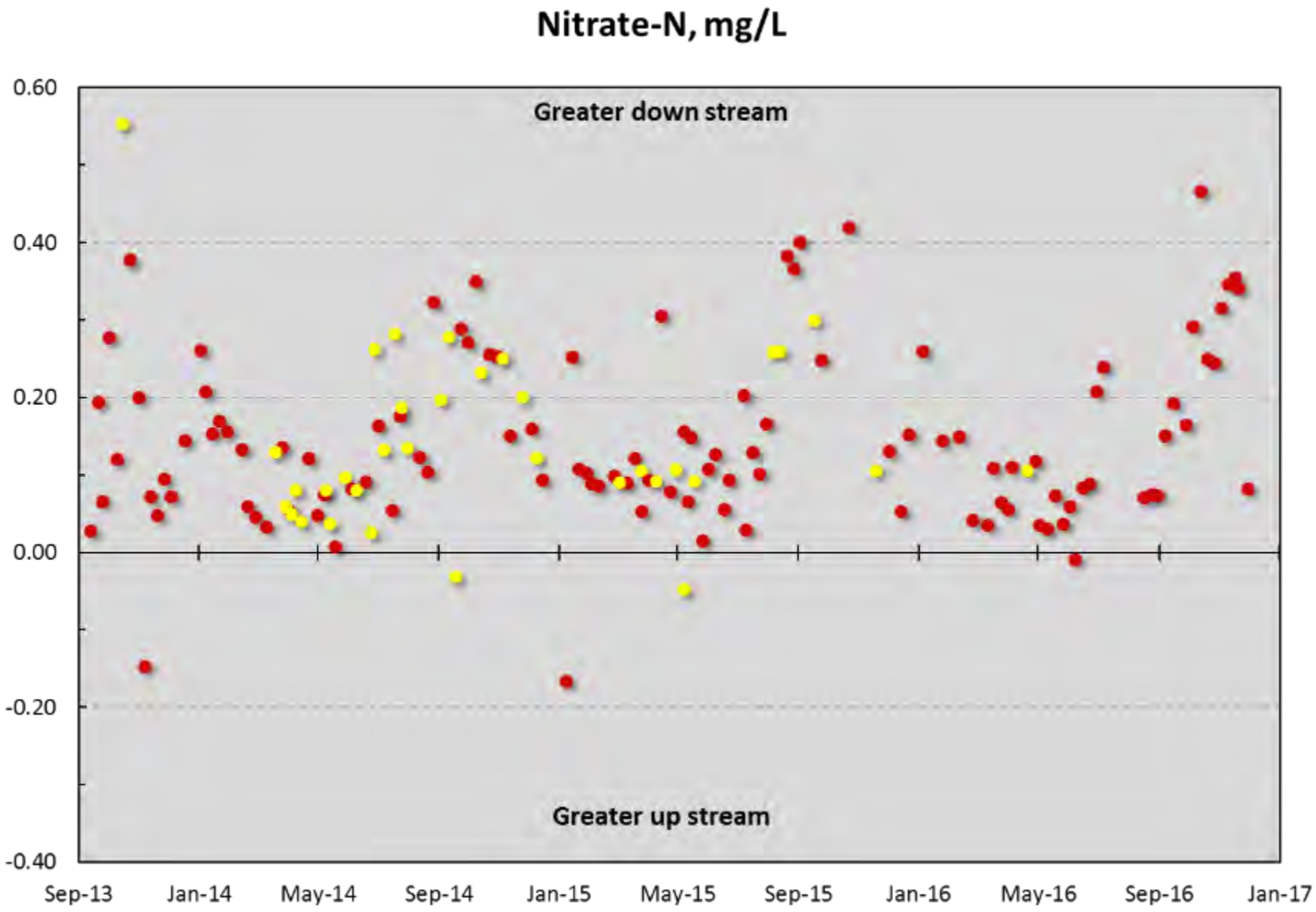


Figure 11. Difference in nitrate-N concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

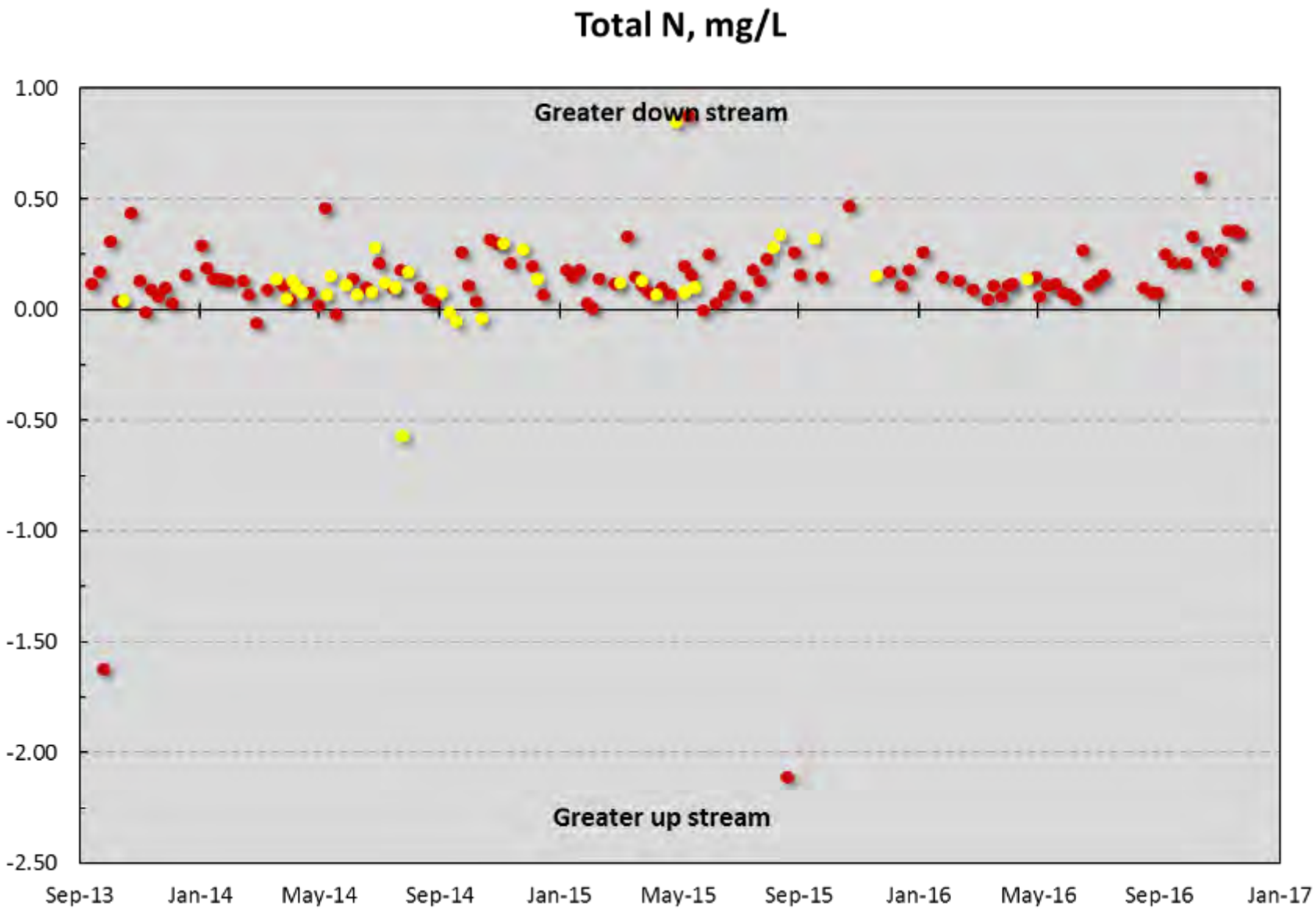


Figure 12. Difference in total N concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

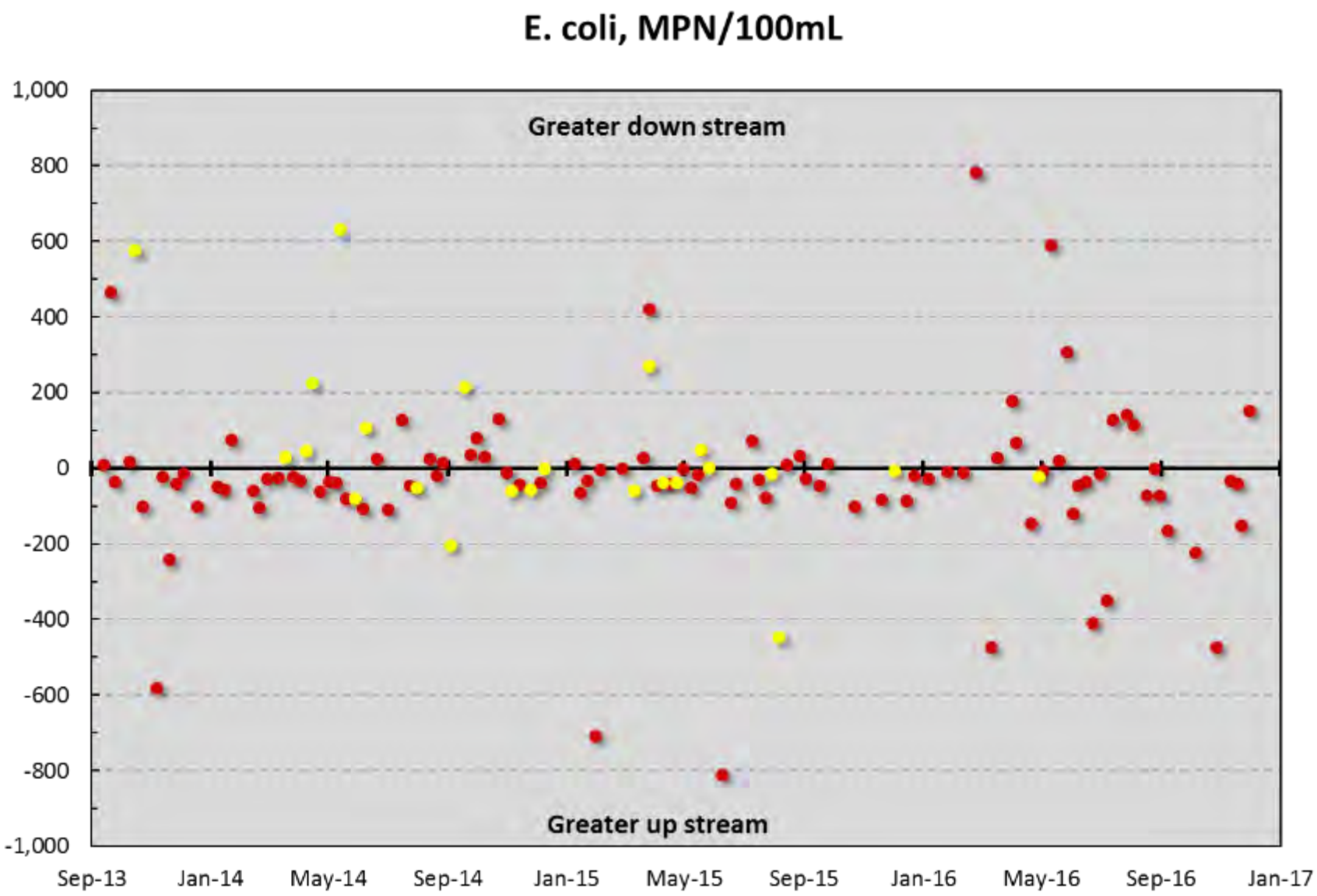


Figure 13. Difference in E. coli numbers in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

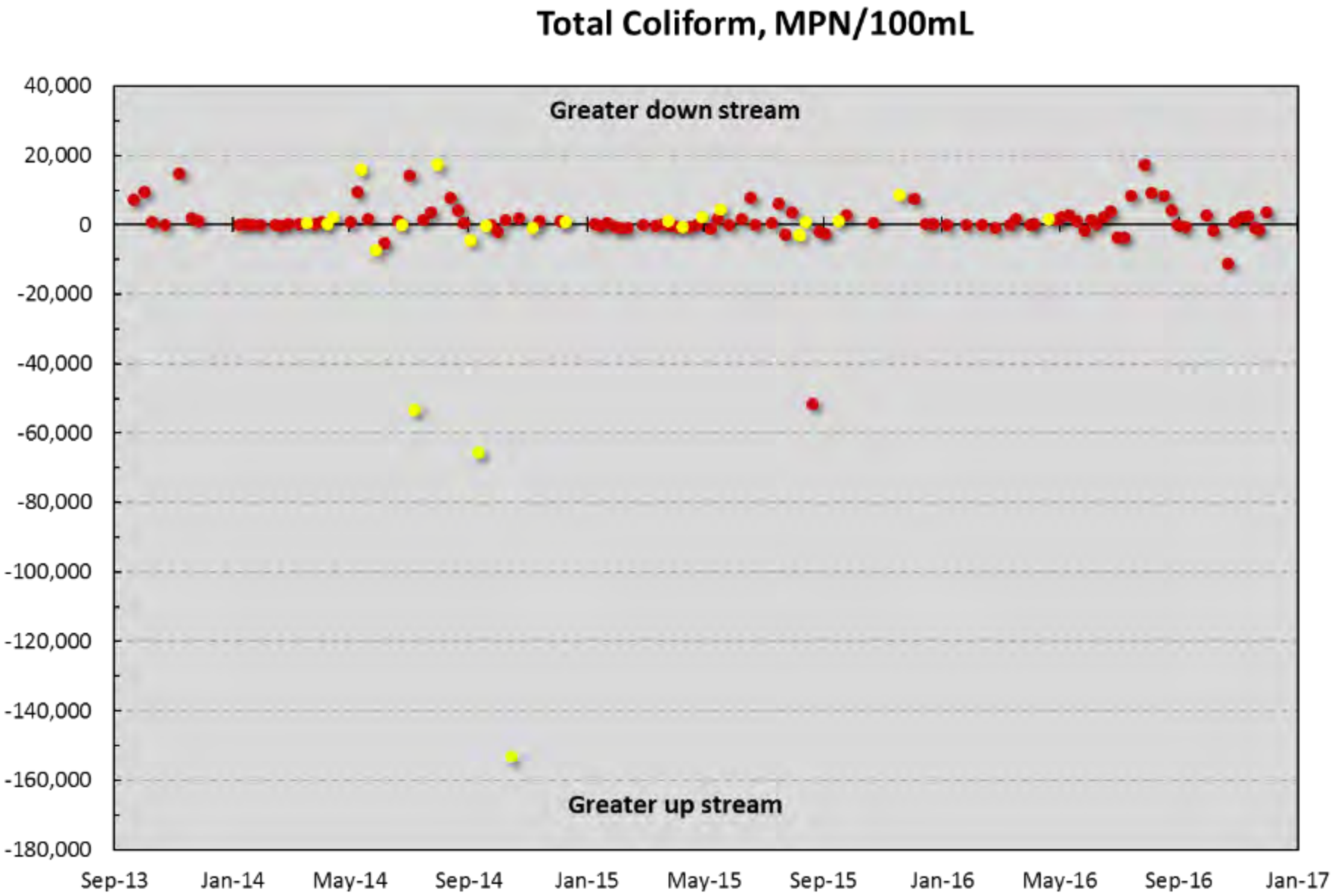


Figure 14. Difference in total coliform numbers in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

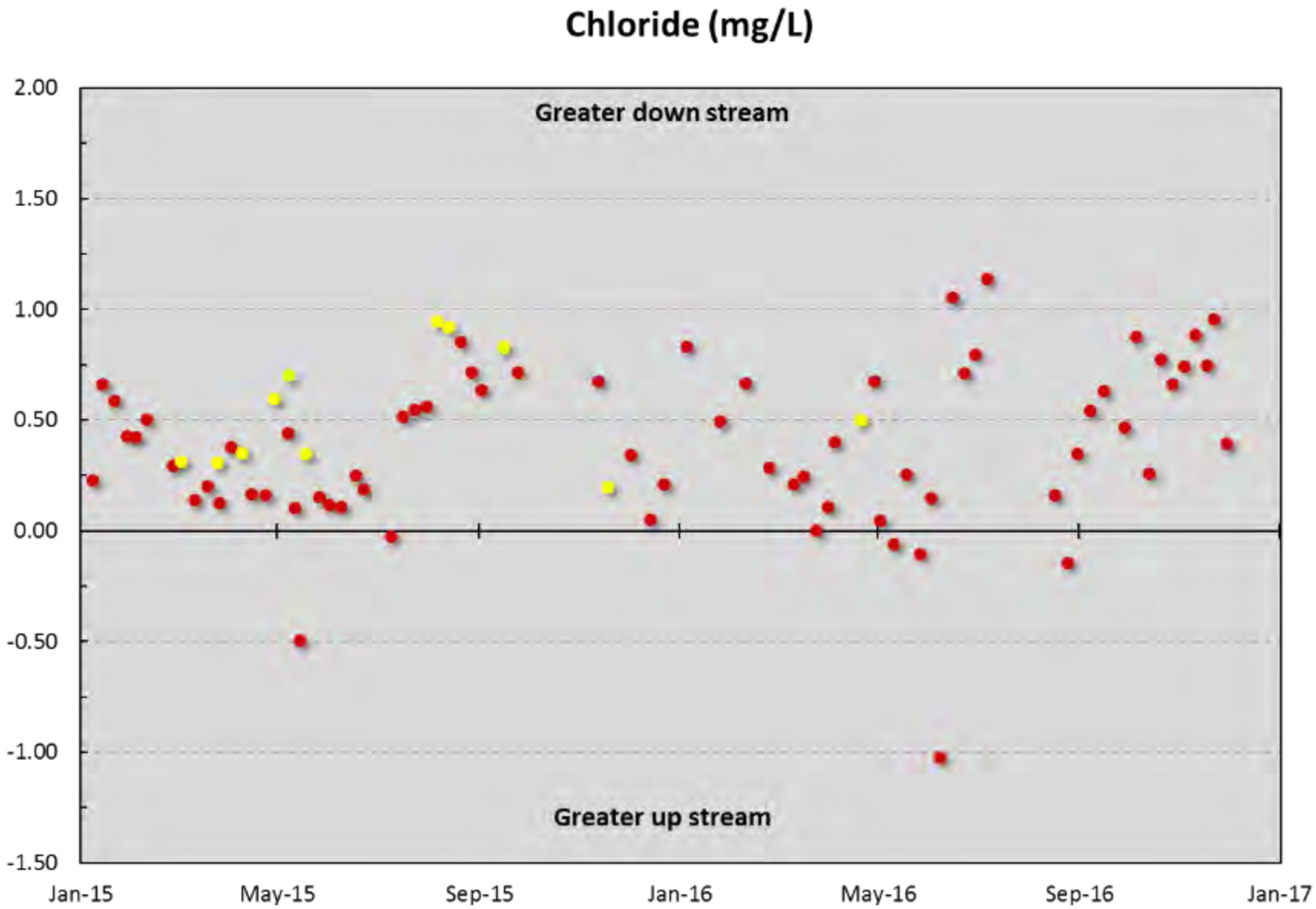


Figure 15. Difference in chloride concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

Core Sample Analyses

Core samples collected adjacent to the swine slurry holding ponds by Harbor Environmental and Safety were split between Arkansas Analytical, Little Rock, and by the Arkansas Soil Testing and Research Laboratory, Division of Agriculture, University of Arkansas System, Fayetteville, AR. Results of Arkansas Analytical are available at the ADEQ website https://www.adeq.state.ar.us/water/bbri/c-and-h/drilling.aspx#collapseResults. The Soil Testing Laboratory results are presented below. BCRET requested the analyses listed in **Table 1**. **Table 1** also lists methods used and significance of the analyses.

All core samples were dried at 60 ^{o}C and ground to pass through a 2mm sieve. Any material that would not crush (mortar and pestle) to pass the 2mm screen was discarded. All analyses used subsamples from the ground material. Laboratory QA/QC includes among other standard protocols, that with every set of environmental samples digested, a blank, a duplicate, and a North American Proficiency Test Program certified soil sample (http://www.naptprogram.org/) are analyzed and compared. If the check is out of acceptable limits, more than 2.5 times the Mean Absolute Deviation value, the sample is digested again and rerun. The digest and duplicate for this set of core samples all met this analytical criterion.

The shallower core samples at 0.5 and 5 ft below land surface showed sand, silt, and clay contents that varied by less than 20% between the size fractions (**Table 2**). Below 10 feet, core sample data show a dramatic increase in the proportion of clay-sized material; the percent of clay-sized material ranged from 86.9 to 95.1% for the 10, 13.5, and 18.5 foot samples. For the deepest sample collected and analyzed, at 25 feet below surface, clay content was much decreased at 22% with a larger proportion of silt- and sand-sized material (**Table 2**).

Material pH increased with sample depth (**Table 3**), and was greatest in the 25-foot depth sample. The measured pH of 8.72 is consistent with the sample containing limestone with the calcite effectively buffering acidity. Electrical conductivity (inverse of resistivity) of water extracted from the sampled material increased as clay content increased, indicating greater mineral-water interaction with the fine-grained clay. Total N and organic matter content also correlated with clay content (**Table 3**). No consistent trends were observed in the concentration of total dissolved P, nitrate-N plus nitrite-N and ammonium-N with depth of sample collected (**Table 3**). Total C concentration was appreciably greater in the 25-foot sample than the depths above, which likely results from the carbon released from calcium carbonate present in the sample form this depth (note the high Ca concentration of 382,176 mg/L; **Table 4**).

Total elemental analysis revealed the concentrations of P, potassium, magnesium, and sodium were closely related to clay content (R^2 of 0.93, 0.99, 0.97, and 0.83, respectively; **Figure 1**), due to the chemical association of those elements with clay minerals and mineralogy (**Table 4**). Concentrations of zinc, copper, and boron were also closely related to clay content of the core samples (0.89, 0.99, 0.64, respectively; **Figure 1** and **Table 5**). The concentration of calcium was greatest at the 25-foot depth (382,176 mg/kg), where the sample was partly composed of weathered limestone bedrock (**Table 4**).

These values are similar to those reported by Arkansas Analytical on split core samples and reported by Harbor Environmental and Safety on the ADEQ website at (https://www.adeq.state.ar.us/water/bbri/c-and-h/files/ch-farms-drilling-study-report-final-12.1.2016.pdf). Variations in determined analyte concentrations are within inter-laboratory variability and within ranges reported by U.S. Geological Survey as background concentrations (see https://mrdata.usgs.gov/geochemistry/ngs.html and Smith et al., 2013 and 2014) and reported in Table 5-1 of the Harbor report noted above. A comparison of total elemental analyses as determined by Arkansas Analytical and Arkansas Soil Testing and Research Laboratory is presented in **Figures 2 and 3**. Elemental concentrations determined by the two laboratories were statistically similar (at <0.005 probability level) as determined by analysis of variance.

The concentrations of elements extracted by the Mehlich-3 solution, which is used by the majority of State Soil Testing Laboratories in the U.S. to estimate plant-available P and other macro and micro-nutrients, are presented in **Table 5**. Other than the close relationship between clay content of core material and Mehlich-3 extractable potassium and sodium, no consistent trends in concentrations of Mehlich-3 elements were observed with depth of sample (**Table 5**). Notably, Mehlich-3 extractable P (i.e., plant-available P) was appreciably lower than values associated with optimum levels for plant growth (i.e., 30 to 50 mg/kg Mehlich-3 P for cool and warm season grasses, respectively). The Mehlich-3 P concentrations of core samples, which ranged from 0.59 to 4.16 mg/kg are consistent with levels present in pristine or unfertilized, ungrazed soils that have received no external inputs of P (3 - 10 mg/kg Sharpley et al., 2007).

The low levels of Mehlich-3 P in all core samples suggest that the total P concentrations represent P associated with the soil and clay matrix and that no significant input of P-rich swine slurry from the holding ponds in the 0 to 25-foot depth sampled had occurred.

References

Sharpley, A.N., S. Herron, and T.C. Daniel. 2007. Phosphorus-based management challenges and strategies for poultry farming. Journal of Soil and Water Conservation, 62(6):152-153.

Smith, D.B., W.F. Cannon, L.G. Woodruff, F. Solano, J.E. Kilburn, and D.L. Fey. 2013. Geochemical and mineralogical data for soils of the conterminous United States. U.S. Geological Survey Data Series 801. 19 pages. http://pubs.usgs.gov/ds/801/

Smith, D.B., W.F. Cannon, L.G. Woodruff, F. Solano, and K.J. Ellefsen. 2014. Geochemical and mineralogical maps for soils of the conterminous United States. U.S. Geological Survey Open-File Report 2014–1082. 386 pages. http://dx.doi.org/10.3133/ofr20141082.

Table 7. Physical, chemical, and biological analyses conducted by the Soil Testing Laboratory for BCRET. Table

Parameter	Analytical method	Description	Source
Particle size distribution	Hydrometer	Measures amount of sand (2 – 0.05 mm), silt (0.05 – 0.002 mm), and clay (<0.002 mm) sized material in a sample. These size fractions influence material conductivity and chemical reactivity, with clay-sized material being most reactive.	Huluka, G., and Miller, R. 2014. Particle size determination by hydrometer method. *In*: F.J. Sikora and K.P. Moore, editors, Soil test methods from the southeastern United States. Southern Coop. Ser. Bull. 419. p. 180-184. Available at http://www.clemson.edu/sera6/MethodsManualFinalSERA6.pdf.
pH	Electrode	Determines the sample pH on a 1:2 (volume basis) solid:water slurry, measured by electrode using a Denver Instrument model 220 with an Orion electrode.	Sikora, F.J., and D.E. Kissel. 2014. Soil pH. *In*: F.J. Sikora and K.P. Moore, editors, Soil test methods from the southeastern United States. Southern Coop. Ser. Bull. 419. p. 48-53. Available at http://www.clemson.edu/sera6/MethodsManualFinalSERA6.pdf.
Electrical conductivity	Electrode	Solid:water 1:2 slurry, measured by electrode on an Oakton 510 series meter.	Wang, J.J., T. Provin, and H. Zhang. 2014. Measurement of soil salinity and sodicity. *In*: F.J. Sikora and K.P. Moore, editors, Soil test methods from the southeastern United States. Southern Coop. Ser. Bull. 419. P.185-193. Available at http://www.clemson.edu/sera6/MethodsManualFinalSERA6.pdf.
Chloride	Inductively-coupled plasma (ICP)	Solid:water 1:2 extract, Whatman 42 quantitative filter, ICP.	
Total dissolved P / Water extractable manure P		Solid:water 1:10 extract, 0.45 micron filter, ICP.	
Ammonium-N	Colorimetry	Method used for ammonium-nitrogen: 5g soil/15ml 2N KCl, shake for 15 minutes, filtered through Whatman 4 paper; analyzed on a Skalar autoanalyzer using a modified Berthelot reaction. Ammonia is chlorinated to monochloramine which reacts with salicylate to 5-aminosalicylate. After oxidation and oxidative coupling a green complex is formed. The absorption of the formed complex is measured at 660nm.	

Nitrate-N plus Nitrite-N	Colorimetry	Method used for nitrate-nitrogen plus nitrite-nitrogen, same KCl extraction as for ammonium-N, also analyzed on the Skalar using a method based on the cadmium reduction method. The sample is passed through a column containing granulated copper-cadmium to reduce the nitrate to nitrite. The nitrite (originally present plus reduced nitrate) is determined by diazotizing with sulfanilamide and coupling with a-naphthylenediamine dihydrochloride to form a highly colored azo dye which is measured at 540nm.	
Organic matter	Loss on ignition	Loss on ignition is equivalent to organic matter. Gravimetric measure, dried at 120 C for 2 hours to remove water, combusted at 360 C.	Zhang, H., and J.J. Wang. 2014. Loss on ignition method. In: F.J. Sikora and K.P. Moore, editors, Soil test methods from the southeastern United States. Southern Coop. Ser. Bull. 419. p.155-157. Available at http://www.clemson.edu/sera6/MethodsManualFinalSERA6.pdf.
Total C and N	Combustion	Total C and N are determined by combustion on an Elementar VarioMax CM.	
Total elemental analysis	Acid digest	Phosphorus, Potassium, Calcium, Magnesium, Sulfur, Sodium, Iron, Manganese, Zinc, Copper, and Boron determined by ICP equipped with cyclonic quartz spray chamber and optimist quartz nebulizer.	EPA 3050b
Mehlich-3 extractable elements	Melich-3 extraction and ICP	Phosphorus, Potassium, Calcium, Magnesium, Sulfur, Sodium, Iron, Manganese, Zinc, Copper, and Boron determined by ICP equipped with cyclonic quartz spray chamber and optimist quartz nebulizer.	Zhang, H., D.H. Hardy, R. Mylavarapu, and J.J. Wang. 2014. Mehlich-3. *In*: Sikora, F.J. and K.P. Moore, editors, Soil test methods from the southeastern United States. Southern Coop. Ser. Bull. 419. Clemson Univ., Clemson, S.C. p. 101-110. Available at http://www.clemson.edu/sera6/MethodsManualFinalSERA6.pdf.

Table 8. Particle-size distribution of the core samples taken from the bore hole drilling at C&H Farm, as determined by the Division of Agriculture University of Arkansas System Soil Testing and Research Laboratory, Fayetteville, AR.

Sample ID	Depth	Particle-size distribution †		
		Sand	Silt	Clay
	feet	---------- % ----------		
B-1S-1	0.5	24.2	33.1	42.7
B-1S-2	5	28.3	41.9	29.9
B-1S-3	10	5.1	8.1	86.9
B-1S-4	13.5	2.2	2.8	95.1
B-1S-5	18.5	8.9	1.5	89.7
B-1S-6	25	37.6	40.2	22.2

Table 9. Physio-chemical properties of the core samples taken from the bore hole drilling at C&H Farm, as determined by the Division of Agriculture University of Arkansas System Soil Testing and Research Laboratory, Fayetteville, AR.

Sample ID	Depth	pH	Electrical conductivity	Total dissolved P †	Chloride	Nitrate-N plus Nitrite-N	Ammonium-N	Total N	Total C	Organic matter
	feet		µmhos/cm	---------- mg/kg ----------				---------- % ----------		
B-1S-1	0.5	4.71	89	2.12	3.8	16.3	5.8	0.023	0.15	1.52
B-1S-2	5	5.2	62	1.97	3.8	7.2	7.4	0.023	0.20	1.34
B-1S-3	10	7.85	571	2.16	72.6	1.2	3.8	0.047	1.84	2.53
B-1S-4	13.5	7.71	458	3.08	93	0.7	6	0.070	0.20	2.84
B-1S-5	18.5	7.88	770	2.17	251.4	Not enough sample		0.061	0.43	2.25
B-1S-6	25	8.72	183	2.15	99.8	0.3	2.1	0.000	10.13	0.29
B-1S-1 duplicate	0.5	N.A. ‡	N.A.	N.A.	N.A.	17.0	5.5	0.028	0.16	1.92

† Equivalent to Water extractable manure P determined for inclusion in the Arkansas Phosphorus Index nutrient management planning and risk assessment tool. See Sharpley, A.N., P. Moore, K. VanDevender, M. Daniels, W. Delp, B. Haggard, T. Daniel, and A. Baber. 2010. Arkansas Phosphorus Index. Cooperative Extension Service, Division of Agriculture, University of Arkansas. Fact Sheet FSA 9531. 8 pages. http://www.uaex.edu/Other_Areas/publications/PDF/FSA-9531.pdf and Sharpley, A.N., M. Daniels, K. VanDevender, B. Haggard, N. Slaton, and C. West, C. 2010. Using the 2010 Arkansas Phosphorus Index. Cooperative Extension Service, Division of Agriculture, University of Arkansas. Miscellaneous Publication MP487. 17 pages. http://www.uaex.edu/Other_Areas/publications/PDF/MP487.pdf

‡ Not analyzed.

Table 10. Total elemental composition of core samples taken from the bore hole drilling at C&H Farm, as determined by the Division of Agriculture University of Arkansas System Soil Testing and Research Laboratory, Fayetteville, AR.

Sample ID	Depth	Total elemental analysis										
		Phosphorus	Potassium	Calcium	Magnesium	Sulfur	Sodium	Iron	Manganese	Zinc	Copper	Boron
	feet	mg/kg										
B-1S-1	0.5	281	1,101	1,262	1,024	62.8	19	49,571	364	33	7.4	12.5
B-1S-2	5	220	879	805	847	53.9	1	31,119	1,745	30	6.2	8.9
B-1S-3	10	1,031	3,488	69,480	3,417	7.2	296	51,696	1,169	273	23.6	12.9
B-1S-4	13.5	929	4,030	7,468	3,844	5.2	308	60,251	1,366	334	26.4	14.2
B-1S-5	18.5	747	3,434	14,752	3,516	0.5	369	50,122	1,620	184	24.6	13.9
B-1S-6	25	56	112	382,176	895	<0.1	105	1,764	227	8	0.5	1.0
B-1S-1 duplicate	0.5	275	1,174	1,228	1,072	67.9	21	45,645	392	36	7.9	12.2

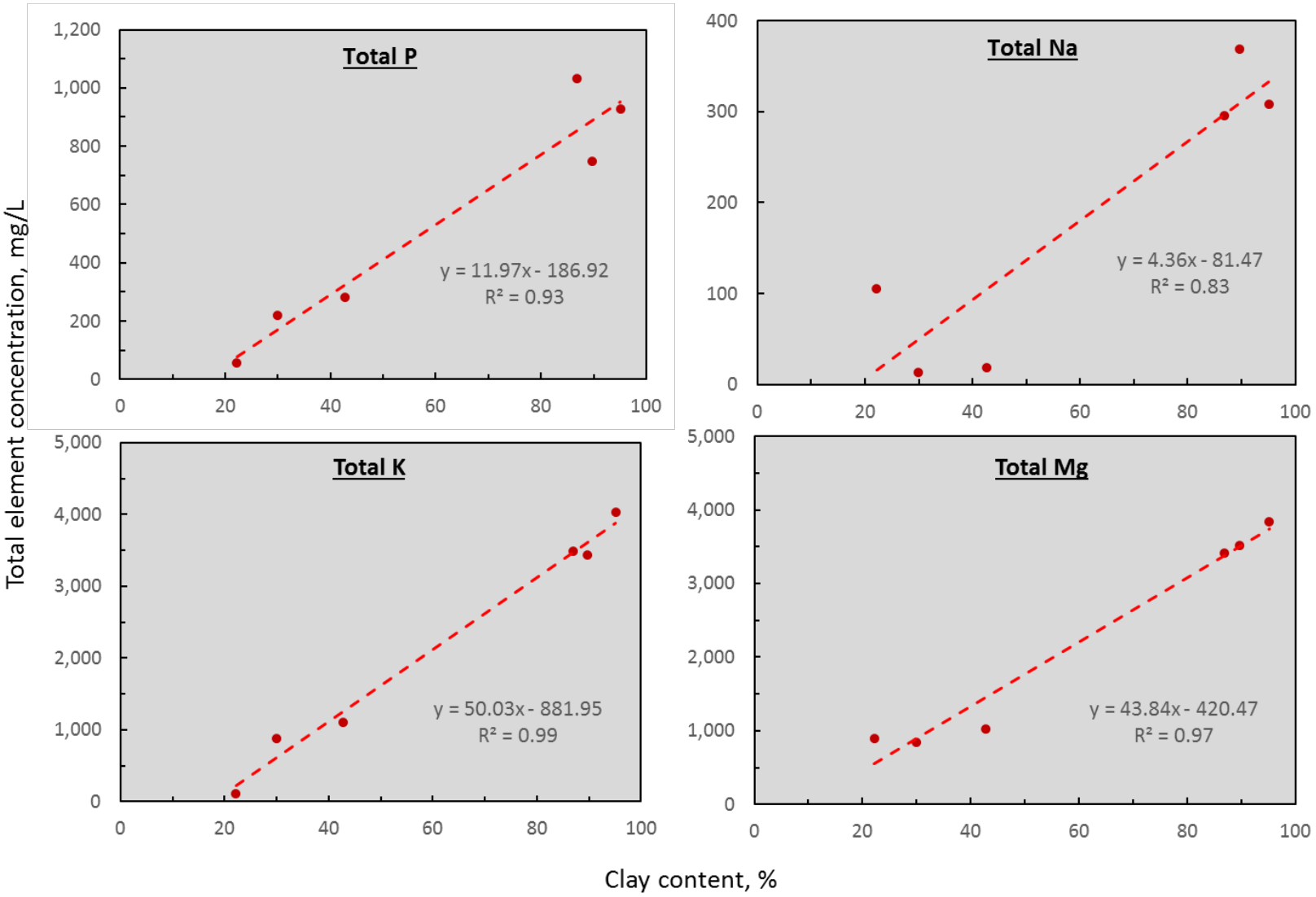


Figure 16. Relationship between total P, Na, K, and Mg concentration and clay content of core samples from the C&H Farm.

Table 11. Mehlich-3 extractable elemental composition of core samples taken from the bore hole drilling at C&H Farm, as determined by the Division of Agriculture University of Arkansas System Soil Testing and Research Laboratory, Fayetteville, AR.

Sample ID	Depth	Mehlich-3 extractable elements										
		Phosphorus	Potassium	Calcium	Magnesium	Sulfur	Sodium	Iron	Manganese	Zinc	Copper	Boron
	feet	mg/kg										
B-1S-1	0.5	0.75	87	1390	149	46	7.0	55.4	32.5	0.41	0.30	<0.01
B-1S-2	5	1.09	97	873	112	37.9	7.5	91.9	295.2	0.35	0.35	<0.01
B-1S-3	10	4.16	287	18133	704	3.8	233.4	35.6	39.6	9.95	0.60	<0.01
B-1S-4	13.5	0.84	314	7036	708	1.5	234.9	44.9	44.7	16.2	0.80	<0.01
B-1S-5	18.5	6.07	280	12742	594	3.1	280.2	49.0	81.4	6.66	0.92	<0.01
B-1S-6	25	0.59	14	34332	97	4.0	32.4	9.4	21.8	0.59	0.07	<0.01

Table 12. Relationship between cation exchange capacity, total elemental analysis and clay content of core samples collected from the C&H Farm. Number of samples is 6. Regression equation is Element = Intercept + Slope x Percent Clay.

Element	Intercept	Slope	R^2	Probability
CEC	7.63	-110.3	0.76*	0.0227
Total P	-186.92	11.97	0.93*	0.0017
Total Mg	-420.74	43.84	0.91*	0.0003
Total K	-881.95	50.03	0.99*	<0.0001
Total Na	-81.47	4.36	0.83*	0.0111
Total Zn	-100.25	3.99	0.89*	0.0050
Total Cu	-6.03	0.34	0.99	<0.0001
Total S	91.30	-0.95	0.92*	0.0095
Total Fe	8,694.11	524.85	0.66*	0.0493
Total B	3.10	0.12	0.64	0.0566
Total Ca	218,357.81	-2,276.14	0.25	0.3129
Total Mn	488.61	9.71	0.25	0.3128

* Significance determined by paired *t* test.

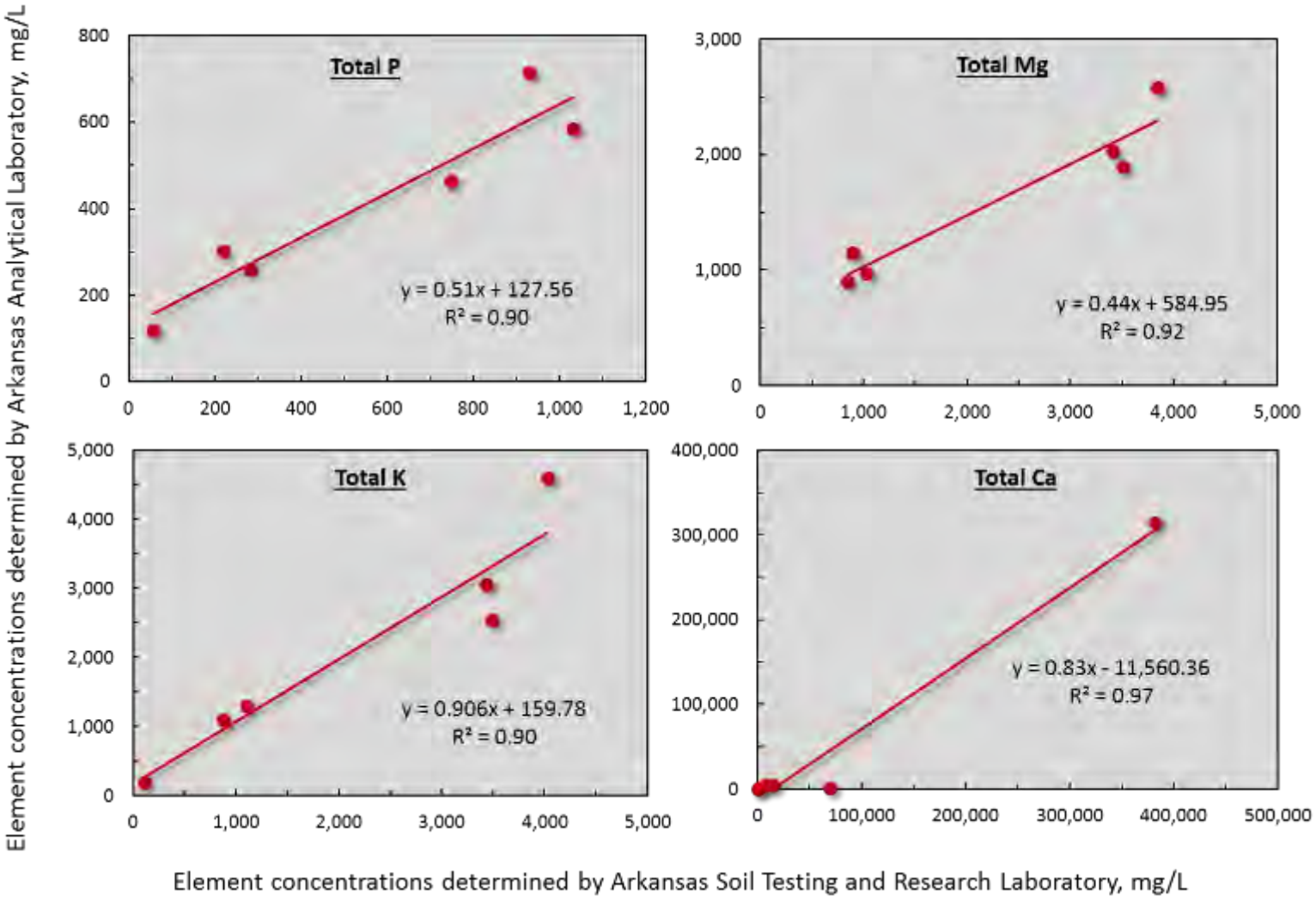


Figure 17. Relationship between total P, Mg, K, and Ca analysis conducted by Arkansas Analytical and the Division of Agriculture University of Arkansas System Soil Testing and Research Laboratory of core samples from the C&H Farm.

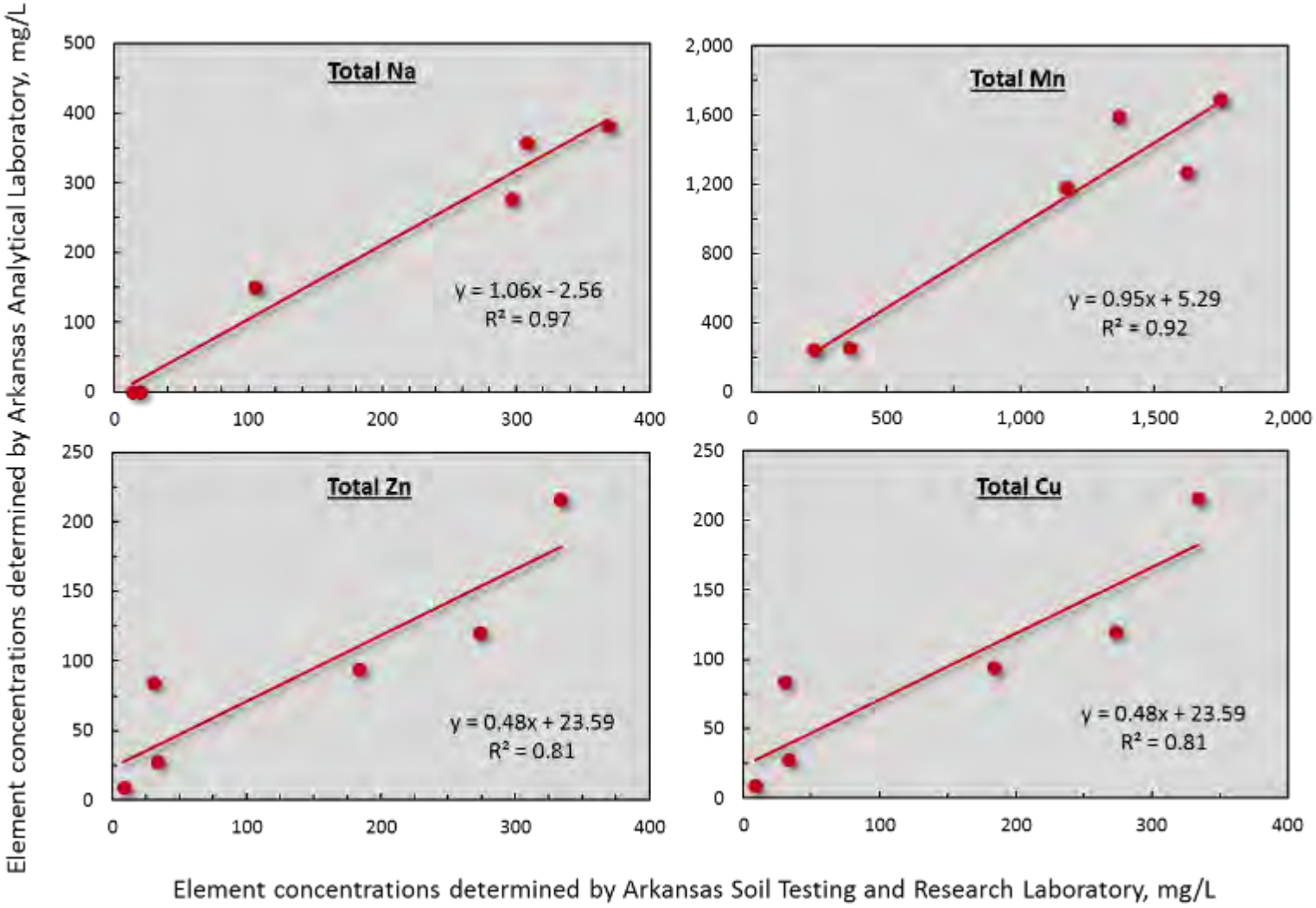


Figure 18. Relationship between total P, Mg, K, and Ca analysis conducted by Arkansas Analytical and the Division of Agriculture University of Arkansas System Soil Testing and Research Laboratory of core samples from the C&H Farm.

Grid-Soil Sampling

BCRET conducted grid-soil sampling of Fields 1, 5a, and 12 in February 2016. A grid network of approximately 0.25 acres was overlain on each field to determine the point of sampling, which were recorded with GPS. Each sample-hole remaining after the soil core was removed was carefully back-filled with commercial top soil. Where rock stopped the core penetrating below a specific layer, no sample was collected beyond that point. This February 2016 sampling is a repeat of the 2014 sampling and was conducted within a 5-foot radius of the original geo-referenced point in order to document any changes in soil composition with time and land management. The results of the 2016 sampling are presented in **Tables 1 to 6**. Unlike the 2014 grid sampling, samples were only collected from the 0 – 4 and 4 – 8 inch depths in February.

The spatial distribution of Mehlich-3 extractable soil P (Mehlich-3 P) only across Fields 1, 5a, and 12 are depicted in **Figures 1 to 3**, for both the 0 – 4 inch and 4 – 8 inch depths. Individual values of the points are noted on the figures. The ranges in Mehlich-3 P concentrations depicted are <25, 25 to 50, 50 – 100, and >100 mg/L, which depict general soil fertility and plant response categories of deficiency levels, optimum levels for cool season grasses, little response to additional P expected for cool and warm season grasses, and no plant growth response expected to added P, respectively.

It is evident from the Mehlich-3 P spatial distribution maps that some accumulation of P occurs in some areas within the surface 0 – 4 inch depth of Fields 1 and 12 (**Figures 1 and 3)**. These areas are generally located around areas of shade on Fields 1 and 12 (northern boundary of this field), where grazing cattle congregate to avoid the sun. On Field 12, the area of Mehlich-3 P greater than 100 mg/kg occurs on the southwest corner of the field and is located at the gated entrance to the field, where cattle are routinely fed hay. Further, individual points with elevated P levels on these fields may be due to cow pats that may no longer be visible at the surface. It should be noted that the accumulation of Mehlich-3 P in the southwest corner of Field 12 also was evident in the 2014 grid soil sampling (**Figure 4**), which was completed January 31, 2014 and that the first application of swine slurry to Field 12 did not occur until April 22, 2014. Thus, in-field spatial variations in Mehlcih-3 P for Field 12 are likely a function of land use and management prior to any swine slurry application. Amounts of swine slurry applied to the permitted fields at the end of December 2013, 2014, and 2015 are presented in **Table 7**.

Data from the 2014 grid-soil sampling are reported in BCRET Quarterly Reports provided for the fourth quarter of 2013 for Field 1 (see http://www.bigcreekresearch.org/project_reports/docs/CH%20Quarterly%20Report%20Oct%20-%20Dec%202013%20Sharpley.pdf), in the second quarter of 2015 for 5a (see http://www.bigcreekresearch.org/project_reports/docs/Quarterly%20Report%20April%20-%20June%202015.pdf), and in first quarter of 2014 for Field 12 (see http://www.bigcreekresearch.org/project_reports/docs/Quarterly%20Report%20Jan%20-%20March%202014.pdf).

Median grid-soil sample concentrations for 0 – 4 inch soil samples collected from Fields 1, 5a, and 12 in 2014 and 2016 are presented in **Table 8**. For Mehlich-3 P, median values for Fields 1 and 5a decreased

slightly from 2014 (59 and 71 mg/L, respectively) to 2016 (57 and 47 mg/L, respectively). For Field 12, however, Mehlich-3 P increased from 50 mg/L in 2014 to 79 mg/L in 2016 (**Table 8**). Differences among all other analytes were not statistically significant at the p <0.05 level (still to verify).

Results of the grid-soil sampling in 2014 and 2016 for Mehlich-3 P are graphically presented in **Figure 4** to more easily compare values. Finally, the difference between 2014 and 2016 grid-soil sampling Mehlich-3 P values for 0 – 4 and 4 – 8 inch samples are given in **Figures 5, 6, and 7**. Too few 4 – 8 inch soil samples were collected on Field 1 to meaningfully represent this field.

We have informed the land owner, who is looking at alternative areas to feed cattle on Field 12, and the owners of C&H Farms have agreed to not spread slurry on this area of the field in order to not contribute to any further increase in surface soil Mehlich-3 P levels. While these areas are not adjacent to the Big Creek river channel, which minimizes the potential for this P to reach the river, management changes are in place to address the accumulation.

Table 13. Soil analyses of 0 to 4 inch samples collected from Field 1, collected February 2016.

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
			mg/kg										
77294	7.2	49	17	189	9104	111	15	12	38	180	1.8	3.6	1
77296	7.5	49	29	117	9064	107	17	6	26	31	1.7	5.4	0.3
77298	6.8	18	123	176	2895	105	12	12	199	105	1.7	4.8	0.6
77300	7.4	39	32	163	7008	118	15	13	69	178	2	5.1	0.7
77302	6.7	31	65	241	5045	205	16	17	77	224	2.4	9.9	1
77304	6.9	18	77	202	2813	141	14	15	121	182	1.8	6.1	0.5
77307	6.4	16	121	274	2031	183	12	15	147	137	1.6	9.8	0.6
77309	6.7	12	44	241	1552	99	15	12	109	254	1.6	3.9	0.4
77311	6.8	14	89	350	1988	129	14	14	117	172	1.5	6.7	0.5
77313	6.1	15	74	238	2028	129	16	19	145	184	1.6	7.7	0.6
77315	6.1	13	63	245	1602	115	11	17	127	259	1.4	5.3	0.6
77318	6.0	12	45	192	1360	101	14	17	124	277	1.4	4.4	0.4
77320	5.8	13	54	185	1334	142	17	17	106	356	1.4	6.7	0.4
77322	5.3	15	72	590	1311	151	16	21	140	285	1.5	9	0.5
77324	5.2	9	43	77	494	53	7	11	195	66	1	2	0.2
77326	5.7	9	21	60	896	60	10	8	117	25	0.8	1.4	0.2
77328	5.2	10	45	106	776	72	13	12	166	58	1	2.5	0.3

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77331	5.2	11	59	151	828	81	13	14	205	90	0.9	3.3	0.4
77333	6.0	12	55	207	1395	93	12	14	147	80	1	4.2	0.6
77335	5.6	10	70	212	870	105	14	13	149	138	1.1	5.2	0.5
77337	6.1	14	85	279	1646	157	12	15	152	169	1.3	7.4	0.6
77339	5.8	18	96	351	2035	178	14	22	160	146	1.3	9.3	0.7
77342	5.5	9	31	176	724	77	11	10	108	148	1.2	2.5	0.4
77343	6.0	12	93	224	1255	148	11	16	137	269	1.7	7	0.5
77345	5.8	12	83	223	1148	96	12	10	143	190	1.5	4.5	0.5
77346	5.7	16	274	165	1927	146	16	20	250	101	12.3	28.6	0.7
77348	6.0	8	31	173	715	76	11	10	109	147	1.2	2.6	0.4
77350	6.4	9	77	206	1037	88	11	8	135	186	1.4	3.9	0.4
77355	6.3	16	130	413	2061	176	10	16	115	273	1.9	9.7	0.6
77357	5.8	16	87	418	1736	202	12	18	131	170	1.6	8.2	0.6
77359	6.3	14	56	154	1769	108	12	13	98	198	1.4	6.2	0.5
77361	5.5	11	109	177	986	177	12	14	149	155	1.5	10.2	0.5
77363	6.2	9	33	104	1075	91	9	8	90	226	1.1	5	0.5
77366	5.1	10	38	123	695	91	8	12	103	65	0.9	3.1	0.3
77368	6.9	13	49	161	1924	81	12	14	104	234	1.4	4.1	0.7
77370	5.1	10	28	98	748	77	16	14	102	390	1.1	2.8	0.4

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77372	5.6	12	115	348	1064	181	11	23	132	297	1.5	7	0.6
77374	6.0	15	126	334	1904	155	17	22	115	340	1.6	9.6	0.7
77376	5.6	14	90	283	1461	159	18	23	153	304	1.6	8.3	0.6
77379	5.4	21	66	378	2463	228	21	24	104	136	1.5	8.1	0.6
77381	5.7	17	103	382	1799	183	19	19	167	113	1.7	8.2	0.7
77383	5.4	14	67	124	1293	178	14	17	110	228	1.5	7.8	0.6
77385	6.0	14	16	85	1960	68	12	13	84	247	1.2	2.5	0.6
77387	5.4	12	51	110	1140	67	11	14	101	168	0.9	3.1	0.4
77390	6.3	22	19	65	3467	59	12	12	75	164	0.9	2.7	0.4
77392	5.0	9	44	69	568	40	14	16	143	75	0.8	2	0.3
77394	5.3	10	29	69	975	82	17	17	115	372	1.2	2.8	0.5
77396	5.4	9	33	60	739	56	13	17	121	374	1.2	3.2	0.4
77398	5.3	12	49	173	1124	78	16	19	105	383	1.2	2.7	0.5
77400	5.8	13	58	318	1361	133	23	19	120	442	1.5	5.8	0.7
77403	6.3	16	74	224	2235	126	16	18	103	295	1.5	6.5	0.7
77405	6.0	24	84	409	3299	226	19	18	80	215	1.4	6	0.7
77407	6.2	13	40	239	1643	108	15	16	128	201	1.1	4.1	0.6
77409	5.5	12	31	119	1102	86	18	14	155	193	0.9	3.2	0.4
77411	5.8	16	19	101	1956	83	17	15	87	364	1	3.3	0.5

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77414	4.9	10	36	43	656	34	12	11	115	70	0.5	1.4	0.3
77416	5.6	9	27	40	1005	37	14	14	118	215	0.8	2.1	0.4
77418	4.9	10	20	54	649	65	14	14	108	131	0.6	1.5	0.3
77420	5.8	10	17	148	900	90	16	12	104	283	0.8	1.8	0.4
77422	5.7	13	40	120	1555	93	14	18	106	290	1.2	3.6	0.4
77424	6.1	18	25	146	2516	123	17	16	69	280	1.8	4.5	0.6
77427	5.8	15	26	113	1832	97	13	18	77	222	0.9	2.2	0.3
77429	5.9	12	26	69	1478	65	15	17	103	232	1	3.3	0.3
77431	5.3	10	24	38	950	47	18	17	132	277	0.8	2.5	0.2
77433	6.0	16	22	93	2273	54	14	17	74	234	0.9	2.6	0.4
77435	4.9	9	25	43	528	47	12	13	115	94	0.6	1.5	0.2
77438	4.9	10	25	42	590	56	11	15	115	225	0.8	2	0.3
77440	5.6	12	55	142	1206	123	11	20	109	191	1	3.3	0.4
77442	5.5	14	27	71	1490	85	12	19	86	349	1.5	3.1	0.3
77444	6.5	26	22	181	4371	115	11	18	49	224	1.3	2.6	0.5
77446	5.4	14	28	81	1547	98	10	19	90	291	1.2	4.2	0.3
Mean	5.86	15	57	183	1845	110	14	15	118	209	1.44	5.09	0.49
Median	5.80	13	47	164	1428	99	14	16	115	208	1.30	4.15	0.50
Minimum	4.80	8	16	38	494	34	7	6	26	25	0.50	1.40	0.20

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
Maximum	7.50	49	274	590	9104	228	23	24	250	442	12.30	28.60	1.00
Standard deviation	0.59	8	40	113	1635	47	3	4	37	95	1.36	3.77	0.17
Coefficient of variation, %	10.2	52.5	70.7	61.8	88.6	43.0	21.7	24.6	31.4	45.1	94.7	74.2	34.3

Table 14. Soil analyses of 4 to 8 inch samples collected from Field 1, collected February 2016.

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
			mg/kg										
77295	7.1	47	11	151	8836	94	27	12	40	130	1.8	4.9	0.7
77297	7.9	48	29	77	9031	84	13	5	22	26	1.4	4.5	0.2
77299	6.8	13	118	136	1911	88	13	11	165	108	1.6	3.8	0.4
77301	7.7	38	18	126	7061	84	20	10	58	216	1.9	4.2	0.6
77303	7.0	34	53	174	5890	192	18	15	69	273	2.4	8.7	1.0
77306	7.1	18	36	133	2893	97	14	11	86	153	1.3	2.9	0.4
77308	6.1	14	83	220	1738	124	24	15	115	120	1.9	5.5	0.4
77310	6.4	9	25	243	1056	84	14	10	114	312	1.3	2.4	0.3
77312	6.6	11	52	278	1431	108	17	13	122	225	1.3	3.7	0.4
77314	6.1	13	54	143	1623	93	12	12	126	166	1.3	5.2	0.5
77316	6.3	10	42	187	1146	78	15	11	112	247	1.2	3.4	0.4
77319	6.3	10	26	115	1236	82	14	11	111	272	1.2	2.7	0.3
77321	6.0	12	17	83	1454	67	18	10	86	364	1.1	3.4	0.3
77323	5.8	11	36	324	1043	88	15	12	111	226	1.2	5.2	0.4
77325	6.5	5	12	51	319	31	10	8	182	37	1.0	1.2	0.2
77327	5.1	9	5	43	596	36	10	8	60	6	0.7	0.6	0.1
77330	5.3	8	24	75	510	45	9	11	132	41	0.9	1.5	0.3

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77332	5.0	9	43	112	547	54	11	12	193	80	0.9	2.5	0.4
77334	6.1	9	37	163	1008	70	11	10	123	60	0.9	2.5	0.4
77336	5.7	8	29	128	640	57	12	9	114	118	0.9	2.1	0.3
77338	6.0	10	44	158	1130	103	14	11	114	171	1.1	4.1	0.4
77340	6.0	9	49	193	907	89	9	9	144	107	0.9	3.4	0.5
77344	6.3	7	28	162	750	72	12	8	100	250	1.3	2.5	0.4
77347	5.7	19	27	113	2538	116	10	13	118	298	1.6	3.7	0.7
77349	6.0	8	28	178	806	75	10	8	102	261	1.3	2.6	0.4
77354	6.1	14	119	251	1767	136	12	16	172	207	1.7	8.3	0.6
77356	6.4	13	69	291	1564	128	11	11	95	323	1.6	4.5	0.5
77358	6.0	14	38	279	1763	151	14	15	95	196	1.4	4.5	0.5
77360	6.2	9	24	66	1053	67	15	9	80	163	1.5	3.3	0.3
77362	5.6	7	55	129	497	72	10	8	107	86	1.0	2.9	0.3
77364	6.4	8	22	79	1048	60	11	7	99	221	1.0	3.6	0.5
77367	5.3	7	18	92	412	39	9	7	83	25	0.8	1.0	0.3
77369	6.5	9	21	96	1183	49	12	9	99	228	1.1	2.0	0.4
77371	5.6	7	8	35	554	46	14	8	93	360	1.0	1.4	0.3
77373	6.1	9	51	245	819	123	12	10	101	300	1.2	2.6	0.5
77375	6.3	9	40	147	1056	70	10	8	94	344	1.2	2.7	0.5

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77378	5.7	13	26	148	1469	132	21	13	117	362	1.6	6.5	0.5
77380	5.9	29	4	248	4646	115	36	13	43	35	0.8	1.4	0.4
77382	5.8	16	50	214	1746	142	23	13	100	128	1.3	3.2	0.5
77384	5.9	10	41	90	1083	113	17	12	134	249	1.3	4.6	0.5
77386	6.5	16	4	70	2430	29	14	6	68	263	1.0	1.3	0.5
77388	6.1	6	18	32	589	26	11	7	88	84	0.7	1.3	0.4
77391	6.1	17	4	65	2689	20	16	6	69	118	0.8	1.3	0.4
77393	5.0	8	24	32	493	23	12	10	102	46	0.7	1.1	0.3
77395	5.8	8	6	33	721	31	12	7	94	303	1.0	1.2	0.4
77397	4.9	10	12	44	648	36	13	11	99	309	1.0	1.9	0.4
77399	5.4	8	10	149	561	33	12	14	109	330	1.0	1.0	0.3
77402	6.0	9	14	153	993	82	14	8	105	391	1.0	2.3	0.4
77404	6.4	11	16	84	1340	70	20	9	90	310	0.9	2.1	0.4
77406	6.6	32	22	236	5404	141	25	11	49	142	0.9	2.2	0.5
77408	6.0	9	13	124	1047	74	12	9	80	138	0.7	1.5	0.4
77410	5.5	10	10	50	961	55	13	8	85	145	0.7	1.2	0.3
77412	6.3	20	9	110	3113	45	19	12	84	333	1.0	1.9	0.5
77415	5.4	7	7	26	527	21	12	6	75	38	0.4	0.9	0.2
77417	5.6	8	9	26	851	16	9	7	92	186	0.6	1.1	0.3

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77419	5.0	11	6	42	857	68	12	8	66	65	0.5	0.8	0.3
77421	5.4	9	4	73	765	62	14	7	107	256	0.6	1.2	0.3
77423	5.7	11	12	65	1138	52	16	9	102	266	0.9	1.6	0.3
77426	5.8	18	13	94	2471	74	17	15	70	293	1.5	2.1	0.4
77428	5.0	20	6	109	2601	54	17	16	53	106	0.6	1.2	0.2
77430	5.8	10	7	37	1045	29	13	10	85	216	0.6	1.1	0.2
77432	5.6	9	14	34	999	31	18	13	108	230	0.8	1.7	0.2
77434	5.9	17	8	76	2627	25	16	12	64	193	0.7	1.6	0.3
77436	4.8	9	6	35	531	36	15	8	60	36	0.4	1.0	0.2
77439	5.1	9	9	35	599	40	12	11	104	211	0.7	1.3	0.2
77441	5.8	9	28	73	846	80	12	14	98	151	0.8	1.7	0.3
77443	5.5	13	13	56	1391	59	14	15	87	351	1.4	1.7	0.2
77445	6.8	24	7	135	4178	53	15	11	40	189	1.0	1.3	0.5
77447	5.8	15	17	69	2181	57	12	17	77	336	1.4	3.0	0.4
Mean	5.98	13	27	121	1759	72	14	10	96	196	1.1	2.7	0.4
Median	6.00	10	21	110	1056	70	13	10	98	207	1.0	2.2	0.4
Minimum	4.80	5	4	26	319	16	9	5	22	6	0.4	0.6	0.1
Maximum	7.90	48	119	324	9031	192	36	17	193	391	2.4	8.7	1.0

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
Standard deviation	0.62	8.8	24	75	1808	37	5	3	32	105	0.4	1.7	0.1
Coefficient of variation, %	10.34	65.5	89	62	103	52	32	27	33	53	35.5	63.7	36.8

Table 15. Soil analyses of 0 to 4 inch samples collected from Field 5a, collected February 2016.

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
			mg/kg										
77198	4.6	8	49	38	260	28	7	26	114	237	0.5	1.3	0.2
77200	4.4	14	12	77	905	150	12	12	55	37	0.3	0.4	0.1
77202	5.9	19	10	95	2810	42	11	9	104	114	2.1	3.6	0.6
77204	6.7	19	20	94	3068	66	15	12	135	174	2.5	4.9	0.8
77206	5.9	15	16	73	2090	82	10	9	115	179	2.1	3.4	0.4
77208	5.4	14	24	67	1570	87	9	11	132	151	2.2	3.0	0.3
77211	5.5	12	37	58	1147	72	9	10	184	184	1.5	2.9	0.3
77213	5.2	11	33	40	987	55	7	8	164	120	1.0	2.7	0.3
77215	5.7	11	26	39	1212	74	10	8	159	154	1.1	2.8	0.3
77217	5.0	11	50	95	830	99	8	14	86	181	0.6	2.9	0.3
77219	4.6	9	84	36	441	30	11	23	107	264	0.6	1.6	0.2
77222	4.7	9	75	58	525	58	10	20	112	220	0.7	2.1	0.2
77224	5.9	17	29	88	2492	78	14	14	105	123	1.9	4.4	0.6
77226	5.2	11	30	67	980	87	9	13	147	149	1.3	1.7	0.3
77228	5.3	12	65	79	1161	83	11	12	187	189	1.9	2.8	0.3
77230	5.2	13	51	75	1130	85	19	11	196	140	1.3	2.4	0.3
77232	5.7	12	28	39	1287	73	11	9	143	145	1.2	3.4	0.4

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77235	6.3	15	25	52	2198	81	10	11	142	172	1.5	4.1	0.7
77237	4.5	9	61	50	377	37	11	23	112	259	0.7	1.7	0.2
77239	6.3	21	34	150	3177	95	23	14	117	141	2.2	5.7	0.8
77241	5.1	10	47	76	778	85	8	12	174	202	1.5	2.6	0.3
77243	5.4	10	43	57	874	62	8	9	183	173	1.0	2.5	0.3
77246	5.1	11	79	96	945	80	7	11	186	236	2.4	4.2	0.3
77248	5.8	15	21	55	1834	79	7	10	143	158	1.5	4.1	0.5
77250	5.7	16	23	51	1953	91	8	9	138	182	1.5	4.0	0.6
77252	5.5	10	46	62	854	74	8	11	172	240	2.0	3.6	0.3
77254	5.0	11	58	80	841	89	10	12	165	113	0.7	1.7	0.2
77256	5.1	9	33	45	506	71	9	14	165	210	1.1	2.3	0.2
77259	5.7	22	21	103	3059	70	19	18	146	158	2.5	5.2	0.8
77261	5.2	10	49	78	756	93	12	18	178	270	1.7	2.2	0.3
77263	6.0	13	24	73	1785	50	16	11	142	142	1.5	2.4	0.5
77265	5.1	9	45	47	468	67	15	14	171	212	1.4	2.8	0.2
77267	5.0	10	47	84	622	88	8	16	171	209	1.7	2.6	0.3
77270	4.9	10	41	64	626	67	8	15	170	240	2.3	2.5	0.3
77272	5.2	11	39	73	905	83	10	13	136	82	1.5	1.8	0.4
77274	6.7	19	19	87	3128	56	11	12	121	145	2.0	3.5	0.7

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77276	4.7	8	77	40	341	48	7	16	207	134	1.3	2.1	0.3
77278	5.9	11	46	61	1288	110	10	15	140	181	1.9	3.0	0.4
77280	5.2	10	44	84	609	86	7	14	138	110	1.2	2.4	0.3
77283	4.7	8	40	38	358	34	10	15	173	152	1.6	1.6	0.3
77285	4.9	9	39	48	457	57	11	14	165	189	1.8	1.9	0.3
77287	5.1	12	35	100	987	93	10	12	202	134	1.6	2.0	0.3
77289	6.1	13	12	67	1719	27	14	7	131	177	2.4	2.3	0.4
77291	4.9	13	30	73	1027	87	10	16	187	128	1.6	2.1	0.3
Mean	5.36	12	39	68	1258	73	11	13	148	171	1.5	2.8	0.4
Median	5.20	11	37	67	987	78	10	12	146	172	1.5	2.6	0.3
Minimum	4.50	8	10	36	341	27	7	7	86	82	0.6	1.6	0.2
Maximum	6.70	22	84	150	3177	150	23	26	207	270	2.5	5.7	0.8
Standard deviation	0.51	3.3	18	23	771	20	4	4	30	45	0.5	1.0	0.2
Coefficient of variation, %	9.55	26.9	45.6	33.4	61.3	26.8	33.4	28.1	20.0	26.4	34.0	35.0	43.1

Table 16. Soil analyses of 4 to 8 inch samples collected from Field 5a, collected February 2016.

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
			mg/kg										
77199	4.7	7	22	24	212	16	9	19	108	281	0.5	0.9	0.1
77201	4.2	12	36	60	656	105	10	20	93	151	0.3	0.8	0.2
77203	5.9	19	19	96	2859	72	13	12	115	114	2.1	5.0	0.6
77205	6.3	18	10	83	2760	50	14	8	106	211	2.5	3.4	0.6
77207	6.1	15	8	71	2088	47	10	6	110	185	2.3	2.4	0.4
77210	5.5	17	15	81	2096	65	11	10	139	155	3	2.4	0.4
77212	5.6	11	32	56	1198	42	9	6	152	143	1.8	2.0	0.2
77214	5.5	9	34	37	918	30	7	6	184	111	1.0	2.1	0.2
77216	5.9	10	19	40	1176	42	9	5	137	123	1.2	1.9	0.3
77218	4.9	9	32	50	477	47	8	12	97	246	0.6	1.6	0.2
77220	4.9	8	35	23	358	22	18	13	98	236	0.8	1.2	0.2
77223	4.9	9	26	29	466	24	15	13	100	230	0.8	1.2	0.2
77225	5.8	16	13	68	2016	40	14	9	98	161	1.7	2.9	0.5
77227	5.2	12	18	66	1075	64	8	11	138	114	1.4	1.1	0.3
77229	5.3	13	50	75	1376	50	9	7	154	148	2.0	1.7	0.3
77231	5.5	12	43	72	1218	45	9	7	173	116	1.1	1.3	0.3
77234	5.8	9	21	30	1005	29	8	5	149	119	1.1	2.2	0.3

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77236	6.5	12	18	41	1675	38	10	7	127	128	1.4	3	0.5
77238	4.5	9	37	33	381	21	11	21	104	253	0.8	1.3	0.2
77240	6.6	19	12	116	3024	76	19	8	103	163	2.3	4.1	0.6
77242	5.1	10	30	58	802	56	10	8	156	159	1.6	1.7	0.2
77244	5.7	9	44	53	895	38	8	7	171	134	1.1	1.6	0.2
77247	5.4	10	65	81	1059	45	8	8	178	204	2.9	3.2	0.3
77249	6.0	14	12	58	2010	51	10	7	129	131	1.5	2.4	0.5
77251	6.0	10	17	35	1220	39	7	5	123	134	1.1	2.5	0.4
77253	5.5	10	33	50	936	43	9	7	148	171	2.3	2.4	0.3
77255	5.0	10	65	74	858	57	9	8	144	58	0.8	0.9	0.2
77258	4.9	9	22	42	498	51	9	13	155	174	1.5	1.6	0.2
77260	6.2	17	11	85	2596	40	15	10	123	177	2.5	3.5	0.6
77262	5.1	9	19	50	579	44	17	12	133	138	1.2	1.0	0.2
77264	6.0	13	18	73	1694	34	15	7	138	125	1.3	1.3	0.3
77266	5.2	8	26	38	480	43	9	9	150	222	1.6	2.0	0.2
77268	5.3	8	22	61	664	49	12	12	153	179	2.0	1.3	0.3
77271	5.3	9	24	55	814	44	9	10	165	226	2.6	1.8	0.3
77273	4.8	11	37	73	827	63	12	12	127	64	1.4	1.0	0.5
77275	6.4	16	12	71	2310	29	9	8	120	165	1.9	2.9	0.5

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77277	4.7	8	66	32	307	34	6	11	176	143	1.3	1.9	0.2
77279	6.0	10	26	51	1167	88	9	11	130	161	1.6	2.1	0.4
77282	5.0	10	36	72	645	64	16	11	143	90	1.7	1.3	0.3
77284	4.9	9	26	33	471	23	10	10	159	163	1.6	1.3	0.3
77286	4.9	9	21	45	564	31	10	8	137	133	1.6	1.1	0.2
77288	5.1	11	32	99	907	90	13	10	158	102	1.4	1.2	0.3
77290	6.0	14	22	62	1902	50	27	14	141	190	2.3	3.6	0.6
77292	4.8	11	14	72	805	57	12	14	150	96	1.2	1.1	0.3
Mean	5.43	11	27	59	1183	47	11	10	136	157	1.6	2.0	0.3
Median	5.35	10	23	58	927	45	10	10	138	153	1.5	1.8	0.3
Minimum	4.20	7	8	23	212	16	6	5	93	58	0.3	0.8	0.1
Maximum	6.60	19	66	116	3024	105	27	21	184	281	3.0	5.0	0.6
Standard deviation	0.58	3	14	21	749	19	4	4	25	50	0.6	1.0	0.1
Coefficient of variation, %	10.69	28.2	52.7	36.5	63.4	39.6	35.1	37.6	18.0	31.6	40.9	48.1	42.9

Table 17. Soil analyses of 0 to 4 inch samples collected from Field 12, collected February 2016.

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
			mg/kg										
77102	5.4	11	148	353	961	129	14	15	214	254	1.5	7.4	0.7
77104	5.5	11	190	183	981	112	16	18	211	244	1.6	5.3	0.5
77106	5.3	10	160	183	912	96	18	16	175	238	1.6	4.8	0.4
77108	5.4	10	178	146	795	92	12	15	196	256	1.7	4.1	0.4
77110	5.2	10	172	119	766	78	11	13	206	216	1.4	3.5	0.4
77112	5.8	16	97	129	1830	134	14	15	215	140	2.4	5.3	0.6
77115	5.2	11	193	189	864	113	22	17	215	251	1.6	6.3	0.4
77117	5.1	11	167	185	751	108	16	16	192	247	1.4	4.8	0.3
77119	5.2	11	168	159	883	117	27	16	206	222	1.6	5.9	0.4
77121	5.5	12	73	82	1176	86	15	13	162	156	1.7	3.2	0.4
77123	5.6	12	49	70	1307	104	16	11	157	156	1.5	3.0	0.4
77126	5.4	10	40	63	991	65	9	8	143	123	1.1	2.2	0.2
77128	5.3	9	115	115	661	88	18	15	149	193	1.3	4.1	0.3
77130	4.9	12	186	276	739	103	24	19	185	215	1.5	5.2	0.4
77132	5.7	12	112	101	1297	115	25	16	172	200	1.9	4.7	0.4
77134	5.3	14	123	75	1316	154	26	16	227	216	2.0	7.2	0.5
77136	5.6	14	101	95	1568	162	27	17	204	175	1.8	5.8	0.5

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77139	5.3	10	64	48	976	80	9	15	241	174	1.3	3.6	0.3
77141	5.1	11	138	147	772	99	24	22	147	174	1.2	5.3	0.3
77143	5.2	15	103	98	1408	128	27	23	175	169	2.1	4.5	0.5
77145	6.0	13	76	121	1575	135	23	19	163	159	1.4	4.2	0.5
77147	5.5	14	97	107	1333	126	21	18	197	232	1.7	6.5	0.5
77150	5.5	10	81	60	962	80	12	16	255	219	1.4	4.0	0.4
77152	5.5	14	57	109	1479	115	30	19	161	195	1.6	3.9	0.5
77154	5.1	17	123	117	1752	165	24	23	195	138	2.1	6.7	0.5
77156	5.5	13	91	102	1225	109	24	22	153	227	1.8	5.2	0.4
77158	5.3	17	59	91	1848	139	29	20	170	109	2.0	4.3	0.5
77160	5.7	13	79	122	1393	122	23	22	187	201	1.8	5.1	0.5
77163	5.6	12	65	164	1135	111	19	15	183	187	1.4	4.0	0.4
77165	5.9	9	77	94	930	108	21	14	181	161	1.2	4.3	0.4
77167	6.1	11	27	59	1378	107	6	9	163	164	1.3	3.8	0.5
77169	5.8	12	55	59	1386	98	9	12	177	174	1.7	3.9	0.4
77171	5.8	17	65	95	2178	139	31	15	133	90	2.1	5.3	0.7
77174	5.4	16	72	85	1697	141	31	15	143	110	2.3	5.1	0.6
77176	5.9	16	65	109	2099	151	40	14	157	137	2.5	5.2	0.6
77178	5.4	14	76	94	1389	101	27	15	187	162	2.2	4.3	0.5

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77180	5.3	14	77	110	1493	121	19	16	192	178	2.4	5.0	0.6
77182	5.5	11	117	79	941	124	23	13	234	202	1.8	7.5	0.6
77184	6.0	17	63	107	2593	75	28	18	136	141	2.3	6.0	1.0
77187	5.3	17	146	245	1791	178	27	19	178	88	2.3	7.0	0.4
77189	5.4	17	117	207	1737	162	20	15	166	94	1.8	5.1	0.5
77191	5.6	15	65	123	1632	142	27	14	161	113	1.8	3.8	0.4
77193	5.3	15	151	315	1326	185	24	18	165	144	1.6	6.9	0.5
77195	5.6	13	82	110	1464	128	22	13	159	143	1.6	5.0	0.4
77470	5.4	10	104	84	845	106	12	16	220	162	1.6	4.2	0.3
Mean	5.48	13	104	129	1301	118	21	16	182	177	1.7	4.9	0.5
Median	5.40	12	97	109	1316	115	22	16	178	174	1.7	5.0	0.4
Minimum	4.90	9	27	48	661	65	6	8	133	88	1.1	2.2	0.2
Maximum	6.10	17	193	353	2593	185	40	23	255	256	2.5	7.5	1.0
Standard deviation	0.27	2	45	66	433	28	7	3	29	47	0.4	1.2	0.1
Coefficient of variation, %	4.88	19.4	43.1	51.6	33.3	23.4	34.6	20.6	15.9	26.4	20.7	24.7	28.7

Table 18. Soil analyses of 4 to 8 inch samples collected from Field 12, collected February 2016.

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
			mg/kg										
77103	5.7	9	107	315	701	96	17	13	158	249	1.3	4.5	0.4
77105	5.6	9	142	97	814	67	16	12	154	170	1.3	2.4	0.3
77107	5.5	10	88	93	847	59	20	12	141	202	1.5	2.1	0.3
77109	5.6	9	118	68	883	65	20	12	163	210	1.7	2.1	0.3
77111	5.7	9	116	77	827	45	14	11	164	149	1.4	1.7	0.4
77114	5.7	15	49	92	1766	104	17	11	153	115	2.4	2.9	0.7
77116	5.6	9	106	107	799	71	17	13	165	203	1.3	2.4	0.4
77118	5.2	10	104	103	723	71	16	13	160	195	1.4	2.3	0.3
77120	5.8	8	73	77	763	47	16	8	131	137	1.2	1.5	0.2
77122	5.7	12	41	66	1356	59	17	10	133	111	1.9	2.0	0.3
77124	6.1	12	25	63	1491	69	15	9	119	115	1.6	1.6	0.4
77127	5.7	10	24	56	1009	48	11	7	106	81	1.1	1.2	0.2
77129	5.4	9	45	66	691	41	18	10	106	127	1.5	1.4	0.2
77131	5.2	10	120	106	756	57	19	14	149	149	1.4	2.4	0.3
77133	5.8	13	60	62	1483	66	25	12	140	143	2.0	2.1	0.4
77135	5.7	13	38	57	1575	73	19	10	146	160	2.0	2.2	0.4
77138	5.7	14	28	64	1639	81	21	14	133	142	1.6	1.8	0.4

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77140	5.8	8	35	32	675	28	9	9	134	94	0.9	1.4	0.2
77142	5.1	9	33	56	653	28	14	16	95	99	0.8	0.9	0.2
77144	5.7	11	47	44	1108	54	20	15	106	92	1.8	1.4	0.3
77146	5.8	13	27	67	1547	83	17	14	115	116	1.4	1.4	0.4
77148	6.0	12	23	54	1472	72	18	12	134	162	1.9	2.1	0.4
77151	5.7	9	45	42	859	43	15	12	157	145	1.2	2.0	0.3
77153	6.2	12	19	57	1567	60	28	14	115	123	1.7	1.2	0.4
77155	5.6	16	50	68	1904	96	23	16	145	121	2.2	2.9	0.5
77157	5.9	10	34	57	1154	44	17	15	103	144	1.5	1.5	0.4
77159	5.6	17	23	65	2111	104	24	18	124	97	2.1	1.9	0.4
77162	5.6	12	26	73	1350	82	20	15	117	114	1.8	1.9	0.3
77164	5.8	12	32	96	1314	81	20	12	132	142	1.8	1.8	0.4
77166	5.5	11	21	67	1072	65	13	11	106	78	1.0	1.2	0.2
77168	6.1	11	27	61	1288	77	7	7	151	125	1.8	3.0	0.4
77170	5.8	12	35	56	1291	46	7	8	133	131	1.8	2.1	0.3
77172	5.9	15	22	65	2202	83	26	11	108	75	1.9	1.9	0.7
77175	5.8	17	19	68	2190	95	28	11	118	86	2.5	1.9	0.5
77177	6.1	17	20	85	2477	97	24	11	132	101	2.6	2.3	0.6
77179	5.7	13	37	72	1516	72	27	11	148	132	2.3	2.6	0.5

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77181	5.8	15	28	86	1714	81	16	12	147	141	2.7	2.5	0.6
77183	5.6	10	36	50	962	64	16	9	142	143	1.7	2.6	0.6
77186	6.2	17	17	81	2600	35	29	11	108	113	1.7	2.0	0.6
77188	5.7	16	55	140	1864	117	21	12	145	62	2.1	2.5	0.4
77190	5.7	15	50	122	1810	126	17	11	135	66	1.9	2.2	0.4
77192	5.7	14	30	75	1592	104	16	11	124	88	1.7	1.9	0.4
77194	5.4	13	61	181	1272	131	15	13	137	86	1.5	2.3	0.4
77196	6.0	11	37	68	1381	86	17	8	131	123	1.6	2.3	0.3
77471	5.4	10	64	76	885	60	14	13	156	105	1.7	1.9	0.3
Mean	5.71	12	50	81	1332	72	18	12	134	128	1.7	2.0	0.4
Median	5.70	12	37	68	1314	71	17	12	134	123	1.7	2.0	0.4
Minimum	5.10	8	17	32	653	28	7	7	95	62	0.8	0.9	0.2
Maximum	6.20	17	142	315	2600	131	29	18	165	249	2.7	4.5	0.7
Standard deviation	0.24	3	33	44	509	25	5	2	19	40	0.4	0.6	0.1
Coefficient of variation, %	4.26	22.4	66.1	55.0	38.2	34.1	28.3	20.7	14.2	31.4	25.3	29.8	33.3

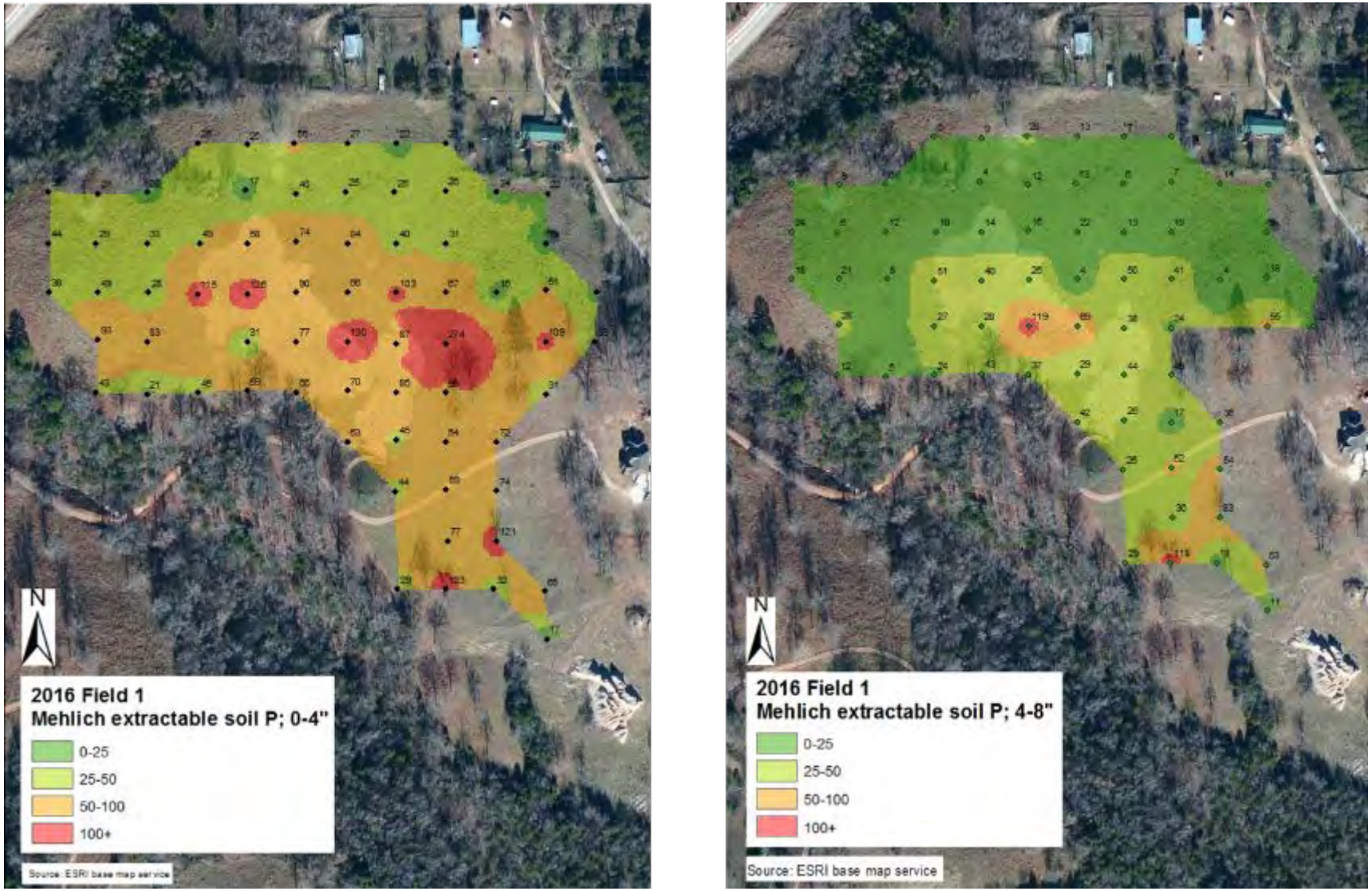


Figure 19. Map of Mehlich-3 extractable soil P in grid-soil sampling of Field 1 for 0 - 4 and 4 – 8 inch samples collected February 2016.

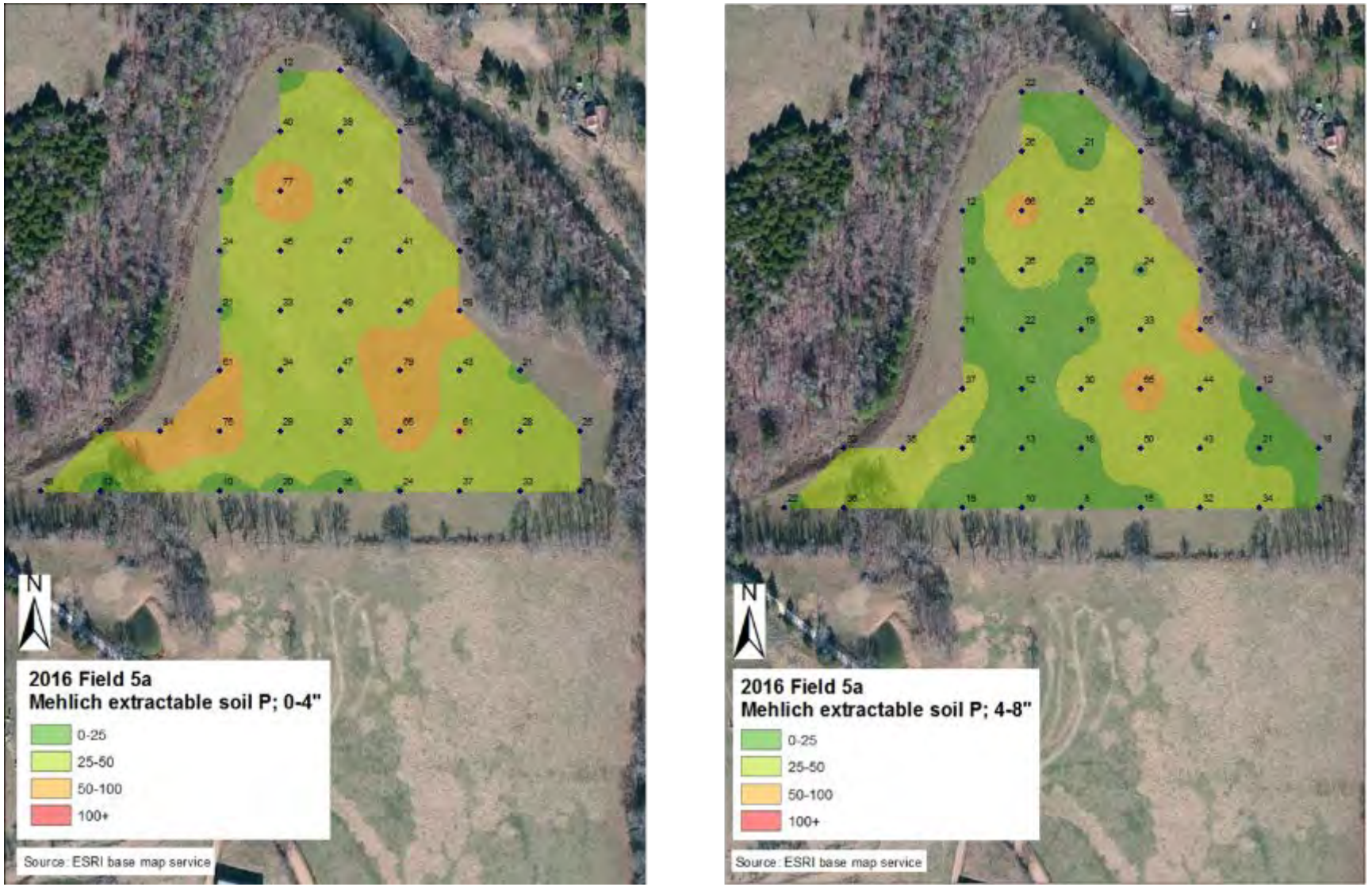


Figure 20. Map of Mehlich-3 extractable soil P in grid-soil sampling of Field 5a for 0 - 4 and 4 – 8 inch samples collected February 2016..

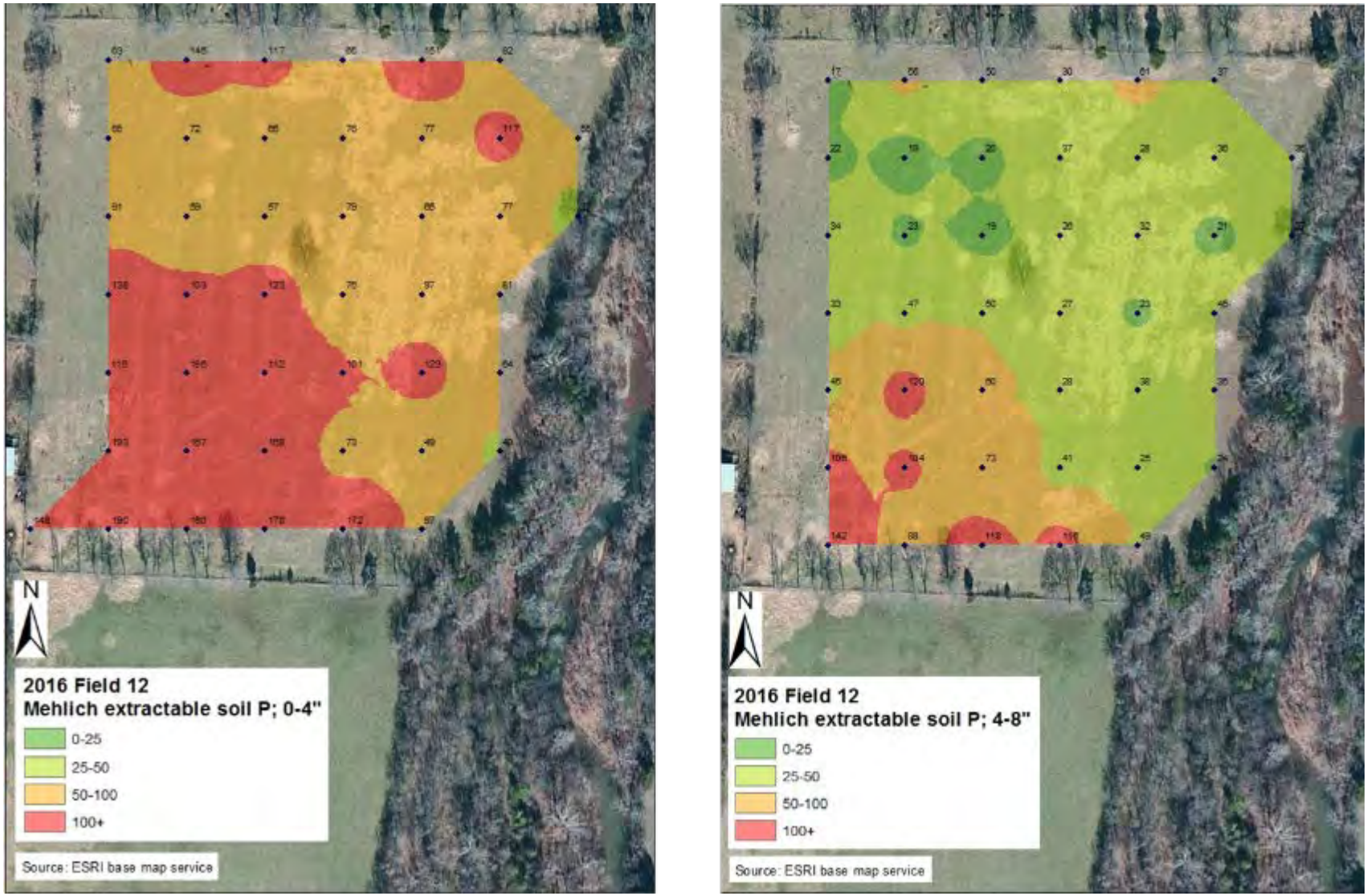


Figure 21. Map of Mehlich-3 extractable soil P in grid-soil sampling of Field 12 for 0 - 4 and 4 – 8 inch samples collected February 2016.

Table 19. Swine slurry applications for 2013, 2014, and 2015 for the C&H Farm operation.

Field	2013 & 2014				2015			
	Gallons applied	Acres	Average gal/acre applied	Average inches applied	Gallons applied	Acres	Average gal/acre applied	Average inches applied
1	46,000	13.0	3,538	0.13	46,000	13.0	3,538	0.13
2	22,600	6.0	3,767	0.14	22,600	6.0	3,767	0.14
3	118,100	27.0	4,374	0.16	118,100	27.0	4,374	0.16
4	28,800	8.5	3,388	0.12	28,800	8.5	3,388	0.12
7	396,200	123.0	3,221	0.12	396,200	123.0	3,221	0.12
8	25,000	9.0	2,778	0.10	25,000	9.0	2,778	0.10
9	103,800	35.0	2,966	0.11	103,800	35.0	2,966	0.11
10	249,200	64.0	3,894	0.14	249,200	64.0	3,894	0.14
11	51,000	17.0	3,000	0.11	51,000	17.0	3,000	0.11
12	48,000	9.9	4,848	0.18	48,000	9.9	4,848	0.18
13	453,550	151.0	3,004	0.11	453,550	151.0	3,004	0.11
14	73,000	23.0	3,174	0.12	73,000	23.0	3,174	0.12
15	434,400	150.0	2,896	0.11	434,400	150.0	2,896	0.11
16	56,000	9.0	6,222	0.23	56,000	9.0	6,222	0.23
17	294,750	105.0	2,807	0.10	294,750	105.0	2,807	0.10

Table 20. Median concentrations (mg/L) of Mehlich-3 extractable elements for 0 to 4 inch soil samples collected in the 2014 and 2016 grid sampling of Fields 1, 5a, and 12 under the C&H Farm operation plan. Parameters followed by the same letter for any given for any given fields are not significantly different between 2014 and 2016 grid-soil samplings, as determined by paired *t* test with a <0.0001 level of probability.

Parameter	Field 1		Field 5a		Field 12	
	2014	2016	2014	2016	2014	2016
No. samples	72	71	33	44	40	45
Phosphorus	54 a	47 a	47 a	37 a	50 b	97 a
Potassium	143 a	164 a	51 a	67 a	68 b	109 a
Calcium	1,591 a	1,428 a	987 a	987 a	1,132 b	1,316 a
Magnesium	107 a	99 a	69 a	78 a	80 b	115 a
Sodium	12 a	14 a	11 a	10 a	10 b	22 a
Sulfur	18 a	16 b	12 a	12 a	14 b	16 a
Iron	109 b	115 a	153 a	146 a	118 b	178 a
Manganese	258 a	208 b	211 a	172 b	156 b	174 a
Copper	0.50 b	1.30 a	1.20 a	1.50 a	1.20 b	1.70 a
Zinc	3.90 a	4.15 a	2.90 a	2.60 b	2.10 b	5.05 a
Boron	0.40 b	0.50 a	0.20 a	0.30 a	0.20 b	0.45 a

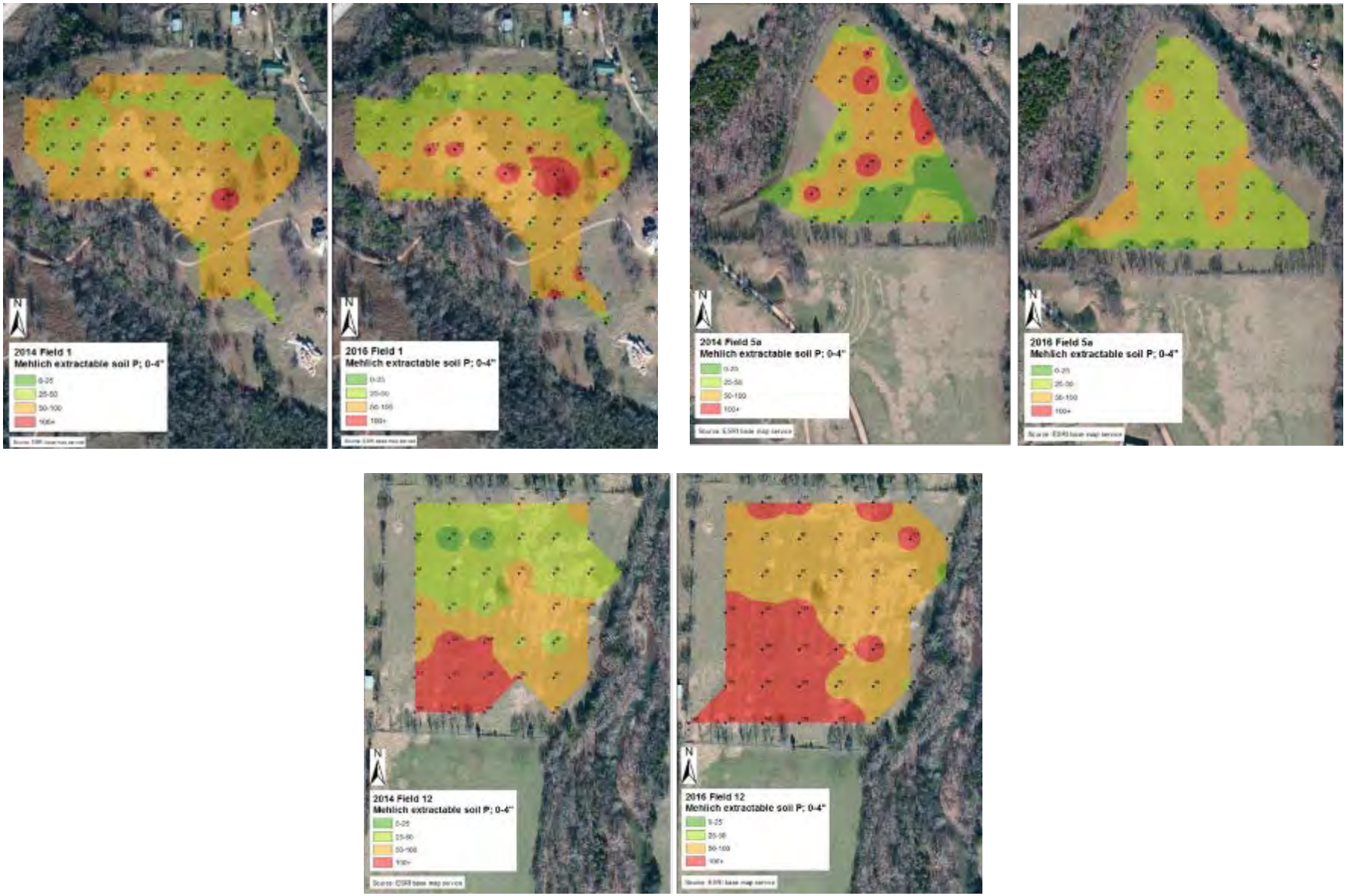


Figure 22. Map of Mehlich-3 extractable soil P in 0 - 4 inch samples for Fields 1, 5a, and 12 collected in 2014 and 2016.

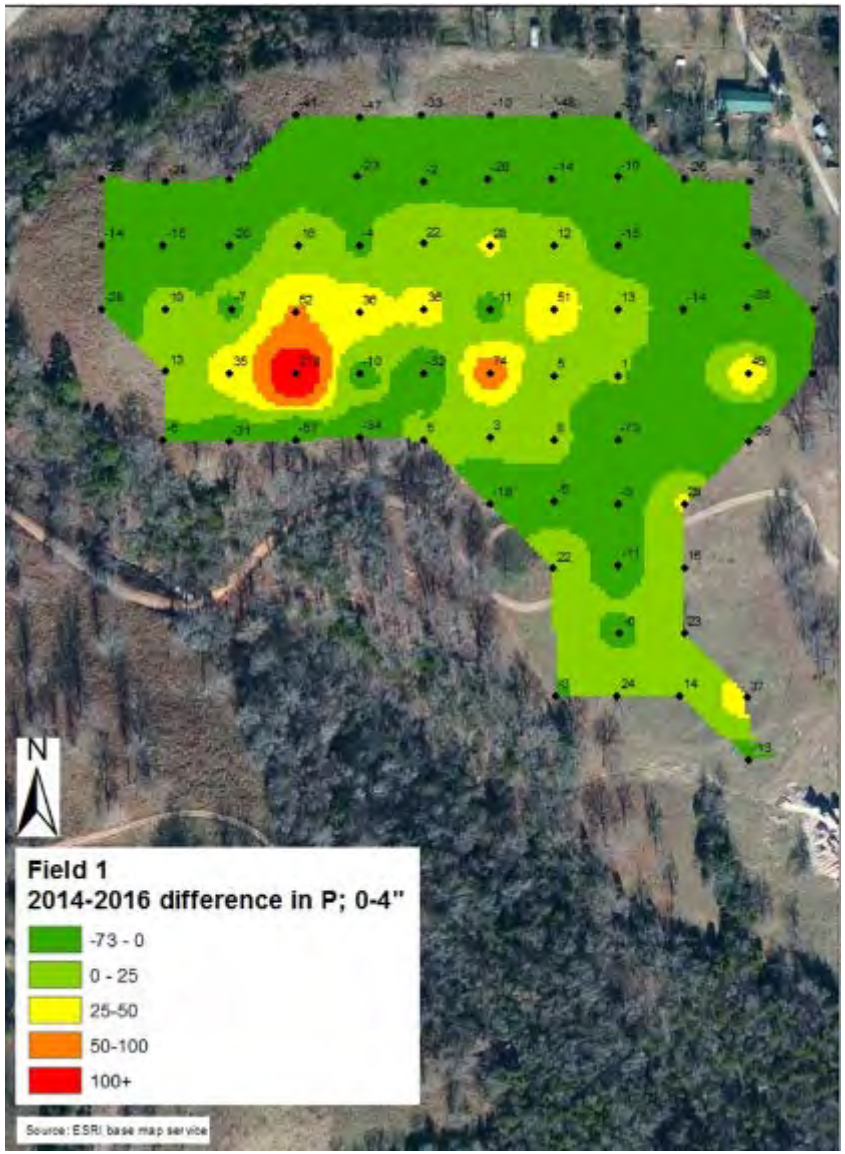
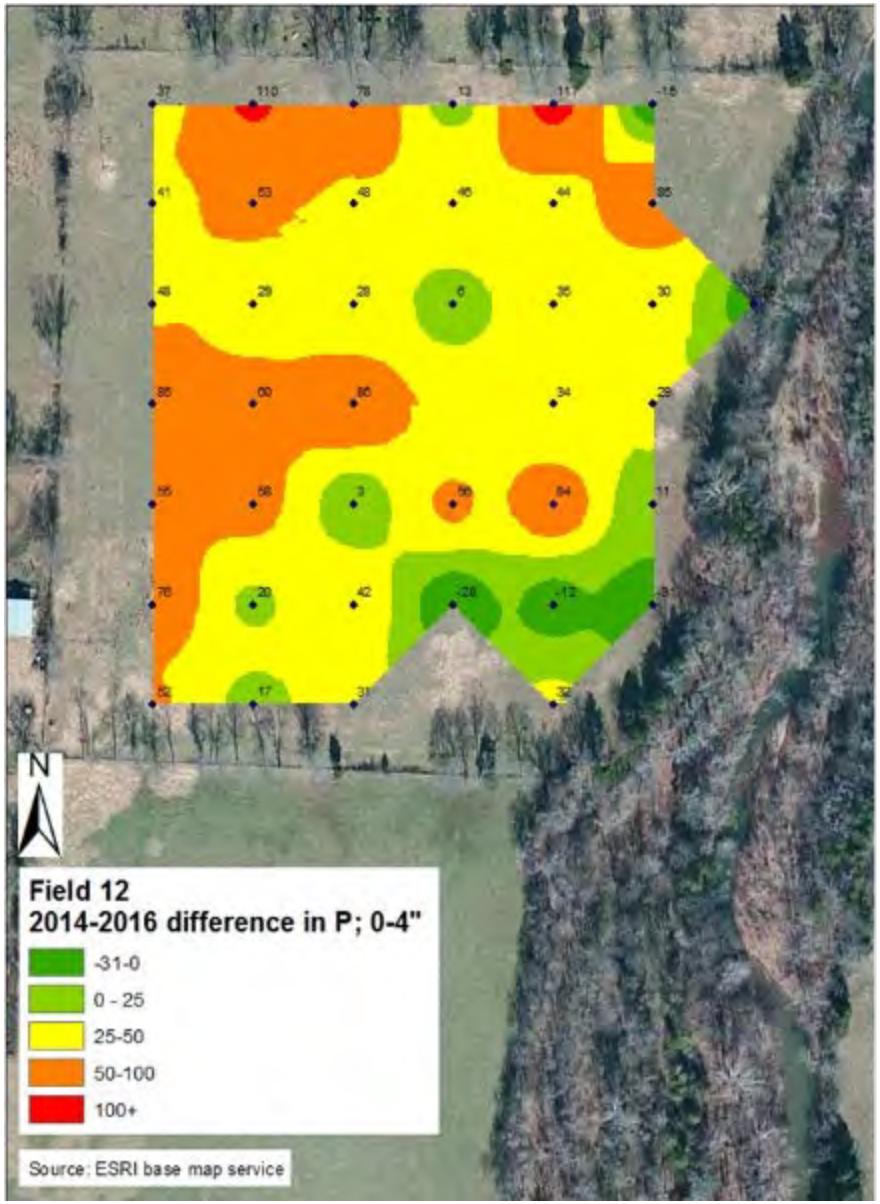


Figure 23. Map of the difference in Mehlich-3 extractable soil P in 0 - 4 inch samples on Field 1 collected in 2014 and 2016.

Figure 24. Map of the difference in Mehlich-3 extractable soil P in 0 - 4 inch samples on Field 5a collected in 2014 and 2016.



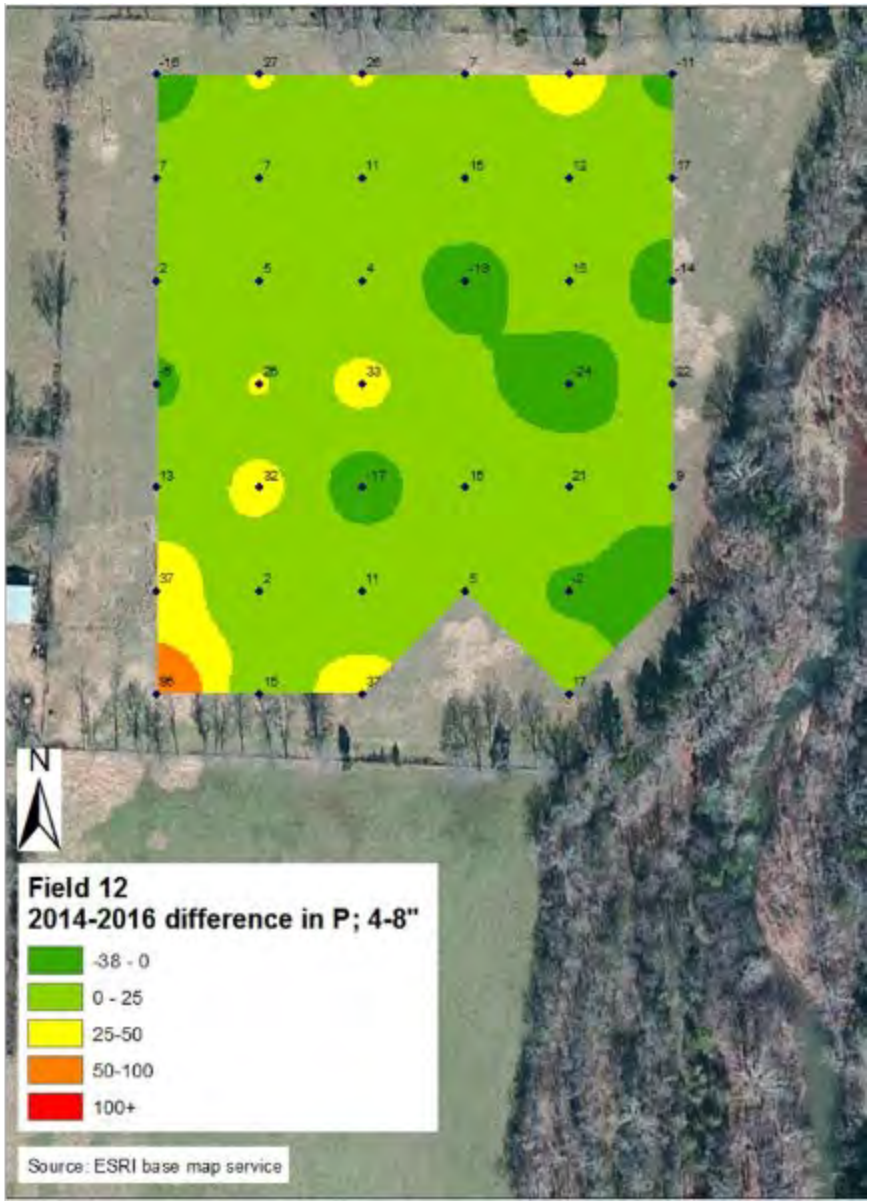


Figure 25. Map of the difference in Mehlich-3 extractable soil P in 0 - 4 inch samples on Field 12 collected in 2014 and 2016.

Manure slurry holding ponds

Measurement of the physical and chemical properties of the manure slurry in the holding ponds have been determined at various times and reported in prior Quarterly Reports. Here, the median values of constituents measured are updated in **Table 1** for samples collected on September 24, 2013; April 10, 2014; October 28, 2014; April 16, 2015; and January 15, May 27, and July 27, 2016.

An increasing linear relationship between total N, total P, total K, and water-extractable P concentrations and the increasing percent solids content of the slurry was observed (**Figure 1**). These nutrient concentrations are selected as they are required by plants for growth and used to determine the nutrient-fertilizer applications from an agronomic perspective. Nitrogen and P are also of interest because of their involvement in eutrophication of waters receiving excess loads of these nutrients. Water-extractable P is of interest due its key role in P Index calculations and determination of acceptable manure application rates. In addition, the total N:P_2O_5 concentration ratio exponentially decreased with increasing percent soils content (**Figure 2**).

These trends reflect the variation in manure nutrient concentrations between ponds and depth within the ponds. C&H Farm management is aware of these variations and the nutrient management opportunities they present when making decisions regarding: which pond to pump from; whether the pond will be agitated; the depth at which to pump from; and which field to make the application. These factors coupled the total number and size of application fields with the frequency in which each field receives a manure application plays a significant role in meeting the crop's nutrient fertility needs, while minimizing soil P accumulation and associated potential P runoff risk.

Table 21. Median concentration of constituent property of manure sampled from the top 6 inches, bottom layer, and profile of holding ponds 1 and 2 on the C&H Farm between September, 2013 and July, 2016.

Property	Pond 1			Pond 2		
	Top 6 inches	Bottom layer	Profile	Top 6 inches	Bottom layer	Profile
pH	7.9	7.5	7.7	8.1	7.9	8.1
Conductivity, µS/cm	13,905	10,710	12,835	10,275	10,475	8,100
Solids, %	0.8	11.9	3.8	0.5	4.3	2.3
Chloride, mg/L	360	409	468	338	409	532
Total N, mg/L	1,692	5,078	2,640	1,213	2,890	1,043
Ammonium-N, mg/L	1,323	1,437	1,150	859	938	536

Nitrate-N, mg/L	0.035	0.035	0.035	0.153	0.035	0.058
Total P, mg/L	180	5,070	1,316	114	458	279
Water-extractable P, mg/L	78	476	194	79	162	89
Total K, mg/L	1,383	1,593	1,416	1,109	1,180	1,073
Total Ca, mg/L	103	6,070	1,218	45	409	193
Total Mg, mg/L	30	2,368	589	6	177	77
Total S, mg/kg	60	1,076	243	23	133	77
Total Fe, mg/L	14	2,290	696	12	1,336	1,397
Total Mn, mg/L	0.6	102	20.5	0.0	9.8	5.4
Total Zn, mg/L	2.6	218	54.7	0.3	18.5	10.0
Total Cu, mg/L	0.5	27.6	7.0	0.0	2.9	1.9
Total Na, mg/L	340	368	349	246	250	314

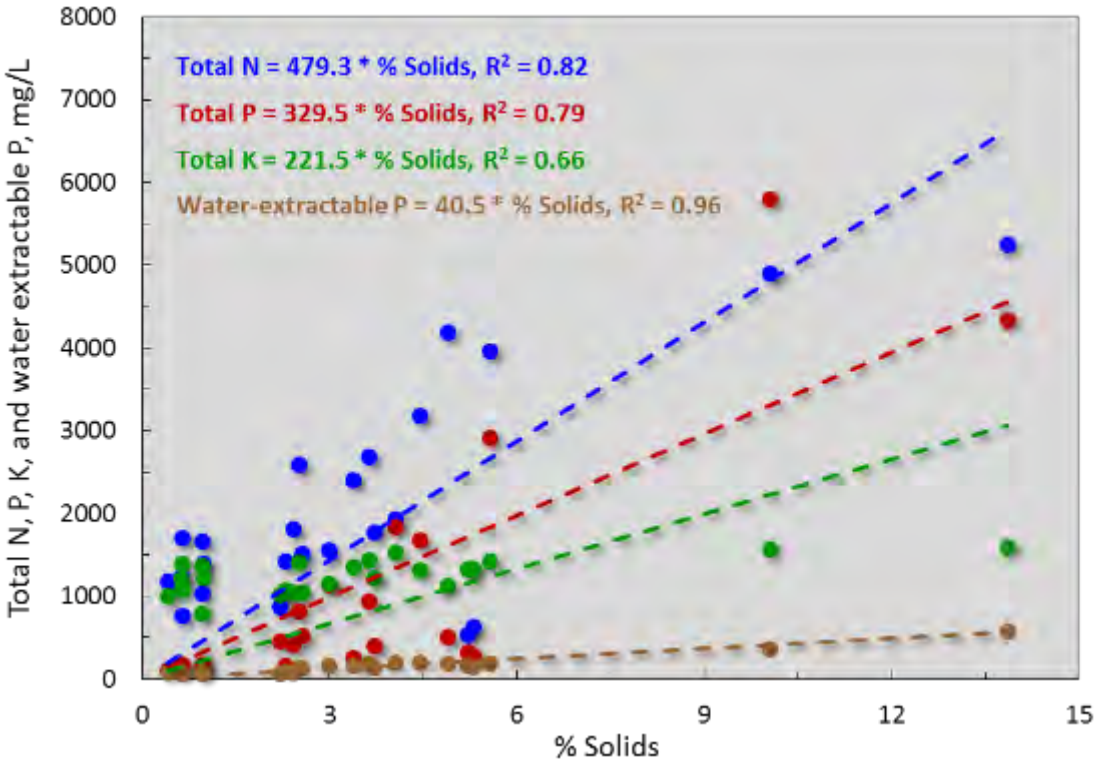


Figure 26. Relationship between total N, P, K and water-extractable P concentration and the percent solids content of swine slurry (all samples collected from ponds 1 and 2) from the C&H Farm operation.

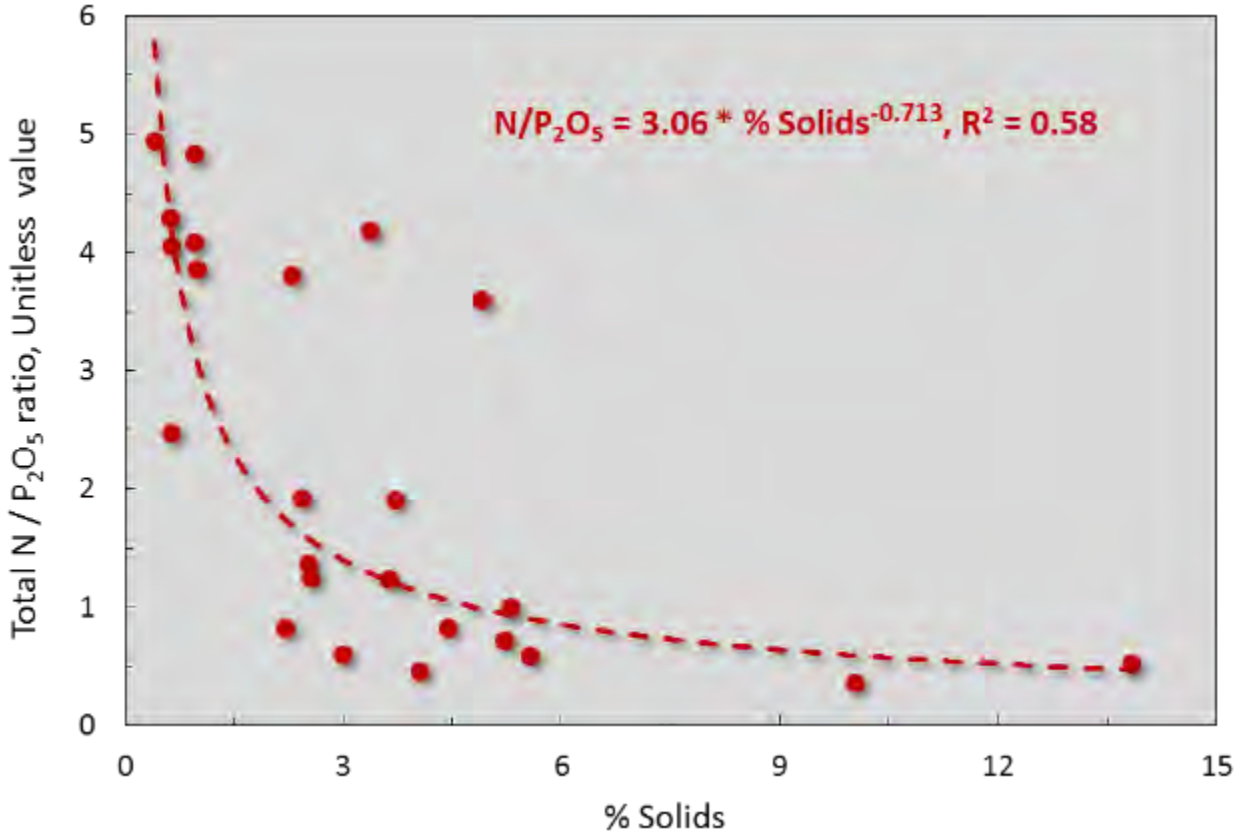


Figure 27. Relationship between the total N and P2O5 concentration ratio and percent solids content of swine slurry (all samples collected from ponds 1 and 2) from the C&H Farm operation.

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Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – January 1 to March 31, 2017

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

The mission of the **Division of Agriculture** is to advance the stewardship of natural resources and the environment, cultivate the improvement of agriculture and agribusiness, develop leadership skills and productive citizenship among youth and adults, enhance economic security and financial responsibility among the citizens of the state, ensure a safe, nutritious food supply, improve the quality of life in communities across Arkansas, and strengthen Arkansas families.

Dr. Mark J. Cochran
Vice President for Agriculture

Executive Summary

This is the first Quarterly Report of 2017 for the Big Creek Research and Extension Team that details activities and progress made from January 1 through March 31, 2017.

1. We continue to collect weekly base flow and periodic stormflow water samples from Big Creek above and below the C&H Farm, along with water from a spring, ephemeral stream, surface runoff sites on Fields 1, 5a, and 12, two interceptor trenches below the slurry holding ponds, and house well for chemical and bacterial analysis.

2. Similar to the last quarter of 2016, the first quarter of 2017 was a relatively dry period, with only one ephemeral gulley and one interceptor trench flow event recorded and sampled on February 15th. Upstream and downstream of the C&H Farm, only base flow was recorded in Big Creek during this first quarter of 2017.

3. Nitrogen, P, sediment, and bacteria concentration – flow regime relationships showed that between April 2014 and February 2017, the concentration of dissolved and total P, sediment and bacteria increased from base, to intermediate, to storm flows. In contrast nitrate-N and total N decreased from base, to intermediate, to storm flows. These patterns reflect the dominant flow pathways contributing to flow in Big Creek during storm flow is surface runoff and during base flow is groundwater flow and provide insight into identifying and targeting conservation practices designed to minimize any nutrient and bacteria transport in the Big Creek watershed.

Big Creek Science Team

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Brian Breaker, M.Sc., Surface-Water Specialist, stream flow and constituent collection, analysis, and statistical evaluation of trends.

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Ed Gbur, Ph.D., Professor and Director, Agricultural Statistics Laboratory - Experimental design, linear and generalized linear mixed models, regression, agricultural applications of statistics.

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Phil Hays, Ph.D. Ground Water Specialist, U.S. Geological Survey and Research Professor with Geosciences Dept., University of Arkansas, application of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems

Tim Kresse, M.Sc., Water Quality Specialist, U.S. Geological Survey, natural geochemical evolution of groundwater and separating these processes from anthropogenic sources of contamination

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Jun Zhu, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians - The Big Creek Research and Extension Team are ably supported by several outstanding and dedicated Program Technicians based in Fayetteville and Little Rock.

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Water Sampling and Analytical Methods

Sampling Locations

Water quality monitoring sites are;

Site 1. Edge-of-field monitoring on Field 1 permitted to receive slurry.

Site 2. Edge-of-field monitoring on Field 5a excluded from receiving slurry.

Site 3. Edge-of-field monitoring on Field 12 permitted to receive slurry.

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities.

Site 5. Spring below Field 1.

Site 6. Big Creek upstream of the C&H Farm operation.

Site 7. Big Creak downstream of the C&H Farm operation.

Site 8. Left Fork downstream of the C&H Farm operation.

Site 9. North interceptor trench below the manure holding ponds.

Site 10. South interceptor trench below the manure holding ponds.

Site 11. House well at animal facility.

Table 1. Location of sampling sites on the Big Creek Research and Extension Team project.

Site description	Latitude	Longitude	Elevation, ft
Field 1	35 55’ 06.42”	93 03’ 38.34”	984
Field 5a	35 56’03.01”	93 04’ 25.85”	778
Field 12	35 54’ 13.57”	93 04’ 04.76”	838
Ephemeral stream	35 55’ 25.89”	93 04’ 14.94”	824
Spring	35 54’ 57.06”	93 03’ 34.64”	977
Big Creek upstream of farm	35 53’ 32.28”	93 04’ 06.38”	857
Big Creek downstream of farm	35 56’ 18.98”	93 04’ 21.81”	769
Left Fork	35 5’”48.04”	93 04” 02.02”	760
Trench 1 (south)	35 55’ 19.24”	93 04’ 23.04”	896
Trench 2 (north)	35 55’ 21.39”	93 04’ 19.93”	883
House well	35 55’ 27.02”	93 04’ 22.71”	915

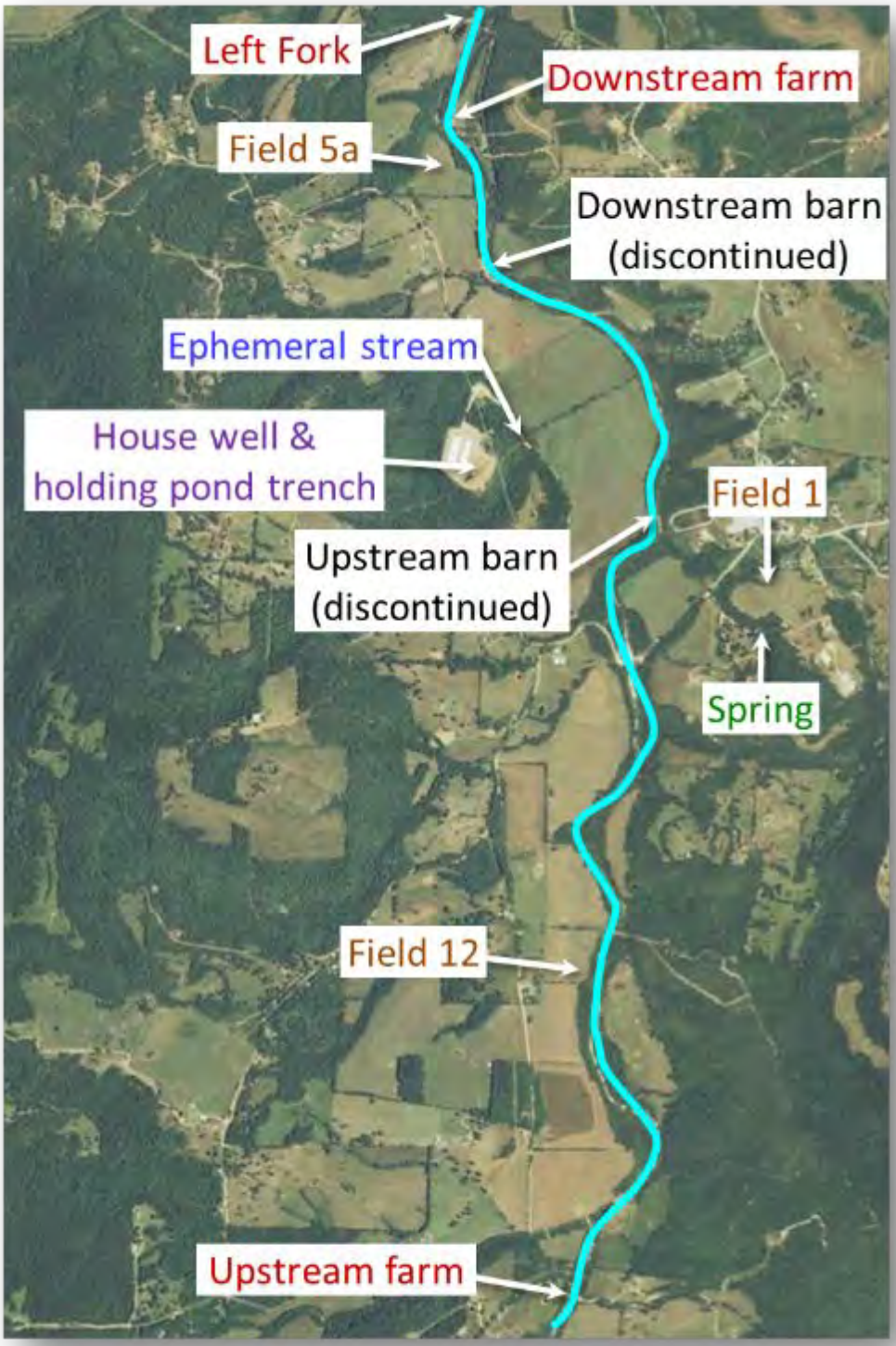

Figure 1. Location of sampling sites for the Big Creek Research and Extension Team project.

Sampling Protocols and Analyses

The following protocols were used to collect, prepare, and analyze all water samples:

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface, where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted, and samples placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
6. Analyses included Alkalinity (APHA 2320-B), Ammonia (EPA 351.2), Chloride (EPA 300.0), Dissolved Phosphorus (EPA 365.2), E. coli (APHA 9223-B), Electrical Conductivity (EPA 120.1), Nitrate (EPA 300.0), pH (EPA 150.1), Total Coliforms (APHA 9223-B), Total Dissolved Solids (EPA 160.1), Total Nitrogen (APHA 4500-P J), Total Phosphorus (APHA 4500-P J), and Total Suspended Solids (EPA 160.2). APHA is American Public Health Association from the Wadeable Streams Assessment, Water Chemistry Laboratory Manual http://www.epa.gov/owow/monitoring/wsa/WRS_lab_manual.pdf
7. Prior to collection of a house well water sample, the well is purged and water temperature, pH, and electrical conductivity measured on-site every 30 seconds until all values stabilize (primarily water temperature). At that point a sample of water is collected in a 1-L acid-washed bottle. This method is taken from USGS and EPA well-water sampling protocols. See USGS methods for sampling at https://water.usgs.gov/owq/FieldManual/chapter4/pdf/Chap4_v2.pdf. Specific and detailed guidance on the collected of water quality data can be found in the USGS National Field Manual at file:///U:/Words/C&H%20Farm/Publications/Planning/USGS%20National%20Field%20Mannual_complete%202015.pdf

   The U.S. EPA also recommend that selected water quality parameters can be monitored during low-rate purging, with stabilization of these parameters indicating when the discharge water represents aquifer water or source well water. See: http://www.csus.edu/indiv/h/hornert/Geol_210_Summer_2012/Week%202%20readings/Puls%20and%20Barcelona%201996%20Low%20flow%20sampling.pdf and https://in-situ.com/wp-content/uploads/2015/01/Low-Flow-Groundwater-Sampling-Techniques-Improve-Sample-Quality-and-Reduce-Monitoring-Program-Costs-Case-Study.pdf
8. Minimum detection limits (MDLs) for each chemical and biological constituent are listed in Table 1. Some constituent concentrations were reported by the laboratory as less than the MDL but greater than zero. Those values are given in subsequent tables but have less confidence in their accuracy than concentrations above the MDL.
9. Chemical and biological analyses of samples collected from the beginning of 2015 to March 31, 2016 are given in Tables 2, 3, and 4.

Table 2. Minimum detection limits (MDLs) for each chemical and biological constituent.

Constituent	Minimum detection limit [1]
Alkalinity, mg/L as $CaCO_3$	2
Chloride, mg/L	0.093
Dissolved P, mg/L	0.002
Conductivity, uS/cm	1
Ammonia-N, mg/L	0.03
Dissolved organic carbon, mg/L	0.18
E. coli, MPN/100 mL	1
Nitrate-N, mg/L	0.004
pH	0.1
Total coliform, MPN/100 mL	1
Total dissolved solids, mg/L	15.22
Total N, mg/L	0.006
Total P, mg/L	0.012
Total suspended solids, mg/L	6.58

[1] MDL the Minimum Detection Limit of an analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. Further information is available at http://water.usgs.gov/owq/OFR_99-193/detection.html

Big Creek Research and Extension Team Monitoring Data

Nutrients, Sediment, and Bacteria by Date of Sampling

Table 3. Water quality analyses at each sample site since 2016, with those collected since the last report noted. Coliform units are Most Probable Number (MPN) per 100 mL of water.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
			---------- mg/L ----------							-- MPN/100 mL --	
1/5/2016	**1/5/2016**	**Grab sample**									
11:52	15:29	Spring	0.007	0.024	<0.03	0.584	0.63	0.7	1.39	16.0	816.4
13:00	15:29	Upstream	0.008	0.026	<0.03	0.158	0.20	0.5	0.95	67.7	648.8
11:40	15:29	Downstream	0.011	0.026	<0.03	0.419	0.46	0.1	1.13	40.8	648.8
11:30	15:29	Left Fork	0.013	0.028	<0.03	0.427	0.48	0.7	1.51	34.1	686.7
12:02	15:29	Ephemeral	0.007	0.018	<0.03	0.883	1.00	1.2	2.15	32.7	686.7
12:13	15:29	Trench 1	0.003	0.016	<0.03	0.243	0.29	0.9	1.11	1.0	209.8
12:44	15:29	House well	0.008	0.020	<0.03	0.528	0.57	0.9	1.08	<1.0	1.0
1/25/2016	**1/25/2016**	**Grab sample**									
11:16	15:25	Spring	0.010	0.022	<0.03	0.565	0.60	0.3	1.27	34.5	1732.9
12:10	15:25	Upstream	0.010	0.022	<0.03	0.068	0.09	1.1	1.52	16.9	290.9
11:00	15:25	Downstream	0.011	0.022	<0.03	0.213	0.24	0.7	1.29	8.6	365.4
10:48	15:25	Left Fork	0.010	0.024	<0.03	0.198	0.25	1.0	1.30	21.1	435.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:28	15:25	Ephemeral	0.011	0.030	<0.03	0.762	0.87	9.8	3.10	1.0	816.4
11:42	15:25	House well	0.012	0.020	<0.03	0.602	0.55	0.5	2.36	<1.0	<1
2/10/2016	**2/10/2016**	**Grab sample**									
12:25	15:26	Spring	0.007	0.040	<0.03	0.634	0.80	17.7	2.70	1.0	325.5
11:15	15:26	Upstream	0.005	0.016	<0.03	0.048	0.11	0.5	1.11	14.5	178.5
11:04	15:26	Downstream	0.005	0.016	<0.03	0.198	0.24	0.9	0.99	4.1	218.7
11:29	15:26	Left Fork	0.003	0.012	<0.03	0.175	0.24	0.8	1.15	7.4	209.8
12:03	15:26	House well	0.007	0.014	<0.03	0.542	0.56	0.1	0.63	<1.0	<1.0
2/24/2016	**2/24/2016**	**Grab sample**									
11:05	14:45	Spring	0.010	0.052	<0.03	1.102	1.46	2.8	N.S.	209.8	3930.0
12:16	14:45	Upstream	0.014	0.052	<0.03	0.099	0.28	6.1	N.S.	1203.3	7330.0
10:52	14:45	Downstream	0.015	0.058	<0.03	0.142	0.37	8.3	N.S.	1986.3	6500.0
10:38	14:45	Left Fork	0.015	0.088	<0.03	0.249	0.63	15.6	N.S.	2780.0	14390.0
11:15	14:45	Ephemeral	0.010	0.056	<0.03	0.195	0.40	12.8	N.S.	387.3	4870.0
11:36	14:45	Trench 1	0.005	0.014	<0.03	0.345	0.39	2.1	N.S.	<1.0	9070.0
11:53	14:45	House well	0.010	0.010	<0.03	0.582	0.55	1.3	N.S.	<1.0	<1.0
3/10/2016	**3/10/2016**	**Grab sample**									
11:04	15:45	Spring	0.012	0.064	0.11	0.104	0.34	9.5	5.38	285.1	3230.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
13:13	15:45	Upstream	0.012	0.048	0.13	0.082	0.20	8.6	2.66	770.1	>2419.2
10:51	15:45	Downstream	0.010	0.044	0.11	0.118	0.25	6.2	2.28	298.7	>2419.2
11:32	15:45	Ephemeral stream	0.006	0.050	0.13	0.918	1.22	26.7	3.12	648.8	8840.0
10:38	15:45	Left Fork	0.013	0.046	0.01	0.154	0.38	8.7	2.64	367.3	2750.0
12:03	15:45	House well	0.011	0.020	0.02	0.562	0.59	0.9	1.19	<1.0	<1.0
11:50	15:45	Trench 1	0.005	0.036	0.10	0.264	0.45	3.5	2.87	2419.2	16690.0
11:46	15:45	Trench 2	0.005	0.054	0.14	1.716	2.35	6.8	6.77	613.1	34480.0
12:41	15:45	Field 12	0.411	0.522	1.17	0.852	4.49	621.5	12.58	410.6	>241920
3/16/2016	**3/16/2016**	**Grab sample**									
11:35	15:05	Spring	0.009	0.036	0.01	0.340	0.44	5.7	3.36	75.4	461.1
12:35	15:05	Upstream	0.008	0.034	<0.03	0.060	0.13	0.4	1.10	52.9	579.4
11:23	15:05	Downstream	0.006	0.028	0.01	0.170	0.24	0.9	1.17	81.3	>2419.2
11:50	15:05	Ephemeral stream	0.006	0.022	0.01	0.520	0.54	<6.58	1.75	88.0	461.1
11:13	15:05	Left Fork	0.009	0.032	<0.03	0.190	0.26	0.3	1.45	35.9	980.4
12:22	15:05	House well	0.009	0.022	<0.03	0.550	0.55	<6.58	1.55	<1.0	<1
12:01	15:05	Trench 1	0.003	0.032	0.02	0.331	0.37	<6.58	1.23	101.7	290.9
3/24/2016	**3/24/2016**	**Storm sample**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:50	15:10	Spring	0.015	0.046	0.06	0.172	0.42	13.1	4.95	N.S.	N.S.
12:50	15:10	Upstream	0.011	0.032	0.06	0.040	0.14	4.5	1.60	N.S.	N.S.
11:35	15:10	Downstream	0.011	0.024	<0.03	0.106	0.20	3.9	1.29	N.S.	N.S.
12:10	15:10	Ephemeral stream	0.010	0.012	<0.03	0.531	0.64	1.3	1.44	N.S.	N.S.
11:25	15:10	Left Fork	0.013	0.048	0.09	0.186	0.39	10.7	2.65	N.S.	N.S.
12:34	15:10	House well	0.012	0.014	<0.03	0.565	0.65	0.2	2.72	N.S.	N.S.
12:20	15:10	Trench 1	0.008	0.016	<0.03	0.208	0.20	2.8	1.33	N.S.	N.S.
3/31/2016	**3/31/3016**	**Grab sample**									
11:06	15:10	Spring	0.011	0.034	<0.03	0.319	0.52	7.4	25.32	71.7	1553.1
12:45	15:10	Upstream	0.008	0.042	0.08	0.100	0.22	6.1	2.49	186.0	>2419.2
10:45	15:10	Downstream	0.011	0.056	0.08	0.156	0.33	12.4	2.67	365.0	>2419.2
11:16	15:10	Ephemeral stream	0.013	0.656	0.68	1.211	3.05	375.0	12.14	16160.0	198630.0
10:33	15:10	Left Fork	0.013	0.056	0.09	0.199	0.40	11.9	2.59	172.0	3640.0
11:49	15:10	House well	0.010	0.018	<0.03	0.556	0.62	0.2	3.93	1.0	26.2
11:40	15:10	Trench 1	0.004	0.018	<0.03	0.347	0.49	5.5	4.76	4.1	2419.2
11:35	15:10	Trench 2	0.006	0.040	0.06	2.800	3.54	20.9	9.29	7.4	10810.0
12:02	15:10	Field 5a	1.154	1.352	0.27	0.302	1.67	26.5	32.74	24890.0	>241920

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
4/4/2016	**4/4/2016**	**Grab sample**									
11:58	15:20	Spring	0.009	0.028	<0.03	0.324	0.42	7.5	1.57	104.7	866.4
12:50	15:20	Upstream	0.008	0.026	<0.03	0.065	0.08	1.7	0.71	8.3	648.8
11:48	15:20	Downstream	0.010	0.026	<0.03	0.176	0.20	1.9	0.98	77.6	1046.2
12:08	15:20	Ephemeral stream	0.008	0.018	<0.03	0.462	0.48	1.3	1.79	12.0	727.0
11:38	15:20	Left Fork	0.009	0.022	<0.03	0.131	0.17	1.5	0.87	44.8	1119.9
12:35	15:20	House well	0.011	0.018	<0.03	0.466	0.48	<6.58	0.94	<1.0	1.0
12:26	15:20	Trench 2	0.004	0.012	<0.03	0.236	0.25	<6.58	0.85	1.0	>2419.2
4/20/2016	**4/20/2016**	**Grab sample**									
12:02	15:52	Spring	0.005	0.042	<0.03	0.410	0.55	22.4	1.04	3.1	195.6
13:20	15:52	Upstream	0.003	0.020	<0.03	0.047	0.06	1.9	0.61	185.0	1299.7
11:42	15:52	Downstream	0.004	0.018	<0.03	0.152	0.20	1.2	0.74	38.4	2920.0
12:11	15:52	Ephemeral stream	0.008	0.020	<0.03	0.517	0.66	4.1	0.68	44.3	21430.0
11:30	15:52	Left Fork	0.005	0.020	<0.03	0.157	0.21	2.1	0.84	35.0	6160.0
12:52	15:52	House well	0.005	0.014	<0.03	0.598	0.50	0.5	0.47	1.0	1.0
4/28/2016	**4/28/2016**	**Grab sample**									
11:55	15:17	Spring	0.010	0.024	<0.03	0.455	0.63	12.0	N.S.	25.6	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
13:00	15:17	Upstream	0.009	0.012	<0.03	0.035	0.12	1.2	N.S.	58.6	648.8
11:30	15:17	Downstream	0.010	0.012	<0.03	0.154	0.27	1.5	N.S.	36.4	2149.2
12:31	15:17	House well	0.011	0.008	<0.03	0.481	0.57	0.3	N.S.	<1.0	<1.0
11:25	15:17	Dry Creek	0.010	0.012	<0.03	0.152	0.27	1.0	N.S.	14.8	3050.0
5/2/2016	**5/3/2016**	**Grab sample**									
12:25	08:55	Spring	0.008	0.012	<0.03	0.338	0.36	2.2	5.08	88.2	>2419.2
14:29	08:55	Upstream	0.006	0.018	<0.03	0.039	0.10	6.7	1.76	185.0	2419.2
11:43	08:55	Downstream	0.008	0.016	<0.03	0.075	0.16	2.0	1.50	178.9	4720.0
12:38	08:55	Ephemeral stream	0.007	0.016	<0.03	0.468	0.59	1.7	2.56	118.7	5380.0
12:38	08:55	Ephemeral stream	0.008	0.112	0.15	1.794	2.62	61.8	4.07	1046.2	23590.0
11:24	08:55	Left Fork	0.009	0.020	<0.03	0.095	0.20	1.9	2.30	172.6	3640.0
13:27	08:55	House well	0.009	0.016	<0.03	0.551	0.56	0.1	1.94	<1.0	<1
5/10/2016	**5/10/2016**	**Grab sample**									
11:15	15:40	Spring	0.008	0.026	<0.03	0.281	0.45	2.9	7.58	410.6	2780.0
12:50	15:40	Upstream	0.007	0.044	0.01	0.070	0.20	6.1	3.10	613.1	4480.0
10:58	15:40	Downstream	0.011	0.060	0.01	0.101	0.31	11.6	2.95	1203.3	7490.0
11:28	15:40	Ephemeral stream	0.195	0.560	0.32	0.649	4.01	1346.7	11.94	579.4	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:35	15:40	Left Fork	0.011	0.072	0.02	0.121	0.37	17.2	3.35	980.4	8230.0
12:08	15:40	House well	0.009	0.008	<0.03	0.533	0.56	0.5	4.39	<1.0	24.9
11:55	15:40	Trench 1	0.002	0.016	<0.03	0.228	0.30	3.9	2.91	13.9	>2419.2
11:45	15:40	Trench 2	0.002	0.038	<0.03	1.706	2.18	5.2	3.72	38.7	>2419.2
12:26	15:40	Field 5a	1.114	1.458	1.69	2.894	6.35	79.9	12.82	22820.0	>2419.2
13:08	15:40	Field 12	0.370	0.666	0.12	0.062	1.03	96.7	6.92	663.0	>2419.2
5/18/2016	**5/18/2016**	**Grab sample**									
11:29	15:20	Spring	0.009	0.024	0.01	0.320	0.51	8.7	2.20	45.7	1413.6
13:08	15:20	Upstream	0.007	0.016	<0.03	0.043	0.13	1.4	1.00	85.5	1299.7
11:10	15:20	Downstream	0.009	0.020	0.02	0.117	0.25	1.2	0.98	107.1	>2419.2
11:43	15:20	Ephemeral stream	0.008	0.014	<0.03	0.479	0.63	3.0	0.84	34.1	2419.2
10:57	15:20	Left Fork	0.010	0.016	0.01	0.139	0.27	1.4	1.54	60.1	2620.0
12:50	15:20	House well	0.009	0.010	<0.03	0.488	0.64	0.4	0.95	<1.0	<1.0
12:05	15:20	Trench 1	0.006	0.006	<0.03	0.169	0.22	0.1	0.54	2.0	5200.0
5/26/2016	**5/26/2016**	**Grab sample**									
11:45	15:30	Spring	0.008	0.020	<0.03	0.219	0.35	6.2	4.15	344.8	3730.0
13:08	15:30	Upstream	0.007	0.030	<0.03	0.056	0.12	4.2	1.56	238.2	5290.0
11:30	15:30	Downstream	0.009	0.036	<0.03	0.094	0.20	4.6	1.75	547.5	3640.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:05	15:30	Ephemeral stream	0.052	0.424	0.39	0.858	2.20	350.6	8.58	22470.0	>2419.2
11:20	15:30	Left Fork	0.010	0.048	0.02	0.123	0.24	10.6	2.66	461.1	6890.0
12:51	15:30	House well	0.009	0.012	<0.03	0.564	0.57	0.7	0.93	1.0	7.4
12:38	15:30	Trench 1	0.008	0.006	<0.03	0.217	0.23	1.4	1.29	1.0	4260.0
6/2/2016	**6/2/2016**	**Grab sample**									
11:15	14:40	Spring	0.007	0.032	<0.03	0.330	0.47	10.8	2.38	64.1	1986.3
12:26	14:40	Upstream farm	0.007	0.018	<0.03	0.046	0.13	4.1	1.8	224.7	1986.3
11:04	14:40	Downstream farm	0.006	0.018	<0.03	0.106	0.20	1.4	1.8	104.6	3410
11:26	14:40	Ephemeral stream	0.008	0.022	<0.03	0.494	0.63	3.6	2.15	770.1	1986.3
10:52	14:40	Left Fork	0.007	0.022	<0.03	0.117	0.22	1.4	1.40	44.1	1986.3
12:06	14:40	House well	0.008	0.018	<0.03	0.597	0.62	0.7	0.99	<1.0	<1.0
11:35	14:40	Trench 1	0.002	0.018	<0.03	0.124	0.30	8.8	3.01	26.5	393.0
6/7/2016	**6/7/2016**	**Grab sample**									
11:25	14:30	Spring	0.011	0.026	<0.03	0.327	0.46	4.6	6.06	140.1	2460.0
12:16	14:30	Upstream farm	0.013	0.018	0.06	0.131	0.14	1.3	2.8	120.1	2720.0
11:10	14:30	Downstream farm	0.012	0.018	0.04	0.123	0.19	1.5	1.94	73.8	2980.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:37	14:30	Ephemeral stream	0.012	0.024	0.01	0.503	0.65	6.9	3.89	2419.2	7980.0
10:50	14:30	Left Fork	0.009	0.016	0.04	0.124	0.19	0.8	2.08	31.8	3180.0
12:00	14:30	House well	0.011	0.014	0.03	0.500	0.58	0.1	3.06	<1.0	<1.0
6/15/2016	**6/15/2016**	**Grab sample**									
11:40	15:00	Spring	0.010	0.016	0.03	0.466	0.65	4.2	<0.18	153.9	1553.1
12:40	15:00	Upstream farm	0.007	0.010	<0.03	0.097	0.15	1.6	0.02	69.1	2310.0
11:25	15:00	Downstream farm	0.008	0.050	0.05	0.181	0.42	25.4	0.38	33.2	4740.0
11:15	15:00	Left Fork	0.009	0.012	0.01	0.198	0.29	2.0	0.94	63.1	8860.0
12:15	15:00	House well	0.008	0.008	<0.03	0.506	0.59	0.7	<0.18	<1.0	<1.0
6/22/2016	**6/22/2016**	**Grab sample**									
10:40	14:35	Spring	0.008	0.012	<0.03	0.532	0.60	1.0	<0.18	38.2	1413.6
12:20	14:35	Upstream farm	0.008	0.016	0.02	0.237	0.33	2.3	0.20	455.0	547.5
10:23	14:35	Downstream farm	0.015	0.028	0.04	0.327	0.44	14.9	<0.18	46.4	4570.0
10:08	14:35	Left Fork	0.008	0.018	0.05	0.220	0.37	2.1	0.70	37.9	676.0
11:38	14:35	House well	0.009	0.008	<0.03	0.545	0.58	0.5	<0.18	<1.0	<1.0
6/29/2016	**6/29/2016**	**Grab sample**									
10:53	14:00	Spring	0.009	0.083	0.02	0.487	0.73	43.4	1.10	5.2	648.8

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:37	14:00	Upstream farm	0.006	0.029	0.06	0.186	0.34	4.6	0.92	55.4	9888.0
10:41	14:00	Downstream farm	0.010	0.021	0.03	0.395	0.47	2.5	0.46	41.3	6310.0
10:25	14:00	Left Fork	0.006	0.023	0.03	0.251	0.35	2.0	0.94	23.5	5200.0
11:12	14:00	House well	0.008	0.014	<0.03	0.569	0.56	0.0	0.23	<1.0	<1.0
7/6/2016	**7/6/2016**	**Grab sample**									
6:44	10:16	Spring	0.011	0.027	<0.03	0.465	0.53	9.8	1.15	25.3	4430
7:41	10:16	Upstream farm	0.009	0.023	<0.03	0.221	0.27	5.9	0.66	387.3	12230.0
6:26	10:16	Downstream farm	0.010	0.023	0.01	0.461	0.43	2.1	0.47	39.3	8570.0
6:08	10:16	Left Fork	0.006	0.020	0.04	0.271	0.36	2.7	0.96	248.1	12590.0
7:18	10:16	House well	0.009	0.013	<0.03	0.874	0.96	1.0	0.73	<1.0	13.5
7/13/2016	**7/13/2016**	**Grab sample**									
7:53	12:30	Spring	0.003	0.023	<0.03	0.355	0.42	12.3	0.90	71.7	2920
7:33	12:30	Downstream farm	0.006	0.017	<0.03	0.365	0.43	4.3	1.12	129.6	8390.0
7:15	12:30	Left Fork	0.005	0.017	<0.03	0.172	0.29	1.9	0.85	95.9	12360.0
8:34	12:30	House well	0.005	0.011	<0.03	0.627	0.63	0.5	0.09	<1.0	<1.0
7/20/2016	**7/20/2016**	**Grab sample**									
7:56	12:05	Spring	0.006	0.024	<0.03	0.298	0.35	9.4	0.55	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
7:39	12:05	Downstream farm	0.005	0.024	<0.03	0.356	0.44	5.1	3.93	N.S	N.S.
7:25	12:05	Left Fork	0.005	0.013	<0.03	0.197	0.76	2.3	2.21	N.S.	N.S.
8:30	12:05	House well	0.007	0.009	0.02	0.594	0.70	0.1	0.14	N.S.	N.S.
7/27/2016	**7/27/2016**	**Grab sample**									
7:38	14:15	Spring	0.001	0.043	<0.03	0.375	0.46	17.6	2.64	55.6	980.4
7:21	14:15	Downstream farm	0.007	0.027	<0.03	0.423	0.47	2.3	1.62	140.8	17260.0
7:02	14:15	Left Fork	0.004	0.021	<0.03	0.255	0.35	3.6	1.79	920.8	15000.0
8:14	14:15	House well	0.006	0.010	<0.03	0.650	0.67	0.1	1.41	<1.0	<1.0
8/3/2016	**8/3/2016**	**Grab sample**									
8:03	12:10	Spring	0.006	0.104	<0.03	0.201	0.49	64.8	7.41	65.7	2920
7:43	12:10	Downstream farm	0.013	0.014	<0.03	0.221	0.29	3.2	3.46	115.3	9320.0
7:28	12:10	Left Fork	0.007	0.016	<0.03	0.212	0.32	2.4	2.21	101.4	7430.0
8/16/2016	**8/16/2016**	**Grab sample**									
10:58	14:50	Spring	0.007	0.027	0.02	0.223	0.39	7.7	9.89	88.2	5380.0
12:16	14:50	Upstream farm	0.009	0.031	0.03	0.089	0.23	4.6	3.14	248.9	9330.0
10:41	14:50	Downstream farm	0.011	0.039	0.03	0.161	0.33	8.1	2.94	178.2	17820.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:25	14:50	Ephemeral stream	0.011	0.023	0.01	1.365	1.59	2.6	2.47	137.6	154945.0
10:28	14:50	Left Fork	0.012	0.082	0.07	0.118	0.30	19.5	3.64	201.4	14550.0
11:40	14:50	Trench 1	0.005	0.006	0.02	0.130	0.17	0.2	2.14	93.4	48840.0
11:50	14:50	Trench 2	0.004	0.036	0.05	0.344	0.99	1.5	8.98	290.9	198630.0
8/24/2016	**8/24/2016**	**Grab sample**									
11:29	15:30	Spring	0.004	0.046	<0.03	0.477	0.97	29.9	2.99	27.8	5630
12:40	15:30	Upstream farm	0.004	0.014	0.03	0.046	0.14	2.0	1.08	72.3	2620.0
10:53	15:30	Downstream farm	0.005	0.016	<0.03	0.122	0.22	3.2	0.85	72.8	7030.0
10:40	15:30	Left Fork	0.004	0.013	0.00	0.045	0.13	1.5	1.62	43.5	6690.0
8/24/2016	**8/24/2016**	**Storm sample**									
11:03	15:30	Downstream farm	<0.002	0.109	0.01	0.002	0.42	66.9	5.89	156.5	38730.0
12:05	15:30	Trench 1	<0.002	0.019	0.03	0.033	0.30	8.3	1.99	21.8	3450.0
8/30/2016	**8/30/2016**	**Grab sample**									
11:24	14:55	Spring	0.003	0.020	<0.03	0.501	0.58	2.9	3.28	195.6	9090.0
12:35	14:55	Upstream farm	0.003	0.020	<0.03	0.042	0.13	1.7	1.37	102.5	5210.0
11:10	14:55	Downstream farm	0.004	0.020	<0.03	0.116	0.21	1.7	1.19	30.1	5200.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:00	14:55	Left Fork	0.005	0.021	0.02	0.157	0.28	2.7	2.00	111.2	17850.0
9/7/2016	**9/7/2016**	**Grab sample**									
7:58	12:25	Spring	0.003	0.219	0.05	0.514	0.92	142.1	5.37	31.8	18500.0
9:03	12:25	Upstream farm	0.007	0.020	0.01	0.113	0.21	1.9	1.89	195.6	5380.0
7:38	12:25	Downstream farm	0.008	0.059	0.01	0.265	0.46	25.4	1.39	30.9	4790.0
7:23	12:25	Left Fork	0.006	0.021	<0.03	0.151	0.24	2.8	1.58	27.5	10170.0
9/15/2016	**9/15/2016**	**Grab sample**									
11:00	14:00	Spring	0.009	0.273	<0.03	0.345	0.83	190.9	13.99	ND	ND
11:20	14:00	Upstream farm	0.012	0.011	<0.03	0.119	0.21	3.2	6.12	ND	ND
10:45	14:00	Downstream farm	0.014	0.016	0.01	0.312	0.42	2.9	5.38	ND	ND
10:32	14:00	Left Fork	0.011	0.014	0.01	0.132	0.25	2.2	5.35	ND	ND
9/28/2016	**9/28/2016**	**Grab sample**									
11:25	14:25	Spring	0.005	0.043	0.01	0.427	0.62	22.0	2.70	7540.0	7590.0
12:26	14:25	Upstream farm	0.008	0.016	0.01	0.128	0.21	1.0	1.33	9330.0	2310.0
11:12	14:25	Downstream farm	0.011	0.017	0.01	0.293	0.42	1.6	2.15	7120.0	5210.0
11:00	14:25	Left Fork	0.006	0.011	0.02	0.101	0.22	1.8	1.31	2530.0	3410.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10/5/2016	**10/5/2016**	**Grab sample**									
10:29	15:40	Spring	0.006	0.513	0.01	0.502	1.40	334.8	4.66	36.8	241920.0
12:01	15:40	Upstream farm	0.009	0.020	<0.03	0.120	0.25	2.1	2.85	770.1	13170.0
10:07	15:40	Downstream farm	0.014	0.043	0.02	0.413	0.58	29.3	3.00	547.1	11690.0
9:54	15:40	Left Fork	0.009	0.023	0.01	0.130	0.29	2.8	2.38	285.1	17820.0
10/13/2016	**10/13/2016**	**Grab sample**									
10:46	15:45	Spring	0.018	0.272	0.05	0.623	1.36	148.0	6.09	>2419.2	28090.0
12:46	15:45	Upstream farm	0.015	0.026	<0.03	0.147	0.28	2.7	2.32	3590.0	46110.0
10:29	15:45	Downstream farm	0.033	0.066	0.02	0.614	0.88	9.6	3.90	4640.0	129970.0
11:03	15:45	Ephemeral stream	0.018	0.047	0.03	1.760	1.97	9.7	5.17	>2419.2	21430.0
10:16	15:45	Left Fork	0.091	0.203	0.04	1.071	1.74	24.2	9.30	14010.0	>241920
12:30	15:45	House well	0.008	0.010	0.01	1.166	1.23	0.6	1.35	<1.0	23.3
10/13/2016	**10/13/2016**	**Storm sample**									
11:15	15:45	Ephemeral stream	0.067	0.213	0.12	2.732	3.83	61.7	11.10	ND	ND
13:10	15:45	Field 1	0.940	1.231	0.13	0.335	2.36	59.0	16.67	ND	ND
10/20/2016	**10/20/2016**	**Grab sample**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:05	15:05	Spring	0.010	0.044	<0.03	0.414	0.56	18.9	11.91	461.1	30760.0
12:03	15:05	Upstream farm	0.010	0.021	<0.03	0.076	0.13	1.1	4.43	3730.0	16640.0
10:48	15:05	Downstream farm	0.014	0.030	0.03	0.327	0.39	2.1	3.11	387.3	5690.0
10:20	15:05	Left Fork	0.008	0.026	0.01	0.146	0.27	1.3	3.95	33.5	17890.0
11:38	15:05	House well	0.009	0.020	0.02	0.739	0.79	0.1	4.56	<1.0	19.7
10/27/2016	**10/27/2016**	**Grab sample**									
11:05	15:25	Spring	0.007	0.253	0.03	0.265	0.88	161.1	14.84	61.7	13960.0
11:50	15:25	Upstream farm	0.010	0.021	<0.03	0.046	0.14	1.1	5.87	517.2	5450.0
10:42	15:25	Downstream farm	0.014	0.021	0.01	0.291	0.36	2.1	7.91	45.5	6440.0
10:27	15:25	Left Fork	0.008	0.016	0.02	0.132	0.26	1.9	7.76	48.8	9340.0
11:30	15:25	House well	0.009	0.010	0.01	0.664	0.74	0.9	8.95	<1.0	5.2
11/03/2016	**11/03/2016**	**Grab sample**									
9:55	14:20	Spring	0.001	0.483	0.03	0.235	0.89	281.7	15.21	3.1	2419.2
11:10	14:20	Upstream farm	0.003	0.031	0.01	0.071	0.20	2.1	6.81	22.6	3010.0
9:36	14:20	Downstream farm	0.008	0.022	0.03	0.388	0.47	1.7	6.07	1732.9	5200.0
9:14	14:20	Left Fork	0.004	0.026	0.03	0.117	0.26	1.5	9.24	33.1	7380.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:38	14:20	House well	0.004	0.010	0.02	0.719	0.75	0.4	9.48	1.0	2.0
11/10/2016	**11/10/2016**	**Grab sample**									
10:56	14:00	Spring	0.003	0.104	<0.03	0.255	0.50	53.0	3.30	17.1	13760.0
11:33	14:00	Upstream farm	0.011	0.013	0.01	0.073	0.12	1.0	2.29	53.7	>2419.2
10:38	14:00	Downstream farm	0.011	0.021	0.02	0.419	0.48	0.7	2.15	22.6	5040.0
10:18	14:00	Left Fork	0.005	0.013	0.01	0.161	0.23	4.1	2.07	7.4	2560.0
11:10	14:00	House well	0.005	0.009	<0.03	0.574	0.68	0.1	2.16	<1.0	1.0
11/17/2016	**11/17/2016**	**Grab sample**									
11:00	13:45	Spring	0.001	0.021	<0.03	0.209	0.32	4.9	2.42	2.0	574.8
11:40	13:45	Upstream farm	0.009	0.020	<0.03	0.057	0.13	0.6	1.84	58.1	3270.0
10:43	13:45	Downstream farm	0.011	0.020	0.01	0.412	0.49	2.5	1.37	18.5	>2419.2
10:20	13:45	Left Fork	0.005	0.011	<0.03	0.195	0.26	0.5	1.77	15.8	2400.0
11:10	13:45	House well	0.006	0.010	0.01	0.660	0.71	0.3	1.57	<1.0	1.0
11/21/2016	**11/21/2016**	**Grab sample**									
10:24	14:15	Spring	0.010	0.313	0.04	0.239	0.87	210.2	4.99	135.4	6770.0
11:15	14:15	Upstream farm	0.010	0.019	<0.03	0.125	0.17	1.3	0.68	178.9	3840.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:05	14:15	Downstream farm	0.012	0.021	0.01	0.466	0.52	1.3	1.23	26.9	>2419.2
9:40	14:15	Left Fork	0.004	0.011	0.01	0.239	0.31	0.4	3.35	11.9	2419.2
10:40	14:15	House well	0.007	0.011	<0.03	0.675	0.75	0.4	1.37	<1.0	<1.0
11/29/2016	**11/29/2016**	**Grab sample**									
11:42	15:15	Spring	0.009	0.100	<0.03	0.329	0.68	45.0	8.06	1046.2	13360.0
12:48	15:15	Upstream farm	0.008	0.026	0.01	0.063	0.12	2.1	2.38	235.9	3790.0
11:30	15:15	Downstream farm	0.007	0.027	<0.03	0.146	0.23	4.4	2.11	387.3	7380.0
11:20	15:15	Left Fork	0.004	0.014	<0.03	0.191	0.28	1.1	1.97	57.6	>2419.2
12:36	15:15	House well	0.004	0.011	<0.03	0.598	0.68	0.4	2.67	<1.0	<1.0
Samples analyzed since the last quarterly report											
12/14/2016	**12/14/2016**	**Grab sample**									
11:15	14:10	Spring	0.009	0.024	0.12	0.384	0.50	7.2	14.25	10.9	1119.9
11:58	14:10	Upstream farm	0.009	0.017	0.03	0.064	0.08	0.9	4.43	67.6	2650.0
11:03	14:10	Downstream farm	0.013	0.024	0.02	0.199	0.27	1.3	2.05	5.2	>2419.2
10:45	14:10	Left Fork	0.007	0.017	0.02	0.144	0.21	0.9	3.77	13.4	2419.2
11:30	14:10	House well	0.010	0.014	0.03	0.678	0.70	0.3	6.19	<1.0	<1.0
1/5/2017	**1/5/2017**	**Grab sample**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:28	15:25	Spring	0.004	0.026	0.04	0.276	0.39	9.5	0.94	74.4	1413.6
13:12	15:25	Upstream farm	0.009	0.014	0.02	0.059	0.09	0.7	0.66	52.0	2419.2
12:00	15:25	Downstream farm	0.012	0.019	0.04	0.257	0.31	1.3	0.55	5.2	1986.3
11:42	15:25	Left Fork	0.006	0.011	0.03	0.229	0.26	0.7	0.85	6.2	1732.9
12:47	15:25	House well	0.008	0.014	0.04	0.610	0.66	0.3	0.30	<1.0	<1.0
1/19/2017	**1/19/2017**	**Grab sample**									
10:41	14:30	Spring	0.009	0.017	0.04	0.286	0.60	33.0	13.31	<1.0	2260.0
11:27	14:30	Upstream farm	0.010	0.016	0.03	0.050	0.14	1.9	4.22	137.6	>2419.2
10:30	14:30	Downstream farm	0.014	0.024	0.02	0.121	0.21	2.5	3.19	60.1	3990.0
10:10	14:30	Left Fork	0.010	0.019	0.03	0.243	0.36	2.6	4.25	55.4	>2419.2
11:00	14:30	House well	0.009	0.013	0.03	0.617	0.69	0.93	7.87	<1.0	<1.0
2/2/2017	**2/2/2017**	**Grab sample**									
10:45	14:30	Spring	0.011	0.030	<0.03	0.823	0.89	7.3	5.06	6.3	1732.9
11:20	14:30	Upstream farm	0.009	0.017	<0.03	0.056	0.07	1.1	1.72	41.9	>2419.2
10:30	14:30	Downstream farm	0.014	0.026	0.01	0.160	0.21	5.1	2.21	41.3	>2419.2
10:15	14:30	Left Fork	0.008	0.019	0.01	0.139	0.18	1.1	1.69	17.1	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:57	14:30	House well	0.011	0.031	0.01	0.614	0.78	0.4	2.22	<1.0	<1.0
2/15/2017	**2/15/2017**	**Grab sample**									
11:50	15:35	Spring	0.013	0.093	0.02	0.201	0.57	12.7	8.76	178.5	4350.0
13:30	15:35	Upstream farm	0.009	0.060	0.01	0.132	0.30	5.0	3.04	1986.3	6570.0
11:24	15:35	Downstream farm	0.012	0.082	0.03	0.159	0.42	9.0	3.46	1732.9	11000.0
12:08	15:35	Ephemeral stream	0.020	0.064	0.02	1.323	1.45	3.1	5.06	166.9	5630.0
11:11	15:35	Left Fork	0.015	0.080	0.03	0.314	0.60	17.7	4.66	648.8	11060.0
12:46	15:35	Trench 1	0.004	0.023	0.01	0.141	0.20	1.3	0.45	1.0	1299.7
12:56	15:35	Trench 2	0.004	0.087	0.04	0.486	1.12	6.1	5.99	19.7	42860.0
12:25	15:35	House well	0.008	0.023	0.02	0.649	0.72	0.5	2.07	<1.0	<1.0

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.
§ N.S. is No Sample.

Nutrients, Sediment, and Bacteria by Date Spring, Upstream, and Downstream Sites

Table 4. Water quality analyses in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application since January 2016, with those collected since the last report noted.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
1/5/2016									
Upstream	0.008	0.026	<0.03	0.158	0.20	0.5	0.95	67.7	648.8
Downstream	0.011	0.026	<0.03	0.419	0.46	0.1	1.13	40.8	648.8
1/25/2016									
Upstream	0.010	0.022	<0.03	0.068	0.09	1.1	1.52	16.9	290.9
Downstream	0.011	0.022	<0.03	0.213	0.24	0.7	1.29	8.6	365.4
2/10/2016									
Upstream	0.005	0.016	<0.03	0.048	0.11	0.5	1.11	14.5	178.5
Downstream	0.005	0.016	<0.03	0.198	0.24	0.9	0.99	4.1	218.7
2/24/2016									
Upstream	0.014	0.052	<0.03	0.099	0.28	6.1	N.D.	1203.3	7330.0
Downstream	0.015	0.058	<0.03	0.142	0.37	8.3	N.D.	1986.3	6500.0
3/10/2016									
Upstream	0.012	0.048	0.13	0.082	0.20	8.6	2.66	770.1	>2419.2
Downstream	0.010	0.044	0.11	0.118	0.25	6.2	2.28	298.7	>2419.2
3/16/2016									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.008	0.034	<0.03	0.060	0.13	0.4	1.10	52.9	579.4
Downstream	0.006	0.028	0.01	0.170	0.24	0.9	1.17	81.3	>2419.2
3/24/2016									
Upstream	0.011	0.032	0.06	0.04	0.14	4.5	1.60	N.S.	N.S.
Downstream	0.011	0.024	<0.03	0.106	0.20	3.9	1.29	N.S.	N.S.
3/31/2016									
Upstream	0.008	0.042	0.08	0.100	0.22	6.1	2.49	186.0	>2419.2
Downstream	0.011	0.056	0.08	0.156	0.33	12.4	2.67	365.0	>2419.2
4/4/2016									
Upstream	0.008	0.026	<0.03	0.065	0.08	1.7	0.71	8.3	648.8
Downstream	0.010	0.026	<0.03	0.176	0.20	1.9	0.98	77.6	1046.2
4/20/2016									
Upstream	0.003	0.020	<0.03	0.047	0.06	1.9	0.61	185.0	1299.7
Downstream	0.004	0.018	<0.03	0.152	0.20	1.2	0.74	38.4	2920.0
4/28/2016									
Upstream	0.009	0.012	<0.03	0.035	0.12	1.2	N.D.	58.6	648.8
Downstream	0.010	0.012	<0.03	0.154	0.27	1.5	N.D.	36.4	2149.2
5/2/2016									
Upstream	0.006	0.018	<0.03	0.039	0.10	6.7	1.76	185.0	2419.2
Downstream	0.008	0.016	<0.03	0.075	0.16	2.0	1.50	178.9	4720.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/10/2016									
Upstream	0.007	0.044	0.01	0.070	0.20	6.1	3.10	613.1	4480.0
Downstream	0.011	0.060	0.01	0.101	0.31	11.6	2.95	1203.3	7490.0
5/18/2016									
Upstream	0.007	0.016	<0.03	0.043	0.13	1.4	1.00	85.5	1299.7
Downstream	0.009	0.020	0.02	0.117	0.25	1.2	0.98	107.1	>2419.2
5/26/2016									
Upstream	0.007	0.030	<0.03	0.056	0.12	4.2	1.56	238.2	5290.0
Downstream	0.009	0.036	<0.03	0.094	0.20	4.6	1.75	547.5	3640.0
6/12/2016									
Upstream	0.007	0.018	<0.03	0.046	0.13	4.1	1.80	224.7	1986.3
Downstream	0.006	0.018	<0.03	0.106	0.20	1.4	1.80	104.6	3410.0
6/7/2016									
Upstream	0.013	0.018	0.06	0.131	0.14	1.3	2.8	120.1	2720.0
Downstream	0.012	0.018	0.04	0.123	0.19	1.5	1.94	73.8	2980.0
6/15/2016									
Upstream	0.007	0.010	<0.03	0.097	0.15	1.6	0.02	69.1	2310.0
Downstream	0.008	0.050	0.05	0.181	0.42	25.4	0.38	33.2	4740.0
6/22/2016									
Upstream	0.008	0.016	0.02	0.237	0.33	2.3	0.20	455.0	547.5

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.015	0.028	0.04	0.327	0.44	14.9	<0.18	46.4	4570.0
6/29/2016									
Upstream	0.006	0.029	0.06	0.186	0.34	4.6	0.92	55.4	9888.0
Downstream	0.010	0.021	0.03	0.395	0.47	2.5	0.46	41.3	6310.0
7/6/2016									
Upstream	0.009	0.023	<0.03	0.221	0.27	5.9	0.66	387.3	12230.0
Downstream	0.010	0.023	0.01	0.461	0.43	2.1	0.47	39.3	8570.0
8/16/2016									
Upstream	0.009	0.031	0.03	0.089	0.23	4.6	3.14	248.9	9330.0
Downstream	0.011	0.039	0.03	0.161	0.33	8.1	2.94	178.2	17820.0
8/24/2016									
Upstream	0.004	0.014	0.03	0.046	0.14	2.0	1.08	72.3	2620.0
Downstream	0.005	0.016	<0.03	0.122	0.22	3.2	0.85	72.8	7030.0
8/30/2016									
Upstream	0.003	0.020	<0.03	0.042	0.13	1.7	1.37	102.5	5210.0
Downstream	0.004	0.020	<0.03	0.116	0.21	1.7	1.19	30.1	5200.0
9/7/2016									
Upstream	0.007	0.020	0.01	0.113	0.21	1.9	1.89	195.6	5380.0
Downstream	0.008	0.059	0.01	0.265	0.46	25.4	1.39	30.9	4790.0
9/15/2016									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.012	0.011	<0.03	0.119	0.21	3.2	6.12	ND	ND
Downstream	0.014	0.016	0.01	0.312	0.42	2.9	5.38	ND	ND
9/28/2016									
Upstream	0.008	0.016	0.01	0.128	0.21	1.0	1.33	9330.0	2310.0
Downstream	0.011	0.017	0.01	0.293	0.42	1.6	2.15	7120.0	5210.0
10/5/2016									
Upstream	0.009	0.020	<0.03	0.120	0.25	2.1	2.85	770.1	13170.0
Downstream	0.014	0.043	0.02	0.413	0.58	29.3	3.00	547.1	11690.0
10/13/2016									
Upstream	0.015	0.026	<0.03	0.147	0.28	2.7	2.32	3590.0	46110.0
Downstream	0.033	0.066	0.02	0.614	0.88	9.6	3.90	4640.0	129970.0
10/20/2016									
Upstream	0.010	0.021	<0.03	0.076	0.13	1.1	4.43	3730.0	16640.0
Downstream	0.014	0.030	0.03	0.327	0.39	2.1	3.11	387.3	5690.0
10/27/2016									
Upstream	0.010	0.021	<0.03	0.046	0.14	1.1	5.87	517.2	5450.0
Downstream	0.014	0.021	0.01	0.291	0.36	2.1	7.91	45.5	6440.0
11/3/2016									
Upstream	0.003	0.031	0.01	0.071	0.20	2.1	6.81	22.6	3010.0
Downstream	0.008	0.022	0.03	0.388	0.47	1.7	6.07	1732.9	5200.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
11/10/2016									
Upstream	0.011	0.013	0.01	0.073	0.12	1.0	2.29	53.7	>2419.2
Downstream	0.011	0.021	0.02	0.419	0.48	0.7	2.15	22.6	5040.0
11/17/2016									
Upstream	0.009	0.020	<0.03	0.057	0.13	0.6	1.84	58.1	3270.0
Downstream	0.012	0.020	0.01	0.412	0.49	2.5	1.37	18.5	>2419.2
11/21/2016									
Upstream	0.010	0.019	0.00	0.125	0.17	1.3	0.68	178.9	3840.0
Downstream	0.012	0.021	0.01	0.466	0.52	1.3	1.23	26.9	>2419.2
11/29/2016									
Upstream	0.008	0.026	0.01	0.063	0.12	2.1	2.38	235.9	3790.0
Downstream	0.007	0.027	<0.03	0.146	0.23	4.4	2.11	387.3	7380.0
Samples analyzed since the last Quarterly Report									
12/14/2016									
Upstream	0.009	0.017	0.03	0.064	0.08	0.9	4.43	67.6	2650.0
Downstream	0.013	0.024	0.02	0.199	0.27	1.3	2.05	5.2	>2419.2
1/5/2017									
Upstream	0.009	0.014	0.02	0.059	0.09	0.7	0.66	52.0	2419.2
Downstream	0.012	0.019	0.04	0.257	0.31	1.3	0.55	5.2	1986.3
1/19/2017									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.010	0.016	0.03	0.050	0.14	1.9	4.22	137.6	2419.2
Downstream	0.014	0.024	0.02	0.121	0.21	2.5	3.19	60.1	3990.0
2/2/2017									
Upstream	0.009	0.017	<0.03	0.056	0.07	1.1	1.72	41.9	>2419.2
Downstream	0.014	0.026	0.01	0.160	0.21	5.1	2.21	41.3	>2419.2
2/15/2017									
Upstream	0.009	0.060	0.01	0.132	0.30	5.0	3.04	1986.3	6570.0
Downstream	0.012	0.082	0.03	0.159	0.42	9.0	3.46	1732.9	11000.0

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

§ N.S. is No Sample.

† N.D. is No Data.

Nutrients, Sediment, and Bacteria by Site for Ephemeral Stream, Trenches, Left Fork and Field Runoff

Table 5. Water quality analyses at the ephemeral stream draining the subwatershed containing the production houses and manure holding ponds, and surface runoff from Fields 1, 5a, and 12 since January, 2015, with those collected since the last report noted.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	---------- mg/L ----------							--- MPN/100 mL ---	
Ephemeral stream									
1/5/2016	0.007	0.018	<0.03	0.883	1.00	1.2	2.15	32.7	686.7
1/25/2016	0.011	0.030	<0.03	0.762	0.87	9.8	3.10	1.0	816.4
2/24/2016	0.010	0.056	<0.03	0.195	0.40	12.8	N.D.	387.3	4870.0
3/10/2016	0.006	0.050	0.13	0.918	1.22	26.7	3.12	648.8	8840.0
3/16/2016	0.006	0.022	0.01	0.520	0.54	<6.58	1.75	88.0	461.1
3/24/2016	0.010	0.012	<0.03	0.531	0.64	1.3	1.44	N.S.	N.S.
3/31/2016	0.013	0.656	0.68	1.211	3.05	375.0	12.14	16160.0	198630.0
4/4/2016	0.008	0.018	<0.03	0.462	0.48	1.3	1.79	12.0	727.0
4/20/2016	0.008	0.020	<0.03	0.517	0.66	4.1	0.68	44.3	21430.0
5/2/2016	0.007	0.016	<0.03	0.468	0.59	1.7	2.56	118.7	5380.0
5/10/2016	0.195	0.560	0.32	0.649	4.01	1346.7	11.94	579.4	241920.0
5/18/2016	0.008	0.014	<0.03	0.479	0.63	3.0	0.84	34.1	2419.2
5/26/2016	0.052	0.424	0.39	0.858	2.20	350.6	8.58	22470.0	241920..0
6/2/2016	0.008	0.022	0.03	0.494	0.63	3.6	2.15	770.1	1986.3

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
6/7/2016	0.012	0.024	0.01	0.5	0.7	6.9	3.89	2419.2	7980
8/16/2016	0.011	0.023	0.01	1.365	1.59	2.6	2.47	137.6	154945.0
10/13/2016 (grab sample)	0.018	0.047	0.03	1.760	1.97	9.7	5.17	>2419.2	21430.0
10/13/2016 (storm sample)	0.067	0.213	0.12	2.732	3.83	61.7	11.10	N.D.	N.D.
Samples analyzed since the last quarterly report									
2/15/2017	0.020	0.064	0.02	1.323	1.45	3.1	5.06	166.9	5630.0
House well									
1/5/2016	0.008	0.020	<0.03	0.528	0.57	0.9	1.08	<1.0	1.0
1/25/2016	0.012	0.020	<0.03	0.602	0.55	0.5	2.36	<1.0	<1
2/10/2016	0.007	0.014	<0.03	0.542	0.56	0.1	0.63	<1.0	<1.0
2/24/2016	0.010	0.010	<0.03	0.582	0.55	1.3	N.S.	<1.0	<1.0
3/10/2016	0.011	0.020	0.02	0.562	0.59	0.9	1.19	<1.0	<1.0
3/16/2016	0.009	0.022	<0.03	0.550	0.55	0.0	1.55	<1.0	<1
3/24/2016	0.012	0.014	<0.03	0.565	0.65	0.2	2.72	N.S.	N.S.
3/31/2016	0.010	0.018	<0.03	0.556	0.62	0.2	3.93	1.0	26.2
4/4/2016	0.011	0.018	<0.03	0.466	0.48	<6.58	0.94	<1.0	1.0
4/20/2016	0.005	0.014	<0.03	0.598	0.50	0.5	0.47	1.0	1.0
4/28/2016	0.011	0.008	<0.03	0.481	0.57	0.3	N.S.	<1.0	<1.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/2/2016	0.009	0.016	<0.03	0.551	0.56	0.1	1.94	<1.0	<1
5/10/2016	0.009	0.008	<0.03	0.533	0.56	0.5	4.39	<1.0	24.9
5/18/2016	0.009	0.010	<0.03	0.488	0.64	0.4	0.95	<1.0	<1.0
5/26/2016	0.009	0.012	<0.03	0.564	0.57	0.7	0.93	1.0	7.4
6/2/2016	0.008	0.018	<0.03	0.597	0.62	0.7	0.99	<1.0	<1.0
6/7/2016	0.011	0.014	0.03	0.500	0.58	0.1	3.06	<1.0	<1.0
6/15/2016	0.008	0.008	<0.03	0.506	0.59	0.7	<0.18	<1.0	<1.0
6/22/2016	0.009	0.008	<0.03	0.545	0.58	0.5	<0.18	<1.0	<1.0
6/29/2016	0.008	0.014	<0.03	0.569	0.56	<6.58	0.23	<1.0	<1.0
7/6/2016	0.009	0.013	<0.03	0.874	0.96	1.0	0.73	<1.0	13.5
7/13/2016	0.005	0.011	<0.03	0.627	0.63	0.5	0.09	<1.0	<1.0
7/20/2016	0.007	0.009	0.02	0.594	0.70	0.1	0.14	N.S.	N.S.
7/27/2016	0.006	0.010	<0.03	0.650	0.67	0.1	1.41	<1.0	<1.0
10/13/2016	0.008	0.010	0.01	1.166	1.23	0.6	1.35	<1.0	23.3
10/13/2016	0.009	0.020	0.02	0.739	0.79	0.1	4.56	<1.0	19.7
10/27/2016	0.009	0.010	0.01	0.664	0.74	0.9	8.95	<1.0	5.2
11/03/2016	0.004	0.010	0.02	0.719	0.75	0.4	9.48	1.0	2.0
11/10/2016	0.005	0.009	<0.03	0.574	0.68	0.1	2.16	<1.0	1.0
11/17/2016	0.006	0.010	0.01	0.660	0.71	0.3	1.57	<1.0	1.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
11/21/2016	0.007	0.011	<0.03	0.675	0.75	0.4	1.37	<1.0	<1.0
11/29/2016	0.004	0.011	<0.03	0.598	0.68	0.4	2.67	<1.0	<1.0
Samples analyzed since the last quarterly report									
12/14/2016	0.010	0.014	0.03	0.678	0.70	0.3	6.19	<1.0	<1.0
1/5/2017	0.008	0.014	0.04	0.610	0.66	0.3	0.30	<1.0	<1.0
1/19/2017	0.009	0.013	0.03	0.617	0.69	0.9	7.87	<1.0	<1.0
2/2/2017	0.011	0.031	0.01	0.614	0.78	0.4	2.22	<1.0	<1.0
2/15/2017	0.008	0.023	0.02	0.649	0.72	0.5	2.07	<1.0	<1.0
Interceptor Trench 1 (South)									
1/5/2016	0.003	0.016	<0.03	0.243	0.29	0.9	1.11	1.0	209.8
2/24/2016	0.005	0.014	<0.03	0.345	0.39	2.1	N.D.	<1.0	9070.0
3/10/2016	0.005	0.036	0.10	0.264	0.45	3.5	2.87	2419.2	16690.0
3/16/2016	0.003	0.032	0.02	0.331	0.37	<6.58	1.23	101.7	290.9
3/24/2016	0.008	0.016	<0.03	0.208	0.20	2.8	1.33	N.S.	N.S.
3/31/2016	0.004	0.018	<0.03	0.347	0.49	5.5	4.76	4.1	2419.2
5/10/2016	0.002	0.016	<0.03	0.228	0.30	3.9	2.91	13.9	2419.2
5/18/2016	0.006	0.006	<0.03	0.169	0.22	0.1	0.54	2.0	5200.0
5/26/2016	0.008	0.006	<0.03	0.217	0.23	1.4	1.29	1.0	4260.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
6/2/2016	0.002	0.018	<0.03	0.124	0.30	8.8	3.01	26.5	393.0
8/16/2016	0.005	0.006	0.02	0.130	0.17	0.2	2.14	93.4	48840.0
8/24/2016	<0.002	0.019	0.03	0.033	0.30	8.3	1.99	21.8	3450.0
8/16/2016	0.005	0.006	0.02	0.130	0.17	0.2	2.14	93.4	48840.0
8/24/2016	<0.002	0.019	0.03	0.033	0.30	8.3	1.99	21.8	3450.0
Samples analyzed since the last quarterly report									
2/15/2017	0.004	0.023	0.01	0.141	0.20	1.3	0.45	1.0	1299.7
Interceptor Trench 2 (North)									
2/24/2016	0.005	0.066	0.13	6.298	7.02	9.7	4.27	30.1	18720.0
3/10/2016	0.005	0.054	0.14	1.716	2.35	6.8	6.77	613.1	34480.0
3/31/2016	0.006	0.040	0.06	2.800	3.54	20.9	9.29	7.4	10810.0
4/4/2016	0.004	0.012	<0.03	0.236	0.25	<6.58	0.85	1.0	2419.2
5/10/2016	0.002	0.038	<0.03	1.706	2.18	5.2	3.72	38.7	1553.0
8/16/2016	0.004	0.036	0.05	0.344	0.99	1.5	8.98	290.9	198630.0
Samples analyzed since the last quarterly report									
2/15/2017	0.004	0.087	0.04	0.486	1.12	6.1	5.99	19.7	42860.0
No flow									
Left Fork									

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
1/5/2016	0.013	0.028	<0.03	0.427	0.48	0.7	1.51	34.1	686.7
1/25/2016	0.010	0.024	<0.03	0.198	0.25	1.0	1.30	21.1	435.2
2/10/2016	0.003	0.012	<0.03	0.175	0.24	0.8	1.15	7.4	209.8
2/24/2016	0.015	0.088	<0.03	0.249	0.63	15.6	N.D.	2780.0	14390.0
3/10/2016	0.013	0.046	0.01	0.154	0.38	8.7	2.64	367.3	2750.0
3/16/2016	0.009	0.032	<0.03	0.190	0.26	0.3	1.45	35.9	980.4
3/24/2016	0.013	0.048	0.09	0.186	0.39	10.7	2.65	N.S.	N.S.
3/31/2016	0.013	0.056	0.09	0.199	0.40	11.9	2.59	172.0	3640.0
4/4/2016	0.009	0.022	<0.03	0.131	0.17	1.5	0.87	44.8	1119.9
4/20/2016	0.005	0.020	<0.03	0.157	0.21	2.1	0.84	35.0	6160.0
5/2/2016	0.009	0.020	<0.03	0.095	0.20	1.9	2.30	172.6	3640.0
5/10/2016	0.011	0.072	0.02	0.121	0.37	17.2	3.35	980.4	8230.0
5/18/2016	0.010	0.016	0.01	0.139	0.27	1.4	1.54	60.1	2620.0
5/26/2016	0.010	0.048	0.02	0.123	0.24	10.6	2.66	461.1	6890.0
6/2/2016	0.007	0.022	0.00	0.117	0.22	1.4	1.40	44.1	1986.3
6/7/2016	0.009	0.016	0.04	0.124	0.19	0.8	2.08	31.8	3180.0
6/15/2016	0.009	0.012	0.01	0.198	0.29	2.0	0.94	63.1	8860.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
6/22/2016	0.008	0.018	0.05	0.220	0.37	2.1	0.70	37.9	676.0
6/29/2016	0.006	0.023	0.03	0.251	0.35	2.0	0.94	23.5	5200.0
7/6/2016	0.006	0.02	0.04	0.271	0.36	2.7	0.96	248.1	12590.0
7/13/2016	0.005	0.017	<0.03	0.172	0.29	1.9	0.85	95.9	12360.0
7/20/2016	0.005	0.013	<0.03	0.197	0.76	2.3	2.21	N.S.	N.S.
7/27/2016	0.004	0.021	<0.03	0.255	0.35	3.6	1.79	920.8	15000.0
8/3/2016	0.007	0.016	<0.03	0.212	0.32	2.4	2.21	101.4	7430.0
8/16/2016	0.012	0.082	0.07	0.118	0.30	19.5	3.64	201.4	14550.0
8/24/2016	0.004	0.013	<0.03	0.045	0.13	1.5	1.62	43.5	6690.0
8/30/2016	0.005	0.021	0.02	0.157	0.28	2.7	2.00	111.2	17850.0
9/7/2016	0.006	0.021	<0.03	0.151	0.24	2.8	1.58	27.5	10170.0
9/15/2016	0.011	0.014	0.01	0.132	0.25	2.2	5.35	ND	ND
9/28/2016	0.006	0.011	0.02	0.101	0.22	1.8	1.31	2530.0	3410.0
10/5/2016	0.009	0.023	0.01	0.130	0.29	2.8	2.38	285.1	17820.0
10/13/2016	0.091	0.203	0.04	1.071	1.74	24.2	9.30	14010.0	>241920
10/20/2016	0.008	0.026	0.01	0.146	0.27	1.3	3.95	33.5	17890.0
10/27/2016	0.008	0.016	0.02	0.132	0.26	1.9	7.76	48.8	9340.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
11/03/2016	0.004	0.026	0.03	0.117	0.26	1.5	9.24	33.1	7380.0
11/10/2016	0.005	0.013	0.01	0.161	0.23	4.1	2.07	7.4	2560.0
11/17/2016	0.005	0.011	<0.03	0.195	0.26	0.5	1.77	15.8	2400.0
11/21/2016	0.004	0.011	0.01	0.239	0.31	0.4	3.35	11.9	2419.2
11/29/2016	0.004	0.014	<0.03	0.191	0.28	1.1	1.97	57.6	>2419.2
Samples analyzed since the last quarterly report									
12/14/2016	0.007	0.017	0.02	0.144	0.21	0.9	3.77	13.4	2419.2
1/5/2017	0.006	0.011	0.03	0.229	0.26	0.7	0.85	6.2	1732.9
1/19/2017	0.010	0.019	0.03	0.243	1.00	2.6	4.25	55.4	>2419.2
2/2/2017	0.008	0.019	0.01	0.139	0.18	1.1	1.69	17.1	>2419.2
2/15/2017	0.015	0.080	0.03	0.314	0.60	17.7	4.66	648.8	11060.0
Field 1									
10/13/2016	0.940	1.231	0.13	0.335	2.36	59.0	16.67	N.S.	N.S.
No samples analyzed since the last quarterly report									
Field 5a									
3/31/2016	1.154	1.352	0.27	0.302	1.67	26.5	32.74	N.S.	N.S.
5/10/2016	1.114	1.458	1.69	2.894	6.35	79.9	12.82	N.S.	N.S.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
No samples analyzed since the last quarterly report									
Field 12									
3/10/2016	0.411	0.522	1.17	0.852	4.49	621.5	12.58	N.S.	N.S.
5/10/2016	0.370	0.666	0.12	0.062	1.03	96.7	6.92	N.S.	N.S.
No samples analyzed since the last quarterly report									

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.

§ N.S. is No Sample. E. coli and total coliform were not measured on surface runoff samples collected by ISCO samplers when sample holding time exceeded the required 8-hour threshold.

† N.D. is No Data.

Water pH, Alkalinity, Chloride, Electrical Conductivity, and Total Dissolved Solids for Several Big Creek Sites

At the beginning of 2015, the pH, alkalinity, chloride concentration, electrical conductivity and total dissolved solids were determined on water samples collected at the upstream and downstream sites, spring, house well, and trenches, to build a data base that will enable to eventually source track the major water source pathways at these sites. These values are given below in Table 6.

Table 6. The pH, Chloride concentration, electrical conducting, and total solids concentration of water samples collected at upstream, downstream, spring, ephemeral stream, house well and trench sites, initiated at the beginning of 2015, with those collected since the last report noted.

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
		------- mg/L ------		µS/cm	mg/L
Upstream					
1/5/2016	7.5	40	1.34	102	62.5
1/25/2016	8.2	46	1.50	115	65.0
2/10/2016	8.6	54	1.69	141	60.0
2/24/2016	7.2	66	1.20	102	97.5
3/10/2016	7.6	38.0	1.268	84.5	60.0
3/16/2016	6.7	38.0	1.252	88.3	52.5
3/24/2016	7.7	46.0	1.825	103.3	56.5
3/31/2016	7.3	30.0	0.933	65.8	235.0
4/4/2016	7.4	40.0	1.163	86.9	55.0
4/20/2016	8.0	58.0	1.405	125.7	65.0
4/29/2016	8.1	66.0	1.373	134.8	72.5
5/3/2016	7.7	38.0	1.150	83.7	52.5
5/10/2016	7.6	32.0	0.914	67.6	57.5
518/2016	8.0	48.0	1.228	102.8	57.5
5/26/2016	7.8	76.0	1.045	78.4	50.0
6/2/2016	7.9	68.0	1.298	105.4	75.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
6/7/2016	8.1	58.0	2.722	128.3	77.5
6/15/2016	8.3	72.0	1.471	150.3	77.5
6/22/2016	8.1	88.0	1.695	182.3	112.5
6/29/2016	7.4	110.0	2.176	203.0	112.5
7/6/2016	7.5	106.0	1.821	212.0	117.5
8/16/2016	7.7	40.0	1.092	88.1	60.0
8/24/2016	8.3	54.0	1.513	121.7	95.0
8/30/2016	8.2	64.0	1.088	143.3	70.0
9/7/2016	7.9	82.0	1.601	176.0	97.5
9/15/2016	8.0	98.0	1.287	206.0	111.1
9/28/2016	8.1	84.0	1.804	217.0	113.3
10/5/2016	7.9	94.0	1.831	230.0	110.0
10/13/2016	7.8		2.540	225.0	242.5
10/20/2016	7.9		2.017	235.0	117.8
10/27/2016	8.0		2.139	299.0	117.5
11/3/2016	7.6		2.330	260.0	
11/10/2016	8.0		2.446	233.0	
11/17/2016	8.0		2.455	272.0	
11/21/2016	8.0		2.314	101.0	
11/29/2016			2.087		
Samples analyzed since the last quarterly report					
12/14/2016	8.3		2.140	129.0	
1/5/2017	8.8		2.264	142.0	
1/19/2017	7.9		2.089		
2/2/2017	8.4		2.044	112.0	
2/15/2017	7.9		2.022	128.0	

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
Downstream					
1/5/2016	7.5	60	2.17	158	92.5
1/25/2016	8.0	80	2.00	191	95.0
2/10/2016	8.0	94	2.36	214	102.5
2/22/2016	7.5	80	1.48	156	110.0
3/10/2016	7.3	54.0	1.481	126.1	80.0
3/16/2016	7.1	60.0	1.500	137.6	75.0
3/24/2016	7.3	68.0	1.827	156.8	79.0
3/31/2016	7.3	48.0	1.043	95.9	50.0
4/4/2016	7.4	66.0	1.563	138.6	80.0
4/20/2016	7.3	92.0	1.903	187.0	105.0
4/29/2016	7.7	100.0	2.052	199.1	107.5
5/3/2016	7.8	60.0	1.197	130.5	87.5
5/10/2016	7.6	44.0	0.856	93.5	75.0
518/2016	7.8	74.0	1.482	154.5	82.5
5/26/2016	7.7	34.0	0.941	114.1	72.5
6/2/2016	8.0	48.0	1.447	154.8	100.0
6/7/2016	7.8	88.0	1.698	176.8	97.5
6/15/2016	7.9	108.0	2.525	205.0	115.0
6/22/2016	7.8	120.0	2.406	230.0	145.0
6/29/2016	7.5	132.0	2.971	259.0	322.5
7/6/2016	7.4	136.0	2.960	262.0	157.5
7/13/2016	7.4	130.0	2.549	289.0	137.5
7/20/2016	7.7	138.0	2.726	305.0	145.0
7/27/2016	7.5	134.0	2.599	286.0	150.0
8/3/2016	7.9	144.0	1.845	258.0	137.5

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
8/16/2016	7.7	60.0	1.255	128.9	82.5
8/24/2016	7.8	84.0	1.368	174.8	97.5
8/24/2016			1.152	122.8	97.5
8/30/2016	7.8	88.0	1.435	193.5	97.5
9/7/2016	7.9	112.0	2.143	240.0	125.0
9/15/2016	7.9	126.0	1.918	265.0	137.8
9/28/2016	7.8	124.0	2.272	281.0	142.2
10/5/2016	7.8	122.0	2.708	288.0	140.0
10/13/2016	7.6		2.799	264.0	152.5
10/20/2016	7.2		2.791	314.0	157.8
10/27/2016	7.6		2.805	304.0	150.0
11/3/2016	7.2		3.074	313.0	
11/10/2016	7.8		3.330	311.0	
11/17/2016	7.8		3.203	366.0	
11/21/2016	7.8		3.272	139.0	
11/29/2016			2.481		
Samples analyzed since the last quarterly report					
12/14/2016	7.8		2.597	206.0	
1/5/2017	8.1		5.692	220.0	
1/19/2017	7.6		2.390		
2/2/2017	7.9		2.414	171.0	
2/15/2017	8.2		2.199	119.0	
Spring					
3/10/2016			1.109	359.0	210.0
3/16/2016			2.038	516.0	250.0
3/24/2016			1.939	446.0	214.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
3/31/2016			1.324	414.0	45.0
4/4/2016			1.971	506.0	272.5
4/20/2016			2.111	554.0	300.0
4/29/2016			2.234	522.0	285.0
5/3/2016			1.879	486.0	275.0
5/10/2016			1.190	417.0	245.0
5/18/2016			2.206	493.0	275.0
5/26/2016			1.370	450.0	250.0
6/2/2016			2.111	512.0	285.0
6/7/2016			2.348	503.0	280.0
6/15/2016			2.523	526.0	305.0
6/22/2016			2.659	543.0	322.5
6/29/2016			2.864	545.0	322.5
7/6/2016			2.749	533.0	267.5
7/13/2016			2.661	272.0	292.5
7/20/2016			2.271	594.0	292.5
7/27/2016			2.424	593.0	297.5
8/3/2016			2.151	541.0	280
8/16/2016			1.435	434.0	242.5
8/24/2016			2.644	556.0	312.5
8/30/2016			2.710	604.0	310.0
9/7/2016			2.822	598.0	322.5
9/15/2016			2.040	590.0	322.2
9/28/2016			2.785	652.0	328.9
10/5/2016			2.272	644.0	315.0
10/13/2016			1.899	455.0	127.5
10/20/2016	6.9		2.528	674.0	331.1

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
10/27/2016	7.2		2.525	637.0	315.0
11/3/2016	6.9		2.361	619.0	
11/10/2016	7.2		2.402	605.0	
11/17/2016	7.1		2.367	695.0	
11/21/2016	7.0		2.433	259.0	
11/29/2016			2.472		
Samples analyzed since the last quarterly report					
12/14/2016	6.9		2.320	519.0	
1/5/2017	7.2		2.462	504.0	
1/19/2017	7.1		2.397		
2/2/2017	7.1		3.099	546.0	
2/15/2017	7.3		2.305	353.0	
Ephemeral Stream					
1/5/2016			2.908	368.0	
1/25/2016			3.454	392.0	
2/24/2016			2.427	264.0	
3/10/2016			2.530	288.0	
3/16/2016			2.427	356.0	
3/24/2016			3.467	399.0	
3/31/2016			3.366	153.2	
4/4/2016			2.544	330.0	
4/20/2016			2.758	380.0	
5/2/2016			2.068	329.0	
5/2/2016			2.571	241.0	
5/10/2016			1.617	143.3	
5/18/2016			2.726	360.0	

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
5/26/2016			2.031	194.5	
6/2/2016			2.733	359.0	
6/7/2016			2.930	344.0	
8/16/2016			3.309	357.0	
10/13/2016	7.2		3.546	393.0	225.0
Samples analyzed since the last quarterly report					
2/15/2017	7.7		3.366	270.0	
House well					
1/5/2016			4.855	439	215.0
1/25/2016			5.278	462	242.5
2/10/2016			5.273	468	215.0
2/24/2016			5.237	447	242.5
3/10/2016			5.366	458	237.5
3/16/2016			4.993	482	240.0
3/24/2016			5.265	484	219.0
3/31/2016			5.023	409	220.0
4/4/2016			4.735	414	210.0
4/20/2016			5.475	417	227.5
4/28/2016			4.671	417	247.5
5/2/2016			5.316	441	237.5
5/10/2016			5.234	411	237.5
5/18/2016			4.450	420	232.5
5/26/2016			5.649	426	220.0
6/2/2016			5.450	409	182.5
6/7/2016			4.670	416	220.0
6/15/2016			4.394	414	242.5
6/22/2016			5.173	424	260.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
6/29/2016			5.557	432	172.5
7/6/2016			5.811	391	237.5
7/13/2016			5.021	561	220.0
7/20/2016			5.561	447	230.0
7/27/2016			5.230	467	227.5
10/13/2016			6.988	476.	245.0
10/20/2016	7.6		6.421	495	244.4
10/27/2016	7.9		6.132	501	142.5
11/3/2016	7.6		5.560	479	
11/10/2016	7.6		5.858	473	
11/17/2016	7.6		5.655	544	
11/21/2016	7.5		5.576	209	
11/29/2016			5.721		
12/14/2016	7.4			411	
Samples analyzed since the last quarterly report					
1/5/2017	7.8		5.371	421.0	
1/19/2017	7.4		5.234		
2/2/2017	7.5		5.290	420.0	
2/15/2017	7.6		5.401	397.0	
Trench 1					
1/5/2016			1.61	161	82.5
2/24/2016			1.16	162	102.5
3/10/2016			1.019	173.7	117.5
3/16/2016			1.451	226.0	120.0
3/24/2016			1.732	229.0	99.0
3/31/2016			1.280	167.9	100.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
5/10/2016			1.122	226.0	130.0
5/19/2016			0.405	196.5	115.0
5/18/2016			1.653	234.0	125.0
5/26/2016			1.421	262.0	142.5
6/2/2016			1.229	320	192.5
8/16/2016			2.051	293	130.0
8/24/2016			1.259	318	170.0
Samples analyzed since the last quarterly report					
2/15/2017	8.0		2.344	397.0	
Trench 2					
3/11/2015			1.77	159	140.8
3/19/2015			1.04	168	104.9
3/26/2015			0.78	135	160.9
5/11/2015			0.41	165	88.5
5/26/2015			0.93	284	141.3
12/14/2016			1.00	148	110.0
2/24/2016			0.99	144	122.5
3/10/2016			0.349	106.8	80.0
3/31/2016			0.424	134.5	87.5
4/4/2016			1.4	192.1	107.5
8/16/2016			0.597	219	117.5
No samples analyzed since the last quarterly report					
2/15/2017	8.0		1.164	135.0	

Temporal Trends in Phosphorus, Nitrogen, Bacteria, and Chloride in Big Creek Above and Below the C&H Farm

The concentration of dissolved P, total P, nitrate-N, total N, bacteria and chloride in Big Creek above and below the C&H Farm are presented in subsequent figures to show the season / temporal trends in measured concentrations (Figures 5, 6, 7, 8, 9, 10, and 11).

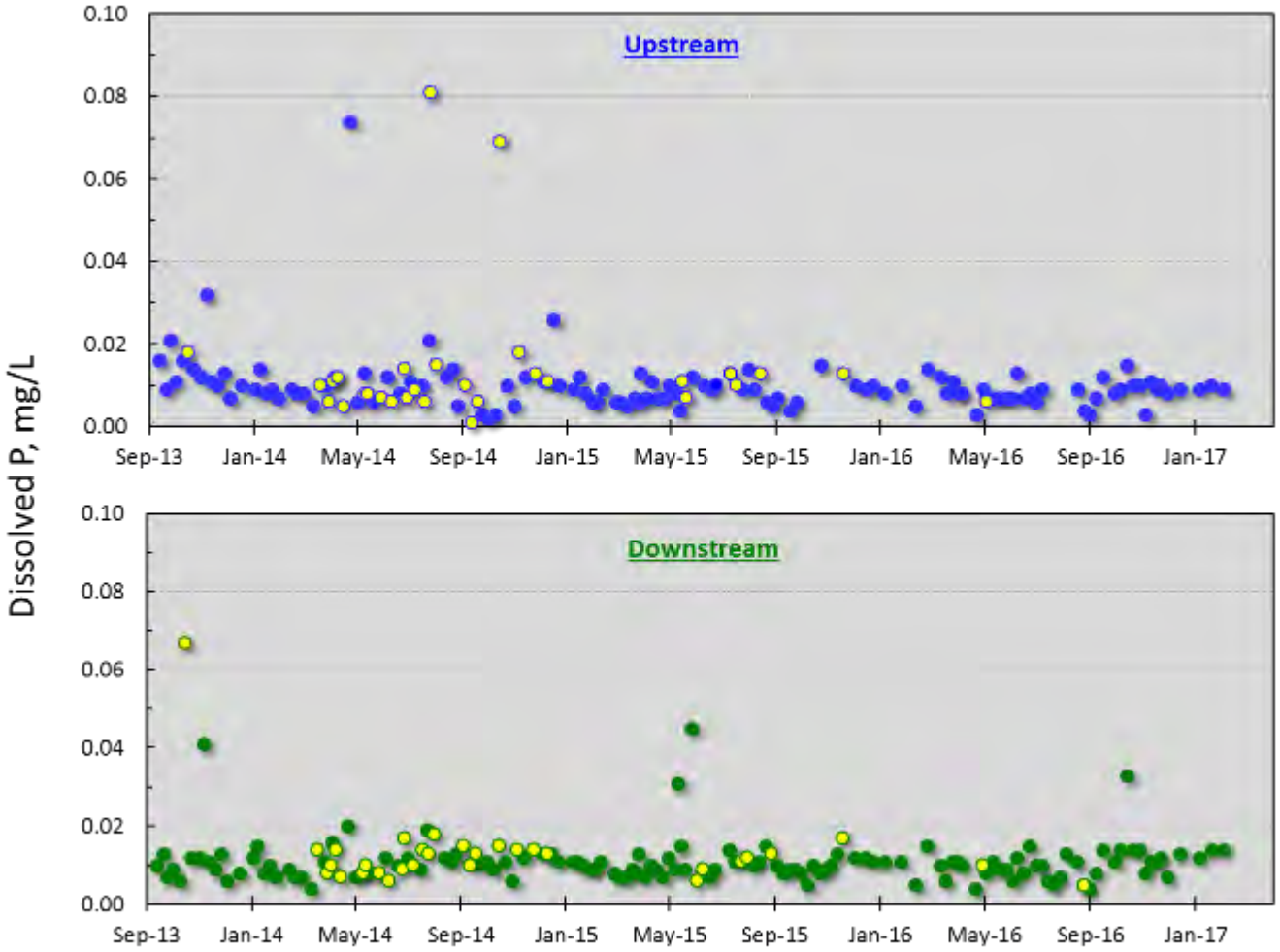

Figure 2. Dissolved P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

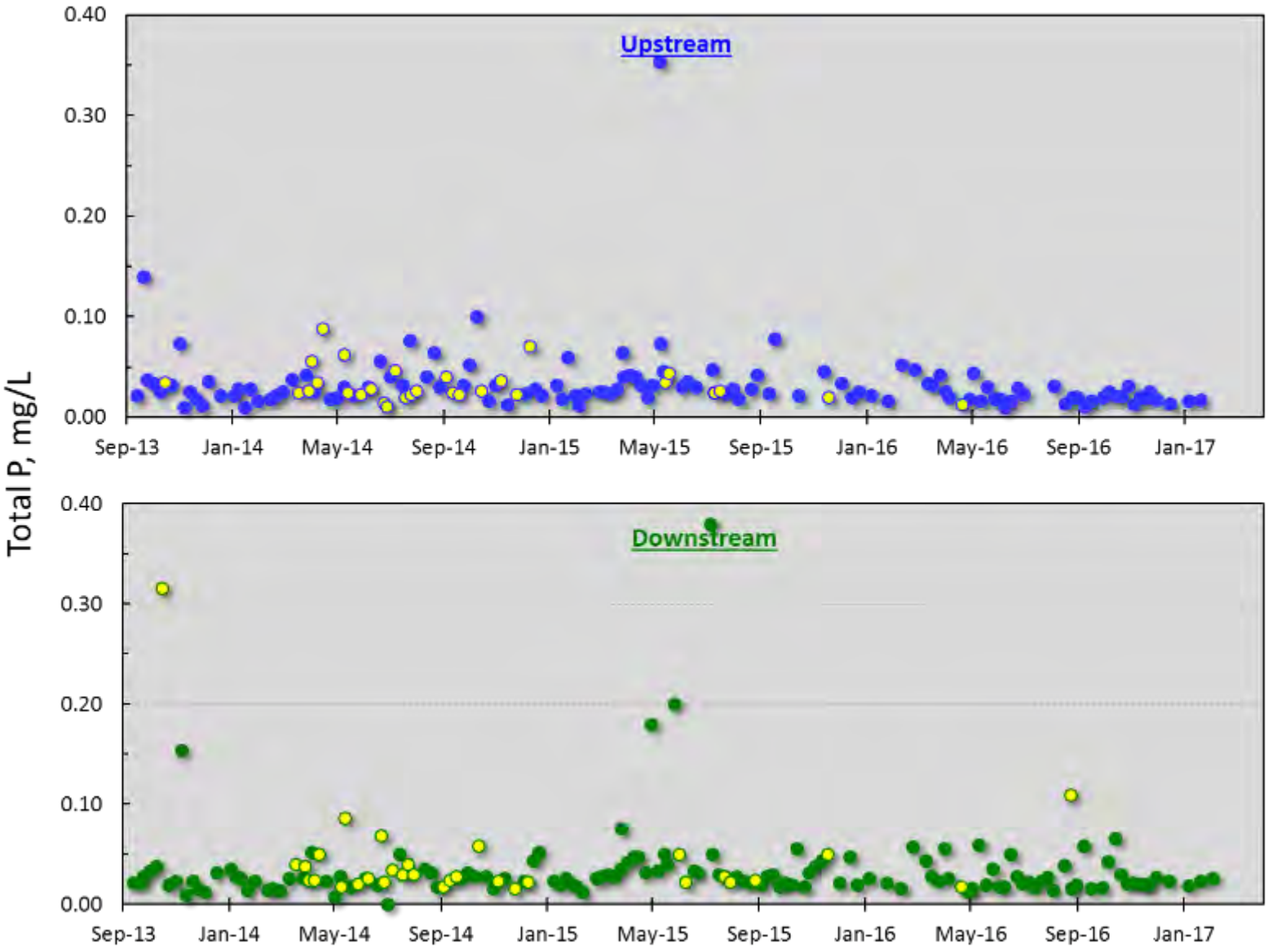

Figure 3. Total P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

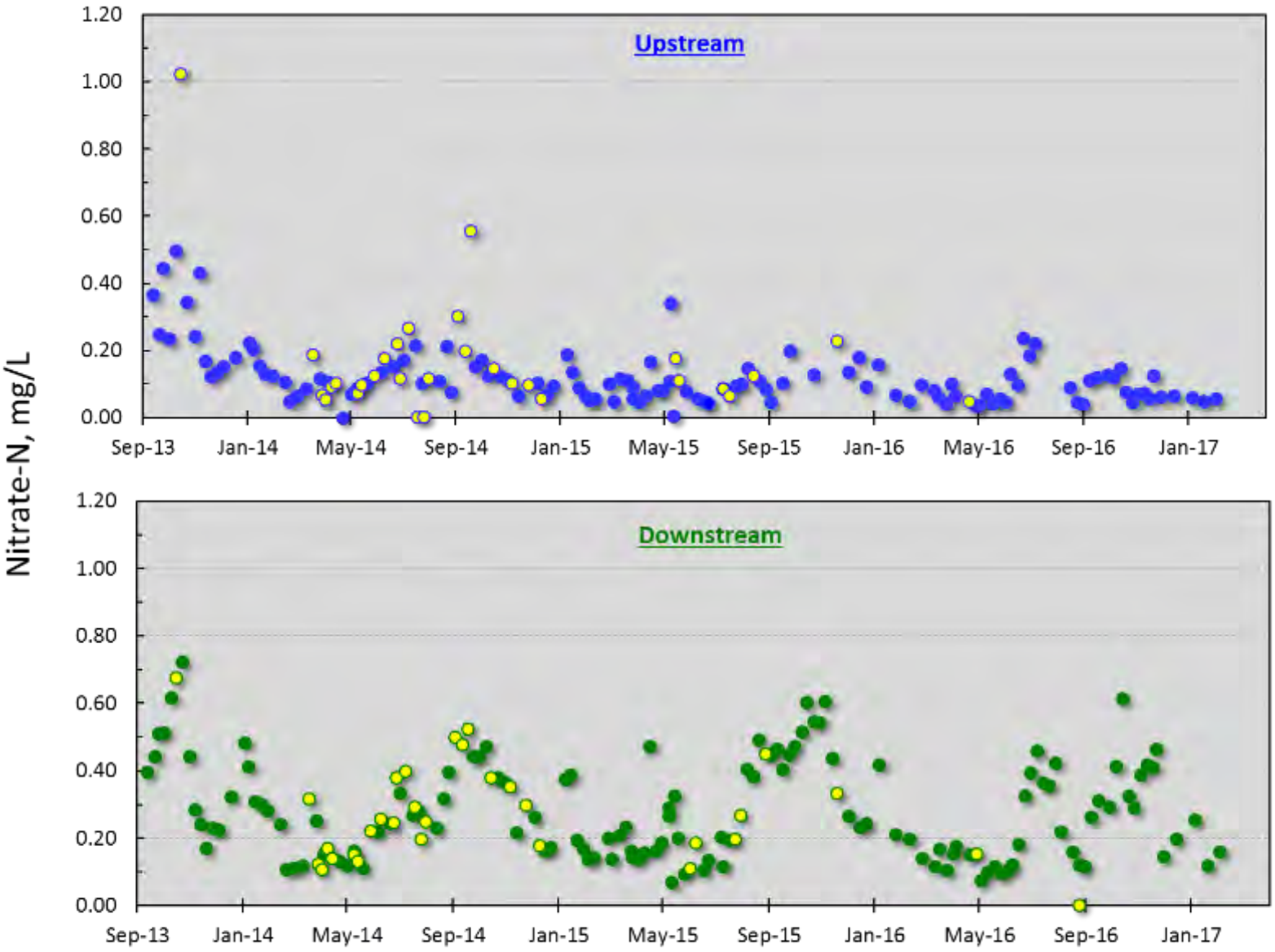

Figure 4. Nitrate-N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

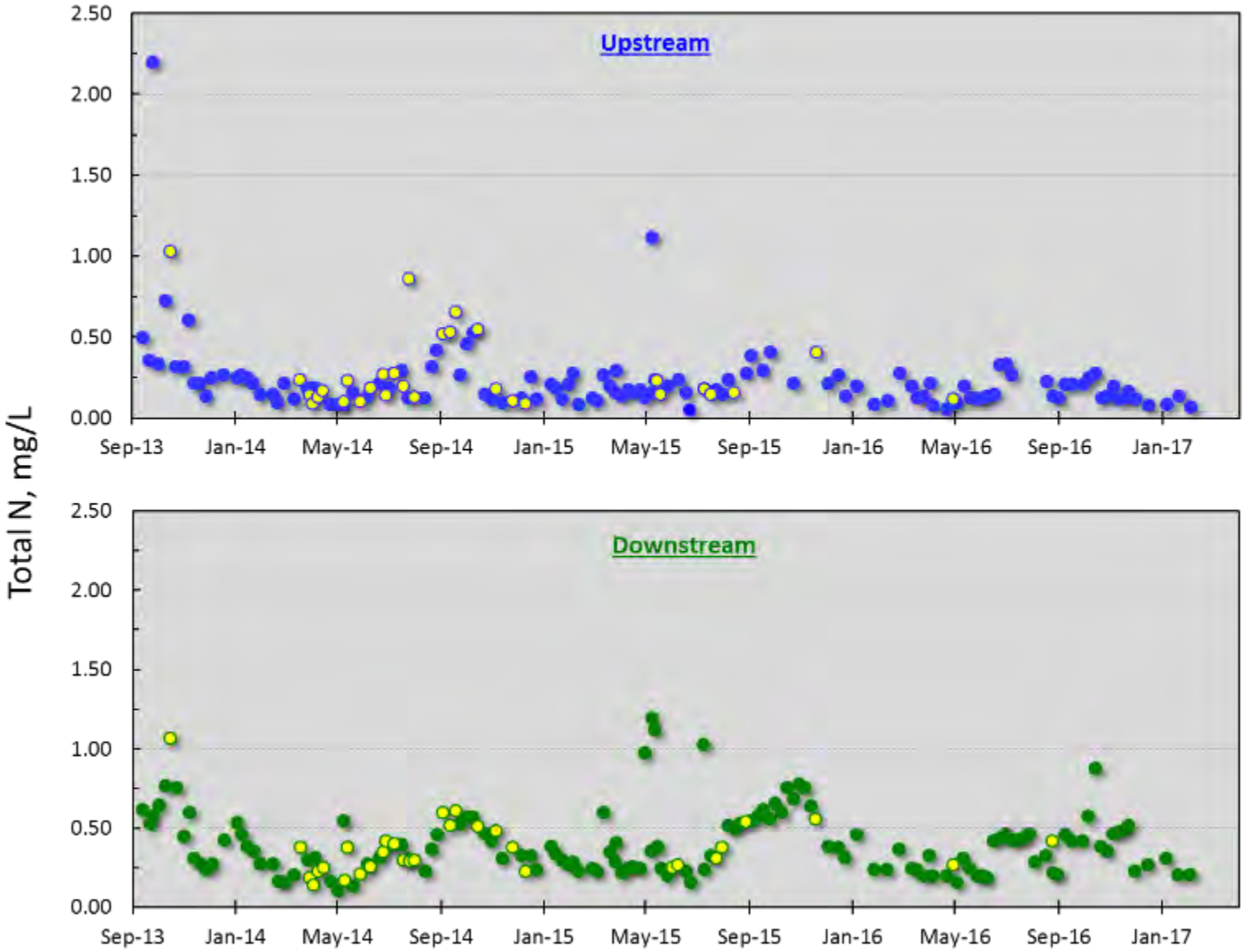

Figure 5. Total N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

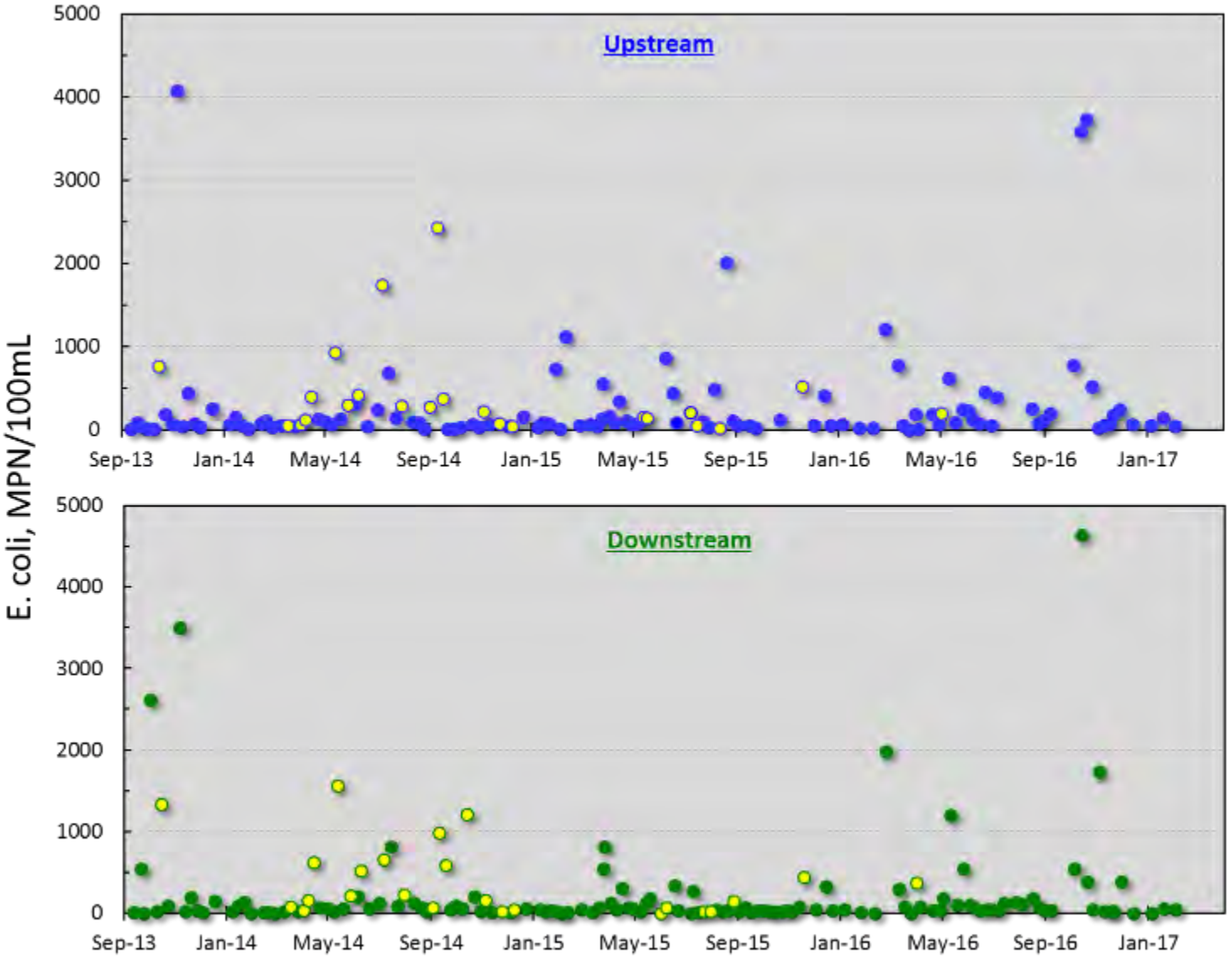

Figure 6. E. coli numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

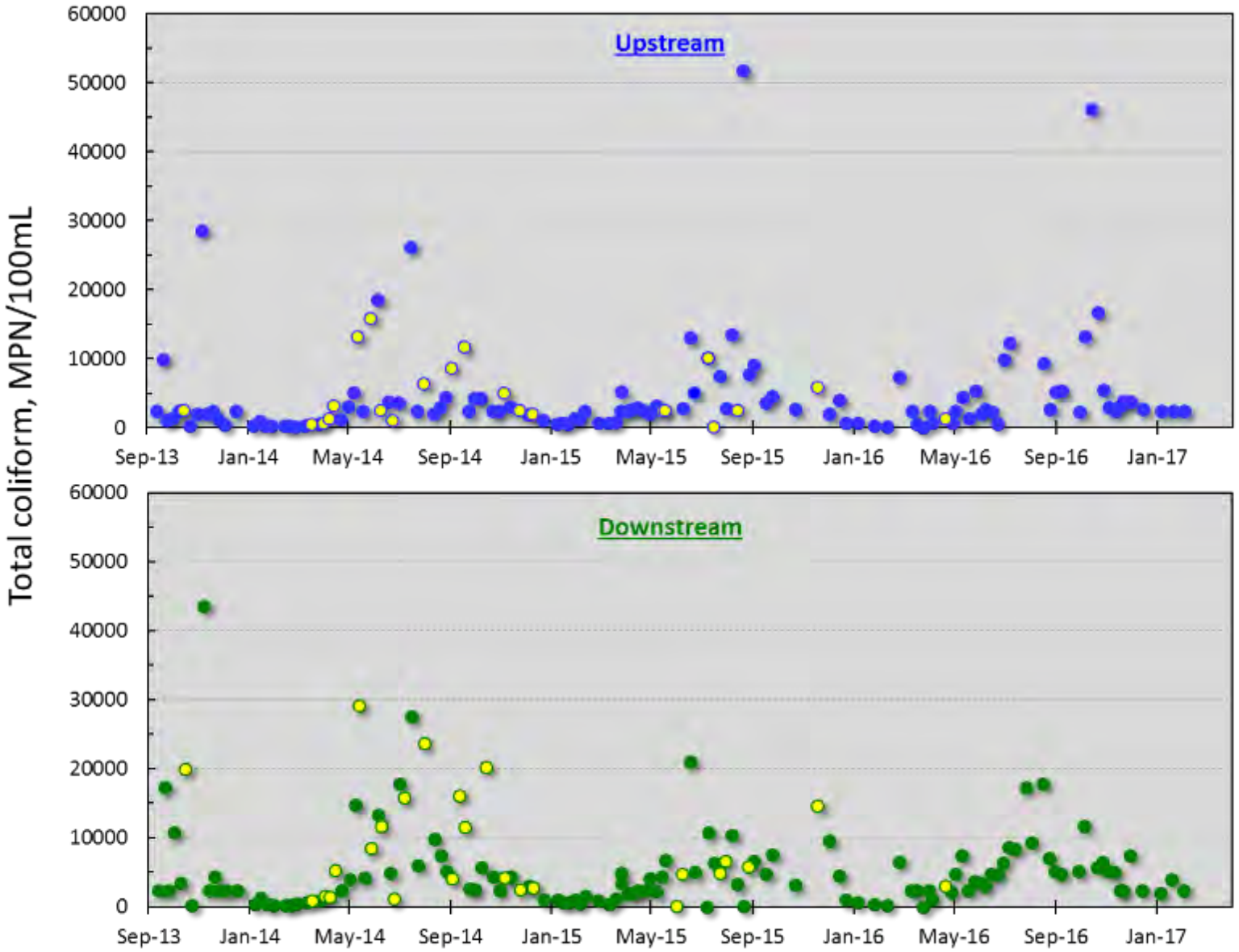

Figure 7. Total coliform numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

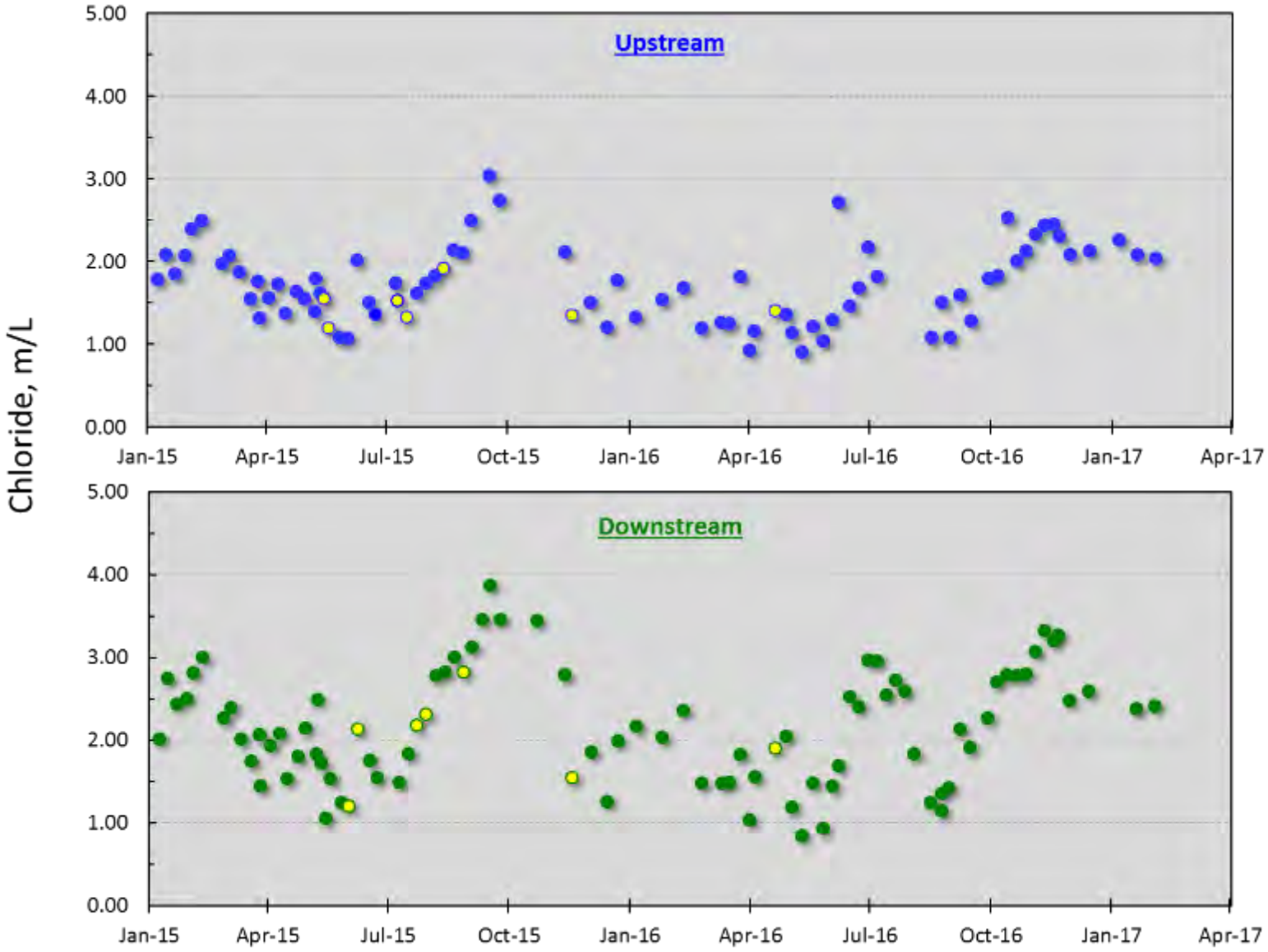

Figure 8. Chloride concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

Geometric Mean Concentrations as a Function of Big Creek Flow

Big Creek flows were classified as base, intermediate or storm flows using hydrographs provided by the United States Geological Survey (USGS – see https://nwis.waterdata.usgs.gov/ar/nwis/uv?cb_00060=on&format=gif_default&site_no=07055790&period=&begin_date=2014-04-16&end_date=2017-04-10). Base flows were assessed by lower, level plateaus of the hydrograph curve, while storm flows were determined by sharp, elevated peaks within the hydrograph. Intermediate flows were determined as being between base and storm and located mid-slope as storm flows descended to base flows on the curve. If the hydrograph for a certain sampling event had pronounced peaks, but did not vary significantly in discharge, the resulting flow was characterized as base flow. There were 102 base, 5 intermediate, and 21 storm flow samples in Big Creek at the site upstream of the C&H Farm and 111, 9, and 21 base, intermediate, and storm flow events, respectively, at the site downstream of the C&H farm between April 2014 and February 2017.

The geometric mean concentrations of analytes measured under each flow condition between April 2014 and February 2017 are presented for Big Creek sites upstream and downstream of the C&H Farm operation in Figure 9 for dissolved and total P, Figure 10 for nitrate-N and total N, Figure 11 for suspended sediment, and Figure 12 for E. coli and total coliform. These relationships provide insight into the dominant flow pathways for P, N, sediment, and bacteria transport in this watershed.

There is an increase in dissolved and total P concentration at both sites with an increase in flow regime (Figure 9), due to an increasing contribution of surface runoff, with greater P concentration, as stream flow increases from base to storm flow. In contrast, nitrate-N and total N concentration increases as flow regime decreases, due to the greater contribution of groundwater flow, with elevated nitrate-N than surface runoff (Figure 10). As expected suspended sediment transport is greater with storm flow, where flows have higher energies and erosivity (Figure 11). Finally, bacteria transport tends to be greater during storm than base flow events at both up and downstream sites (Figure 12). Averaged for storm and base flow, E. coli was greater at the up than downstream site, while there was an opposite trend for coliform concentrations (Figure 12).

Better understanding these flow – concentration relationships in Big Creek with help identify and target effective conservation measures aimed at minimizing P, N, sediment, and bacterial loss and input to Big Creek.

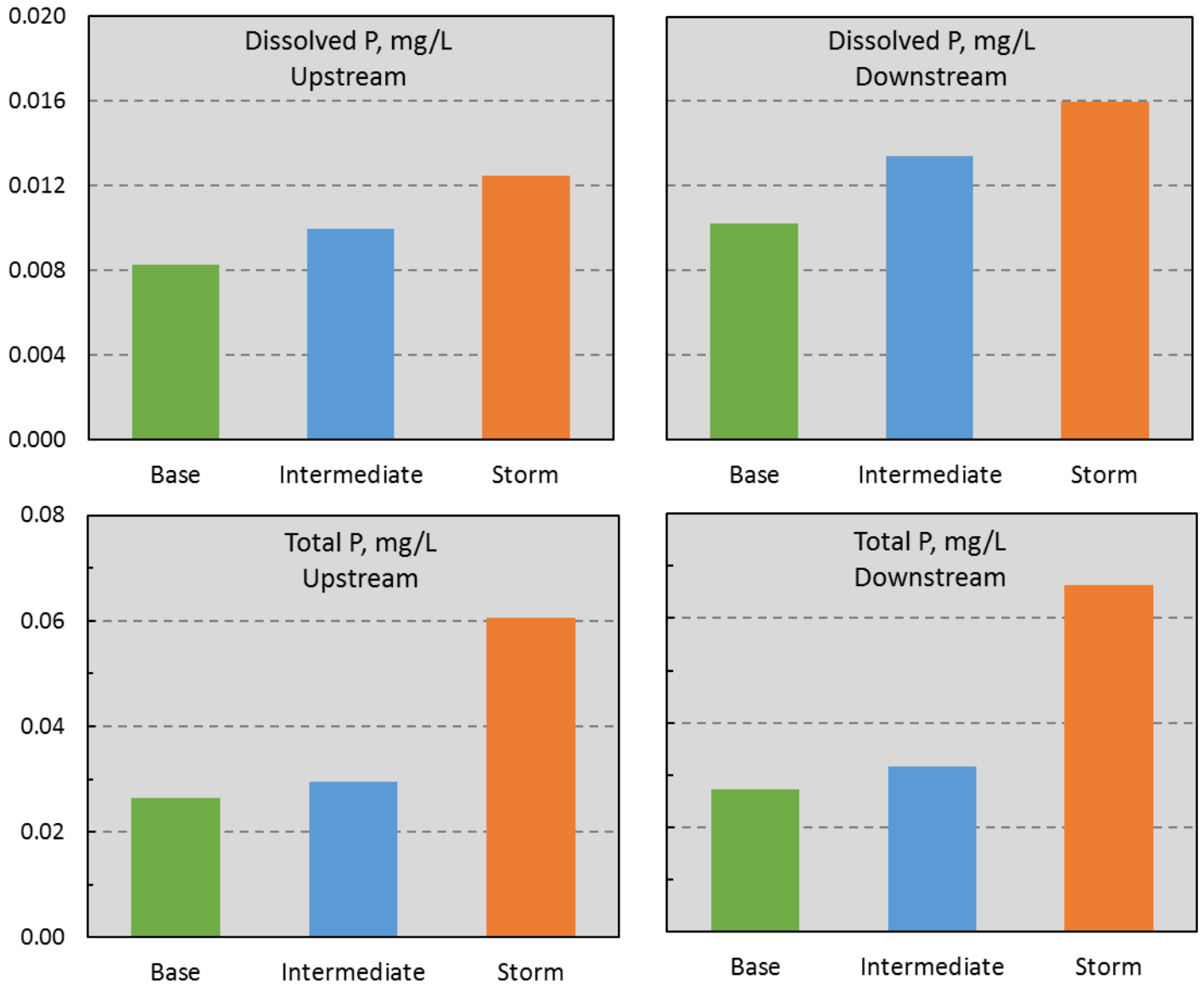

Figure 9. Geomean dissolved and total P concentration as a function of flow regime in Big Creek upstream and downstream of the C&H Farm, Newton County, AR.

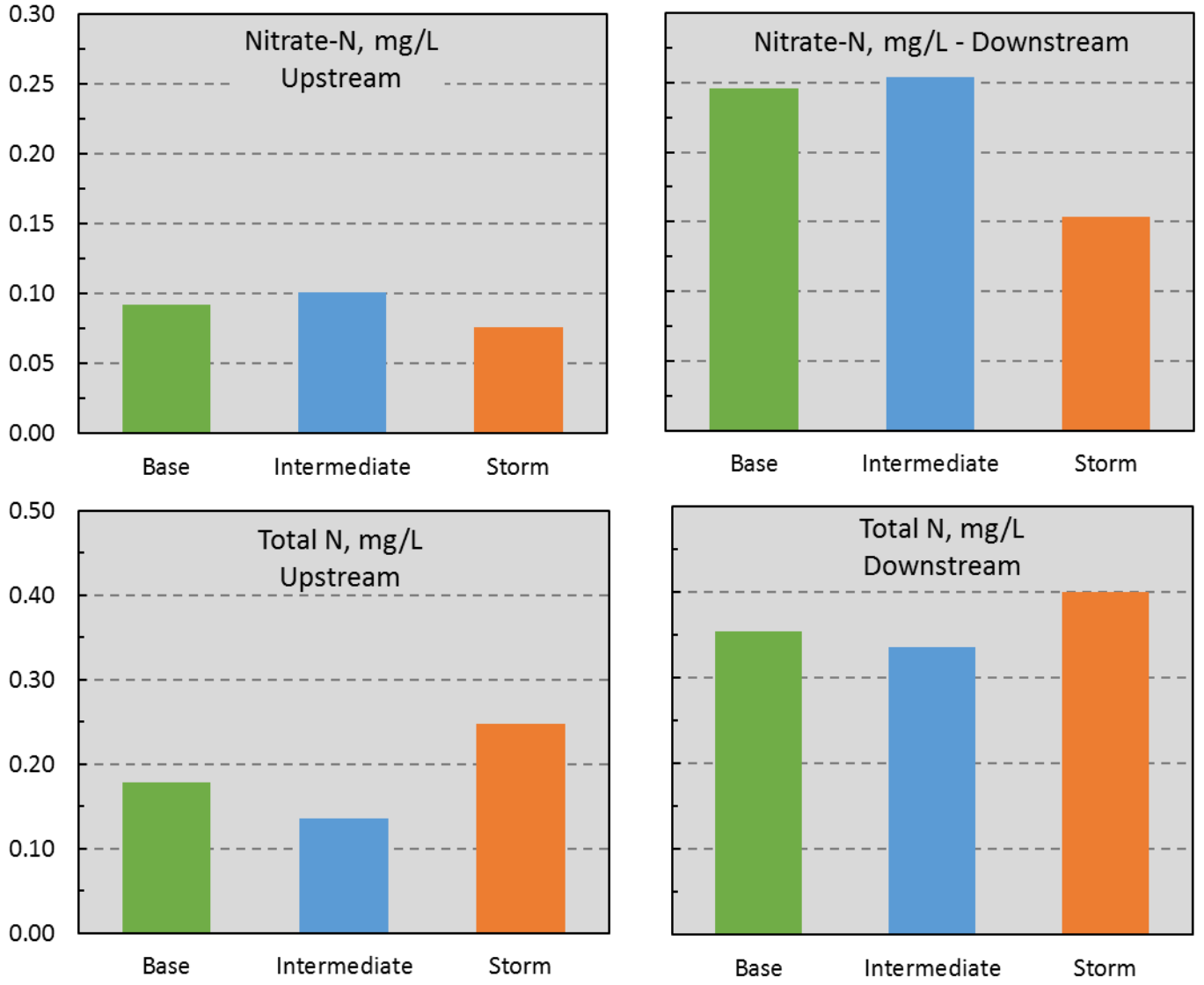

Figure 10. Geomean nitrate-N and total N concentration as a function of flow regime in Big Creek upstream and downstream of the C&H Farm, Newton County, AR.

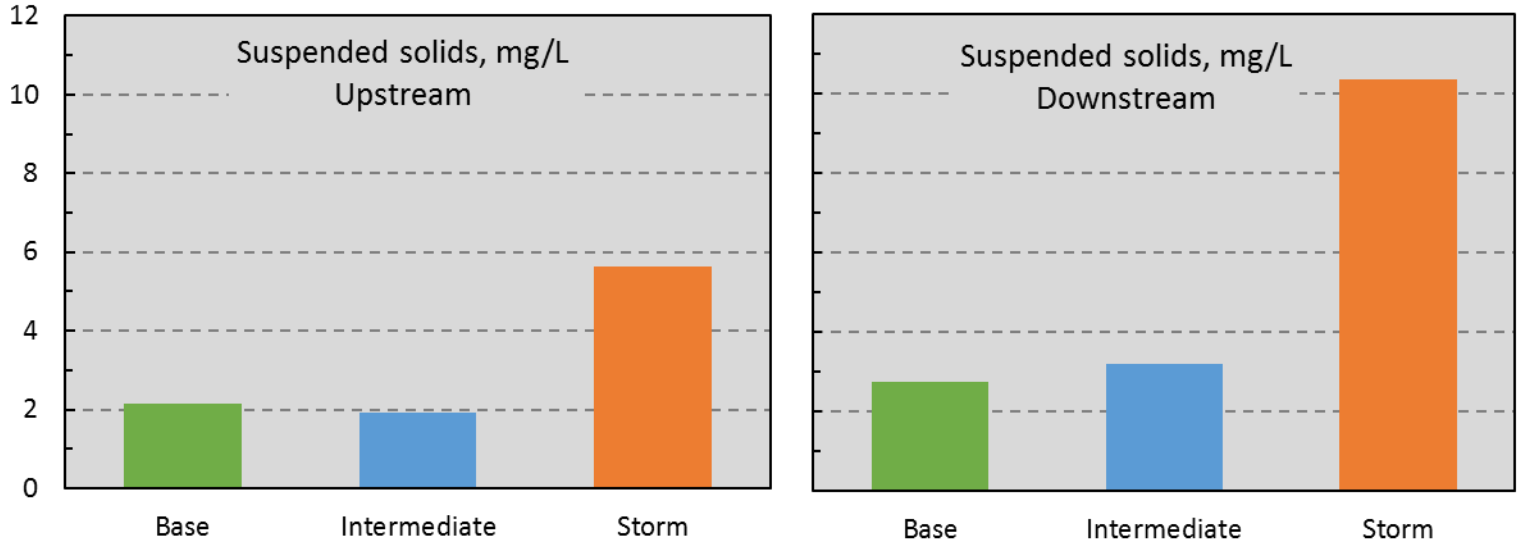

Figure 11. Geomean suspended solid concentration as a function of flow regime in Big Creek upstream and downstream of the C&H Farm, Newton County, AR.

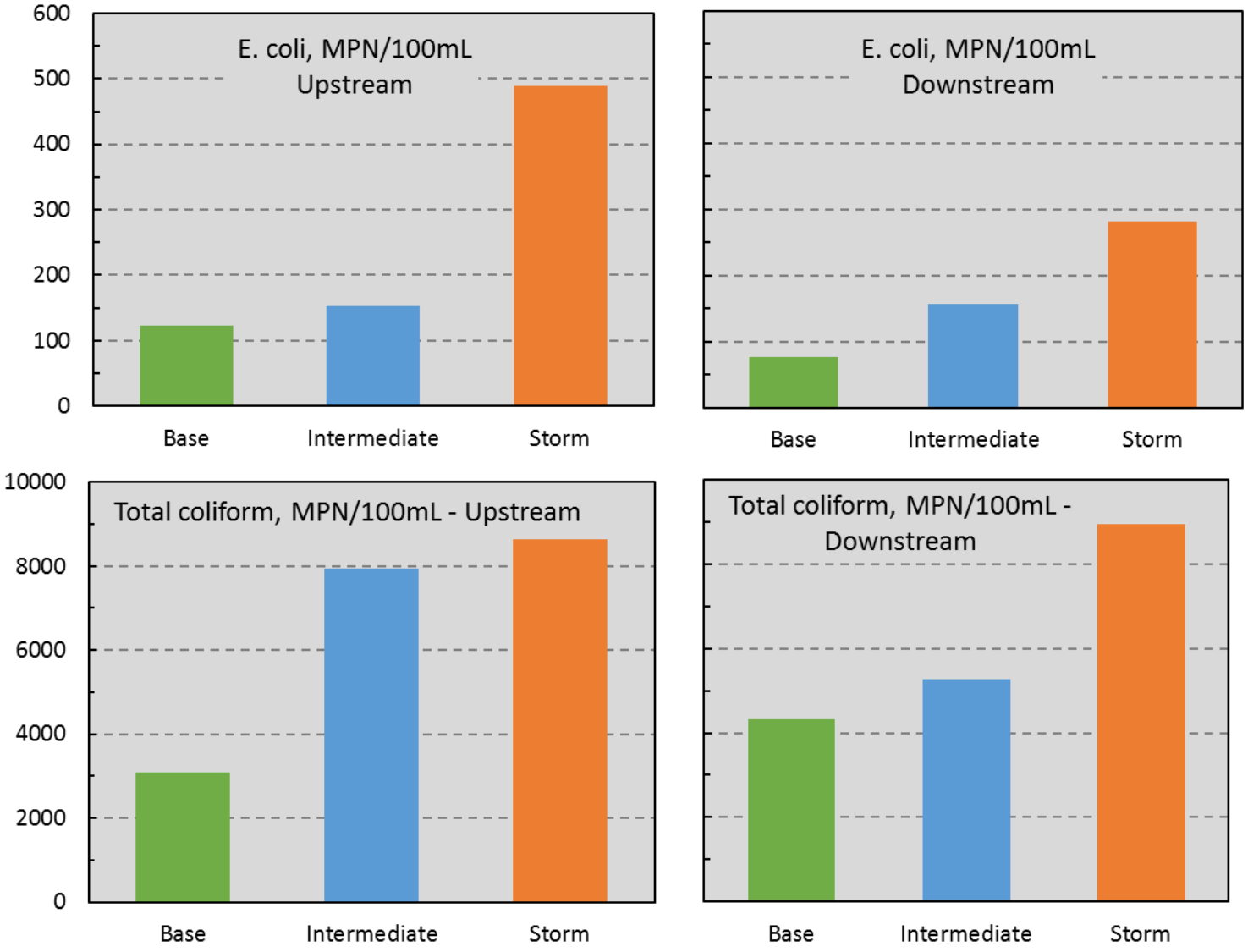

Figure 12. Geomean E. coli and total coliform concentration as a function of flow regime in Big Creek upstream and downstream of the C&H Farm, Newton County, AR.

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Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – April 1 to June 30, 2017

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

The mission of the **Division of Agriculture** is to advance the stewardship of natural resources and the environment, cultivate the improvement of agriculture and agribusiness, develop leadership skills and productive citizenship among youth and adults, enhance economic security and financial responsibility among the citizens of the state, ensure a safe, nutritious food supply, improve the quality of life in communities across Arkansas, and strengthen Arkansas families.

Dr. Mark J. Cochran
Vice President for Agriculture

Executive Summary

This is the second Quarterly Report of 2017 for the Big Creek Research and Extension Team that details activities and progress made from April 1 through June 01, 2017.

1. We continue to collect weekly base flow and periodic stormflow water samples from Big Creek above and below the C&H Farm, along with water from a spring, ephemeral stream, surface runoff sites on Fields 1, 5a, and 12, two interceptor trenches below the slurry holding ponds, and house well for chemical and bacterial analysis.

2. Flows at the downstream site are now available at https://nwis.waterdata.usgs.gov/ar/nwis/uv/?cb_00065=on&cb_00045=on&cb_00010=on&format=gif_default&period=&begin_date=2014-04-16&end_date=2014-04-23&site_no=07055790. Information on development of the rating curve by USGS at this site is available at https://nwis.waterdata.usgs.gov/ar/nwis/uv/?cb_00065=on&cb_00045=on&cb_00010=on&format=gif_default&period=&begin_date=2014-04-16&end_date=2014-04-23&site_no=07055790.

3. In the Ozark Mountain karst region, nutrient concentrations in streams of the Buffalo, Upper Illinois, and Upper White River Watersheds increase as the percent of land in pasture and urban use increases. Averaged over the last three years, nutrient concentrations in Big Creek above and below the C&H Farm are similar to concentrations found in other watersheds where there is a similar amount of pasture and urban land use.

Big Creek Science Team

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Brian Breaker, M.Sc., Surface-Water Specialist, stream flow and constituent collection, analysis, and statistical evaluation of trends.

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Ed Gbur, Ph.D., Professor and Director, Agricultural Statistics Laboratory - Experimental design, linear and generalized linear mixed models, regression, agricultural applications of statistics.

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Phil Hays, Ph.D. Ground Water Specialist, U.S. Geological Survey and Research Professor with Geosciences Dept., University of Arkansas, application of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Jun Zhu, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians - The Big Creek Research and Extension Team are ably supported by several outstanding and dedicated Program Technicians based in Fayetteville and Little Rock.

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Water Sampling and Analytical Methods

Sampling Locations

Water quality monitoring sites are;

Site 1. Edge-of-field monitoring on Field 1 permitted to receive slurry.

Site 2. Edge-of-field monitoring on Field 5a excluded from receiving slurry.

Site 3. Edge-of-field monitoring on Field 12 permitted to receive slurry.

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities.

Site 5. Spring below Field 1.

Site 6. Big Creek upstream of the C&H Farm operation.

Site 7. Big Creak downstream of the C&H Farm operation.

Site 8. Left Fork downstream of the C&H Farm operation.

Site 9. North interceptor trench below the manure holding ponds.

Site 10. South interceptor trench below the manure holding ponds.

Site 11. House well at animal facility.

Table 1. Location of sampling sites on the Big Creek Research and Extension Team project.

Site description	Latitude	Longitude	Elevation, ft
Field 1	35 55’ 06.42”	93 03’ 38.34”	984
Field 5a	35 56’03.01”	93 04’ 25.85”	778
Field 12	35 54’ 13.57”	93 04’ 04.76”	838
Ephemeral stream	35 55’ 25.89”	93 04’ 14.94”	824
Spring	35 54’ 57.06”	93 03’ 34.64”	977
Big Creek upstream of farm	35 53’ 32.28”	93 04’ 06.38”	857
Big Creek downstream of farm	35 56’ 18.98”	93 04’ 21.81”	769
Left Fork	35 5’”48.04”	93 04” 02.02”	760
Trench 1 (south)	35 55’ 19.24”	93 04’ 23.04”	896
Trench 2 (north)	35 55’ 21.39”	93 04’ 19.93”	883
House well	35 55’ 27.02”	93 04’ 22.71”	915

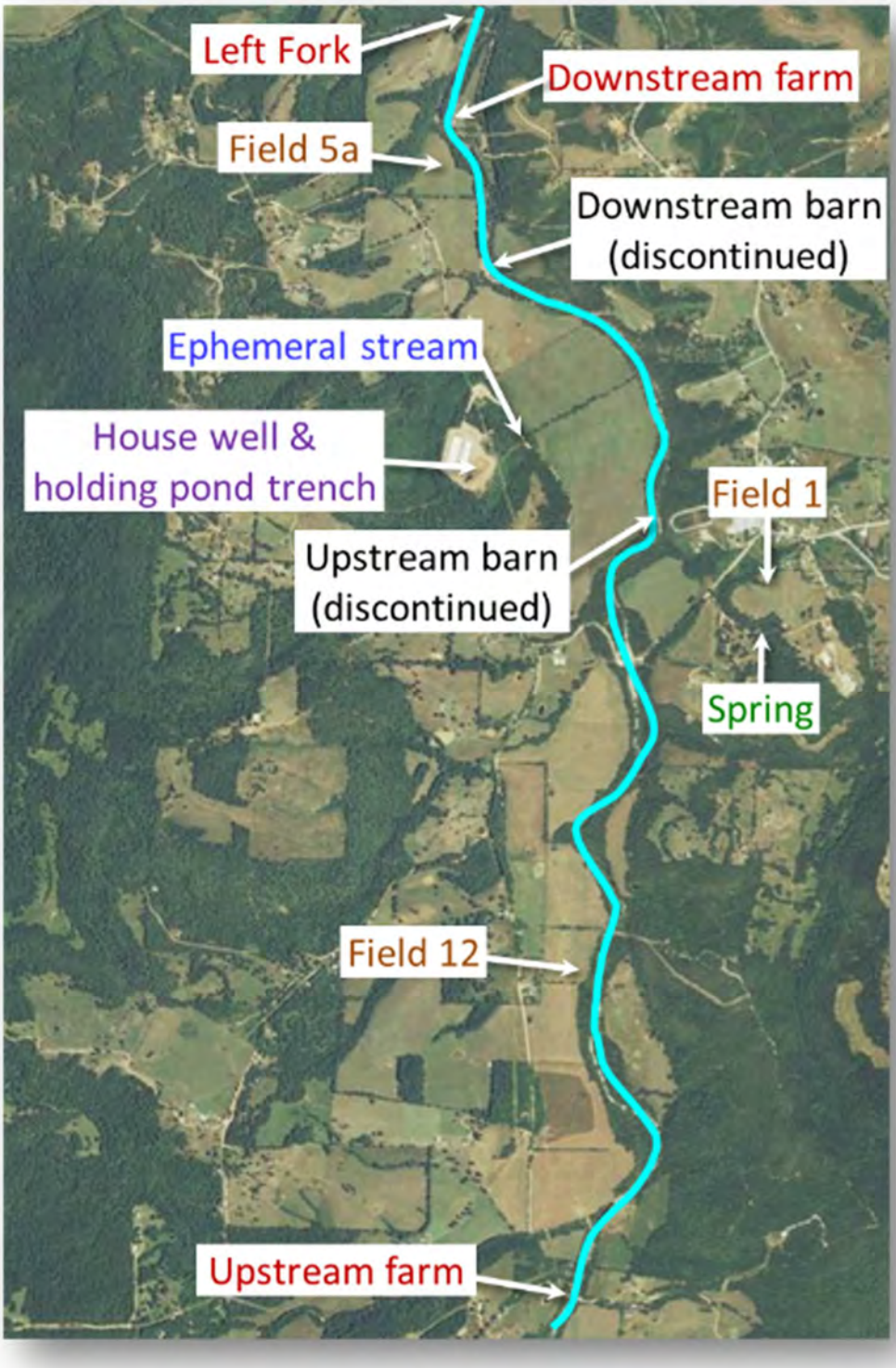

Figure 1. Location of sampling sites for the Big Creek Research and Extension Team project.

Sampling Protocols and Analyses

The following protocols were used to collect, prepare, and analyze all water samples:

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface, where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted, and samples placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
6. Analyses included Alkalinity (APHA 2320-B), Ammonia (EPA 351.2), Chloride (EPA 300.0), Dissolved Phosphorus (EPA 365.2), E. coli (APHA 9223-B), Electrical Conductivity (EPA 120.1), Nitrate (EPA 300.0), pH (EPA 150.1), Total Coliforms (APHA 9223-B), Total Dissolved Solids (EPA 160.1), Total Nitrogen (APHA 4500-P J), Total Phosphorus (APHA 4500-P J), and Total Suspended Solids (EPA 160.2). APHA is American Public Health Association from the Wadeable Streams Assessment, Water Chemistry Laboratory Manual http://www.epa.gov/owow/monitoring/wsa/WRS_lab_manual.pdf
7. Prior to collection of a house well water sample, the well is purged and water temperature, pH, and electrical conductivity measured on-site every 30 seconds until all values stabilize (primarily water temperature). At that point a sample of water is collected in a 1-L acid-washed bottle. This method is taken from USGS and EPA well-water sampling protocols. See USGS methods for sampling at https://water.usgs.gov/owq/FieldManual/chapter4/pdf/Chap4_v2.pdf. Specific and detailed guidance on the collected of water quality data can be found in the USGS National Field Manual at file:///U:/Words/C&H%20Farm/Publications/Planning/USGS%20National%20Field%20Mannual_complete%202015.pdf

   The U.S. EPA also recommend that selected water quality parameters can be monitored during low-rate purging, with stabilization of these parameters indicating when the discharge water represents aquifer water or source well water. See: http://www.csus.edu/indiv/h/hornert/Geol_210_Summer_2012/Week%202%20readings/Puls%20and%20Barcelona%201996%20Low%20flow%20sampling.pdf and https://in-situ.com/wp-content/uploads/2015/01/Low-Flow-Groundwater-Sampling-Techniques-Improve-Sample-Quality-and-Reduce-Monitoring-Program-Costs-Case-Study.pdf
8. Minimum detection limits (MDLs) for each chemical and biological constituent are listed in Table 1. Some constituent concentrations were reported by the laboratory as less than the MDL but greater than zero. Those values are given in subsequent tables but have less confidence in their accuracy than concentrations above the MDL.
9. Chemical and biological analyses of samples collected from the beginning of 2017 to May 31, 2017 are given in Tables 3, 4, 5, and 6.

Table 2. Minimum detection limits (MDLs) for each chemical and biological constituent.

Constituent	Minimum detection limit [1]
Alkalinity, mg/L as $CaCO_3$	2
Chloride, mg/L	0.093
Dissolved P, mg/L	0.002
Conductivity, uS/cm	1
Ammonia-N, mg/L	0.03
Dissolved organic carbon, mg/L	0.18
E. coli, MPN/100 mL	1
Nitrate-N, mg/L	0.004
pH	0.1
Total coliform, MPN/100 mL	1
Total dissolved solids, mg/L	15.22
Total N, mg/L	0.006
Total P, mg/L	0.012
Total suspended solids, mg/L	6.58

[1] MDL the Minimum Detection Limit of an analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. Further information is available at http://water.usgs.gov/owq/OFR_99-193/detection.html

Big Creek Research and Extension Team Monitoring Data

Nutrients, Sediment, and Bacteria by Date of Sampling

Table 3. Water quality analyses at each sample site since January 2017, with those collected since the last report noted. Coliform units are Most Probable Number (MPN) per 100 mL of water.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
			mg/L							MPN/100 mL	
1/5/2017	**1/25/2017**	**Grab sample**									
12:28	15:25	Spring	0.004	0.026	0.04	0.276	0.39	9.5	0.94	74.4	1413.6
13:12	15:25	Upstream farm	0.009	0.014	0.02	0.059	0.09	0.7	0.66	52.0	2419.2
12:00	15:25	Downstream farm	0.012	0.019	0.04	0.257	0.31	1.3	0.55	5.2	1986.3
11:42	15:25	Left Fork	0.006	0.011	0.03	0.229	0.26	0.7	0.85	6.2	1732.9
12:47	15:25	House well	0.008	0.014	0.04	0.610	0.66	0.3	0.30	<1.0	<1.0
1/19/2017	**1/19/2017**	**Grab sample**									
10:41	14:30	Spring	0.009	0.017	0.04	0.286	0.60	33.0	13.31	<1.0	2260.0
11:27	14:30	Upstream farm	0.010	0.016	0.03	0.050	0.14	1.9	4.22	137.6	>2419.2
10:30	14:30	Downstream farm	0.014	0.024	0.02	0.121	0.21	2.5	3.19	60.1	3990.0
10:10	14:30	Left Fork	0.010	0.019	0.03	0.243	0.36	2.6	4.25	55.4	>2419.2
11:00	14:30	House well	0.009	0.013	0.03	0.617	0.69	0.9	7.87	<1.0	<1.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
2/2/2017	**2/2/2017**	**Grab sample**									
10:45	14:30	Spring	0.011	0.030	<0.03	0.823	0.89	7.3	5.06	6.3	1732.9
11:20	14:30	Upstream farm	0.009	0.017	<0.03	0.056	0.07	1.1	1.72	41.9	>2419.2
10:30	14:30	Downstream farm	0.014	0.026	0.01	0.160	0.21	5.1	2.21	41.3	>2419.2
10:15	14:30	Left Fork	0.008	0.019	0.01	0.139	0.18	1.1	1.69	17.1	>2419.2
10:57	14:30	House well	0.011	0.031	0.01	0.614	0.78	0.4	2.22	<1.0	<1.0
2/15/2017	**2/15/2017**	**Grab sample**									
11:50	15:35	Spring	0.013	0.093	0.02	0.201	0.57	12.7	8.76	178.5	4350.0
13:30	15:35	Upstream farm	0.009	0.060	0.01	0.132	0.30	5.0	3.04	1986.3	6570.0
11:24	15:35	Downstream farm	0.012	0.082	0.03	0.159	0.42	9.0	3.46	1732.9	11000.0
12:08	15:35	Ephemeral stream	0.020	0.064	0.02	1.323	1.45	3.1	5.06	166.9	5630.0
11:11	15:35	Left Fork	0.015	0.080	0.03	0.314	0.60	17.7	4.66	648.8	11060.0
12:46	15:35	Trench 1	0.004	0.023	0.01	0.141	0.20	1.3	0.45	1.0	1299.7
12:56	15:35	Trench 2	0.004	0.087	0.04	0.486	1.12	6.1	5.99	19.7	42860.0
12:25	15:35	House well	0.008	0.023	0.02	0.649	0.72	0.5	2.07	<1.0	<1.0
Samples analyzed since the last quarterly report											
3/1/2017	**3/1/2017**	**Grab sample**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:38	14:55	Upstream farm	0.009	0.044	0.03	0.069	0.24	4.7	3.93	2590.0	7940.0
11:18	14:55	Downstream farm	0.005	0.016	0.03	0.148	0.27	2.6	3.24	71.7	2430.0
11:43	14:55	Ephemeral stream	0.011	0.016	0.02	0.659	0.71	1.5	6.75	195.6	5730.0
11:00	14:55	Left Fork	0.008	0.024	0.02	0.136	0.28	4.3	2.46	1119.9	4260.0
12:16	14:55	Trench 2	0.002	0.050	0.04	0.345	0.76	11.6	4.90	98.8	34480.0
11:52	14:55	House well	0.012	0.040	0.03	0.620	0.72	0.5	5.85	<1.0	<1.0
3/16/2017	**3/16/2017**	**Grab sample**									
7:30	11:45	Spring	0.009	0.061	<0.03	0.729	0.99	15.5	2.69	24.0	>2419.2
8:38	11:45	Upstream farm	0.006	0.046	<0.03	0.118	0.29	1.7	1.08	75.9	1299.7
7:13	11:45	Downstream farm	0.010	0.031	<0.03	0.266	0.30	2.9	0.97	68.3	1986.3
7:38	11:45	Ephemeral stream	0.005	0.021	<0.03	0.738	0.800	0.8	2.99	14.8	2419.2
7:00	11:45	Left Fork	0.009	0.043	<0.03	0.300	0.41	3.1	1.77	45.5	>2419.2
8:00	11:45	Trench 1	0.006	0.020	<0.03	0.083	0.11	1.1	1.87	<1.0	179.3
7:46	11:45	House well	0.009	0.023	<0.03	0.856	0.88	0.1	1.52	<1.0	1.0
3/27/2017	**3/27/2017**	**Grab sample**									
11:27	15:40	Spring	0.007	0.044	0.00	0.213	0.60	7.2	9.58	770.1	8800.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:51	15:40	Upstream farm	0.012	0.122	0.06	0.181	0.74	131.4	5.72	1986.3	17850.0
10:51	15:40	Downstream farm	0.047	0.096	0.20	0.173	1.49	321.9	6.68	9840.0	72150.0
10:37	15:40	Left Fork	0.058	0.164	0.17	0.206	1.50	1005.1	8.51	9330.0	38770.0
11:50	15:40	Trench 1	0.004	0.048	0.03	0.129	0.39	3.1	4.36	387.3	17230.0
11:55	15:40	Trench 2	0.009	0.102	0.13	0.060	0.82	7.0	7.13	488.4	29240.0
12:38	15:40	House well	0.007	0.038	0.02	0.573	0.63	1.6	3.83	18.1	261.3
3/27/2017	**3/27/2017**	**Storm sample**									
11:40	15:40	Ephemeral stream	0.151	0.268	0.29	1.704	3.30	448.3	16.47	18500.0	66530.0
11:05	15:40	Field 1	0.420	0.670	0.43	0.090	18.70	124.4	9.29	8390.0	45690.0
12:15	15:40	Field 5a	2.980	3.232	1.40	0.122	1.80	30.2	32.01	2419.2	69100.0
13:06	15:40	Field 12	0.800	1.276	2.02	2.798	6.04	134.2	9.35	7120.0	96060.0
3/30/2017	**3/30/2017**	**Storm sample**									
11:15	14:15	Ephemeral stream	0.005	0.032	0.01	0.796	0.86	8.6	1.89	2.7	224.0
4/6/2017	**4/6/2017**	**Grab sample**									
11:40	15:25	Spring	0.009	0.032	0.01	0.265	0.42	5.2	6.36	1413.6	1413.6
11:30	15:25	Upstream farm	0.007	0.038	0.01	0.099	0.21	2.3	2.53	72.0	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:55	15:25	Downstream farm	0.009	0.034	0.01	0.173	0.26	3.1	1.96	107.6	>2419.2
11:20	15:25	Ephemeral stream	0.008	0.022	<0.03	0.717	0.76	1.6	1.69	148.3	1986.3
11:50	15:25	Left Fork	0.010	0.048	0.01	0.222	0.41	4.7	2.32	135.4	2780.0
10:20	15:25	Trench 1	0.004	0.022	0.03	0.165	0.30	17.2	1.98	47.2	2750.0
4/6/2017	**4/6/2017**	**Storm sample**									
11:15	15:25	Ephemeral stream	0.018	0.080	0.06	0.807	1.14	19.9	4.14	ND	ND
4/13/2017	**4/13/2017**	**Grab sample**									
12:22	15:30	Spring	0.011	0.022	<0.03	0.600	0.63	3.6	15.57	8.6	816.4
13:05	15:30	Upstream farm	0.008	0.054	<0.03	0.026	0.11	2.5	4.64	83.6	2419.2
11:56	15:30	Downstream farm	0.009	0.028	0.01	0.092	0.17	1.1	2.33	135.4	>2419.2
12:50	15:30	Ephemeral stream	0.010	0.018	<0.03	0.593	0.60	1.5	7.73	71.7	6700.0
11:33	15:30	Left Fork	0.010	0.024	<0.03	0.123	0.21	1.6	2.75	22.3	>2419.2
12:35	15:30	House well	0.011	0.020	<0.03	0.564	0.59	0.1	6.22	<1.0	1.0
4/17/2017	**4/17/2017**	**Grab sample**									
12:02	14:55	Spring	0.007	0.044	0.02	0.154	0.40	5.3	6.46	1413.6	18420.0
11:45	14:55	Upstream farm	0.019	0.054	<0.03	0.025	0.12	5.3	1.55	1553.1	9330.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:51	14:55	Downstream farm	0.011	0.046	0.01	0.129	0.24	3.3	1.51	866.4	8360.0
11:10	14:55	Ephemeral stream	0.005	0.018	<0.03	0.651	0.68	0.9	1.71	410.6	7270.0
10:40	14:55	Left Fork	0.040	0.112	0.02	0.173	0.46	19.5	4.55	9090.0	129970.0
11:25	14:55	House well	0.006	0.016	0.01	0.563	0.57	0.2	1.94	<1.0	12.1
4/24/2017	**4/24/2017**	**Storm sample**									
11:50	15:30	Ephemeral stream	0.007	0.128	0.04	0.000	1.83	318.0	7.35	ND	ND
11:15	15:30	Field 1	0.395	0.592	0.13	0.143	1.50	43.1	7.25	ND	ND
11:35	15:30	Field 5a	0.961	1.212	0.12	0.321	1.53	11.7	11.53	ND	ND
12:15	15:30	Trench 1	0.005	0.040	0.20	0.133	1.76	18.5	7.04	ND	ND
12:20	15:30	Trench 2	0.010	0.084	0.04	0.087	0.93	8.2	8.78	ND	ND
4/27/2017	**4/27/2017**	**Grab sample**									
11:05	16:25	Spring	0.011	0.022	<0.03	0.380	0.44	3.1	2.58	165.8	>2419.2
12:10	16:25	Upstream farm	0.010	0.036	<0.03	0.117	0.12	7.1	1.34	172.3	2430.0
10:35	16:25	Downstream farm	0.014	0.042	<0.03	0.231	0.24	10.7	1.70	214.3	6090.0
10:20	16:25	Left Fork	0.016	0.046	<0.03	0.306	0.32	16.4	2.08	275.5	7230.0
11:30	16:25	House well	0.011	0.014	<0.03	0.532	0.49	0.1	0.69	5.1	52.8
11:43	16:25	Trench 2	0.006	0.046	0.04	0.029	0.42	2.4	4.95	115.3	2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
4/27/2017	**4/27/2017**	**Storm sample**									
11:52	16:25	Ephemeral stream	0.042	0.253	0.01	0.302	2.57	734.5	8.29	186.0	>2419.2
10:50	16:25	Field 1	0.550	0.784	0.08	0.107	1.32	52.2	8.46	ND	ND
11:15	16:25	Field 5a	0.686	0.846	0.07	0.063	0.86	11.3	7.26	ND	ND
13:40	16:25	Field 12	0.326	0.544	0.02	0.105	0.71	102.3	5.64	ND	ND
11:40	16:25	Trench 1	0.006	0.048	1.04	0.081	1.43	7.2	4.04	40.4	3990.0
5/18/2017	**5/18/2017**	**Grab sample**									
10:55	15:00	Spring	0.006	0.018	<0.03	0.220	0.34	0.4	4.91	88.0	2419.2
11:40	15:00	Upstream farm	0.006	0.048	<0.03	0.067	0.19	2.9	1.50	260.2	>2419.2
10:45	15:00	Downstream farm	0.008	0.024	<0.03	0.189	0.30	1.9	1.10	129.6	3690.0
11:05	15:00	Ephemeral stream	0.012	0.020	<0.03	0.692	0.75	1.7	1.76	49.6	2419.2
10:30	15:00	Left Fork	0.009	0.022	<0.03	0.167	0.26	1.9	1.54	50.4	2419.2
11:15	15:00	House well	0.011	0.020	<0.03	0.431	0.60	0.6	5.05	1.0	3.1
5/31/2017	**5/31/2017**	**Grab sample**									
10:38	13:50	Spring	0.007	0.036	0.00	0.163	0.32	13.2	3.81	235.9	4280.0
11:05	13:50	Upstream farm	0.009	0.020	0.00	0.053	0.14	1.9	1.34	157.6	2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:30	13:50	Downstream farm	0.008	0.052	0.00	0.188	0.25	1.6	1.33	150.0	2419.2
10:55	13:50	Ephemeral stream	0.009	0.020	0.00	0.769	0.79	2.5	1.53	275.5	3500.0
10:20	13:50	Left Fork	0.008	0.020	0.00	0.156	0.22	1.5	1.58	260.2	4720.0
10:51	13:50	House well	0.019	0.026	0.00	0.605	0.92	0.4	1.86	<1.0	22.1

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.
§ N.S. is No Sample.

Nutrients, Sediment, and Bacteria by Date Spring, Upstream, and Downstream Sites

Table 4. Water quality analyses in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application since January 2017, with those collected since the last report noted.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	---------- mg/L ----------							--- MPN/100 mL ---	
1/5/2017									
Upstream	0.009	0.014	0.02	0.059	0.09	0.7	0.66	52.0	2419.2
Downstream	0.012	0.019	0.04	0.257	0.31	1.3	0.55	5.2	1986.3
1/19/2017									
Upstream	0.010	0.016	0.03	0.050	0.14	1.9	4.22	137.6	2419.2
Downstream	0.014	0.024	0.02	0.121	0.21	2.5	3.19	60.1	3990.0
2/2/2017									
Upstream	0.009	0.017	<0.03	0.056	0.07	1.1	1.72	41.9	>2419.2
Downstream	0.014	0.026	0.01	0.160	0.21	5.1	2.21	41.3	>2419.2
2/15/2017									
Upstream	0.009	0.060	0.01	0.132	0.30	5.0	3.04	1986.3	6570.0
Downstream	0.012	0.082	0.03	0.159	0.42	9.0	3.46	1732.9	11000.0
Samples analyzed since the last Quarterly Report									
3/1/2017									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.009	0.044	0.03	0.069	0.24	4.7	3.93	2590.0	7940.0
Downstream	0.005	0.016	0.03	0.148	0.27	2.6	3.24	71.7	2430.0
3/16/2017									
Upstream	0.006	0.046	<0.03	0.118	0.29	1.7	1.08	75.9	1299.7
Downstream	0.010	0.031	<0.03	0.266	0.30	2.9	0.97	68.3	1986.3
3/27/2017									
Upstream	0.012	0.122	0.06	0.181	0.74	131.4	5.72	1986.3	17850.0
Downstream	0.047	0.096	0.20	0.173	1.49	321.9	6.68	9840.0	72150.0
4/6/2017									
Upstream	0.007	0.038	0.01	0.099	0.21	2.3	2.53	72.0	>2419.2
Downstream	0.009	0.034	0.01	0.173	0.26	3.1	1.96	107.6	>2419.2
4/13/2017									
Upstream	0.008	0.054	<0.03	0.026	0.11	2.5	4.64	83.6	2419.2
Downstream	0.009	0.028	0.01	0.092	0.17	1.1	2.33	135.4	>2419.2
4/17/2017									
Upstream	0.019	0.054	<0.03	0.025	0.12	5.3	1.55	1553.1	9330.0
Downstream	0.011	0.046	0.01	0.129	0.24	3.3	1.51	866.4	8360.0
4/27/2017									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.010	0.036	<0.03	0.117	0.12	7.1	1.34	172.3	2430.0
Downstream	0.014	0.042	<0.03	0.231	0.24	10.7	1.70	214.3	6090.0
5/18/2017									
Upstream	0.006	0.048	<0.03	0.067	0.19	2.9	1.50	260.2	>2419.2
Downstream	0.008	0.024	<0.03	0.189	0.30	1.9	1.10	129.6	3690.0
5/31/2017									
Upstream	0.009	0.020	0.00	0.053	0.14	1.9	1.34	157.6	2419.2
Downstream	0.008	0.052	0.00	0.188	0.25	1.6	1.33	150.0	2419.2

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

§ N.S. is No Sample.

† N.D. is No Data.

Nutrients, Sediment, and Bacteria by Site for Ephemeral Stream, Trenches, Left Fork and Field Runoff

Table 5. Water quality analyses at the ephemeral stream draining the subwatershed containing the production houses and manure holding ponds, and surface runoff from Fields 1, 5a, and 12 since January, 2017, with those collected since the last report noted.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
Ephemeral stream									
2/15/2017	0.020	0.064	0.02	1.323	1.45	3.1	5.06	166.9	5630.0
Samples analyzed since the last quarterly report									
3/1/2017	0.011	0.016	0.02	0.659	0.71	1.5	6.75	195.6	5730.0
3/16/2017	0.005	0.021	0.00	0.738	0.800	0.8	2.99	14.8	2419.2
3/27/2017	0.151	0.268	0.29	1.704	3.30	448.3	16.47	18500.0	66530.0
3/30/2017	0.005	0.032	0.01	0.796	0.86	8.6	1.89	2.7	224.0
4/6/2017	0.008	0.022	<0.03	0.717	0.76	1.6	1.69	148.3	1986.3
4/6/2017	0.018	0.080	0.06	0.807	1.14	19.9	4.14	ND	ND
4/17/2017	0.005	0.018	<0.03	0.651	0.68	0.9	1.71	410.6	7270.0
4/24/2017	0.007	0.128	0.04	0.000	1.83	318.0	7.35	ND	ND
4/27/2017	0.042	0.253	0.01	0.302	2.57	734.5	8.29	186.0	>2419.2
5/18/2017	0.012	0.020	<0.03	0.692	0.75	1.7	1.76	49.6	2419.2

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/31/2017	0.009	0.020	0.00	0.769	0.79	2.5	1.53	275.5	3500.0
House well									
1/5/2017	0.008	0.014	0.04	0.610	0.66	0.3	0.30	<1.0	<1.0
1/19/2017	0.009	0.013	0.03	0.617	0.69	0.9	7.87	<1.0	<1.0
2/2/2017	0.011	0.031	0.01	0.614	0.78	0.4	2.22	<1.0	<1.0
2/15/2017	0.008	0.023	0.02	0.649	0.72	0.5	2.07	<1.0	<1.0
Samples analyzed since the last quarterly report									
3/1/2017	0.012	0.040	0.03	0.620	0.72	0.5	5.85	<1.0	<1.0
3/16/2017	0.009	0.023	<0.03	0.856	0.88	0.1	1.52	<1.0	1.0
3/27/2017	0.007	0.038	0.02	0.573	0.63	1.6	3.83	18.1	261.3
4/13/2017	0.011	0.020	<0.03	0.564	0.59	0.1	6.22	<1.0	1.0
4/17/2017	0.006	0.016	0.01	0.563	0.57	0.2	1.94	<1.0	12.1
4/27/2017	0.011	0.014	<0.03	0.532	0.49	0.1	0.69	5.1	52.8
5/18/2017	0.011	0.020	<0.03	0.431	0.60	0.6	5.05	1.0	3.1
5/31/2017	0.019	0.026	0.00	0.605	0.92	0.4	1.86	<1.0	22.1
Interceptor Trench 1 (South)									
2/15/2017	0.004	0.023	0.01	0.141	0.20	1.3	0.45	1.0	1299.7

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Samples analyzed since the last quarterly report									
3/16/2017	0.006	0.020	0.00	0.083	0.11	1.1	1.87	<1.0	179.3
3/27/2017	0.004	0.048	0.03	0.129	0.39	3.1	4.36	387.3	17230.0
4/6/2017	0.004	0.022	0.03	0.165	0.30	17.2	1.98	47.2	2750.0
4/24/2017	0.005	0.040	0.20	0.133	1.76	18.5	7.04	ND	ND
4/27/2017	0.006	0.048	1.04	0.081	1.43	7.2	4.04	40.4	3990.0
Interceptor Trench 2 (North)									
2/15/2017	0.004	0.087	0.04	0.486	1.12	6.1	5.99	19.7	42860.0
Samples analyzed since the last quarterly report									
3/1/2017	0.002	0.050	0.04	0.345	0.76	11.6	4.90	98.8	34480.0
3/27/2017	0.009	0.102	0.13	0.060	0.82	7.0	7.13	488.4	29240.0
4/24/2017	0.010	0.084	0.04	0.087	0.93	8.2	8.78	ND	ND
4/27/2017	0.006	0.046	0.04	0.029	0.42	2.4	4.95	115.3	2419.2
Left Fork									
1/5/2017	0.006	0.011	0.03	0.229	0.26	0.7	0.85	6.2	1732.9
1/19/2017	0.010	0.019	0.03	0.243	1.00	2.6	4.25	55.4	>2419.2

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
2/2/2017	0.008	0.019	0.01	0.139	0.18	1.1	1.69	17.1	>2419.2
2/15/2017	0.015	0.080	0.03	0.314	0.60	17.7	4.66	648.8	11060.0
Samples analyzed since the last quarterly report									
3/1/2017	0.008	0.024	0.02	0.136	0.28	4.3	2.46	1119.9	4260.0
3/16/2017	0.009	0.043	<0.03	0.300	0.41	3.1	1.77	45.5	>2419.2
3/27/2017	0.058	0.164	0.17	0.206	1.50	1005.1	8.51	9330.0	38770.0
4/6/2017	0.010	0.048	0.01	0.222	0.41	4.7	2.32	135.4	2780.0
4/13/2017	0.010	0.024	<0.03	0.123	0.21	1.6	2.75	22.3	>2419.2
4/17/2017	0.040	0.112	0.02	0.173	0.46	19.5	4.55	9090.0	129970.0
4/27/2017	0.016	0.046	<0.03	0.306	0.32	16.4	2.08	275.5	7230.0
5/18/2017	0.009	0.022	<0.03	0.167	0.26	1.9	1.54	50.4	2419.2
5/31/2017	0.008	0.020	0.00	0.156	0.22	1.5	1.58	260.2	4720.0
Field 1									
10/13/2016	0.940	1.231	0.13	0.335	2.36	59.0	16.67	N.S.	N.S.
No samples analyzed since the last quarterly report									
3/27/2017	0.420	0.670	0.43	0.090	18.70	124.4	9.29	8390.0	45690.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
4/24/2017	0.395	0.592	0.13	0.143	1.50	43.1	7.25	ND	ND
4/27/2017	0.550	0.784	0.08	0.107	1.32	52.2	8.46	ND	ND
Field 5a									
3/31/2016	1.154	1.352	0.27	0.302	1.67	26.5	32.74	N.S.	N.S.
5/10/2016	1.114	1.458	1.69	2.894	6.35	79.9	12.82	N.S.	N.S.
No samples analyzed since the last quarterly report									
3/27/2017	2.980	3.232	1.40	0.122	1.80	30.2	32.01	2419.2	69100.0
4/24/2017	0.961	1.212	0.12	0.321	1.53	11.7	11.53	ND	ND
4/27/2017	0.686	0.846	0.07	0.063	0.86	11.3	7.26	ND	ND
Field 12									
3/10/2016	0.411	0.522	1.17	0.852	4.49	621.5	12.58	N.S.	N.S.
5/10/2016	0.370	0.666	0.12	0.062	1.03	96.7	6.92	N.S.	N.S.
No samples analyzed since the last quarterly report									
3/27/2017	0.800	1.276	2.02	2.798	6.04	134.2	9.35	7120.0	96060.0
4/27/2017	0.326	0.544	0.02	0.105	0.71	102.3	5.64	ND	ND

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.

§ N.S. is No Sample. E. coli and total coliform were not measured on surface runoff samples collected by ISCO samplers when sample holding time exceeded the required 8-hour threshold.

† N.D. is No Data.

Water pH, Alkalinity, Chloride, Electrical Conductivity, and Total Dissolved Solids for Several Big Creek Sites

At the beginning of 2015, the pH, alkalinity, chloride concentration, electrical conductivity and total dissolved solids were determined on water samples collected at the upstream and downstream sites, spring, house well, and trenches, to build a data base that will enable to eventually source track the major water source pathways at these sites. These values are given below in Table 6.

Table 6. The pH, Chloride concentration, and electrical conducting of water samples collected at upstream, downstream, spring, ephemeral stream, house well and trench sites, initiated at the beginning of 2017, with those collected since the last report noted.

Date	pH	Chloride	Electrical conductivity
		mg/L	µS/cm
Upstream			
1/5/2017	8.8	2.264	142.0
1/19/2017	7.9	2.089	
2/2/2017	8.4	2.044	112.0
2/15/2017	7.9	2.022	128.0
Samples analyzed since the last quarterly report			
3/1/2017	8.4	1.696	115.0
3/16/2017	7.8	1.508	88.0
3/27/2017	7.6	0.997	50.0
4/6/2017	7.5	1.436	72.0
4/13/2017	7.8	1.392	76.0
4/17/2017	7.9	1.372	95.8
4/27/2017	7.7	1.003	68.0
5/18/2017	8.3	1.518	110.0
5/31/2017	8.0	1.296	122.0
Downstream			

Date	pH	Chloride	Electrical conductivity
1/5/2017	8.1	5.692	220.0
1/19/2017	7.6	2.390	
2/2/2017	7.9	2.414	171.0
2/15/2017	8.2	2.199	119.0
Samples analyzed since the last quarterly report			
3/1/2017	7.8	2.926	162.0
3/16/2017	7.5	1.792	128.0
3/27/2017	7.5	1.113	69.0
4/6/2017	7.5	1.649	106.0
4/13/2017	7.7	1.665	114.0
4/17/2017	7.8	1.849	162.9
4/27/2017	7.6	1.160	102.0
5/18/2017	7.7	2.009	172.0
5/31/2017	8.0	1.714	171.0
Spring			
1/5/2017	7.2	2.462	504.0
1/19/2017	7.1	2.397	
2/2/2017	7.1	3.099	546.0
2/15/2017	7.3	2.305	353.0
Samples analyzed since the last quarterly report			
3/16/2017	7.4	2.618	602.0
3/27/2017	7.3	1.223	373.0
4/6/2017	7.1	2.010	486.0
4/13/2017	7.1	2.810	547.0
4/17/2017	7.2	1.720	445.0
4/27/2017	7.4	1.565	476.0

Date	pH	Chloride	Electrical conductivity
5/18/2017	7.0	1.988	474.0
5/31/2017	7.5	1.305	471.0
Ephemeral Stream			
2/15/2017	7.7	3.366	270.0
3/1/2017	7.8	4.328	396.0
3/16/2017	7.5	3.415	354.0
3/27/2017	7.4	4.373	180.0
3/30/2017	7.8	2.705	224.0
4/6/2017	7.3	3.154	223.0
4/13/2017	7.7	3.585	377.0
4/17/2017	7.5	3.997	394.0
4/23/2017	7.5	2.221	321.0
4/27/2017	7.5	1.414	109.0
5/18/2017	7.6	3.247	346.0
5/31/2017	8.0	3.161	380.0
House Well			
1/5/2017	7.8	5.371	421.0
1/19/2017	7.4	5.234	420.0
2/2/2017	7.5	5.290	420.0
2/15/2017	7.6	5.401	397.0
Samples analyzed since the last quarterly report			
3/1/2017	7.5	5.162	432.0
3/16/2017	7.5	5.453	416.0
3/27/2017	7.8	5.192	438.0
4/13/2017	7.4	5.508	445.0
4/17/2017	7.5	5.315	285.0

Date	pH	Chloride	Electrical conductivity
4/27/2017	7.5	5.000	429.0
5/1/2017	7.6	5.021	436.0
5/11/2017	7.4	6.819	433.0
5/18/2017	7.4	5.024	406.0
5/25/2017	7.7	4.124	442.0
5/31/2017	7.7	4.859	327.0
Trench 1			
2/15/2017	8.0	2.344	397.0
Samples analyzed since the last quarterly report			
3/16/2017	7.8	1.483	164.0
3/27/2017	7.4	1.018	164.0
4/6/2017	7.4	1.877	168.0
4/24/2017	7.4	0.895	160.0
4/27/2017	7.8	0.557	150.0
5/1/2017	7.7	1.193	172.0
Trench 2			
2/15/2017	8.0	1.164	135.0
Samples analyzed since the last quarterly report			
3/1/2017	7.3	0.808	159.0
3/27/2017	7.1	0.376	90.0
4/6/2017	7.0	0.325	175.0
4/24/2017	7.3	0.322	134.0
4/27/2017	7.5	0.217	129.0
5/1/2017	7.7	0.340	157.0

Discharge at USGS 07055790 Site Downstream of C&H Operation

Discharge downstream of the C&H Farm (USGS station 07055790 Big Creek near Mt. Judea, AR) is available at https://nwis.waterdata.usgs.gov/ar/nwis/uv/?cb_00065=on&cb_00045=on&cb_00010=on&format=gif_default&period=&begin_date=2014-04-16&end_date=2014-04-23&site_no=07055790

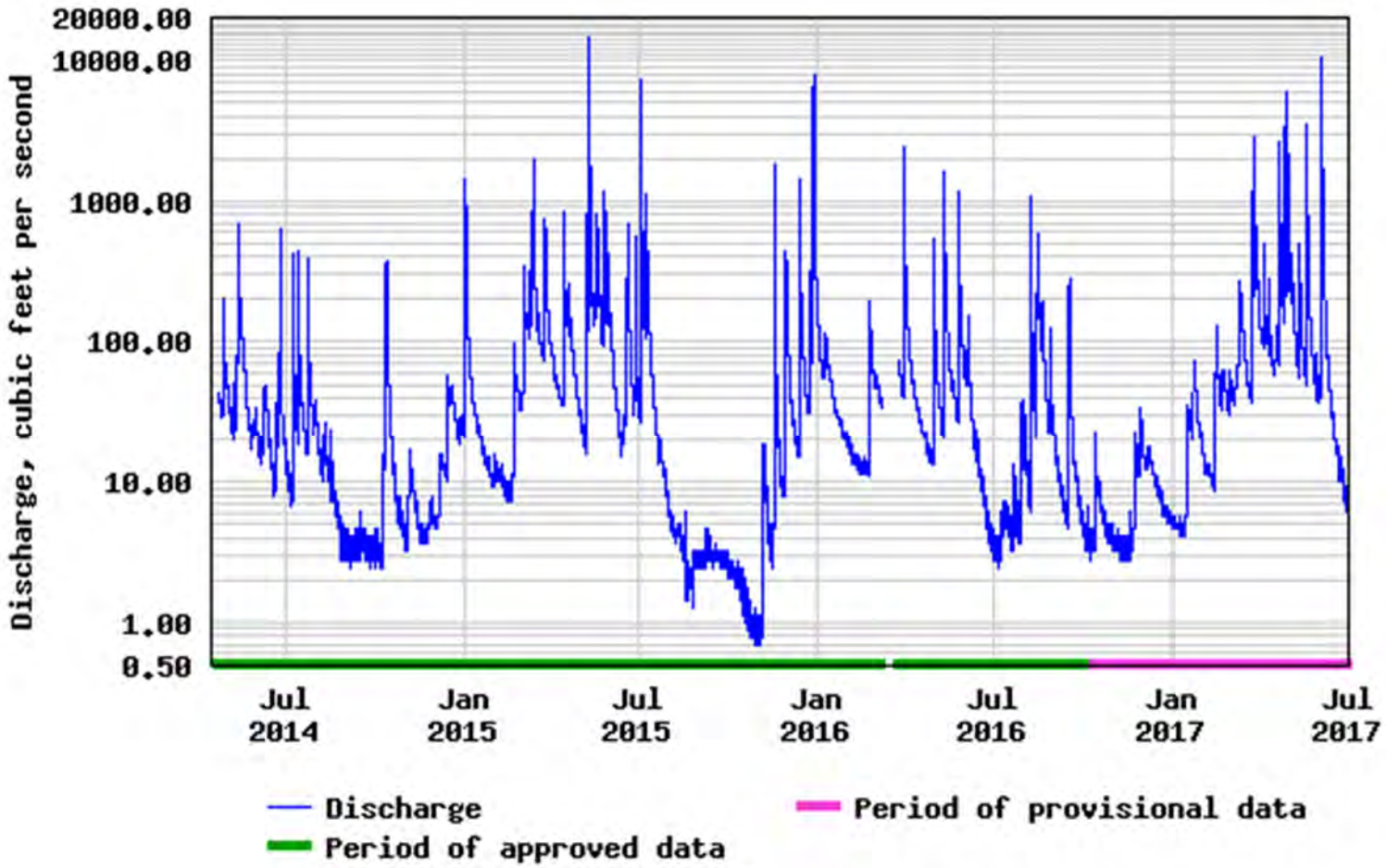

Figure 2. Discharge in Big Creek downstream of the C&H Farm for the period of monitoring; April 2014 to July 2017.

Temporal Trends in Phosphorus, Nitrogen, Bacteria, and Chloride in Big Creek Above and Below the C&H Farm

The concentration of dissolved P, total P, nitrate-N, total N, bacteria and chloride in Big Creek above and below the C&H Farm are presented in subsequent figures to show the season / temporal trends in measured concentrations (Figures 3, 4, 5, 6, 7, 8, and 9).

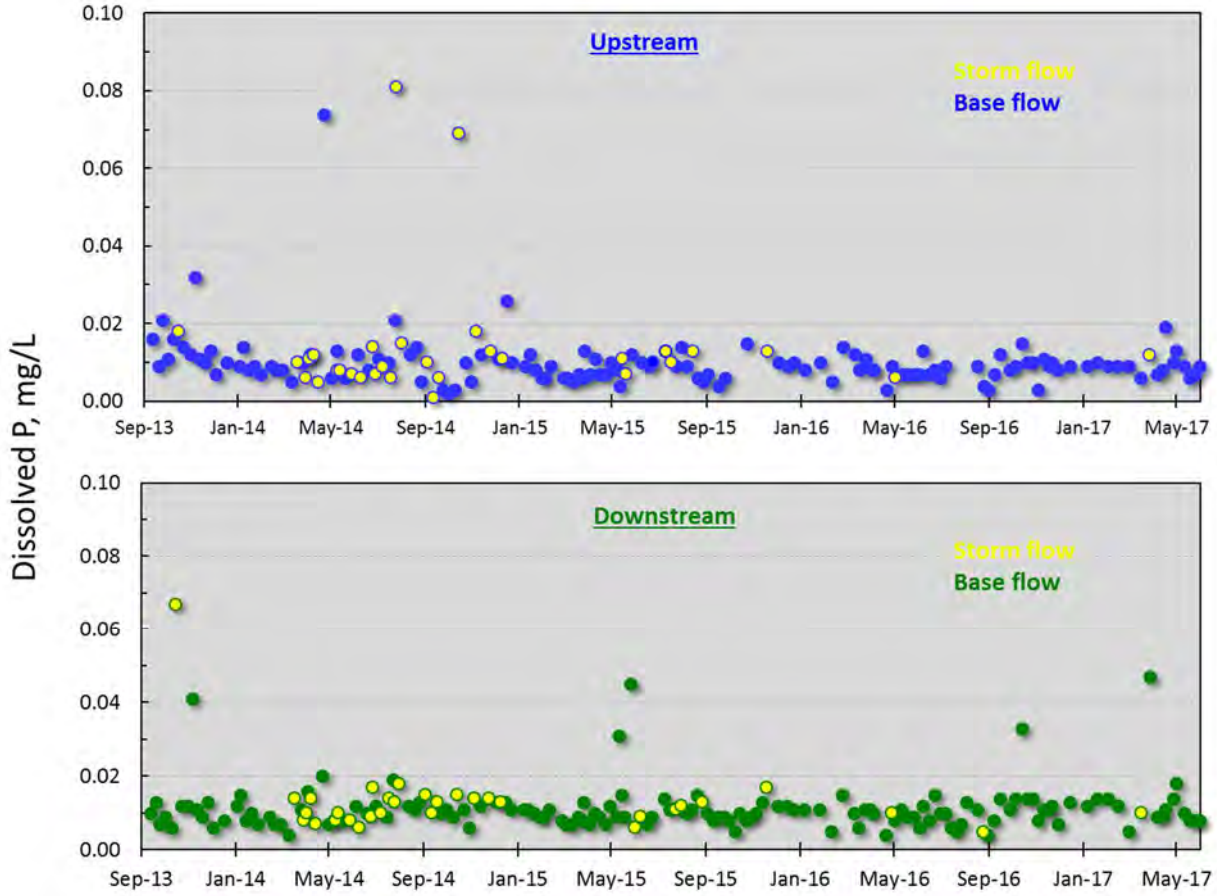

Figure 3. Dissolved P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

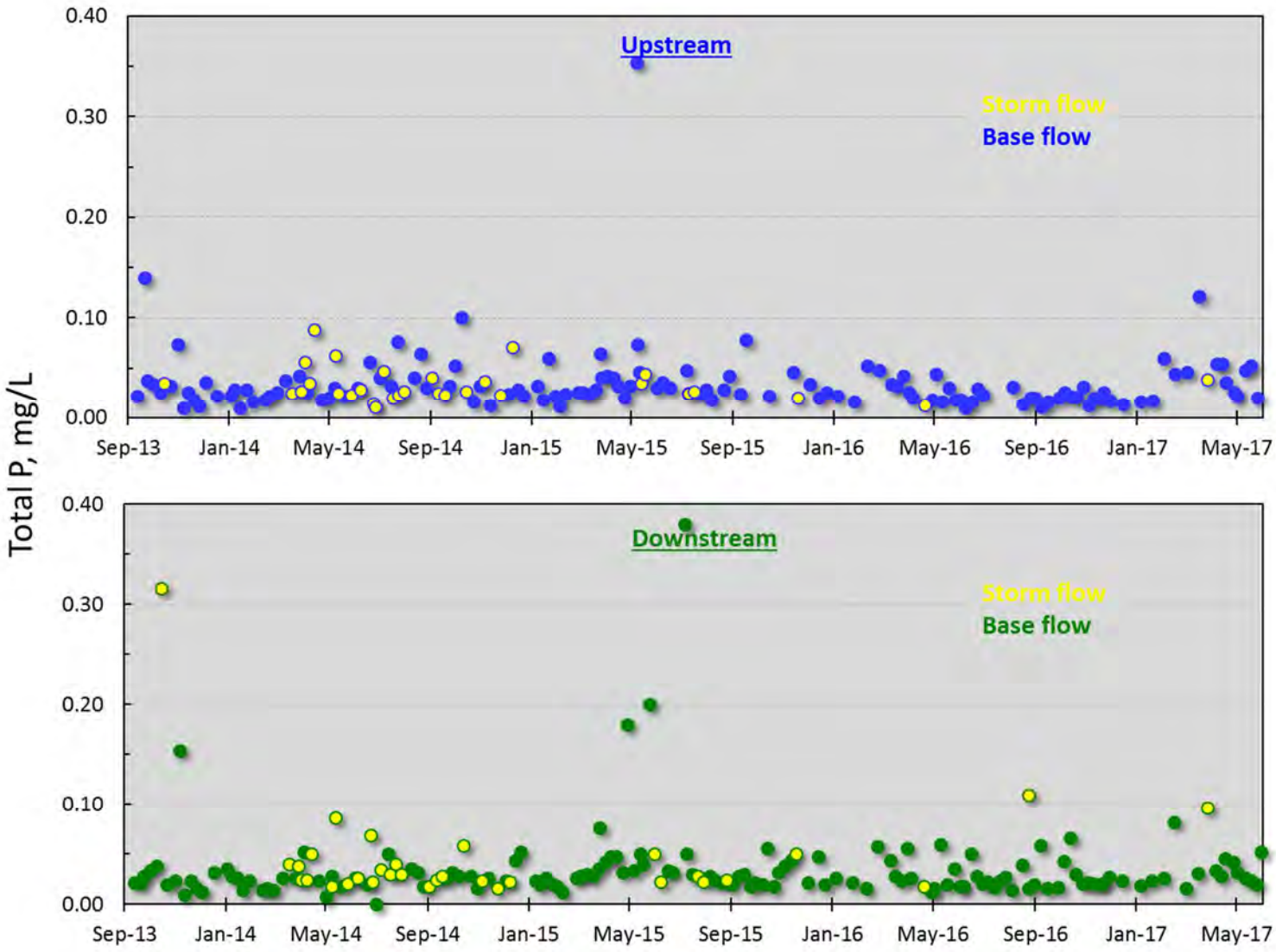

Figure 4. Total P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

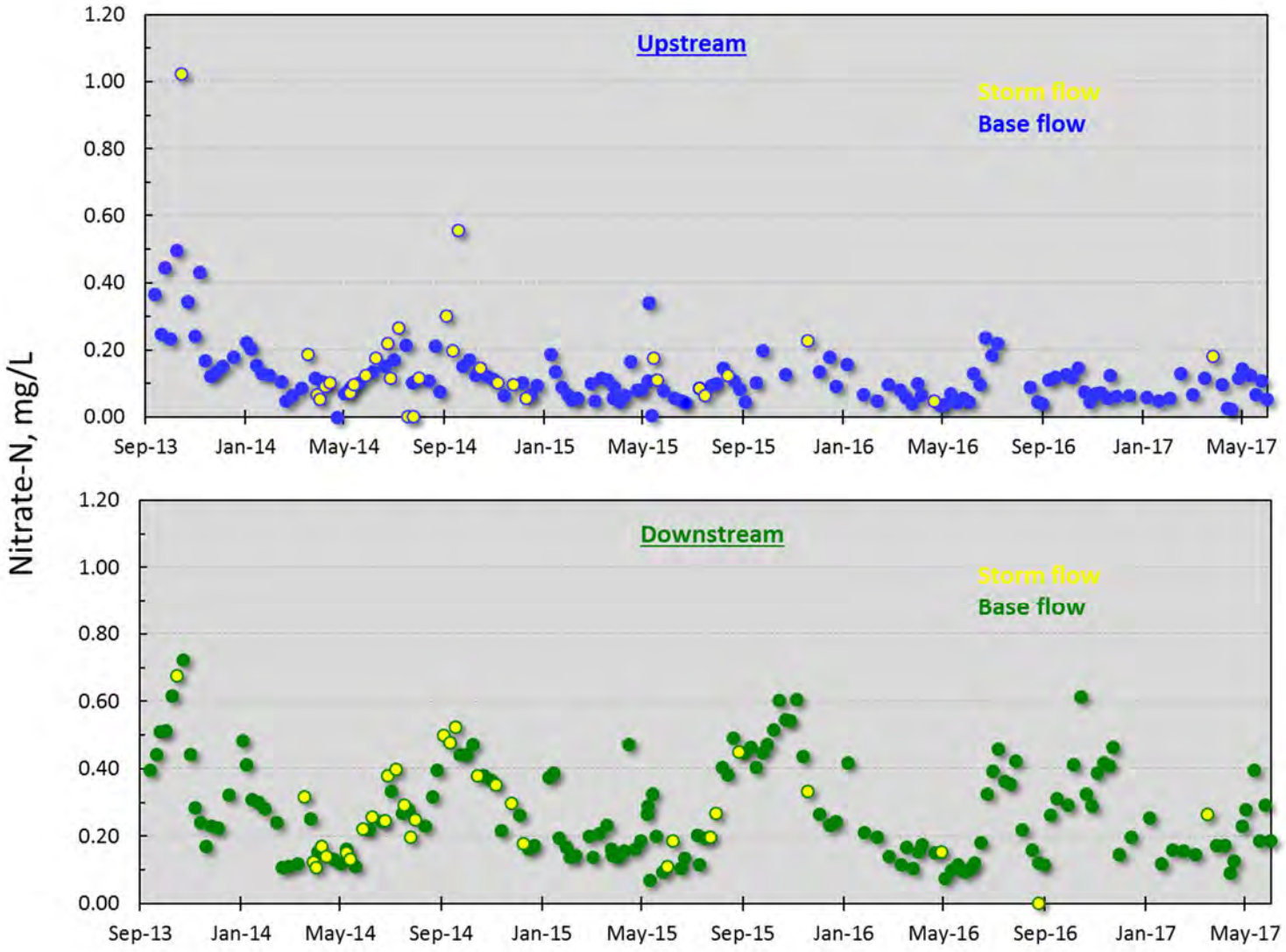

Figure 5. Nitrate-N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

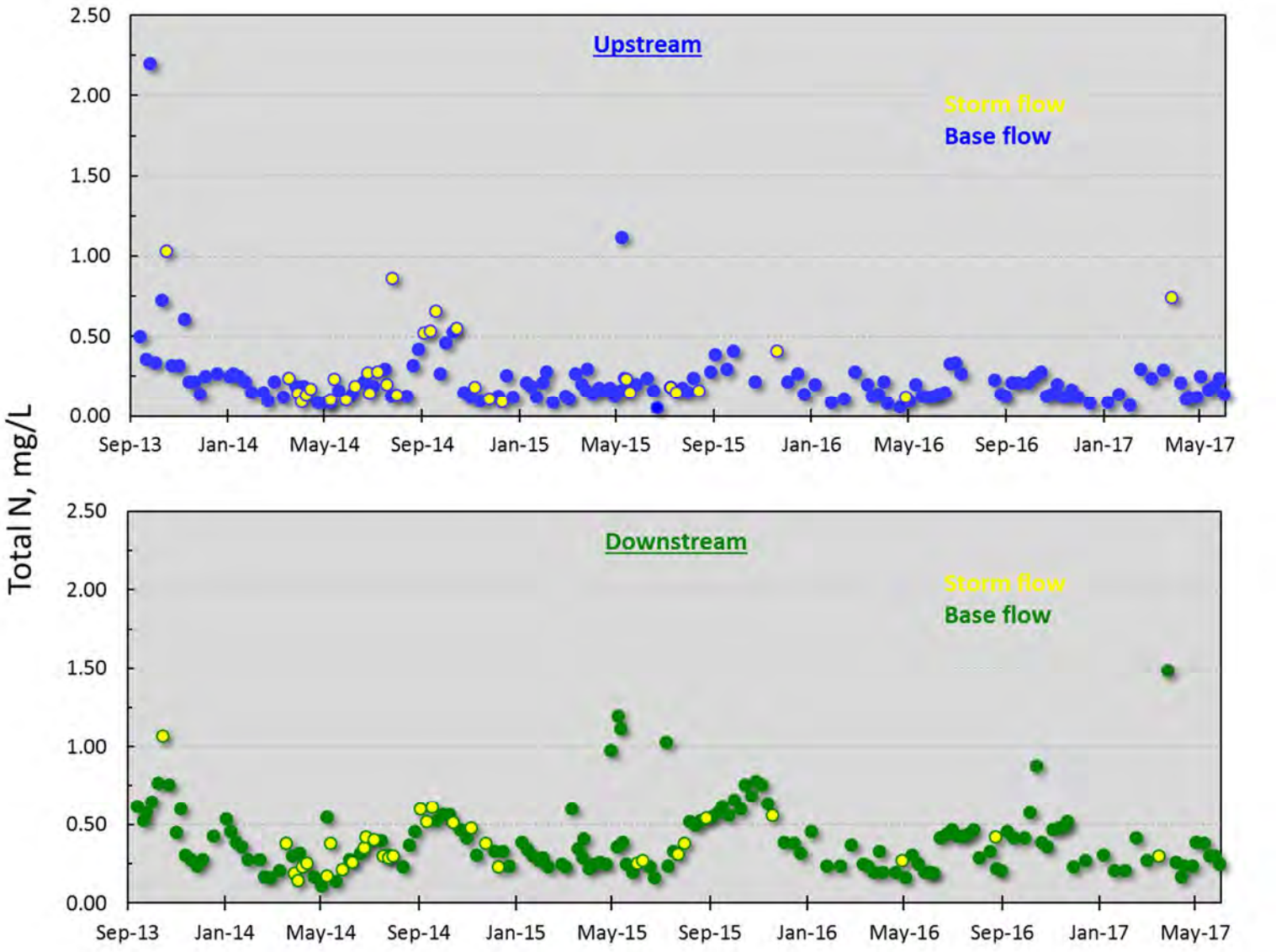

Figure 6. Total N concentration at **the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.**

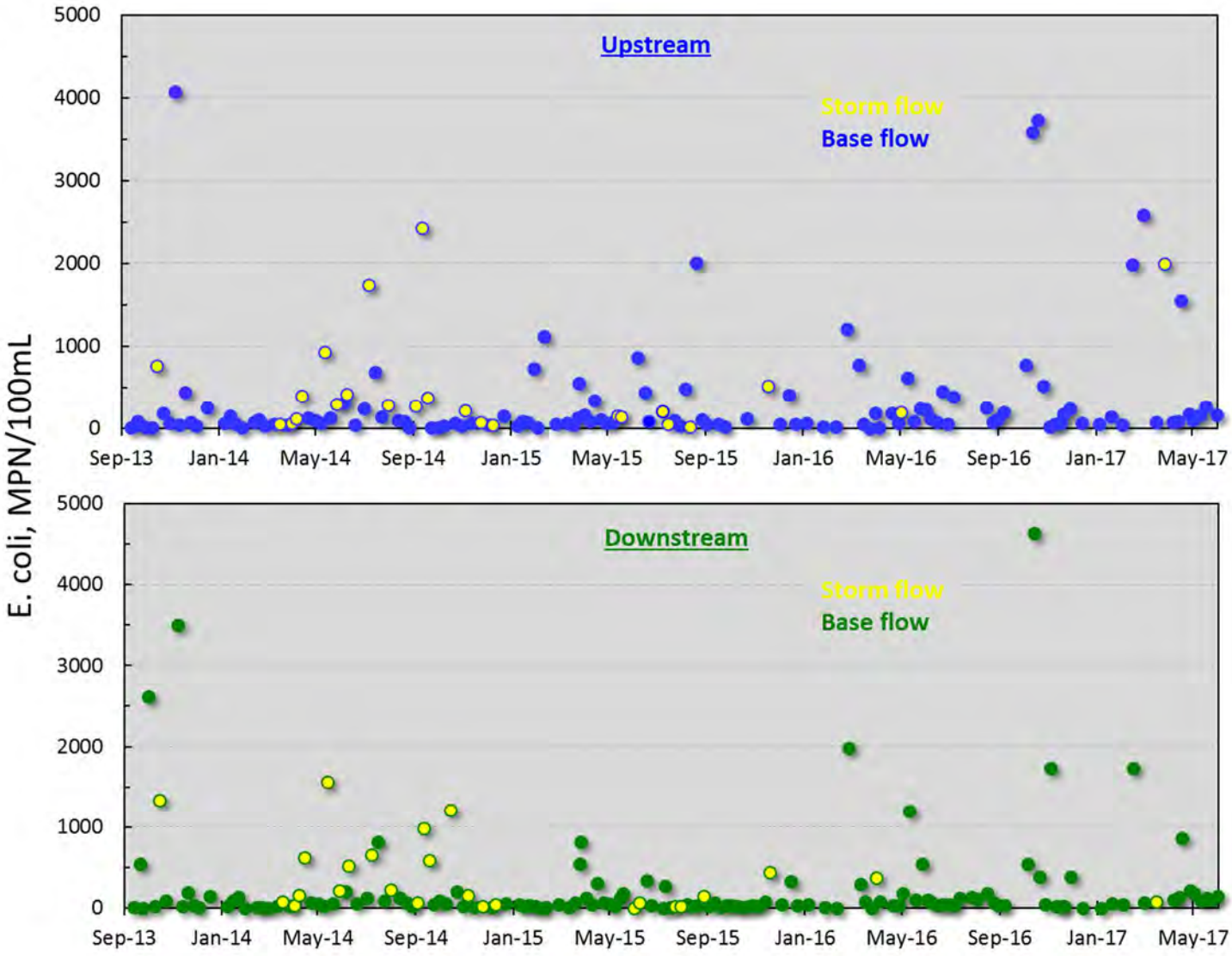

Figure 7. E. coli numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

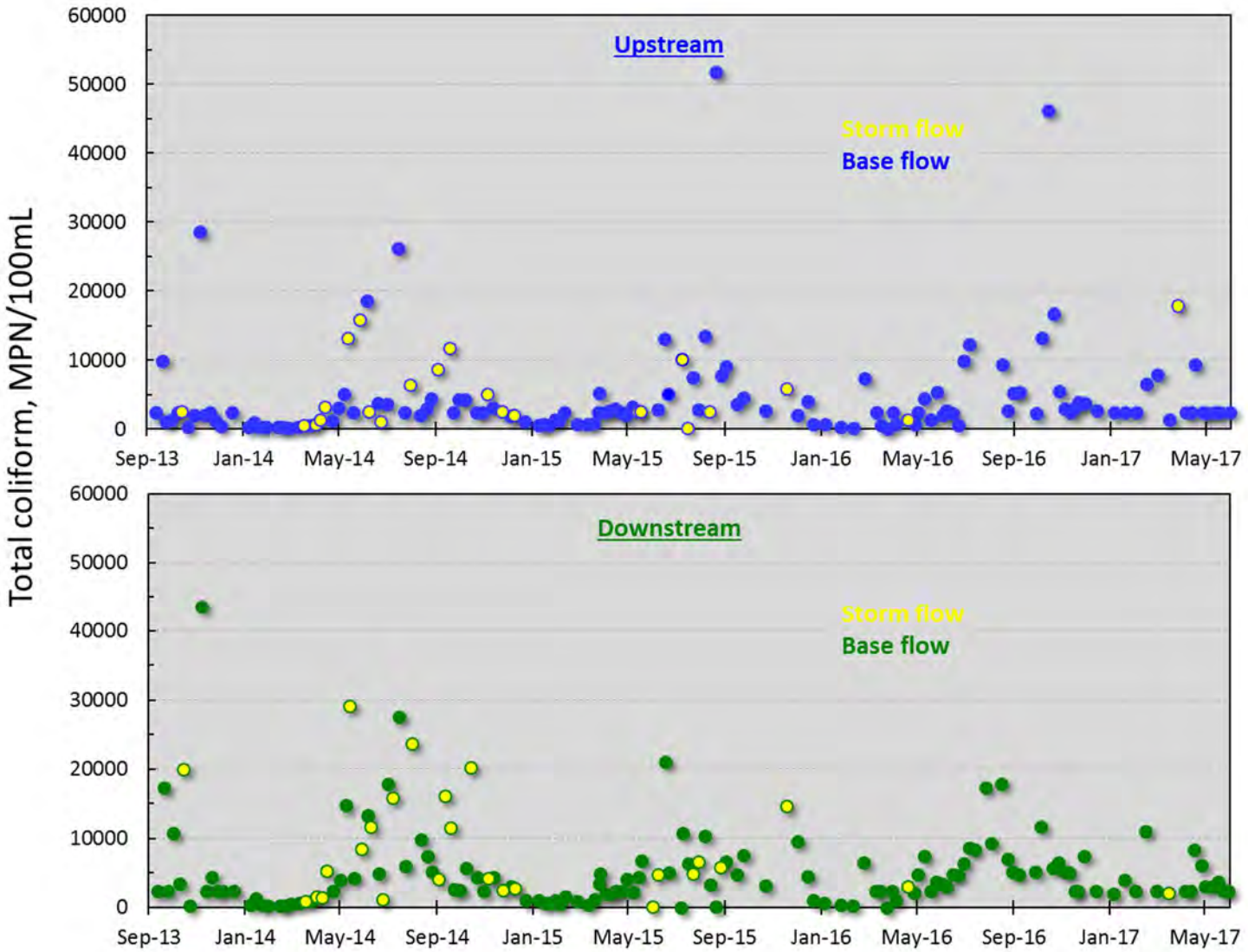

Figure 8. Total coliform numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

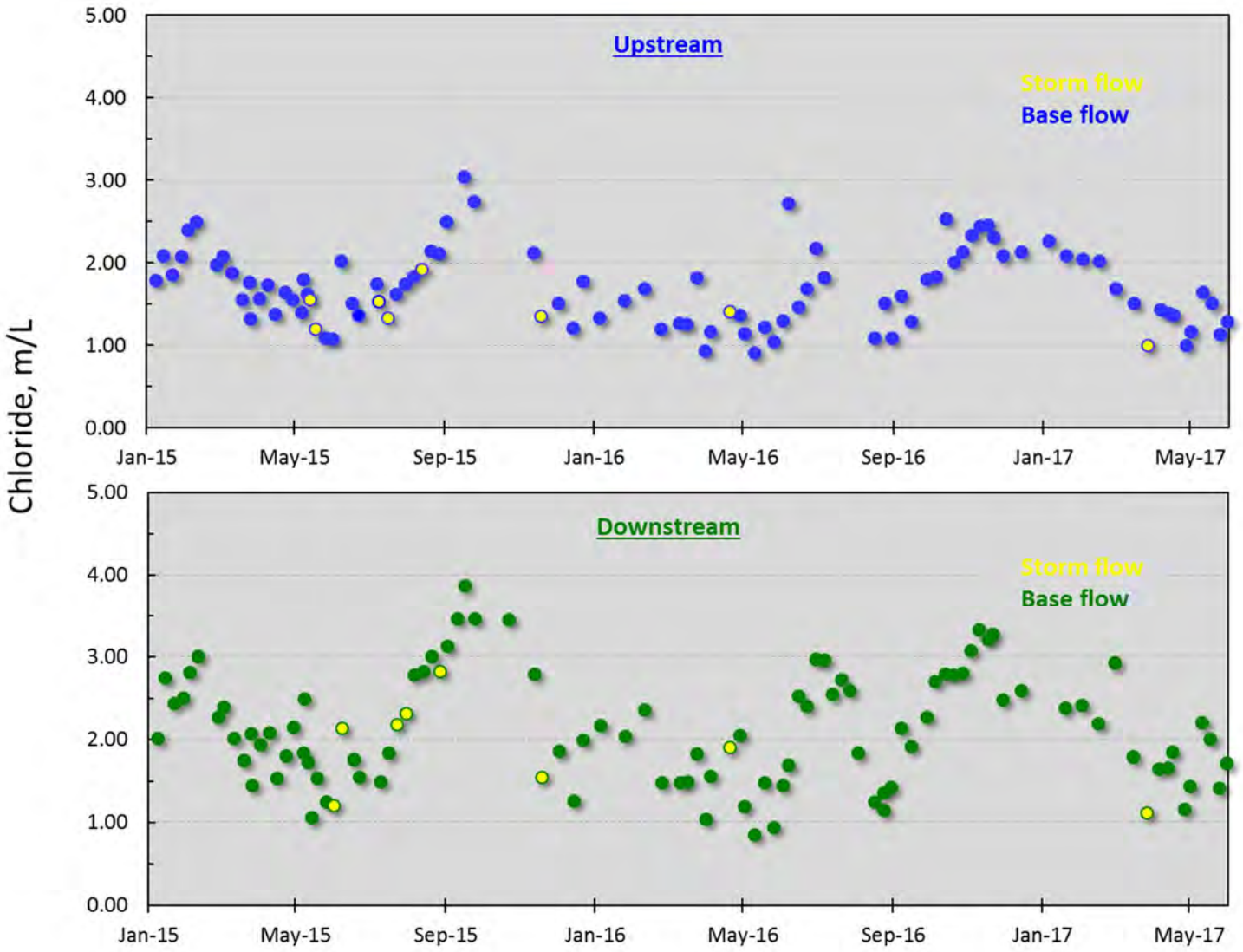

Figure 9. Chloride concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

Relating Land Use and Nutrient Concentrations in Streams of Ozark Mountain Watersheds

Background

Nutrient impairment of surface waters continues despite widespread conservation efforts to reduce losses from urban and rural, specifically agricultural, land uses (Scavia et al., 2014; U.S. Environmental Protection Agency, 2015). Land use within watersheds influences the quantity and quality of water draining from a watershed. In fact, as land disturbance increases and use intensifies, there is a general increase in stormwater runoff and nutrient inputs that lead to a greater potential for nutrient discharge to receiving waters (Dubrovsky et al., 2010; Rebich et al., 2011). For instance, with urban growth, more impervious surfaces increase the flashiness of water runoff, alter the hydrologic response of watersheds, and increase wastewater treatment discharge (Alexander et al., 2008; Dale et al., 2008). As areas of agricultural production grow, more nutrients are often land applied as fertilizer nitrogen (N) and phosphorus (P) that are required for optimum production (Reddy et al., 2010).

Numerous factors determine the relationship between land use in a given watershed and nutrient discharge from that watershed. With an increase in the percent of a watershed drainage area in pasture, row crop, or urban use, a general increase in nutrient concentrations in storm and base flows (Buck et al., 2004; McCarty and Haggard, 2016). In forested watersheds, little nutrient input and land disturbance is usually observed, unless trees are harvested. Thus, nutrient concentrations in streams draining forested watersheds tend to be lower than in watersheds with considerable anthropogenic land use (Dodds, 2007; Haggard, 2010).

Here we assess the affect of land use on stream N and P concentrations in the Ozark Highlands and Boston Mountains ecoregions of northwest Arkansas by combining previously published data for the Upper Illinois River Watershed (Haggard et al., 2010), Upper White River Watershed (Giovannetti et al., 2013), and ongoing monitoring in the Buffalo River Watershed.

For a range of reasons, a great deal of interest has been expressed in N and P concentrations in several streams of the Boston and Ozark Mountains regions. The Upper Illinois River Watershed is the subject of several ongoing nutrient-related strategies, which include development of numeric nutrient criteria, and litigation between downstream receivers of water and upstream users. The Upper White River Watershed is the main source of drinking water for over 330,000 residents of northwest Arkansas and several strategies are in place to protect nutrient-related water quality in the watershed.

The Ozark region includes the first National Scenic River, the Buffalo River, which, together with its tributaries, drain the Buffalo River Watershed. The location of these watersheds are designated on Figure 1. The relationship between stream nutrient concentrations and land use for the region are used to determine if a permitted concentrated animal feeding operation (CAFO) in Big Creek Watershed, a sub-watershed of the Buffalo River Watershed, has affected stream water quality.

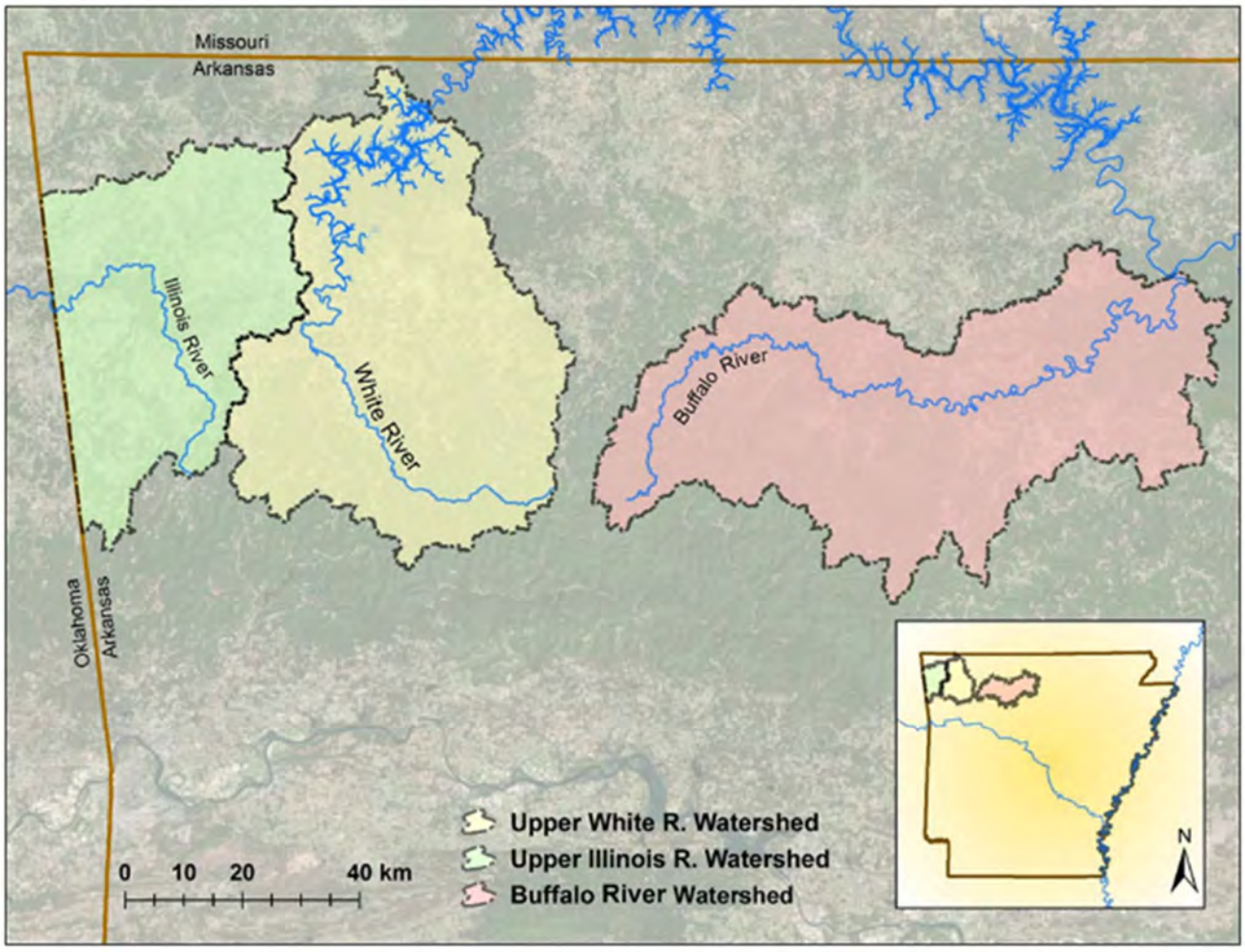

Figure 10. The location of Buffalo River, Upper Illinois, and Upper White River Watershed in northwestern Arkansas. Information from U.S. Geological Survey (USGS), Environmental Systems Research Institute (ESRI), and Aeronautics and Space Administration (NASA).

Sites and Water Quality Data Collection

The concentration of nitrate-N and total N and dissolved and total P have been measured over varying periods in base flow at the outlet of sub-watersheds of the Buffalo (Figure 2), Upper Illinois, and Upper White River Watersheds (Figure 3). In the Buffalo River Watershed, the National Park Service, in partnership with the U.S. Geological Survey and Arkansas Department of Environmental Quality, periodically measured nutrient concentrations at 20 stream locations from 1985-2015 and reported various relationships between land use and nutrient concentrations (Mott and Laurans, 2004; Petersen et al., 1998).

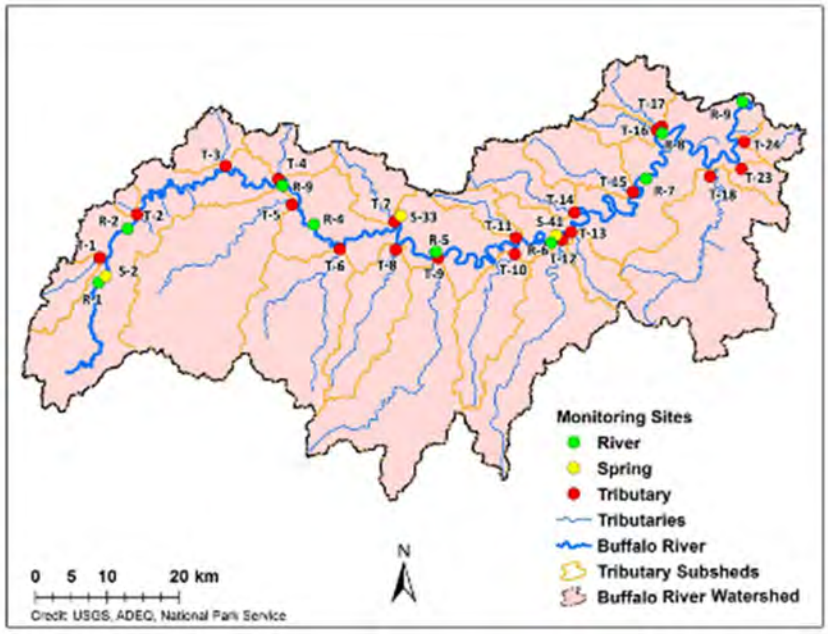

Figure 11. Monitoring sites established in the Buffalo River Watershed in northwest Arkansas, whose tributaries drain forested uplands and agricultural lowlands with poultry and beef cattle operations. Data is from the Arkansas Department of Environmental Quality (1985-2015).

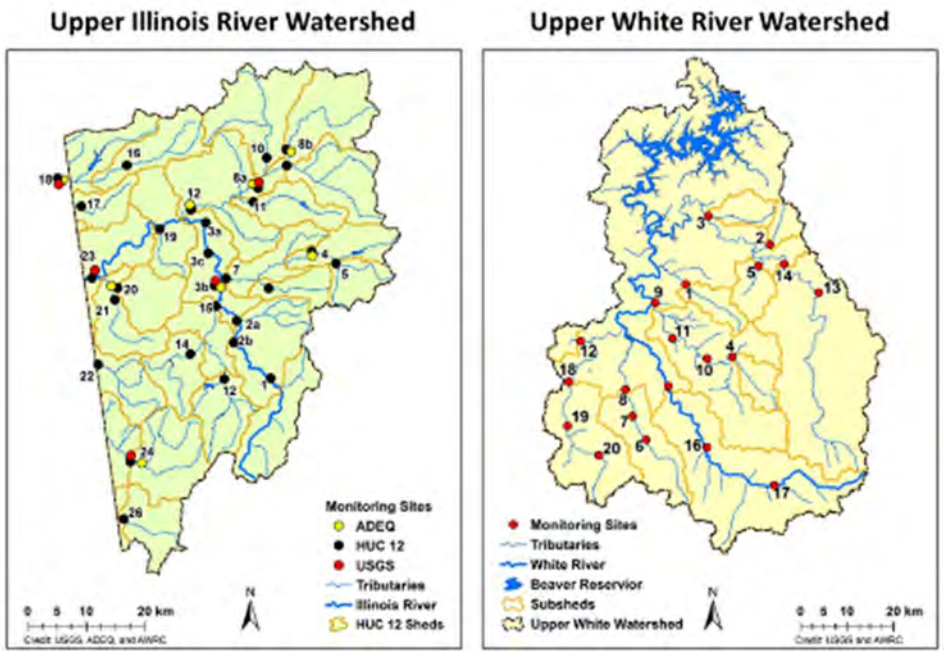

Figure 12. Monitoring sites established in the Upper Illinois (left) and Upper White River Watersheds (right) in northwest Arkansas, whose tributaries drain forested uplands and agricultural lowlands with poultry and beef cattle operations. Data are from Haggard et al. (2010) and Giovannetti et al. (2013), respectively.

In the Upper Illinois River Watershed, Haggard et al. (2010) measured N and P concentrations during baseflow at monthly intervals during 2009 at 29 stream locations. In the Upper White Watershed, Giovannetti et al. (2013) monitored N and P concentrations at 20 stream locations for one year (June 2005 to July 2006) by collecting monthly samples from each location during base flow. While samples were also collected during or immediately following rainfall that produced enough runoff to increase stream flow in both the Upper Illinois River and Upper White Watershed studies, stream-flow values were not included in this analysis.

Forest, pasture, and urban land-use areas, which are the three main land uses in each of the sub-watersheds, are summarized in Tables 1, 2, and 3 for the Buffalo, Upper Illinois, and Upper White River Watersheds, respectively. High-resolution (4 m), land use-land cover depiction was created using 2006 imagery. The range in land-use distribution in the three watersheds is summarized in Table 4.

Information for the permitted swine CAFO, publicly available permit, and manure application records were obtained from the Arkansas Department of Environmental Quality (2017a). The farm was initially permitted for 3 Boars (450 lbs), 2100 Gestating Sows (375 lbs), 400 Lactation Sows (475 lbs), and 4,000 Nursery Pigs (10 lbs). The original permit included 17 land application fields for a total of 630 acres available for land application (Figure 4). All of the fields were established pastures grazed and/or cut for hay with a history of inorganic fertilizer and poultry litter applications.

The planned swine manure applications replaced future poultry litter applications. Table 5 summarizes the manure applications from 2013 to 2016. The 630 acres available for land application does not include additional fields that could not receive manure due to permit constraints, such as setbacks adjacent to stream and other water bodies, rock outcrops, sink holes, adjacent property and residences, and slopes greater than 8%. As indicated on Figure 4 some fields are adjacent to Big Creek or a tributary to it, while others are more distant from the creek.

Relating Stream Nutrient Concentrations and Land Use

Geometric mean stream nutrient concentrations are related to the percentage of the watershed in pasture and urban land use for the Buffalo, Upper Illinois, and Upper White River Watersheds (Figures 5 and 6). The dashed lines on Figures 5 and 6 represent the upper and lower thresholds concentrations, where there is a 95% confidence that a stream draining a watershed with a specific percent pasture and urban land use will have a P and N concentration within those thresholds.

As the percent pasture and urban (i.e., land use intensity) increases, so does stream nutrient concentration. The general increase in nutrient concentrations is consistent with the fact that fertilizer (as mineral and manure sources) is routinely applied to pastures to maintain forage production, as well as deposition of nutrients by grazing cattle.

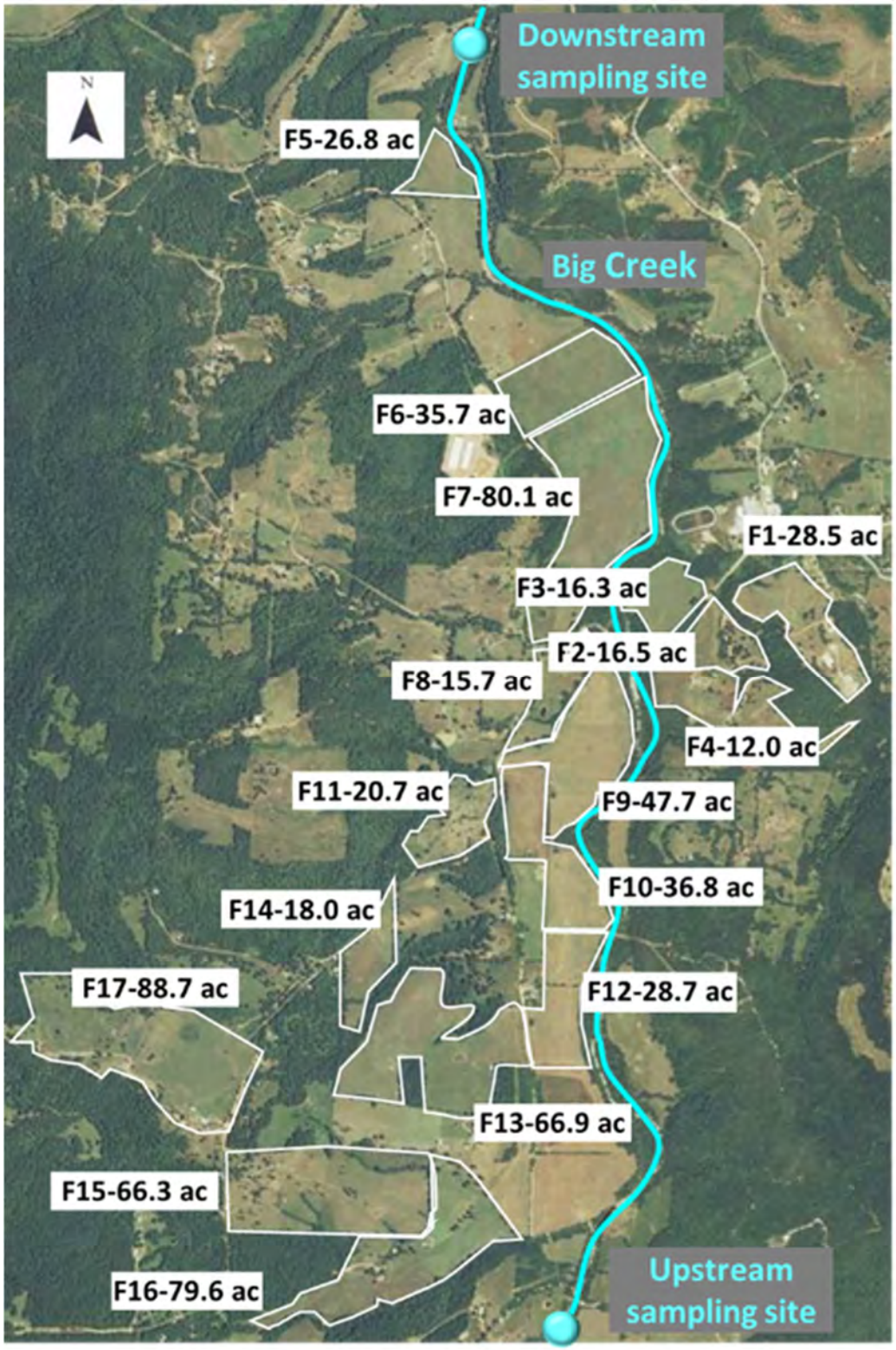

Figure 13. Location of field permitted to receive swine slurry on the C&H Farm and water quality sampling sites on Big Creek up and downstream of the C&H operation.

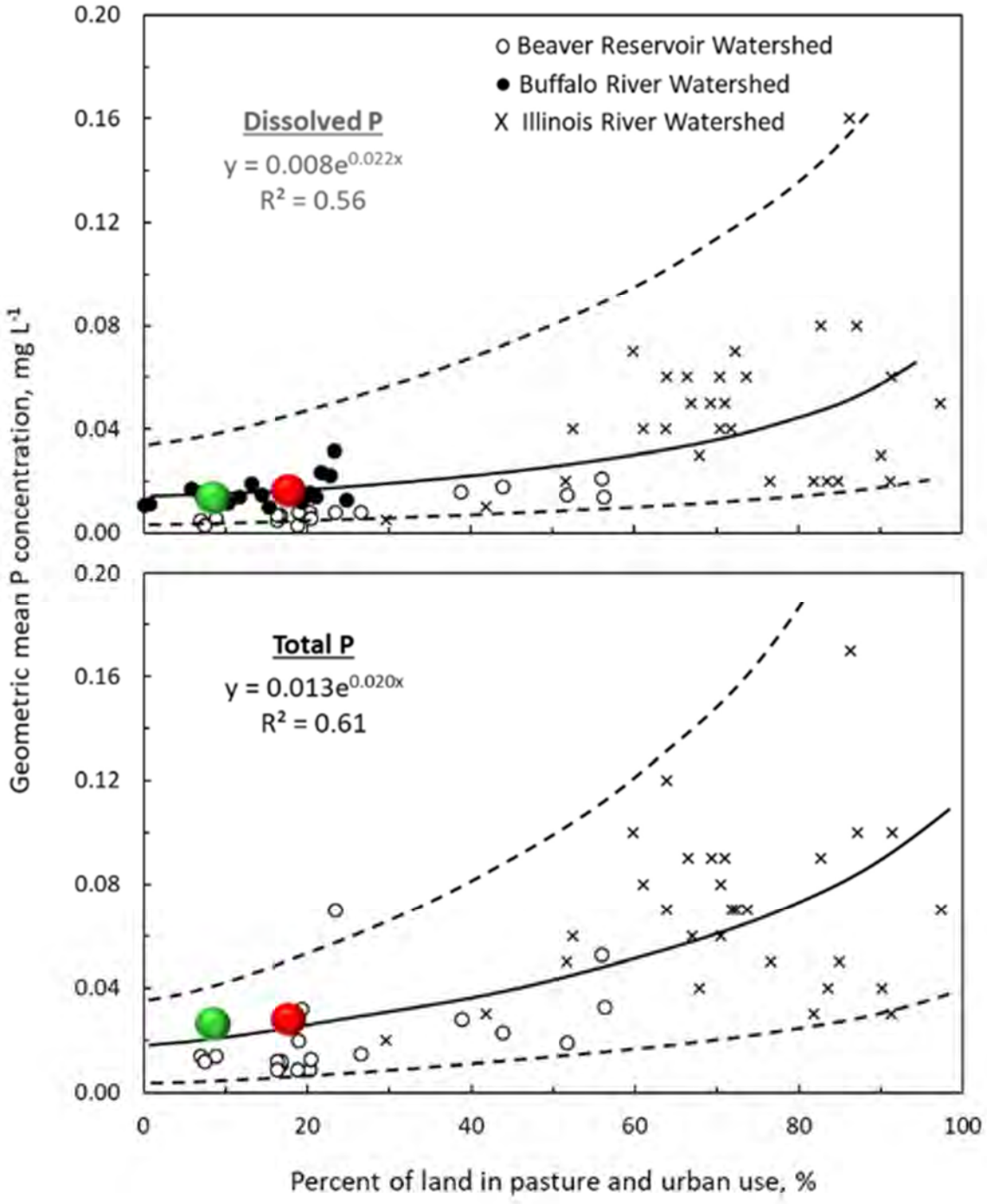

Figure 14. Relationship between land use and the geometric mean dissolved and total P concentrations (mg L^{-1}) in the Buffalo, Upper Illinois, and Upper White River Watersheds. Dashed lines represent the 95% confidence intervals for observed values. Green and red points represent Big Creek geometric means for September 2013 to April 2017 upstream and downstream the swine production facility, respectively.

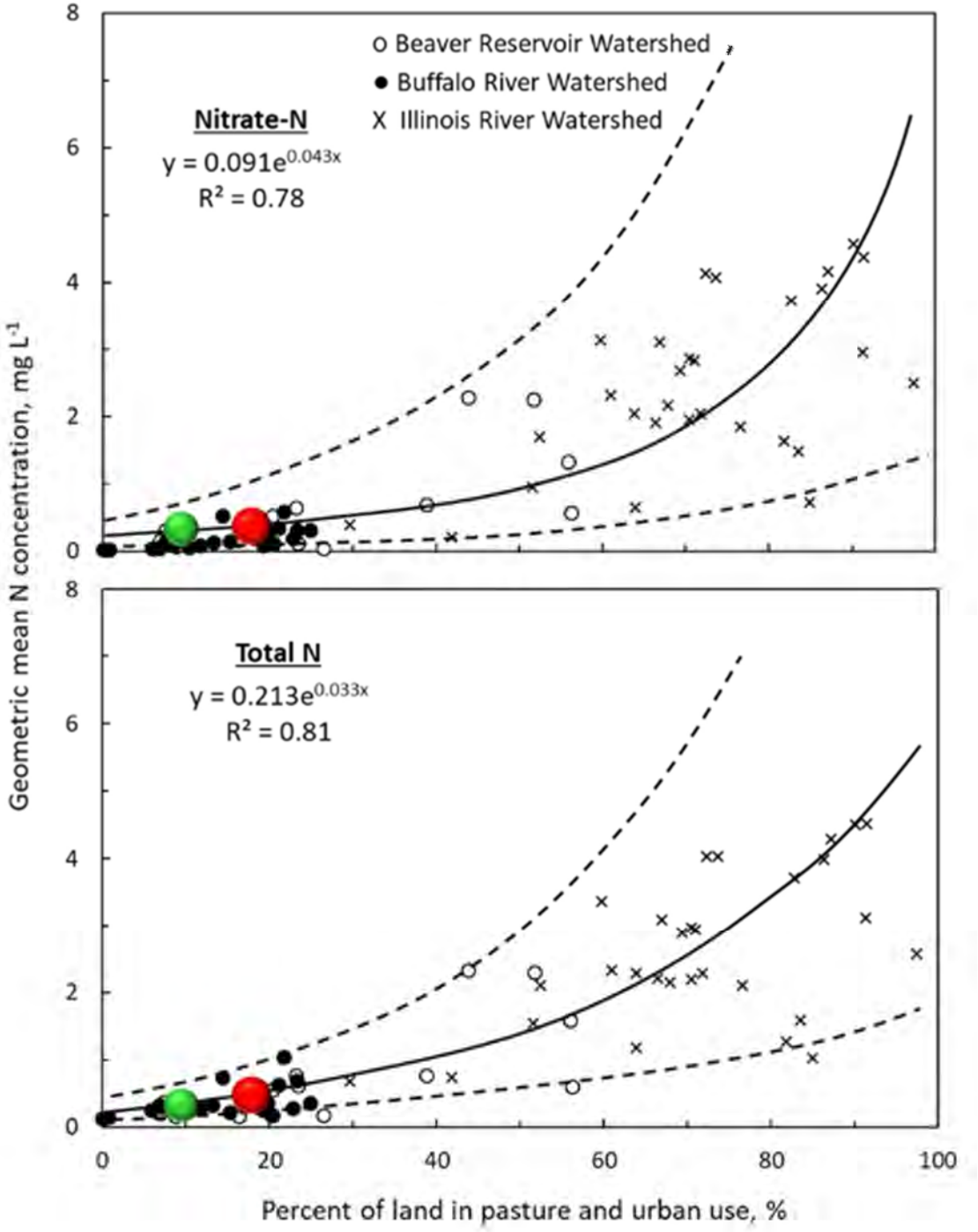

Figure 15. Relationship between land use and the geometric mean nitrate-N and total N concentrations in (mg L^{-1}) in the Buffalo River, Upper Illinois, and Upper White River Watersheds. Dashed lines represent the 95% confidence intervals for the estimated mean (solid line). Green and red points represent Big Creek geometric means for September 2013 to April 2017 upstream and downstream the swine production facility, respectively.

In Big Creek, upstream of the swine production CAFO in the Buffalo River Watershed, the geometric mean concentration of dissolved P, total P, nitrate-N, and total N were 0.009, 0.030, 0.10 and 0.20 mg L^{-1}, respectively, between September 2013 and April 2017. Directly downstream of the CAFO, geometric mean concentrations in Big Creek during base flow over the same period were 0.011, 0.031, 0.23, and 0.36 mg L^{-1} for dissolved P, total P, nitrate-N, and total N, respectively. Relative to water quality standards, the total P concentrations are below the Oklahoma standard of 0.037 mg L^{-1} for the Illinois River (Oklahoma Water Resources Board, 2017) and nitrate-N is below the EPA drinking water standard of 10 mg L^{-1} (U.S. Environmental Protection Agency, 2017).

Geometric mean nutrient concentrations in Big Creek above and below the swine production CAFO and its current potential sphere of influence from slurry applications are similar to or lower than concentrations measured in rivers draining other sub-watersheds in the Upper Illinois and Upper White River Watersheds with similar proportions of agricultural land use (Figures 5 and 6). The proportion of pasture and urban land use in Big Creek up and downstream of the CAFO is 10.6 and 20.5%, respectively, and are in the low range of level of human development in the Buffalo, Upper Illinois, and Upper White River Watersheds.

At the present time, nutrient concentrations in Big Creek above and below the CAFO are consistent with the range seen for other watersheds with similar pasture and urban land-use characteristics. However, this does not preclude the possibility that nutrient concentrations in Big Creek may increase in the future with continued farming operations. Use of these relationships provides a method to determine if nutrient concentrations in a given watershed are changing over time, relative to observed nutrient concentration-land use gradients in other watersheds of the Ozark Highlands and Boston Mountains.

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Table 7. Land use in the sub-watersheds of the Buffalo River Watershed sampled from 1985-2015. See Figure 2 for site location.

Site #	Stream description	Area	Land use			Geometric mean base-flow concentration			
			Forest	Pasture	Urban	Dissolved P	Total P	Nitrate-N	Total N
		km^2	---------- % ----------			---------- mg L^{-1} ----------			
T1	Brush Creek at Hwy 21	53.9	85.3	6.8	0.0	0.016	0.020	0.05	0.34
T2	Ponca Creek at Hwy 74	12.6	82.8	7.2	0.0	0.013	0.017	0.11	0.31
T3	Cecil Creek	65.5	75.5	10.3	0.0	0.012	0.010	0.06	0.24
T4	Mill Creek near Pruitt	64.2	68.0	14.4	0.0	0.015	0.025	0.53	0.75
T5	Little Buffalo River	405.0	80.2	8.4	0.1	0.015	0.015	0.09	0.34
T6	Big Creek near Carver	268.7	71.5	13.2	0.0	0.019	0.021	0.13	0.34
T7	Davis Creek	91.7	55.7	21.0	0.0	0.014	0.025	0.35	0.64
T8	Cave Creek	153.8	74.8	11.7	0.0	0.014	0.019	0.09	0.29
T9	Richland Creek	354.6	86.4	5.8	0.0	0.017	0.027	0.05	0.26
T10	Calf Creek	161.8	51.5	23.2	0.0	0.032	0.033	0.32	0.70
T11	Mill Creek at Tyler Bend	45.7	58.2	19.6	0.1	0.015	0.012	0.28	0.37
T12	Bear Creek	308.9	52.1	22.4	0.4	0.023	0.025	0.20	0.29
T13	Brush Creek	64.5	53.9	20.5	1.1	0.024	0.032	0.59	1.05
T14	Tomahawk Creek	117.1	48.5	24.5	0.0	0.013	0.016	0.31	0.37
T15	Water Creek	116.9	67.1	15.2	0.0	0.010	0.008	0.16	0.22
T16	Rush Creek	42.2	82.5	7.6	0.0	0.012	0.027	0.17	0.30
T17	Clabber Creek	84.9	60.0	19.2	0.0	0.012	0.026	0.10	0.26
T18	Big Creek in Lower Wilderness	435.3	56.9	20.3	0.0	0.016	0.019	0.13	0.18
T23	Leatherwood Creek	27.8	98.6	0.0	0.0	0.011	0.031	0.03	0.14
T24	Cow Creek	33.1	97.1	0.7	0.0	0.011	0.015	0.04	0.16

Table 8. Land use in the sub-watersheds of the Upper Illinois River Watershed sampled as part of the one-year monitoring program in 2011. See Figure 3 for site location.

Site #	Sub-watershed name	Area	Land use			Geometric mean base-flow concentration			
			Forest	Pasture	Urban	Dissolved P	Total P	Nitrate-N	Total N
		km^2	---------- % ----------			---------- $mg\ L^{-1}$ ----------			
1	Headwaters Illinois	95.8	57.9	37.0	4.7	0.01	0.03	0.21	0.74
2a	Goose Creek-Illinois River	114.0	39.7	50.0	9.7	0.07	0.10	3.13	3.37
2b	Goose Creek-Illinois River	114.0	14.5	72.9	10.6	0.02	0.04	1.49	1.59
3a	Lake Wedington-Illinois River	82.9	28.5	49.5	20.9	0.04	0.06	1.95	2.20
3b	Lake Wedington-Illinois River	82.9	38.1	52.7	8.2	0.04	0.08	2.32	2.34
3c	Lake Wedington-Illinois River	82.9	35.1	47.6	16.1	0.04	0.07	2.04	2.29
4	Lake Fayetteville-Clear Creek	59.6	16.6	30.6	51.2	0.02	0.03	1.63	1.28
5	Mud Creek-Clear Creek	44.0	11.2	50.2	34.8	0.02	0.05	0.72	1.03
6	Hamstring Creek	38.9	22.6	36.6	39.6	0.02	0.05	1.85	2.11
7	Little Wildcat-Clear Creek	59.6	26.9	37.6	34.1	0.04	0.07	2.04	2.29
8a	Headwaters Osage Creek-Illinois River	121.7	12.0	50.2	36.7	0.08	0.10	4.16	4.29
8b	Headwaters Osage Creek-Illinois River	121.7	7.4	30.8	60.5	0.06	0.10	4.38	4.52
9	Spring Creek-Osage Creek	95.8	12.3	42.3	44.0	0.16	0.17	3.9	3.99
10	Little Osage Creek	121.7	9.5	69.4	20.4	0.03	0.04	4.58	4.50
11	Brush Creek-Osage Creek	62.2	7.3	52.9	38.4	0.02	0.03	2.96	3.13
12	Osage Creek-Illinois River	137.3	16.4	54.1	28.6	0.08	0.09	3.73	3.72

Site #	Sub-watershed name	Area	Land use			Geometric mean base-flow concentration			
			Forest	Pasture	Urban	Dissolved P	Total P	Nitrate-N	Total N
13	Upper Muddy Fork-Illinois River	72.5	46.9	45.2	6.4	0.02	0.05	0.96	1.55
14	Moore's Creek-Muddy Fork	64.8	34.6	55.9	7.9	0.06	0.12	0.65	1.18
15	Lower Muddy Fork-Illinois River	54.4	32.5	59.2	7.1	0.06	0.09	1.91	2.22
16	Headwaters Flint Creek	75.1	26.9	66.6	5.7	0.07	0.07	4.13	4.04
17	Sager Creek	38.9	2.4	61.4	36.0	0.05	0.07	2.50	2.58
18	Middle Flint Creek	64.8	30.2	58.5	9.3	0.03	0.04	2.17	2.15
19	Chambers Hollow-Illinois River	80.3	28.6	49.4	20.9	0.06	0.08	2.86	2.97
20	Wedington Creek	59.6	26.2	69.1	4.3	0.06	0.07	4.08	4.04
21	Cincinnati Creek	67.3	32.7	61.8	5.1	0.05	0.06	3.11	3.09
22	Upper Ballard Creek	62.2	28.9	62.8	8.1	0.05	0.09	2.83	2.94
23	Lake Frances-Illinois River	77.7	29.7	50.8	18.4	0.05	0.09	2.68	2.89
24	Upper Baron Fork	106.2	47.3	48.2	4.2	0.04	0.06	1.70	2.10
26	Upper Evansville Creek	62.2	69.9	26.9	2.7	0.00	0.02	0.40	0.68

Table 9. Land use in the sub-watersheds of the stream sites sampled in the Upper White River Watershed as part of the June 2005 to July 2006 monitoring program. See Figure 3 for site location. From Giovannetti et al., (2013).

Site #	Stream description	Area	Land use			Geometric mean base-flow concentration			
			Forest	Pasture	Urban	Dissolved P	Total P	Nitrate-N	Total N
		km^2	---------- % ----------			---------- $mg\ L^{-1}$ ----------			
1	Brush Creek at Hwy 45	51.8	50.9	38.5	0.3	0.016	0.028	0.69	0.78
2	Clear Creek at CR 8516	32.0	40.1	43.8	0.0	0.018	0.023	2.28	2.33
3	Clift Creek at CR 751 and Hwy 12	48.5	36.1	51.7	0.0	0.015	0.019	2.26	2.3
4	Drakes Creek at CR 6245	52.4	69.9	20.3	0.0	0.008	0.009	0.53	0.56
5	Glade Creek at CR 8500	56.4	34	54.8	1.1	0.021	0.053	1.34	1.59
6	Middle Fork, White River at CR 119	73.2	75.6	16.7	0.0	0.007	0.011	0.48	0.5
7	Middle Fork, White River at CR 43	104.5	75.8	16.7	0.0	0.007	0.012	0.46	0.48
8	Middle Fork, White River at CR 57	148.8	76.5	16.3	0.0	0.005	0.012	0.17	0.25
9	Richland Creek Hwy 45	361.0	64.8	26.1	0.4	0.008	0.015	0.05	0.18
10	Richland Creek Hwy 74	239.2	72.4	19.3	0.0	0.015	0.032	0.34	0.52
11	Richland Creek Hwy 79	306.9	68	23.4	0.0	0.008	0.07	0.12	0.62
12	Town Branch at Armstrong Road East of Hwy 156	25.6	36.5	11.9	44.3	0.014	0.033	0.57	0.6
13	War Eagle at Hwy 412	425.8	74.6	18.7	0.2	0.008	0.02	0.21	0.29
14	War Eagle at CR 8500	534.7	69.5	21.9	1.2	--	--	0.65	0.77
15	White River at Springston Ford on CR 49	437.1	86.9	8.7	0.1	0.006	0.014	0.07	0.17
16	White River at CR 5430	344.0	89.4	6.7	0.2	0.005	0.014	0.17	0.22

Site #	Stream description	Area	Land use			Geometric mean base-flow concentration			
			Forest	Pasture	Urban	Dissolved P	Total P	Nitrate-N	Total N
17	White River at CR 5640	104.4	89.6	6.9	0.5	0.003	0.012	0.32	0.38
18	West Fork, White River at CR 1192	211.2	71.6	15.7	4.7	0.006	0.013	0.12	0.19
19	West Fork, White River at Hwy 71 South of West Fork	150.1	76.3	13.7	2.6	0.007	0.009	0.16	0.17
20	West Fork, White River at Hwy 71 Rest Area	64.9	73.1	16.5	2.3	0.003	0.009	0.38	0.4

Table 10. Range percent forest pasture, and urban land use in the Big Creek, Buffalo River, Upper Illinois, and Upper White Watersheds.

Watershed	Forest	Pasture	Urban
	---------- % ----------		
Big Creek [1]			
Upstream	89.5	8.0	2.6
Downstream	79.5	17.0	3.5
Buffalo River	52 - 99	0 - 25	0 - 1
Upper White River	34 - 90	7 - 55	0 – 44
Upper Illinois River	2 - 70	27 – 69	3 – 61

Table 11. Big Creek swine manure application summary information for 2013 to 2016.

Year	Number of Fields	Total Area	Total Volume	Average Rate	Average Depth
		ha	m^3	L ha^{-1}	mm
2013	1	4.9	136.3	28,061	2.8
2014	15	231.6	8,961.6	38,686	3.9
2015	15	231.6	12,208.0	52,701	5.3
2016	14	197.9	10,254.7	51,808	5.2

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Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – July 1 to September 30, 2017

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

The mission of the **Division of Agriculture** is to advance the stewardship of natural resources and the environment, cultivate the improvement of agriculture and agribusiness, develop leadership skills and productive citizenship among youth and adults, enhance economic security and financial responsibility among the citizens of the state, ensure a safe, nutritious food supply, improve the quality of life in communities across Arkansas, and strengthen Arkansas families.

Dr. Mark J. Cochran
Vice President for Agriculture

Executive Summary

This is the third Quarterly Report of 2017 for the Big Creek Research and Extension Team that details activities and progress made from July 1 through September 30, 2017.

1. We continue to collect weekly base flow and periodic stormflow water samples from Big Creek above and below the C&H Farm, along with water from a spring, ephemeral stream, surface runoff sites on Fields 1, 5a, and 12, two interceptor trenches below the slurry holding ponds, and house well for chemical and bacterial analysis.

2. During this quarter (i.e., third quarter of 2017), no consistent trends in nutrient (nitrogen or phosphorus) and bacterial concentrations were observed at each of the field sites.

Big Creek Science Team

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Ed Gbur, Ph.D., Professor and Director, Agricultural Statistics Laboratory - Experimental design, linear and generalized linear mixed models, regression, agricultural applications of statistics.

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Phil Hays, Ph.D. Ground Water Specialist, U.S. Geological Survey and Research Professor with Geosciences Dept., University of Arkansas, application of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Jun Zhu, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians - The Big Creek Research and Extension Team are ably supported by several outstanding and dedicated Program Technicians based in Fayetteville and Little Rock.

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Water Sampling and Analytical Methods

Sampling Locations

Water quality monitoring sites are;

Site 1. Edge-of-field monitoring on Field 1 permitted to receive slurry.

Site 2. Edge-of-field monitoring on Field 5a excluded from receiving slurry.

Site 3. Edge-of-field monitoring on Field 12 permitted to receive slurry.

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities.

Site 5. Spring below Field 1.

Site 6. Big Creek upstream of the C&H Farm operation.

Site 7. Big Creak downstream of the C&H Farm operation.

Site 8. Left Fork downstream of the C&H Farm operation.

Site 9. North interceptor trench below the manure holding ponds.

Site 10. South interceptor trench below the manure holding ponds.

Site 11. House well at animal facility.

Table 1. Location of sampling sites on the Big Creek Research and Extension Team project.

Site description	Latitude	Longitude	Elevation, ft
Field 1	35 55’ 06.42”	93 03’ 38.34”	984
Field 5a	35 56’03.01”	93 04’ 25.85”	778
Field 12	35 54’ 13.57”	93 04’ 04.76”	838
Ephemeral stream	35 55’ 25.89”	93 04’ 14.94”	824
Spring	35 54’ 57.06”	93 03’ 34.64”	977
Big Creek upstream of farm	35 53’ 32.28”	93 04’ 06.38”	857
Big Creek downstream of farm	35 56’ 18.98”	93 04’ 21.81”	769
Left Fork	35 5’”48.04”	93 04” 02.02”	760
Trench 1 (south)	35 55’ 19.24”	93 04’ 23.04”	896
Trench 2 (north)	35 55’ 21.39”	93 04’ 19.93”	883
House well	35 55’ 27.02”	93 04’ 22.71”	915

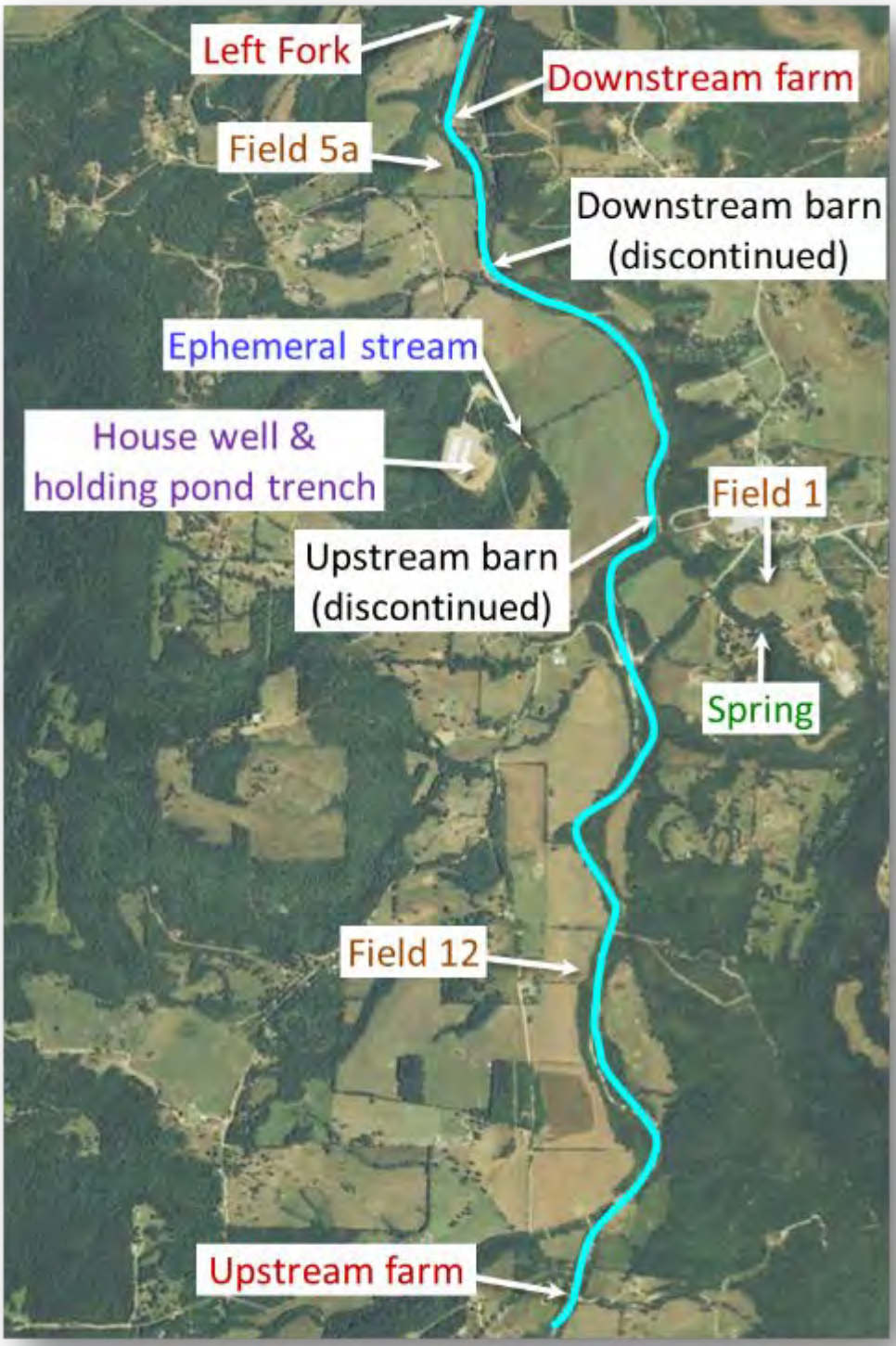

Figure 1. Location of sampling sites for the Big Creek Research and Extension Team project.

Sampling Protocols and Analyses

The following protocols were used to collect, prepare, and analyze all water samples:

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface, where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted, and samples placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
6. Analyses included Alkalinity (APHA 2320-B), Ammonia (EPA 351.2), Chloride (EPA 300.0), Dissolved Phosphorus (EPA 365.2), E. coli (APHA 9223-B), Electrical Conductivity (EPA 120.1), Nitrate (EPA 300.0), pH (EPA 150.1), Total Coliforms (APHA 9223-B), Total Dissolved Solids (EPA 160.1), Total Nitrogen (APHA 4500-P J), Total Phosphorus (APHA 4500-P J), and Total Suspended Solids (EPA 160.2). APHA is American Public Health Association from the Wadeable Streams Assessment, Water Chemistry Laboratory Manual http://www.epa.gov/owow/monitoring/wsa/WRS_lab_manual.pdf
7. Prior to collection of a house well water sample, the well is purged and water temperature, pH, and electrical conductivity measured on-site every 30 seconds until all values stabilize (primarily water temperature). At that point a sample of water is collected in a 1-L acid-washed bottle. This method is taken from USGS and EPA well-water sampling protocols. See USGS methods for sampling at https://water.usgs.gov/owq/FieldManual/chapter4/pdf/Chap4_v2.pdf. Specific and detailed guidance on the collected of water quality data can be found in the USGS National Field Manual at file:///U:/Words/C&H%20Farm/Publications/Planning/USGS%20National%20Field%20Mannual_complete%202015.pdf

   The U.S. EPA also recommend that selected water quality parameters can be monitored during low-rate purging, with stabilization of these parameters indicating when the discharge water represents aquifer water or source well water. See: http://www.csus.edu/indiv/h/hornert/Geol_210_Summer_2012/Week%202%20readings/Puls%20and%20Barcelona%201996%20Low%20flow%20sampling.pdf and https://in-situ.com/wp-content/uploads/2015/01/Low-Flow-Groundwater-Sampling-Techniques-Improve-Sample-Quality-and-Reduce-Monitoring-Program-Costs-Case-Study.pdf
8. Minimum detection limits (MDLs) for each chemical and biological constituent are listed in Table 1. Some constituent concentrations were reported by the laboratory as less than the MDL but greater than zero. Those values are given in subsequent tables but have less confidence in their accuracy than concentrations above the MDL.
9. Chemical and biological analyses of samples collected from the beginning of 2017 to May 31, 2017 are given in Tables 3, 4, 5, and 6.

Table 2. Minimum detection limits (MDLs) for each chemical and biological constituent.

Constituent	Minimum detection limit [1]
Alkalinity, mg/L as $CaCO_3$	2
Chloride, mg/L	0.093
Dissolved P, mg/L	0.002
Conductivity, uS/cm	1
Ammonia-N, mg/L	0.03
Dissolved organic carbon, mg/L	0.18
E. coli, MPN/100 mL	1
Nitrate-N, mg/L	0.004
pH	0.1
Total coliform, MPN/100 mL	1
Total dissolved solids, mg/L	15.22
Total N, mg/L	0.006
Total P, mg/L	0.012
Total suspended solids, mg/L	6.58

[1] MDL the Minimum Detection Limit of an analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. Further information is available at http://water.usgs.gov/owq/OFR_99-193/detection.html

Big Creek Research and Extension Team Monitoring Data

Nutrients, Sediment, and Bacteria by Date of Sampling

Table 3. Water quality analyses at each sample site since January 2017, with those collected since the last report noted. Coliform units are Most Probable Number (MPN) per 100 mL of water.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
			---------- mg/L ----------							-- MPN/100 mL --	
1/5/2017	**1/25/2017**	**Grab sample**									
12:28	15:25	Spring	0.004	0.026	0.04	0.276	0.390	9.5	0.94	74.4	1413.6
13:12	15:25	Upstream farm	0.009	0.014	0.02	0.059	0.090	0.7	0.66	52.0	2419.2
12:00	15:25	Downstream farm	0.012	0.019	0.04	0.257	0.310	1.3	0.55	5.2	1986.3
11:42	15:25	Left Fork	0.006	0.011	0.03	0.229	0.260	0.7	0.85	6.2	1732.9
12:47	15:25	House well	0.008	0.014	0.04	0.610	0.660	0.3	0.30	<1.0 ¶	<1.0
1/19/2017	**1/19/2017**	**Grab sample**									
10:41	14:30	Spring	0.009	0.017	0.04	0.286	0.600	33.0	13.31	<1.0	2260.0
11:27	14:30	Upstream farm	0.010	0.016	0.03	0.050	0.140	1.9	4.22	137.6	>2419.2
10:30	14:30	Downstream farm	0.014	0.024	0.02	0.121	0.210	2.5	3.19	60.1	3990.0
10:10	14:30	Left Fork	0.010	0.019	0.03	0.243	0.360	2.6	4.25	55.4	>2419.2
11:00	14:30	House well	0.009	0.013	0.03	0.617	0.690	0.9	7.87	<1.0	<1.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
2/2/2017	**2/2/2017**	**Grab sample**									
10:45	14:30	Spring	0.011	0.030	<0.03	0.823	0.890	7.3	5.06	6.3	1732.9
11:20	14:30	Upstream farm	0.009	0.017	<0.03	0.056	0.070	1.1	1.72	41.9	>2419.2
10:30	14:30	Downstream farm	0.014	0.026	0.01	0.160	0.210	5.1	2.21	41.3	>2419.2
10:15	14:30	Left Fork	0.008	0.019	0.01	0.139	0.180	1.1	1.69	17.1	>2419.2
10:57	14:30	House well	0.011	0.031	0.01	0.614	0.780	0.4	2.22	<1.0	<1.0
2/15/2017	**2/15/2017**	**Grab sample**									
11:50	15:35	Spring	0.013	0.093	0.02	0.201	0.570	12.7	8.76	178.5	4350.0
13:30	15:35	Upstream farm	0.009	0.060	0.01	0.132	0.300	5.0	3.04	1986.3	6570.0
11:24	15:35	Downstream farm	0.012	0.082	0.03	0.159	0.420	9.0	3.46	1732.9	11000.0
12:08	15:35	Ephemeral stream	0.020	0.064	0.02	1.323	1.450	3.1	5.06	166.9	5630.0
11:11	15:35	Left Fork	0.015	0.080	0.03	0.314	0.600	17.7	4.66	648.8	11060.0
12:46	15:35	Trench 1	0.004	0.023	0.01	0.141	0.200	1.3	0.45	1.0	1299.7
12:56	15:35	Trench 2	0.004	0.087	0.04	0.486	1.120	6.1	5.99	19.7	42860.0
12:25	15:35	House well	0.008	0.023	0.02	0.649	0.720	0.5	2.07	<1.0	<1.0
3/1/2017	**3/1/2017**	**Grab sample**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:38	14:55	Upstream farm	0.009	0.044	0.03	0.069	0.240	4.7	3.93	2590.0	7940.0
11:18	14:55	Downstream farm	0.005	0.016	0.03	0.148	0.270	2.6	3.24	71.7	2430.0
11:43	14:55	Ephemeral stream	0.011	0.016	0.02	0.659	0.710	1.5	6.75	195.6	5730.0
11:00	14:55	Left Fork	0.008	0.024	0.02	0.136	0.280	4.3	2.46	1119.9	4260.0
12:16	14:55	Trench 2	0.002	0.050	0.04	0.345	0.760	11.6	4.90	98.8	34480.0
11:52	14:55	House well	0.012	0.040	0.03	0.620	0.720	0.5	5.85	<1.0	<1.0
3/16/2017	**3/16/2017**	**Grab sample**									
7:30	11:45	Spring	0.009	0.061	<0.03	0.729	0.990	15.5	2.69	24.0	>2419.2
8:38	11:45	Upstream farm	0.006	0.046	<0.03	0.118	0.290	1.7	1.08	75.9	1299.7
7:13	11:45	Downstream farm	0.010	0.031	<0.03	0.266	0.300	2.9	0.97	68.3	1986.3
7:38	11:45	Ephemeral stream	0.005	0.021	<0.03	0.738	0.800	0.8	2.99	14.8	2419.2
7:00	11:45	Left Fork	0.009	0.043	<0.03	0.300	0.410	3.1	1.77	45.5	>2419.2
8:00	11:45	Trench 1	0.006	0.020	<0.03	0.083	0.110	1.1	1.87	<1.0	179.3
7:46	11:45	House well	0.009	0.023	<0.03	0.856	0.880	0.1	1.52	<1.0	<1.0
3/27/2017	**3/27/2017**	**Grab sample**									
11:27	15:40	Spring	0.007	0.044	<0.03	0.213	0.600	7.2	9.58	770.1	8800.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:51	15:40	Upstream farm	0.012	0.122	0.06	0.181	0.740	131.4	5.72	1986.3	17850.0
10:51	15:40	Downstream farm	0.047	0.096	0.20	0.173	1.490	321.9	6.68	9840.0	72150.0
10:37	15:40	Left Fork	0.058	0.164	0.17	0.206	1.500	1005.1	8.51	9330.0	38770.0
11:50	15:40	Trench 1	0.004	0.048	0.03	0.129	0.390	3.1	4.36	387.3	17230.0
11:55	15:40	Trench 2	0.009	0.102	0.13	0.060	0.820	7.0	7.13	488.4	29240.0
12:38	15:40	House well	0.007	0.038	0.02	0.573	0.630	1.6	3.83	18.1	261.3
3/27/2017	**3/27/2017**	**Storm sample**									
11:40	15:40	Ephemeral stream	0.151	0.268	0.29	1.704	3.300	448.3	16.47	18500.0	66530.0
11:05	15:40	Field 1	0.420	0.670	0.43	0.090	1.870	124.4	9.29	8390.0	45690.0
12:15	15:40	Field 5a	2.980	3.232	1.40	0.122	1.800	30.2	32.01	2419.2	69100.0
13:06	15:40	Field 12	0.800	1.276	2.02	2.798	6.040	134.2	9.35	7120.0	96060.0
3/30/2017	**3/30/2017**	**Storm sample**									
11:15	14:15	Ephemeral stream	0.005	0.032	0.01	0.796	0.860	8.6	1.89	ND §	ND
4/6/2017	**4/6/2017**	**Grab sample**									
11:40	15:25	Spring	0.009	0.032	0.01	0.265	0.420	5.2	6.36	1413.6	1413.6
11:30	15:25	Upstream farm	0.007	0.038	0.01	0.099	0.210	2.3	2.53	72.0	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:55	15:25	Downstream farm	0.009	0.034	0.01	0.173	0.260	3.1	1.96	107.6	>2419.2
11:20	15:25	Ephemeral stream	0.008	0.022	<0.03	0.717	0.760	1.6	1.69	148.3	1986.3
11:50	15:25	Left Fork	0.010	0.048	0.01	0.222	0.410	4.7	2.32	135.4	2780.0
10:20	15:25	Trench 1	0.004	0.022	0.03	0.165	0.300	17.2	1.98	47.2	2750.0
4/6/2017	**4/6/2017**	**Storm sample**									
11:15	15:25	Ephemeral stream	0.018	0.080	0.06	0.807	1.140	19.9	4.14	ND	ND
4/13/2017	**4/13/2017**	**Grab sample**									
12:22	15:30	Spring	0.011	0.022	<0.03	0.600	0.630	3.6	15.57	8.6	816.4
13:05	15:30	Upstream farm	0.008	0.054	<0.03	0.026	0.110	2.5	4.64	83.6	2419.2
11:56	15:30	Downstream farm	0.009	0.028	0.01	0.092	0.170	1.1	2.33	135.4	>2419.2
12:50	15:30	Ephemeral stream	0.010	0.018	<0.03	0.593	0.600	1.5	7.73	71.7	6700.0
11:33	15:30	Left Fork	0.010	0.024	<0.03	0.123	0.210	1.6	2.75	22.3	>2419.2
12:35	15:30	House well	0.011	0.020	<0.03	0.564	0.590	0.1	6.22	<1.0	1.0
4/17/2017	**4/17/2017**	**Grab sample**									
12:02	14:55	Spring	0.007	0.044	0.02	0.154	0.400	5.3	6.46	1413.6	18420.0
11:45	14:55	Upstream farm	0.019	0.054	<0.03	0.025	0.120	5.3	1.55	1553.1	9330.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:51	14:55	Downstream farm	0.011	0.046	0.01	0.129	0.240	3.3	1.51	866.4	8360.0
11:10	14:55	Ephemeral stream	0.005	0.018	<0.03	0.651	0.680	0.9	1.71	410.6	7270.0
10:40	14:55	Left Fork	0.040	0.112	0.02	0.173	0.460	19.5	4.55	9090.0	129970.0
11:25	14:55	House well	0.006	0.016	0.01	0.563	0.570	0.2	1.94	<1.0	12.1
4/24/2017	**4/24/2017**	**Storm sample**									
11:50	15:30	Ephemeral stream	0.007	0.128	0.04	0.000	1.830	318.0	7.35	ND	ND
11:15	15:30	Field 1	0.395	0.592	0.13	0.143	1.500	43.1	7.25	ND	ND
11:35	15:30	Field 5a	0.961	1.212	0.12	0.321	1.530	11.7	11.53	ND	ND
12:15	15:30	Trench 1	0.005	0.040	21.95	0.133	22.760	18.5	7.04	ND	ND
12:20	15:30	Trench 2	0.010	0.084	0.04	0.087	0.930	8.2	8.78	ND	ND
4/27/2017	**4/27/2017**	**Grab sample**									
11:05	16:25	Spring	0.011	0.022	<0.03	0.380	0.440	3.1	2.58	165.8	>2419.2
12:10	16:25	Upstream farm	0.010	0.036	<0.03	0.117	0.120	7.1	1.34	172.3	2430.0
10:35	16:25	Downstream farm	0.014	0.042	<0.03	0.231	0.240	10.7	1.70	214.3	6090.0
10:20	16:25	Left Fork	0.016	0.046	<0.03	0.306	0.320	16.4	2.08	275.5	7230.0
11:30	16:25	House well	0.011	0.014	<0.03	0.532	0.530	0.1	0.69	5.1	52.8

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:43	16:25	Trench 2	0.006	0.046	0.04	0.029	0.420	2.4	4.95	115.3	2419.2
4/27/2017	**4/27/2017**	**Storm sample**									
11:52	16:25	Ephemeral stream	0.042	0.253	0.01	0.302	2.570	734.5	8.29	186.0	>2419.2
10:50	16:25	Field 1	0.550	0.784	0.08	0.107	1.320	52.2	8.46	ND	ND
11:15	16:25	Field 5a	0.686	0.846	0.07	0.063	0.860	11.3	7.26	ND	ND
13:40	16:25	Field 12	0.326	0.544	0.02	0.105	0.710	102.3	5.64	ND	ND
11:40	16:25	Trench 1	0.006	0.048	1.04	0.081	1.430	7.2	4.04	40.4	3990.0
5/1/2017	**5/1/2017**	**Grab sample**									
11:35	15:45	Spring	0.012	0.012	<0.03	0.343	0.480	0.3	4.34	127.4	2419.2
13:05	15:45	Upstream farm	0.013	0.026	<0.03	0.144	0.250	4.1	1.01	95.9	2280.0
11:01	15:45	Downstream farm	0.018	0.032	<0.03	0.279	0.390	6.9	1.22	187.2	3010.0
12:54	15:45	Ephemeral stream	0.014	0.018	<0.03	0.681	0.750	68.2	1.12	146.7	1986.3
10:50	15:45	Left Fork	0.019	0.068	<0.03	0.362	0.550	14.1	1.68	129.1	7430.0
12:15	15:45	House well	0.015	0.042	<0.03	0.529	0.650	1.8	1.59	4.1	3740.0
12:30	15:45	Trench 1	0.007	0.008	<0.03	0.124	0.180	2.3	1.05	435.2	12960.0
12:40	15:45	Trench 2	0.013	0.022	<0.03	0.000	0.230	3.4	3.02	435.2	3890.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
5/1/2017	**5/1/2017**	**Storm sample**									
11:20	15:45	Field 1	0.534	0.760	0.33	0.321	2.200	36.7	12.66	ND	ND
12:00	15:45	Field 5a	0.734	0.916	0.22	0.281	1.560	13.1	9.81	ND	ND
13:15	15:45	Field 12	0.224	0.374	0.03	0.166	1.060	40.6	7.25	ND	ND
12:30	15:45	Trench 1	0.009	0.050	0.61	0.076	2.400	10.7	4.56	ND	ND
12:40	15:45	Trench 2	0.008	0.066	0.02	0.010	0.810	11.2	8.31	ND	ND
5/11/2017	**5/11/2017**	**Grab sample**									
7:40	12:05	Spring	0.013	0.016	<0.03	0.406	0.410	0.9	4.97	30.5	1986.3
8:25	12:05	Upstream farm	0.009	0.022	<0.03	0.125	0.170	2.4	1.32	165.8	2419.2
7:24	12:05	Downstream farm	0.010	0.026	<0.03	0.397	0.400	2.4	1.18	93.3	3090.0
7:50	12:05	Ephemeral stream	0.009	0.018	<0.03	0.682	0.740	1.5	1.49	48.0	2419.2
7:13	12:05	Left Fork	0.012	0.024	<0.03	0.383	0.380	1.3	1.09	78.9	5460.0
7:55	12:05	House well	0.010	0.016	<0.03	1.023	1.080	0.6	1.19	<1.0	6.3
5/18/2017	**5/18/2017**	**Grab sample**									
10:55	15:00	Spring	0.006	0.018	<0.03	0.220	0.340	0.4	4.91	88.0	2419.2
11:40	15:00	Upstream farm	0.006	0.048	<0.03	0.067	0.190	2.9	1.50	260.2	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:45	15:00	Downstream farm	0.008	0.024	<0.03	0.189	0.300	1.9	1.10	129.6	3690.0
11:05	15:00	Ephemeral stream	0.012	0.020	<0.03	0.692	0.750	1.7	1.76	49.6	2419.2
10:30	15:00	Left Fork	0.009	0.022	<0.03	0.167	0.260	1.9	1.54	50.4	2419.2
11:15	15:00	House well	0.011	0.020	<0.03	0.431	0.600	0.6	5.05	1.0	3.1
5/25/2017	**5/25/2017**	**Grab sample**									
12:16	15:27	Spring	0.007	0.042	0.01	0.219	0.330	22.2	3.76	68.9	2419.2
13:06	15:27	Upstream farm	0.007	0.052	0.01	0.109	0.240	1.9	1.53	ND	ND
11:35	15:27	Downstream farm	0.008	0.020	0.01	0.295	0.300	1.7	1.41	101.7	>2419.2
12:25	15:27	Ephemeral stream	0.013	0.016	0.01	0.661	0.710	0.4	2.01	72.8	>2419.2
11:18	15:27	Left Fork	0.010	0.022	0.01	0.303	0.320	1.4	1.48	58.1	2419.2
12:48	15:27	House well	0.010	0.016	0.02	0.525	0.570	0.3	1.71	<1.0	613.1
5/25/2017	**5/25/2017**	**Storm sample**									
11:35	15:27	Downstream farm	0.006	0.050	<0.03	0.274	0.310	3.0	1.35	ND	ND
5/31/2017	**5/31/2017**	**Grab sample**									
10:38	13:50	Spring	0.007	0.036	<0.03	0.163	0.320	13.2	3.81	235.9	4280.0
11:05	13:50	Upstream farm	0.009	0.020	<0.03	0.053	0.140	1.9	1.34	157.6	2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:30	13:50	Downstream farm	0.008	0.052	<0.03	0.188	0.250	1.6	1.33	150.0	2419.2
10:55	13:50	Ephemeral stream	0.009	0.020	<0.03	0.769	0.790	2.5	1.53	275.5	3500.0
10:20	13:50	Left Fork	0.008	0.020	<0.03	0.156	0.220	1.5	1.58	260.2	4720.0
10:51	13:50	House well	0.019	0.026	<0.03	0.605	0.920	0.4	1.86	<1.0	22.1
Samples analyzed since the last quarterly report											
6/5/2017	**6/5/2017**	**Grab sample**									
10:53	14:35	Spring	0.007	0.026	0.02	0.225	0.330	9.7	6.63	160.7	4640.0
11:51	14:35	Upstream farm	0.007	0.054	0.01	0.114	0.210	8.3	3.01	178.5	5040.0
10:35	14:35	Downstream farm	0.013	0.064	0.01	0.185	0.290	12.9	1.81	313.0	9330.0
11:03	14:35	Ephemeral stream	0.010	0.028	<0.03	0.706	0.710	1.5	2.38	613.1	5830.0
10:25	14:35	Left Fork	0.011	0.070	0.01	0.179	0.320	14.4	1.63	579.4	24000.0
11:09	14:35	House well	0.008	0.026	0.01	0.586	0.590	0.3	0.00	6.3	48.0
11:30	14:35	Trench 2	0.003	0.086	0.02	0.018	0.750	8.7	7.04	2780.0	>241920
6/6/2017	**6/6/2017**	**Storm sample**									
11:17	15:30	Field 1	0.747	0.998	0.51	0.438	2.340	56.0	10.39	ND	ND
12:12	15:30	Field 5a	1.000	1.430	0.05	1.861	2.380	<10.0	6.21	ND	ND

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:46	15:30	Field 12	0.316	0.470	0.03	0.166	1.660	280.8	6.65	ND	ND
11:30	15:30	Ephemeral stream	0.041	0.816	0.14	0.580	4.610	1788.2	9.24	ND	ND
11:02	15:30	Downstream farm	0.018	0.118	0.03	0.073	0.900	291.5	6.35	ND	ND
6/12/2017	**6/12/2017**	**Grab sample**									
10:27	14:25	Spring	0.006	0.084	0.01	0.193	0.400	53.3	2.57	29.5	155310.0
11:02	14:25	Upstream farm	0.008	0.026	0.01	0.105	0.130	2.0	1.01	121.1	6280.0
10:14	14:25	Downstream farm	0.009	0.020	0.01	0.256	0.270	1.6	0.77	119.8	4350.0
10:35	14:25	Ephemeral stream	0.010	0.882	<0.03	0.732	0.730	0.6	0.67	33.6	2419.2
10:05	14:25	Left Fork	0.006	0.016	<0.03	0.143	0.190	0.9	1.17	77.1	4350.0
10:40	14:25	House well	0.010	0.012	0.00	0.591	0.590	0.0	1.20	<1.0	3.1
6/19/2017	**6/19/2017**	**Grab sample**									
10:45	14:25	Spring	0.007	0.046	0.01	0.227	0.710	25.6	7.34	9.6	1986.3
11:17	14:25	Upstream farm	0.009	0.014	<0.03	0.089	0.120	1.4	2.99	60.1	3640.0
10:35	14:25	Downstream farm	0.007	0.016	0.01	0.256	0.300	1.9	2.75	75.9	7590.0
10:25	14:25	Left Fork	0.006	0.018	0.01	0.226	0.280	2.1	2.15	32.3	4130.0
11:00	14:25	House well	0.009	0.014	0.02	0.582	0.580	0.3	6.92	<1.0	<1.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
6/29/2017	**6/29/2017**	**Grab sample**									
11:47	14:55	Spring	0.006	0.016	0.01	0.244	0.280	5.0	9.08	9.8	866.4
12:19	14:55	Upstream farm	0.007	0.016	0.01	0.083	0.130	1.1	3.10	52.9	3950.0
11:35	14:55	Downstream farm	0.010	0.018	0.02	0.293	0.360	1.8	2.27	28.8	3410.0
11:24	14:55	Left Fork	0.010	0.016	0.02	0.236	0.320	1.3	2.77	29.8	3640.0
12:01	14:55	House well	0.009	0.014	0.01	0.574	0.640	0.3	4.39	1.0	2.0
7/5/2016	**7/5/2016**	**Grab sample**									
11:25	14:55	Spring	0.008	0.022	<0.03	0.107	0.250	1.9	9.11	90.7	4430.0
12:15	14:55	Upstream farm	0.011	0.028	<0.03	0.094	0.180	2.5	2.76	261.3	9060.0
11:05	14:55	Downstream farm	0.011	0.026	<0.03	0.169	0.270	3.1	2.29	185.0	18500.0
10:55	14:55	Left Fork	0.014	0.040	<0.03	0.220	0.390	8.7	3.37	387.3	28510.0
N/A	14:55	House well	0.009	0.010	<0.03	0.570	0.570	0.0	2.61	1.0	31.1
7/11/2017	**7/11/2017**	**Grab sample**									
10:40	13:48	Spring	0.004	0.008	<0.03	0.296	0.330	1.5	7.60	20.1	>2419.2
11:23	13:48	Upstream farm	0.004	0.026	0.01	0.064	0.110	1.5	2.56	585.0	5860.0
10:26	13:48	Downstream farm	0.006	0.014	<0.03	0.154	0.210	1.5	1.45	55.4	11120.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:17	13:48	Left Fork	0.005	0.020	0.02	0.125	0.210	3.0	2.52	73.8	12590.0
10:50	13:48	House well	0.006	0.012	0.03	0.573	0.570	0.3	3.50	<1.0	1.0
7/19/2017	**7/19/2017**	**Grab sample**									
10:51	15:30	Spring	0.002	0.214	0.03	0.295	0.770	156.7	0.75	4.1	1119.9
12:04	15:30	Upstream farm	0.003	0.030	0.01	0.105	0.130	1.3	0.92	27.2	7514.7
10:26	15:30	Downstream farm	0.005	0.016	0.01	0.232	0.280	1.7	0.53	35.0	9060.0
10:12	15:30	Left Fork	0.004	0.018	0.01	0.213	0.310	6.4	1.62	19.3	10810.0
11:40	15:30	House well	0.005	0.012	0.04	0.730	0.730	0.0	0.47	<1.0	<1.0
7/26/2017	**7/26/2017**	**Grab sample**									
7:28	11:40	Spring	0.001	0.248	0.02	0.209	0.760	174.7	3.47	2.0	>2419.2
8:08	11:40	Upstream farm	0.005	0.014	0.04	0.162	0.290	3.6	1.87	166.4	11530.0
7:05	11:40	Downstream farm	0.005	0.018	0.03	0.364	0.450	3.1	1.78	28.1	15660.0
6:51	11:40	Left Fork	0.003	0.016	0.05	0.223	0.370	2.7	1.89	27.8	14670.0
7:44	11:40	House well	0.004	0.012	0.01	0.779	0.820	0.1	2.62	<1.0	<1.0
8/3/2017	**8/3/2017**	**Grab sample**									
11:52	15:08	Spring	0.001	0.036	0.01	0.156	0.240	7.5	3.98	33.1	3680.0
12:32	15:08	Upstream Farm	0.005	0.022	<0.03	0.136	0.210	1.0	0.89	27.2	6500.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:25	15:08	Downstream Farm	0.007	0.026	0.02	0.297	0.390	1.5	0.84	43.2	12110.0
11:12	15:08	Left Fork	0.003	0.022	0.04	0.221	0.360	2.0	1.24	14.6	7800.0
12:09	15:08	House well	0.006	0.018	0.02	0.542	0.630	0.0	1.09	<1.0	1.0
8/3/2017	**8/3/2017**	**Storm sample**									
11:25	15:08	Downstream farm	0.000	0.032	0.01	0.185	0.250	1.1	7.88	ND	ND
8/9/2017	**8/9/2017**	**Grab sample**									
11:56	15:00	Spring	0.004	0.024	0.04	0.158	0.200	3.5	0.59	22.8	>2419.2
12:36	15:00	Upstream farm	0.008	0.022	0.04	0.162	0.210	1.0	0.50	177.9	7710.0
11:29	15:00	Downstream farm	0.010	0.036	0.02	0.351	0.440	1.5	0.38	23.1	7980.0
11:11	15:00	Left Fork	0.007	0.032	0.03	0.259	0.370	2.1	0.78	60.9	5300.0
12:10	15:00	House well	0.008	0.020	0.00	0.596	0.630	0.3	0.03	<1.0	<1.0
8/16/2017	**8/16/2017**	**Grab sample**									
7:04	11:50	Spring	0.005	0.094	0.01	0.111	0.470	40.7	7.99	816.4	16690.0
7:58	11:50	Upstream farm	0.010	0.030	<0.03	0.092	0.210	3.9	2.50	648.8	13540.0
6:47	11:50	Downstream farm	0.010	0.028	<0.03	0.216	0.320	3.3	1.66	157.6	12960.0
6:29	11:50	Left Fork	0.010	0.028	0.01	0.659	0.770	4.6	2.20	517.2	15530.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
7:24	11:50	House well	0.016	0.016	<0.03	0.652	0.650	0.3	1.83	<1.0	2.0
8/24/2016	**8/24/2016**	**Grab sample**									
11:58	14:55	Spring	0.005	0.064	<0.03	0.075	0.360	27.0	4.38	435.2	20140.0
12:38	14:55	Upstream farm	0.011	0.038	<0.03	0.132	0.280	3.3	2.35	344.8	18420.0
11:23	14:55	Downstream farm	0.012	0.040	0.01	0.192	0.330	3.5	2.37	261.3	31300.0
11:11	14:55	Left Fork	0.011	0.044	<0.03	0.175	0.330	5.3	2.14	461.1	17820.0
12:15	14:55	House well	0.014	0.018	<0.03	0.625	0.640	0.2	0.59	<1.0	4.1
8/24/2017	**8/24/2017**	**Storm sample**									
11:23	14:55	Downstream farm	0.007	0.126	<0.03	0.182	0.570	38.1	26.88	ND	ND
8/31/2017	**8/31/2017**	**Grab sample**									
11:28	14:15	Spring	0.008	0.084	0.16	0.299	0.520	42.3	2.77	101.7	7490.0
11:55	14:15	Upstream farm	0.009	0.024	0.02	0.075	0.150	1.5	0.73	105.0	5370.0
11:18	14:15	Downstream farm	0.010	0.026	<0.03	0.167	0.230	2.7	1.08	47.2	10460.0
11:00	14:15	Left Fork	0.008	0.024	<0.03	0.063	0.140	2.2	0.00	55.7	6570.0
11:41	14:15	House well	0.010	0.018	0.01	0.664	0.660	0.5	0.52	1.0	4.1

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.
§ ND is No Data, due to coliform not measured on water samples collected automatically by non-sterilized ISCO sampler.

Nutrients, Sediment, and Bacteria by Date Spring, Upstream, and Downstream Sites

Table 4. Water quality analyses in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application since January 2017, with those collected since the last report noted.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	---------- mg/L ----------							--- MPN/100 mL ---	
1/5/2017									
Upstream	0.009	0.014	0.02	0.059	0.09	0.7	0.66	52.0	2419.2
Downstream	0.012	0.019	0.04	0.257	0.31	1.3	0.55	5.2	1986.3
1/19/2017									
Upstream	0.010	0.016	0.03	0.050	0.14	1.9	4.22	137.6	2419.2
Downstream	0.014	0.024	0.02	0.121	0.21	2.5	3.19	60.1	3990.0
2/2/2017									
Upstream	0.009	0.017	<0.03 ¶	0.056	0.07	1.1	1.72	41.9	>2419.2
Downstream	0.014	0.026	0.01	0.160	0.21	5.1	2.21	41.3	>2419.2
2/15/2017									
Upstream	0.009	0.060	0.01	0.132	0.30	5.0	3.04	1986.3	6570.0
Downstream	0.012	0.082	0.03	0.159	0.42	9.0	3.46	1732.9	11000.0
3/1/2017									
Upstream	0.009	0.044	0.03	0.069	0.24	4.7	3.93	2590.0	7940.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.005	0.016	0.03	0.148	0.27	2.6	3.24	71.7	2430.0
3/16/2017									
Upstream	0.006	0.046	<0.03	0.118	0.29	1.7	1.08	75.9	1299.7
Downstream	0.010	0.031	<0.03	0.266	0.30	2.9	0.97	68.3	1986.3
3/27/2017									
Upstream	0.012	0.122	0.06	0.181	0.74	131.4	5.72	1986.3	17850.0
Downstream	0.047	0.096	0.20	0.173	1.49	321.9	6.68	9840.0	72150.0
4/6/2017									
Upstream	0.007	0.038	0.01	0.099	0.21	2.3	2.53	72.0	>2419.2
Downstream	0.009	0.034	0.01	0.173	0.26	3.1	1.96	107.6	>2419.2
4/13/2017									
Upstream	0.008	0.054	<0.03	0.026	0.11	2.5	4.64	83.6	2419.2
Downstream	0.009	0.028	0.01	0.092	0.17	1.1	2.33	135.4	>2419.2
4/17/2017									
Upstream	0.019	0.054	<0.03	0.025	0.12	5.3	1.55	1553.1	9330.0
Downstream	0.011	0.046	0.01	0.129	0.24	3.3	1.51	866.4	8360.0
4/27/2017									
Upstream	0.010	0.036	<0.03	0.117	0.12	7.1	1.34	172.3	2430.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.014	0.042	<0.03	0.231	0.24	10.7	1.70	214.3	6090.0
5/18/2017									
Upstream	0.006	0.048	<0.03	0.067	0.19	2.9	1.50	260.2	>2419.2
Downstream	0.008	0.024	<0.03	0.189	0.30	1.9	1.10	129.6	3690.0
5/31/2017									
Upstream	0.009	0.020	0.00	0.053	0.14	1.9	1.34	157.6	2419.2
Downstream	0.008	0.052	0.00	0.188	0.25	1.6	1.33	150.0	2419.2
Samples analyzed since the last Quarterly Report									
6/5/2017									
Upstream	0.007	0.054	0.01	0.114	0.210	8.3	3.01	178.5	5040
Downstream	0.013	0.064	0.01	0.185	0.290	12.9	1.81	313.0	9330
6/12/2017									
Upstream	0.008	0.026	0.01	0.105	0.130	2	1.01	121.1	6280
Downstream	0.009	0.02	0.01	0.256	0.270	1.6	0.77	119.8	4350
6/19/2017									
Upstream	0.009	0.014	<0.03	0.089	0.120	1.4	2.99	60.1	3640
Downstream	0.007	0.016	0.01	0.256	0.300	1.9	2.75	75.9	7590
6/29/2017									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.007	0.016	0.01	0.083	0.130	1.1	3.1	52.9	3950
Downstream	0.010	0.018	0.02	0.293	0.360	1.8	2.27	28.8	3410
7/5/2016									
Upstream	0.011	0.028	<0.03	0.094	0.180	2.5	2.76	261.3	9060
Downstream	0.011	0.026	<0.03	0.169	0.270	3.1	2.29	185.0	18500
7/11/2017									
Upstream	0.004	0.026	0.01	0.064	0.110	1.5	2.56	585.0	5860
Downstream	0.006	0.014	<0.03	0.154	0.210	1.5	1.45	55.4	11120
7/19/2017									
Upstream	0.003	0.03	0.01	0.105	0.130	1.3	0.92	27.2	7514.7
Downstream	0.005	0.016	0.01	0.232	0.280	1.7	0.53	35.0	9060
7/26/2017									
Upstream	0.005	0.014	0.04	0.162	0.290	3.6	1.87	166.4	11530
Downstream	0.005	0.018	0.03	0.364	0.450	3.1	1.78	28.1	15660
8/3/2017									
Upstream	0.005	0.022	0	0.136	0.210	1	0.89	27.2	6500
Downstream	0.000	0.032	0.01	0.185	0.250	1.1	7.88	ND §	ND
8/9/2017									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.008	0.022	0.04	0.162	0.210	1	0.5	177.9	7710
Downstream	0.010	0.036	0.02	0.351	0.440	1.5	0.38	23.1	7980
8/16/2017									
Upstream	0.010	0.03	<0.03	0.092	0.210	3.9	2.5	648.8	13540
Downstream	0.010	0.028	<0.03	0.216	0.320	3.3	1.66	157.6	12960
8/24/2017									
Upstream	0.011	0.038	<0.03	0.132	0.280	3.3	2.35	344.8	18420
Downstream	0.012	0.040	0.01	0.192	0.330	3.5	2.37	261.3	31300
8/31/2017									
Upstream	0.009	0.024	0.02	0.075	0.150	1.5	0.73	105.0	5370
Downstream	0.010	0.026	<0.03	0.167	0.230	2.7	1.08	47.2	10460

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

§ ND is No Data, due to coliform not measured on water samples collected automatically by non-sterilized ISCO sampler.

Nutrients, Sediment, and Bacteria by Site for Ephemeral Stream, Trenches, Left Fork and Field Runoff

Table 5. Water quality analyses at the ephemeral stream draining the subwatershed containing the production houses and manure holding ponds, and surface runoff from Fields 1, 5a, and 12 since January, 2017, with those collected since the last report noted.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	---------- mg/L ----------							--- MPN/100 mL ---	
Ephemeral stream									
2/15/2017	0.020	0.064	0.02	1.323	1.45	3.1	5.06	166.9	5630.0
3/1/2017	0.011	0.016	0.02	0.659	0.71	1.5	6.75	195.6	5730.0
3/16/2017	0.005	0.021	<0.03 ¶	0.738	0.800	0.8	2.99	14.8	2419.2
3/27/2017	0.151	0.268	0.29	1.704	3.30	448.3	16.47	18500.0	66530.0
3/30/2017	0.005	0.032	0.01	0.796	0.86	8.6	1.89	2.7	224.0
4/6/2017	0.008	0.022	<0.03	0.717	0.76	1.6	1.69	148.3	1986.3
4/6/2017	0.018	0.080	0.06	0.807	1.14	19.9	4.14	ND §	ND
4/17/2017	0.005	0.018	<0.03	0.651	0.68	0.9	1.71	410.6	7270.0
4/24/2017	0.007	0.128	0.04	0.000	1.83	318.0	7.35	ND	ND
4/27/2017	0.042	0.253	0.01	0.302	2.57	734.5	8.29	186.0	>2419.2
5/18/2017	0.012	0.020	<0.03	0.692	0.75	1.7	1.76	49.6	2419.2
5/31/2017	0.009	0.020	<0.03	0.769	0.79	2.5	1.53	275.5	3500.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Samples analyzed since the last quarterly report									
6/5/2017	0.010	0.028	<0.03	0.706	0.710	1.5	2.38	613.1	5830
6/6/2017	0.041	0.816	0.14	0.58	4.610	1788.2	9.24	ND	ND
6/12/2017	0.010	0.882	<0.03	0.732	0.730	0.6	0.67	33.6	2419.2
House well									
1/5/2017	0.008	0.014	0.04	0.610	0.66	0.3	0.30	<1.0	<1.0
1/19/2017	0.009	0.013	0.03	0.617	0.69	0.9	7.87	<1.0	<1.0
2/2/2017	0.011	0.031	0.01	0.614	0.78	0.4	2.22	<1.0	<1.0
2/15/2017	0.008	0.023	0.02	0.649	0.72	0.5	2.07	<1.0	<1.0
3/1/2017	0.012	0.040	0.03	0.620	0.72	0.5	5.85	<1.0	<1.0
3/16/2017	0.009	0.023	<0.03	0.856	0.88	0.1	1.52	<1.0	1.0
3/27/2017	0.007	0.038	0.02	0.573	0.63	1.6	3.83	18.1	261.3
4/13/2017	0.011	0.020	<0.03	0.564	0.59	0.1	6.22	<1.0	1.0
4/17/2017	0.006	0.016	0.01	0.563	0.57	0.2	1.94	<1.0	12.1
4/27/2017	0.011	0.014	<0.03	0.532	0.49	0.1	0.69	5.1	52.8
5/18/2017	0.011	0.020	<0.03	0.431	0.60	0.6	5.05	1.0	3.1

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/31/2017	0.019	0.026	<0.03	0.605	0.92	0.4	1.86	<1.0	22.1
Samples analyzed since the last quarterly report									
6/5/2017	0.008	0.026	0.01	0.586	0.590	0.3	0	6.3	48
6/12/2017	0.010	0.012	<0.03	0.591	0.590	0	1.2	<1.0	3.1
6/19/2017	0.009	0.014	0.02	0.582	0.580	0.3	6.92	<1.0	<1.0
6/29/2017	0.009	0.014	0.01	0.574	0.640	0.3	4.39	1.0	2
7/5/2016	0.009	0.01	<0.03	0.57	0.570	0	2.61	1.0	31.1
7/11/2017	0.006	0.012	0.03	0.573	0.570	0.3	3.5	<1.0	1
7/19/2017	0.005	0.012	0.04	0.73	0.730	0	0.47	<1.0	<1.0
7/26/2017	0.004	0.012	0.01	0.779	0.820	0.1	2.62	<1.0	<1.0
8/3/2017	0.006	0.018	0.02	0.542	0.630	0	1.09	<1.0	1
8/9/2017	0.008	0.02	<0.03	0.596	0.630	0.3	0.03	<1.0	<1.0
8/16/2017	0.016	0.016	<0.03	0.652	0.650	0.3	1.83	<1.0	2
8/24/2016	0.014	0.018	<0.03	0.625	0.640	0.2	0.59	<1.0	4.1
8/31/2017	0.010	0.018	0.01	0.664	0.660	0.5	0.52	1.0	4.1
Interceptor Trench 1 (South)									

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
2/15/2017	0.004	0.023	0.01	0.141	0.20	1.3	0.45	1.0	1299.7
3/16/2017	0.006	0.020	<0.03	0.083	0.11	1.1	1.87	<1.0	179.3
3/27/2017	0.004	0.048	0.03	0.129	0.39	3.1	4.36	387.3	17230.0
4/6/2017	0.004	0.022	0.03	0.165	0.30	17.2	1.98	47.2	2750.0
4/24/2017	0.005	0.040	0.20	0.133	1.76	18.5	7.04	ND	ND
4/27/2017	0.006	0.048	1.04	0.081	1.43	7.2	4.04	40.4	3990.0
No samples collected and analyzed since the last quarterly report									
Interceptor Trench 2 (North)									
2/15/2017	0.004	0.087	0.04	0.486	1.12	6.1	5.99	19.7	42860.0
3/1/2017	0.002	0.050	0.04	0.345	0.76	11.6	4.90	98.8	34480.0
3/27/2017	0.009	0.102	0.13	0.060	0.82	7.0	7.13	488.4	29240.0
4/24/2017	0.010	0.084	0.04	0.087	0.93	8.2	8.78	ND	ND
4/27/2017	0.006	0.046	0.04	0.029	0.42	2.4	4.95	115.3	2419.2
Samples analyzed since the last quarterly report									
6/5/2017	0.003	0.086	0.02	0.018	0.750	8.7	7.04	2780.0	>241920
Left Fork									

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
1/5/2017	0.006	0.011	0.03	0.229	0.26	0.7	0.85	6.2	1732.9
1/19/2017	0.010	0.019	0.03	0.243	1.00	2.6	4.25	55.4	>2419.2
2/2/2017	0.008	0.019	0.01	0.139	0.18	1.1	1.69	17.1	>2419.2
2/15/2017	0.015	0.080	0.03	0.314	0.60	17.7	4.66	648.8	11060.0
3/1/2017	0.008	0.024	0.02	0.136	0.28	4.3	2.46	1119.9	4260.0
3/16/2017	0.009	0.043	<0.03	0.300	0.41	3.1	1.77	45.5	>2419.2
3/27/2017	0.058	0.164	0.17	0.206	1.50	1005.1	8.51	9330.0	38770.0
4/6/2017	0.010	0.048	0.01	0.222	0.41	4.7	2.32	135.4	2780.0
4/13/2017	0.010	0.024	<0.03	0.123	0.21	1.6	2.75	22.3	>2419.2
4/17/2017	0.040	0.112	0.02	0.173	0.46	19.5	4.55	9090.0	129970.0
4/27/2017	0.016	0.046	<0.03	0.306	0.32	16.4	2.08	275.5	7230.0
5/18/2017	0.009	0.022	<0.03	0.167	0.26	1.9	1.54	50.4	2419.2
5/31/2017	0.008	0.020	0.00	0.156	0.22	1.5	1.58	260.2	4720.0
Samples analyzed since the last quarterly report									
7/5/2016	0.014	0.04	<0.03	0.22	0.390	8.7	3.37	387.3	28510

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
8/24/2016	0.011	0.044	<0.03	0.175	0.330	5.3	2.14	461.1	17820
6/5/2017	0.011	0.07	0.01	0.179	0.320	14.4	1.63	579.4	24000
6/12/2017	0.006	0.016	<0.03	0.143	0.190	0.9	1.17	77.1	4350
6/19/2017	0.006	0.018	0.01	0.226	0.280	2.1	2.15	32.3	4130
6/29/2017	0.010	0.016	0.02	0.236	0.320	1.3	2.77	29.8	3640
7/11/2017	0.005	0.02	0.02	0.125	0.210	3	2.52	73.8	12590
7/19/2017	0.004	0.018	0.01	0.213	0.310	6.4	1.62	19.3	10810
7/26/2017	0.003	0.016	0.05	0.223	0.370	2.7	1.89	27.8	14670
8/3/2017	0.003	0.022	0.04	0.221	0.360	2	1.24	14.6	7800
8/9/2017	0.007	0.032	0.03	0.259	0.370	2.1	0.78	60.9	5300
8/16/2017	0.010	0.028	0.01	0.659	0.770	4.6	2.2	517.2	15530
8/31/2017	0.008	0.024	<0.03	0.063	0.140	2.2	0	55.7	6570
Field 1									
10/13/2016	0.940	1.231	0.13	0.335	2.36	59.0	16.67	N.S.	N.S.
3/27/2017	0.420	0.670	0.43	0.090	18.70	124.4	9.29	8390.0	45690.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
4/24/2017	0.395	0.592	0.13	0.143	1.50	43.1	7.25	ND	ND
4/27/2017	0.550	0.784	0.08	0.107	1.32	52.2	8.46	ND	ND
No samples analyzed since the last quarterly report									
6/6/2017	0.747	0.998	0.51	0.438	2.340	56	10.39	ND	ND
Field 5a									
3/31/2016	1.154	1.352	0.27	0.302	1.67	26.5	32.74	ND	ND
5/10/2016	1.114	1.458	1.69	2.894	6.35	79.9	12.82	ND	ND
3/27/2017	2.980	3.232	1.40	0.122	1.80	30.2	32.01	2419.2	69100.0
4/24/2017	0.961	1.212	0.12	0.321	1.53	11.7	11.53	ND	ND
4/27/2017	0.686	0.846	0.07	0.063	0.86	11.3	7.26	ND	ND
No samples analyzed since the last quarterly report									
6/6/2017	1.000	1.430	0.05	1.861	2.380	<10.0	6.21	ND	ND
Field 12									
3/10/2016	0.411	0.522	1.17	0.852	4.49	621.5	12.58	ND	ND
5/10/2016	0.370	0.666	0.12	0.062	1.03	96.7	6.92	ND	ND
3/27/2017	0.800	1.276	2.02	2.798	6.04	134.2	9.35	7120.0	96060.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
4/27/2017	0.326	0.544	0.02	0.105	0.71	102.3	5.64	ND	ND
No samples analyzed since the last quarterly report									
6/6/2017	0.316	0.470	0.03	0.166	1.660	280.8	6.65	ND	ND

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.

§ ND is No Sample. E. coli and total coliform were not measured on surface runoff samples collected by ISCO samplers when sample holding time exceeded the required 8-hour threshold.

Water pH, Alkalinity, Chloride, Electrical Conductivity, and Total Dissolved Solids for Several Big Creek Sites

At the beginning of 2015, the pH, alkalinity, chloride concentration, electrical conductivity and total dissolved solids were determined on water samples collected at the upstream and downstream sites, spring, house well, and trenches, to build a data base that will enable to eventually source track the major water source pathways at these sites. These values are given below in Table 6.

Table 6. The pH, Chloride concentration, and electrical conducting of water samples collected at upstream, downstream, spring, ephemeral stream, house well and trench sites, initiated at the beginning of 2017, with those collected since the last report noted.

Date	pH	Chloride	Electrical conductivity
		mg/L	µS/cm
Upstream			
1/5/2017	8.8	2.264	142.0
1/19/2017	7.9	2.089	
2/2/2017	8.4	2.044	112.0
2/15/2017	7.9	2.022	128.0
3/1/2017	8.4	1.696	115.0
3/16/2017	7.8	1.508	88.0
3/27/2017	7.6	0.997	50.0
4/6/2017	7.5	1.436	72.0
4/13/2017	7.8	1.392	76.0
4/17/2017	7.9	1.372	95.8
4/27/2017	7.7	1.003	68.0
5/18/2017	8.3	1.518	110.0
5/31/2017	8.0	1.296	122.0
Samples analyzed since the last quarterly report			
6/5/2017	7.9	0.781	75.0
6/12/2017	8.0	1.231	120.0

Date	pH	Chloride	Electrical conductivity
6/19/2017	7.8	1.379	146.0
6/29/2017	7.8	1.554	170.0
7/5/2017	7.6	1.235	109.0
7/11/2017	8.2	1.543	113.0
7/19/2017	8.4	1.415	174.0
7/26/2017	7.8	1.664	193.0
8/3/2017	7.9	1.690	206.0
8/9/2017	8.0	1.930	206.0
8/16/2017	7.4	1.199	163.0
8/24/2017	8.1	1.381	133.0
8/31/2017	8.2	1.461	161.0
Downstream			
1/5/2017	8.1	5.692	220.0
1/19/2017	7.6	2.390	
2/2/2017	7.9	2.414	171.0
2/15/2017	8.2	2.199	119.0
3/1/2017	7.8	2.926	162.0
3/16/2017	7.5	1.792	128.0
3/27/2017	7.5	1.113	69.0
4/6/2017	7.5	1.649	106.0
4/13/2017	7.7	1.665	114.0
4/17/2017	7.8	1.849	162.9
4/27/2017	7.6	1.160	102.0
5/18/2017	7.7	2.009	172.0
5/31/2017	8.0	1.714	171.0
Samples analyzed since the last quarterly report			

Date	pH	Chloride	Electrical conductivity
6/5/2017	7.7	1.810	178.0
6/12/2017	7.9	1.942	225.0
6/19/2017	7.9	2.643	224.0
6/29/2017	7.6	2.652	231.0
7/5/2017	7.7	2.841	246.0
7/11/2017	7.8	1.716	201.0
7/19/2017	7.8	1.350	161.0
7/26/2017	7.3	1.690	213.0
8/3/2017	7.9	1.810	178.0
8/9/2017	7.9	1.942	225.0
8/16/2017	7.6	2.643	224.0
8/24/2017	7.9	2.652	231.0
8/31/2017	8.0	2.841	246.0
Spring			
1/5/2017	7.2	2.462	504.0
1/19/2017	7.1	2.397	
2/2/2017	7.1	3.099	546.0
2/15/2017	7.3	2.305	353.0
3/16/2017	7.4	2.618	602.0
3/27/2017	7.3	1.223	373.0
4/6/2017	7.1	2.010	486.0
4/13/2017	7.1	2.810	547.0
4/17/2017	7.2	1.720	445.0
4/27/2017	7.4	1.565	476.0
5/18/2017	7.0	1.988	474.0
5/31/2017	7.5	1.305	471.0

Date	pH	Chloride	Electrical conductivity
Samples analyzed since the last quarterly report			
6/5/2017	7.5	1.042	469.0
6/12/2017	8.0	1.532	482.0
6/19/2017	7.5	1.766	527.0
6/29/2017	7.2	1.982	451.0
7/5/2017	7.0	1.265	438.0
7/11/2017	7.1	1.972	521.0
7/19/2017	7.1	2.299	567.0
7/26/2017	6.8	2.394	559.0
8/3/2017	7.4	2.349	539.0
8/9/2017	7.4	2.129	518.0
8/16/2017	7.5	1.590	430.0
8/24/2017	7.2	1.690	459.0
8/31/2017	7.5	2.068	560.0
Ephemeral Stream			
2/15/2017	7.7	3.366	270.0
3/1/2017	7.8	4.328	396.0
3/16/2017	7.5	3.415	354.0
3/27/2017	7.4	4.373	180.0
3/30/2017	7.8	2.705	224.0
4/6/2017	7.3	3.154	223.0
4/13/2017	7.7	3.585	377.0
4/17/2017	7.5	3.997	394.0
4/23/2017	7.5	2.221	321.0
4/27/2017	7.5	1.414	109.0
5/18/2017	7.6	3.247	346.0

Date	pH	Chloride	Electrical conductivity
5/31/2017	8.0	3.161	380.0
Samples analyzed since the last quarterly report			
6/5/2017	7.3	1.834	230.0
6/12/2017	8.1	2.961	363.0
House Well			
1/5/2017	7.8	5.371	421.0
1/19/2017	7.4	5.234	420.0
2/2/2017	7.5	5.290	420.0
2/15/2017	7.6	5.401	397.0
3/1/2017	7.5	5.162	432.0
3/16/2017	7.5	5.453	416.0
3/27/2017	7.8	5.192	438.0
4/13/2017	7.4	5.508	445.0
4/17/2017	7.5	5.315	285.0
4/27/2017	7.5	5.000	429.0
5/1/2017	7.6	5.021	436.0
5/11/2017	7.4	6.819	433.0
5/18/2017	7.4	5.024	406.0
5/25/2017	7.7	4.124	442.0
5/31/2017	7.7	4.859	327.0
Samples analyzed since the last quarterly report			
6/5/2017	7.82	4.744	425
6/12/2017	7.87	5.025	415
6/19/2017	7.57	5.140	185
6/29/2017	7.44	5.209	438
7/5/2016	7.36	5.105	417
7/11/2017	7.65	5.136	389

Date	pH	Chloride	Electrical conductivity
7/19/2017	7.45	12.717	430
7/26/2017	7.34	5.722	402
8/3/2017	7.75	5.085	419
8/9/2017	7.75	5.107	419
8/16/2017	8.00	5.121	413
8/24/2016	7.80	5.115	314
8/31/2017	7.75	4.910	419
Trench 1			
2/15/2017	8.0	2.344	397.0
3/16/2017	7.8	1.483	164.0
3/27/2017	7.4	1.018	164.0
4/6/2017	7.4	1.877	168.0
4/24/2017	7.4	0.895	160.0
4/27/2017	7.8	0.557	150.0
5/1/2017	7.7	1.193	172.0
No samples collected and analyzed since the last quarterly report			
Trench 2			
2/15/2017	8.0	1.164	135.0
3/1/2017	7.3	0.808	159.0
3/27/2017	7.1	0.376	90.0
4/6/2017	7.0	0.325	175.0
4/24/2017	7.3	0.322	134.0
4/27/2017	7.5	0.217	129.0
5/1/2017	7.7	0.340	157.0
Samples analyzed since the last quarterly report			
6/5/2017	7.0	0.298	160.0

Discharge at USGS 07055790 Site Downstream of C&H Operation

Discharge downstream of the C&H Farm (USGS station 07055790 Big Creek near Mt. Judea, AR) is available at https://nwis.waterdata.usgs.gov/ar/nwis/uv/?cb_00065=on&cb_00045=on&cb_00010=on&format=gif_default&period=&begin_date=2014-04-16&end_date=2014-04-23&site_no=07055790

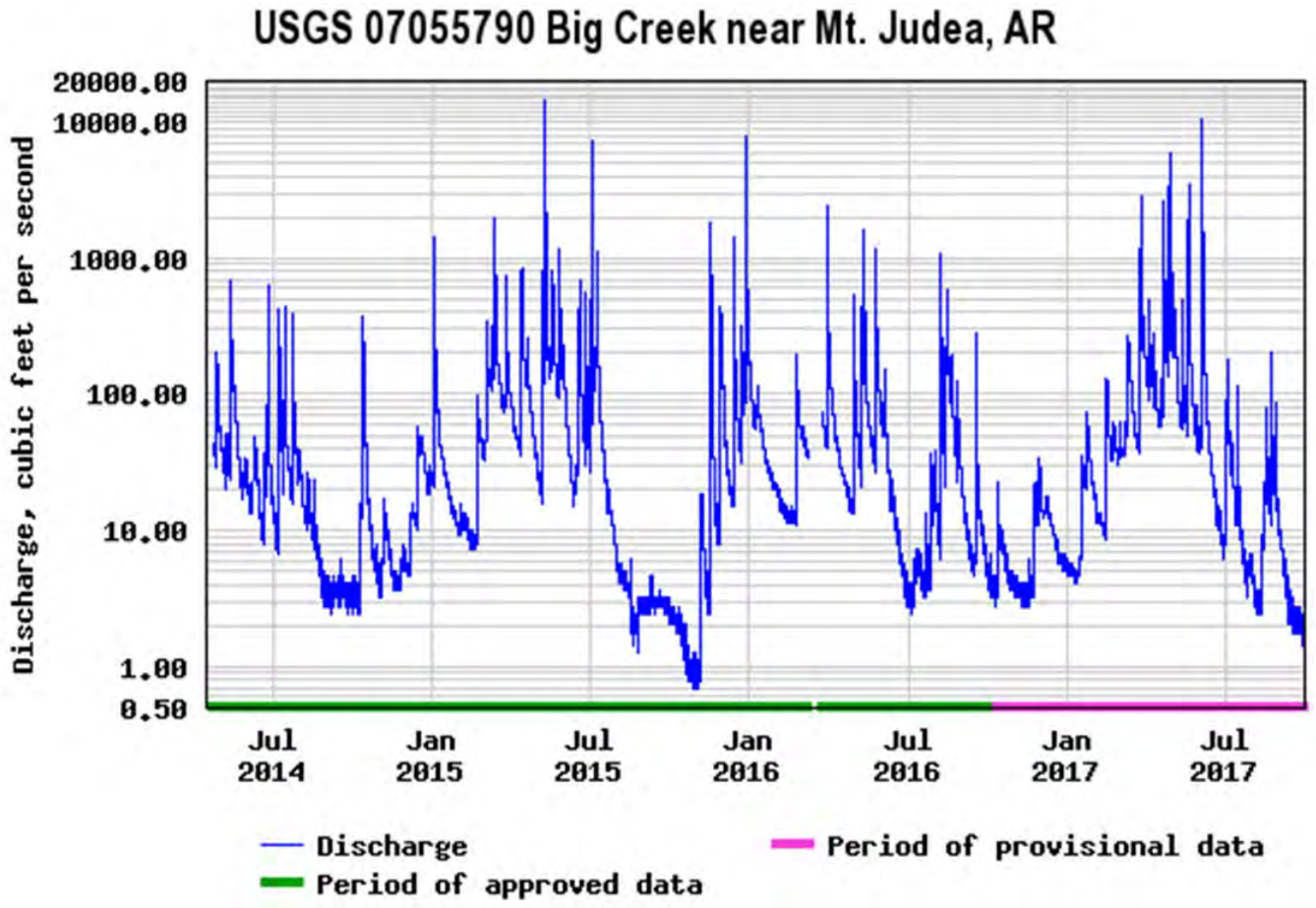

Figure 2. Discharge in Big Creek downstream of the C&H Farm for the period of monitoring; April 2014 to September 2017.

Temporal Trends in Phosphorus, Nitrogen, Bacteria, and Chloride in Big Creek Above and Below the C&H Farm

The concentration of dissolved P, total P, nitrate-N, total N, bacteria and chloride in Big Creek above and below the C&H Farm are presented in subsequent figures to show the season / temporal trends in measured concentrations (Figures 3, 4, 5, 6, 7, 8, and 9).

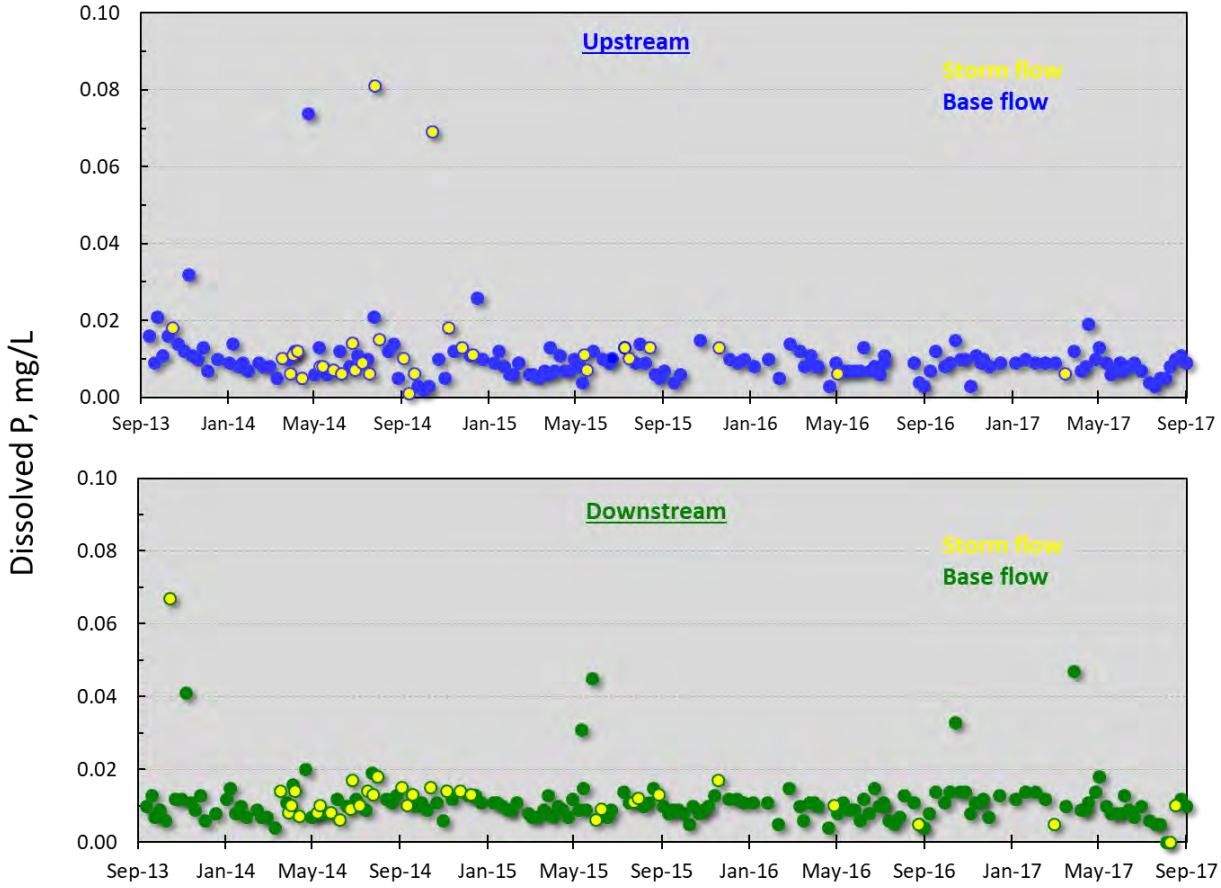

Figure 3. Dissolved P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

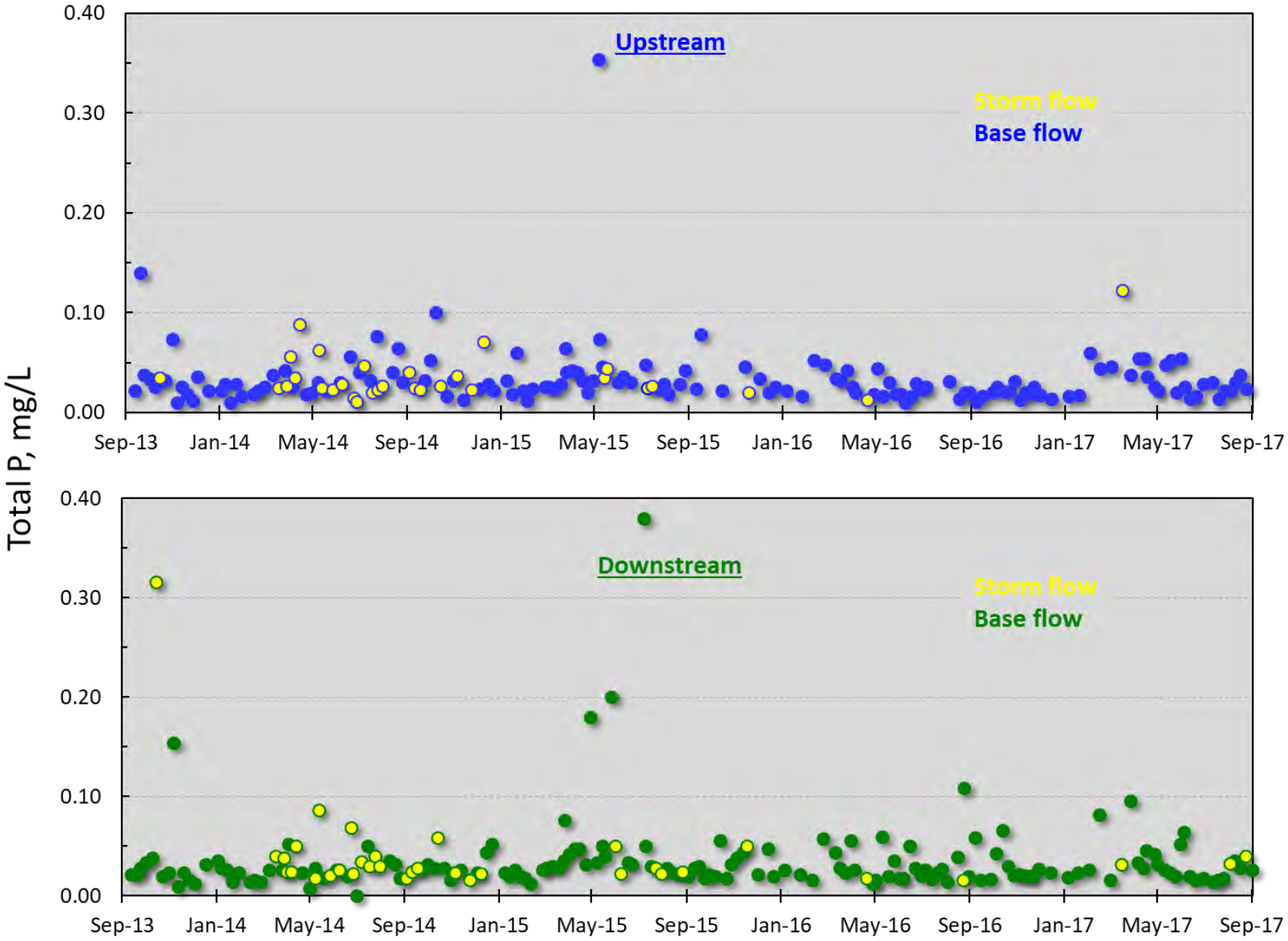

Figure 4. Total P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

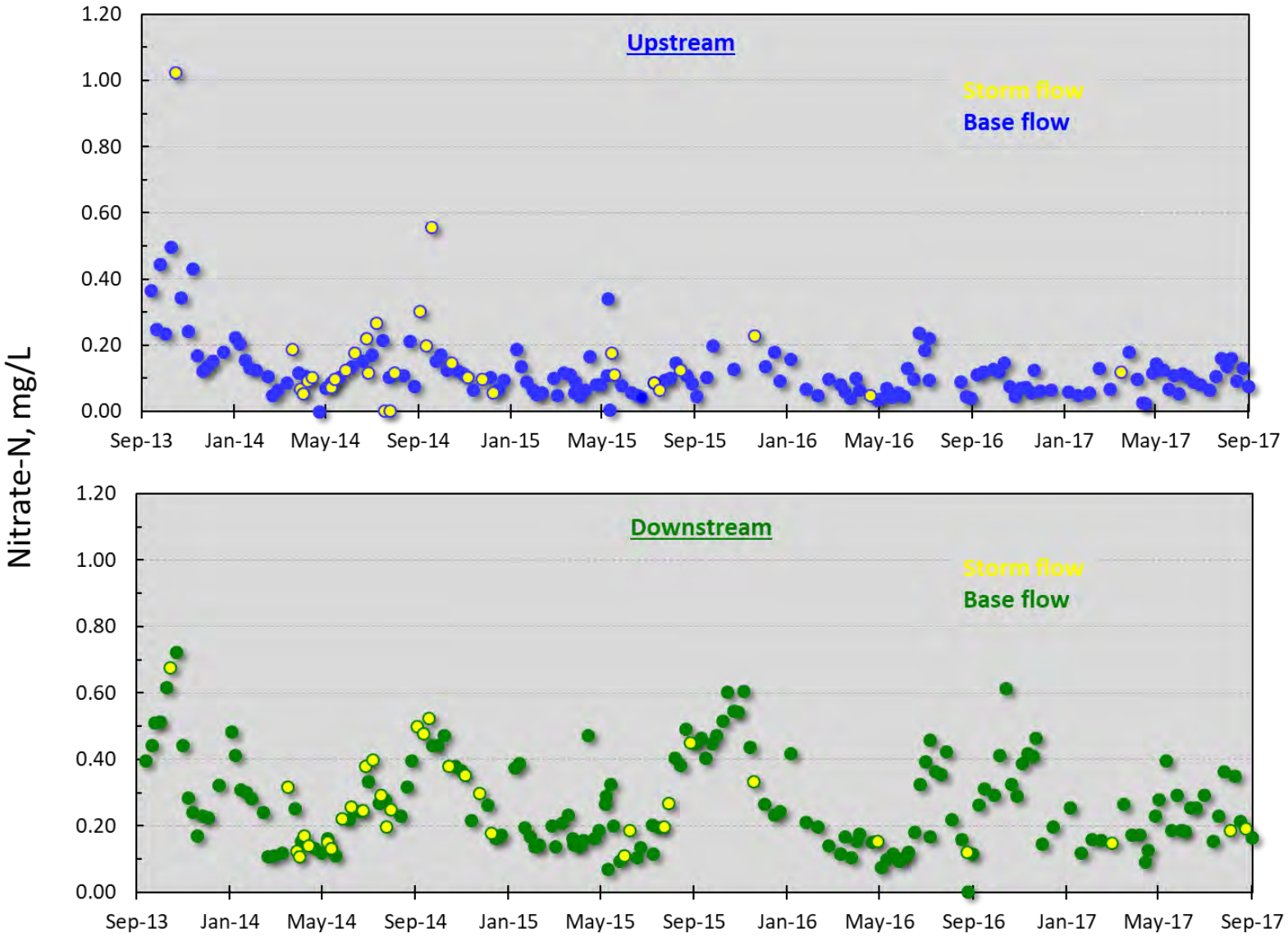

Figure 5. Nitrate-N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

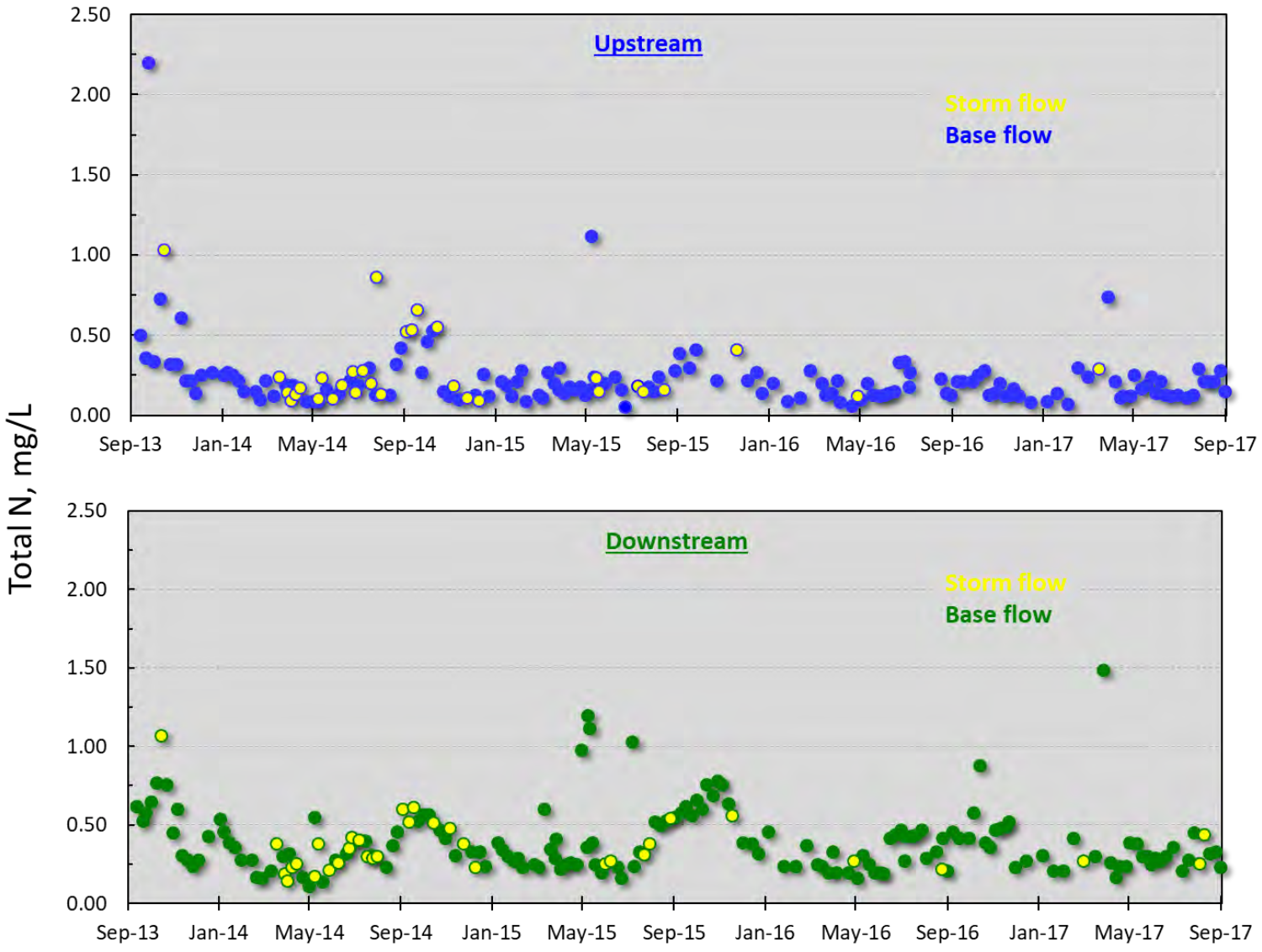

Figure 6. Total N concentration at **the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.**

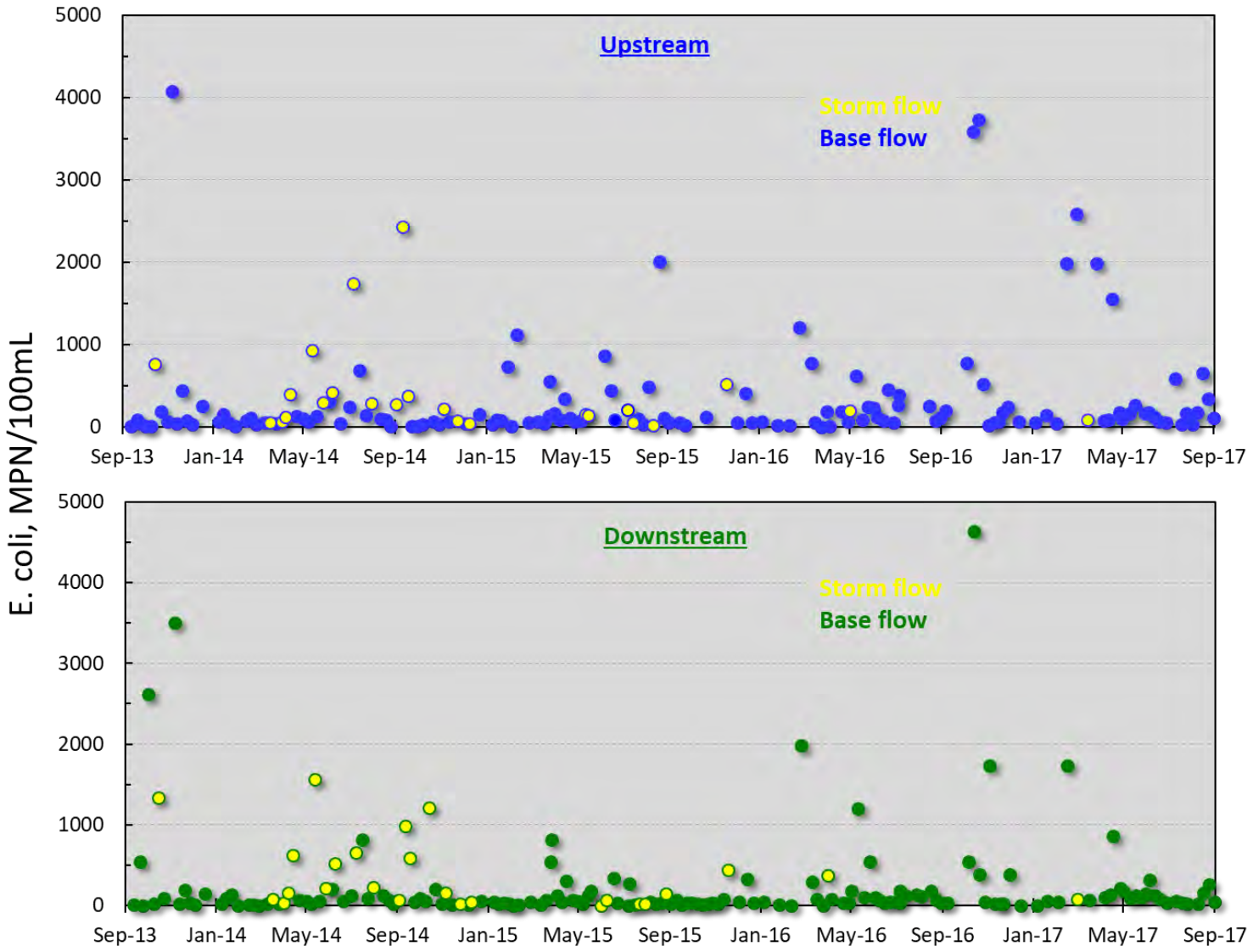

Figure 7. E. coli numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

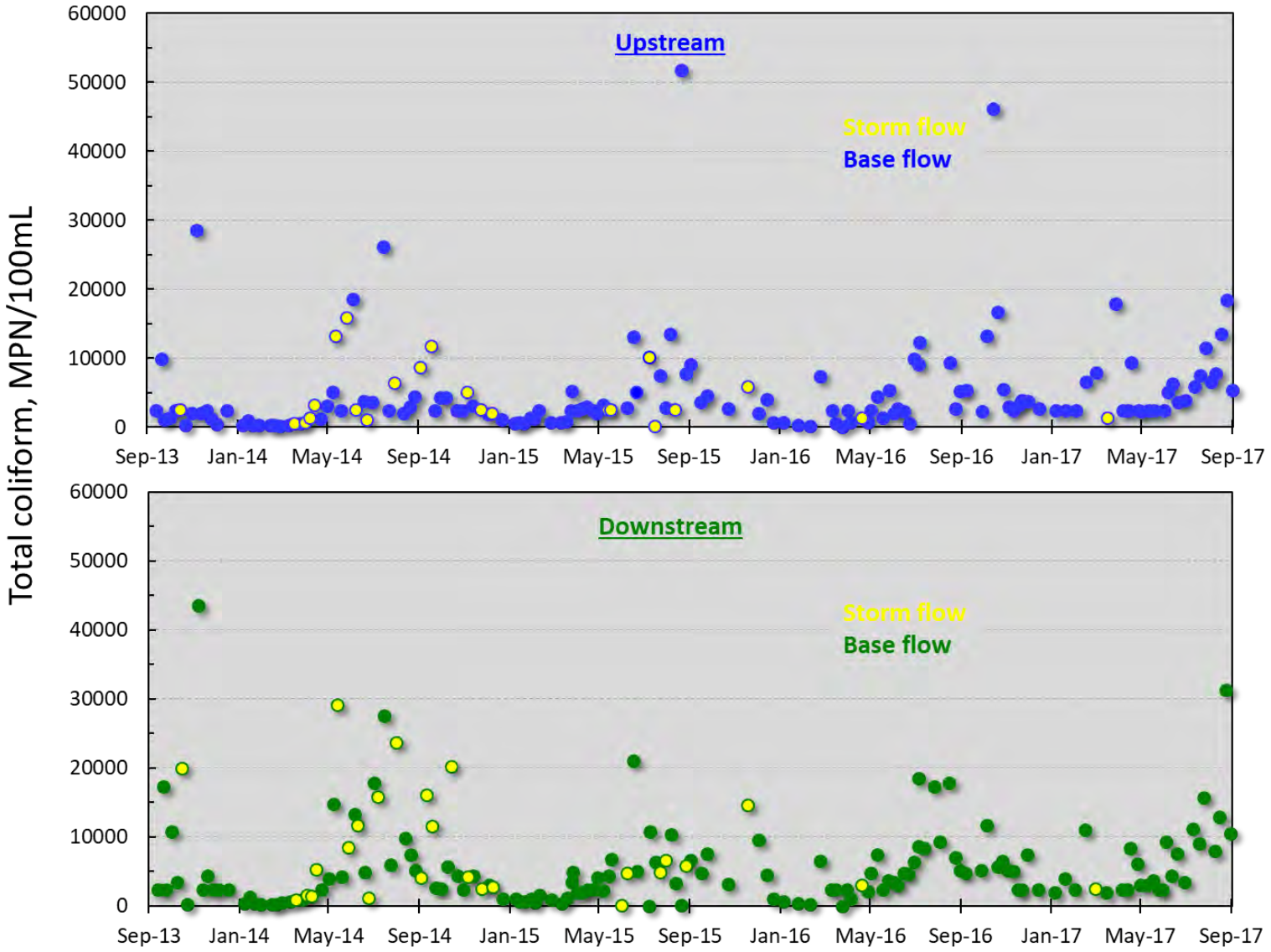

Figure 8. Total coliform numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

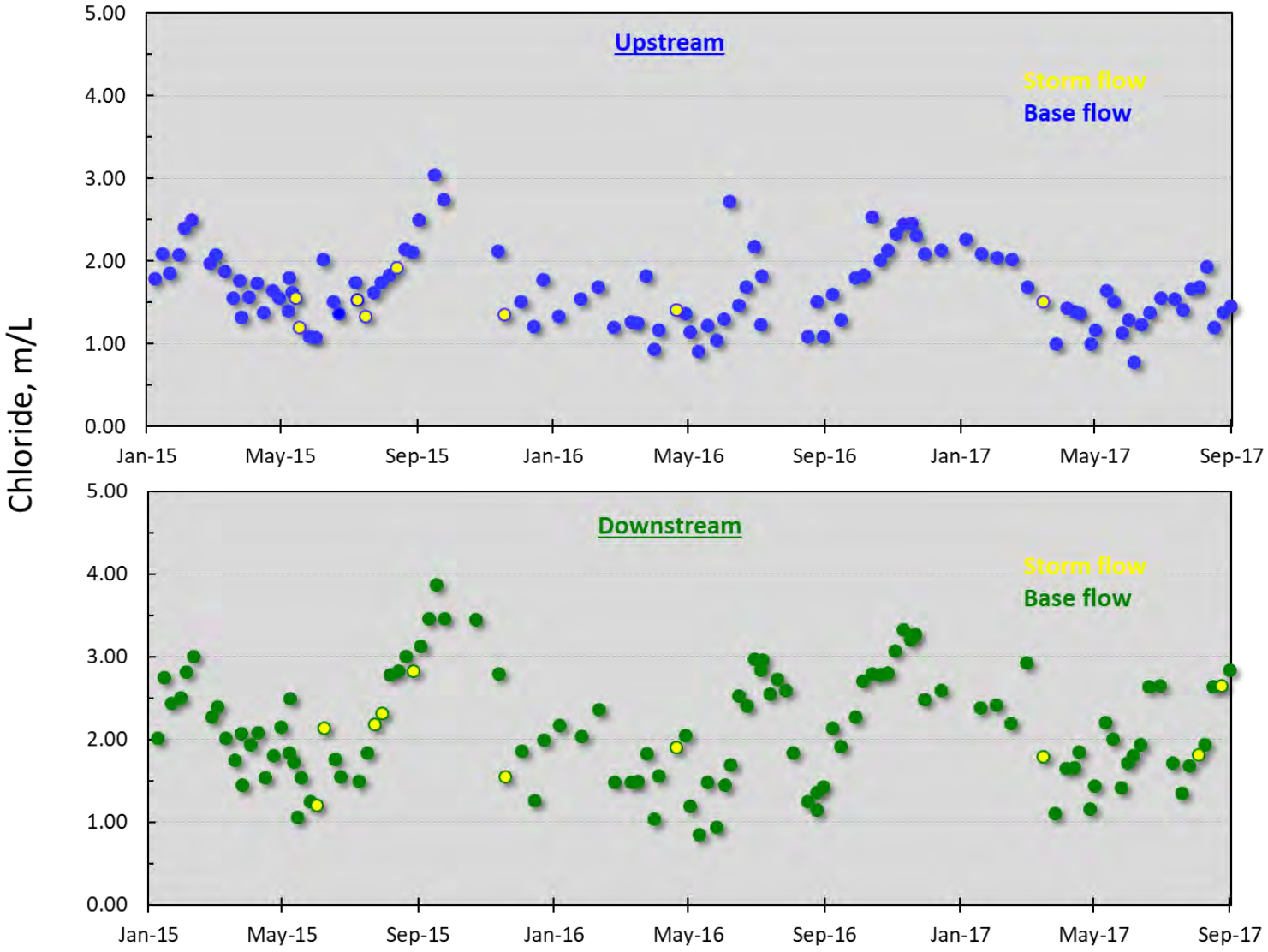

Figure 9. Chloride concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

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C & H HOG FARMS
GESTATION-FARROWING FARM

ENGINEERING PLAN SHEETS

SECTION 26, T 15 N, R 20 W
NEWTON COUNTY, ARKANSAS

DATE: APRIL 15, 2015

SHEET INDEX

ADDENDUM 1 – WASTE STORAGE POND HDPE LINER DETAILS
ADDENDUM 2 – WASTE STORAGE POND 1 HDPE COVER DETAILS
ADDENDUM 3 – WASTE STORAGE POND 1 BALLAST PIPE DETAILS
ADDENDUM 4 – MISCELLANEOUS DETAILS
ADDENDUM 5 – MISCELLANEOUS DETAILS 2
ADDENDUM 6 – WASTE STORAGE POND 1 BASELINER PANEL LAYOUT
ADDENDUM 7 – WASTE STORAGE POND 2 BASELINER PANEL LAYOUT
ADDENDUM 8 – BASELINER DETAILS
ADDENDUM 9 – UNDER LINER VENT DETAILS

GENERAL NOTES

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No 15552
4/15/15
NATHANA PESTA

No.	Revision/Issue	Date

DeHaan, Grabs & Associates, LLC
Consulting Engineers
PO Box 522, Mandan, ND 58554
(701) 663-1116, FAX: (701) 667-1356
www.dgaengineering.com

C & H HOG FARMS
GESTATION-FARROWING FARM

SECTION 26, T 15 N, R 20 W
NEWTON COUNTY, AR

COVER SHEET

DATE: APRIL 15, 2015	SHEET: COVER
SCALE: NONE	
DRAWN BY: NAP	
CHECKED BY: DLD	

FILE NAME: OS PROJECT FILES/SWINE/HENSON/CFILES/PLAN

NOTE: POND 1 AND 2 TO BE LINED WITH HDPE LINER

890
895
900
905
910
915

185.4'
237.9'
3:1 SIDE SLOPE

CONCRETE WALL

6" PERFORATED PERIMETER BIOGAS COLLECTION PIPE

NOTES:
POND 1:
BOTTOM EL. 901.3
TOP EL. 912.0

POND 2:
BOTTOM EL. 894.3
TOP EL. 907.5

TOP OF POND

EDGE OF ANCHOR TRENCH

6' WIDE SPILLWAY EL. 910.4

12" PVC SEWER PIPE

121.1'
177.7'
3:1 SIDE SLOPE

EDGE OF ANCHOR TRENCH

GENERAL NOTES

LEGEND

CULVERT/PIPE

SCALE, FEET
0 20 40 60 80

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No. 15552
NATHANA PESTA
4/15/15

No.	Revision/Issue	Date

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C & H HOG FARMS
GESTATION-FARROWING FARM

SECTION 26, T 15 N, R 20 W
NEWTON COUNTY, AR

WASTE STORAGE POND HDPE LINER DETAILS

DATE: APR 7, 2015	SHEET: ADDENDUM 1
SCALE: 1" = 40'	
DRAWN BY: NAP	
CHECKED BY: DLD	

FILE NAME: OS PROJECT FILES/SWINE/HENSON/CFILES/PLAN

TOP OF POND

EDGE OF ANCHOR TRENCH

CONCRETE WALL

915

910

912

905

902

911

22.0'

22.0'

22.0'

HDPE FLOATING COVER
80-MIL THICK

COVER WEDGE WELD

6" PERFORATED PERIMETER BIOGAS COLLECTION PIPE

GENERAL NOTES

LEGEND

CULVERT/PIPE

N

SCALE, FEET

0 10 20 30 40

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No 15552
9/15/15
NATHANA PESTA

No.	Revision/Issue	Date

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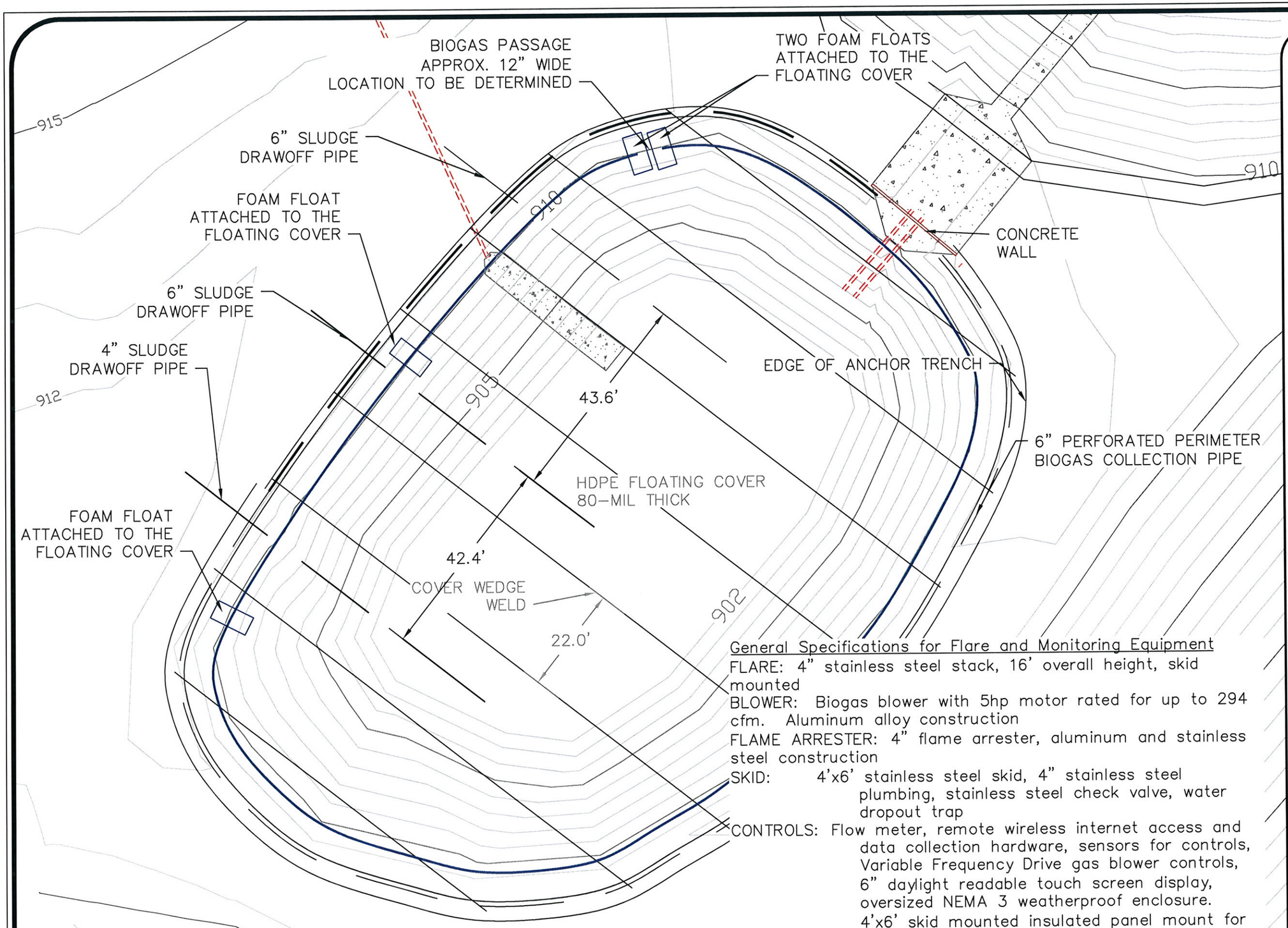
C & H HOG FARMS
GESTATION-FARROWING FARM

SECTION 26, T 15 N, R 20 W
NEWTON COUNTY, AR

WASTE STORAGE POND 1
HDPE COVER DETAILS

DATE: APR 7, 2015	SHEET:
SCALE: 1" = 20'	
DRAWN BY: NAP	ADDENDUM 2
CHECKED BY: DLD	

FILE NAME: OS PROJECT FILES/SWINE/HENSON/CFILES/PLAN



General Specifications for Flare and Monitoring Equipment

FLARE: 4" stainless steel stack, 16' overall height, skid mounted

BLOWER: Biogas blower with 5hp motor rated for up to 294 cfm. Aluminum alloy construction

FLAME ARRESTER: 4" flame arrester, aluminum and stainless steel construction

SKID: 4'x6' stainless steel skid, 4" stainless steel plumbing, stainless steel check valve, water dropout trap

CONTROLS: Flow meter, remote wireless internet access and data collection hardware, sensors for controls, Variable Frequency Drive gas blower controls, 6" daylight readable touch screen display, oversized NEMA 3 weatherproof enclosure. 4'x6' skid mounted insulated panel mount for NEMA 3 weatherproof enclosure constructed of stainless steel

GENERAL NOTES

SCALE, FEET

0 10 20 30 40

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No 15552
4/15/15
NATHANA PESTA

No.	Revision/Issue	Date

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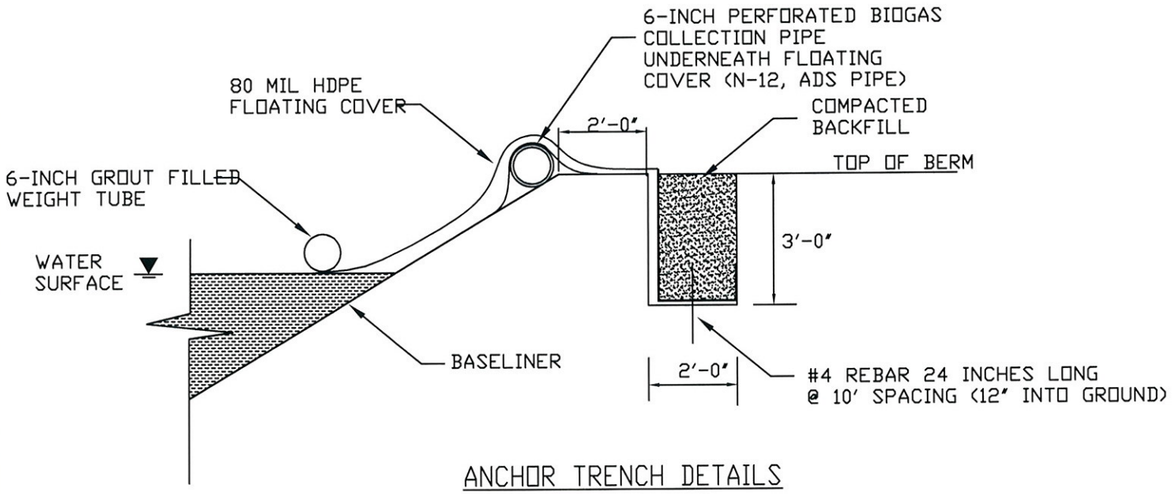
C & H HOG FARMS
GESTATION-FARROWING FARM

SECTION 26, T 15 N, R 20 W
NEWTON COUNTY, AR

WASTE STORAGE POND 1
BALLAST PIPE DETAILS

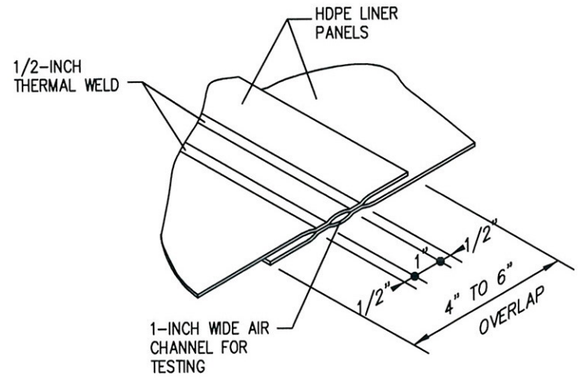
DATE: APR 7, 2015	SHEET:
SCALE: 1" = 20'	ADDENDUM 3
DRAWN BY: NAP	
CHECKED BY: DLD	

FILE NAME: OS PROJECT FILES/SWNE/HENSON/CFILES/PLAN

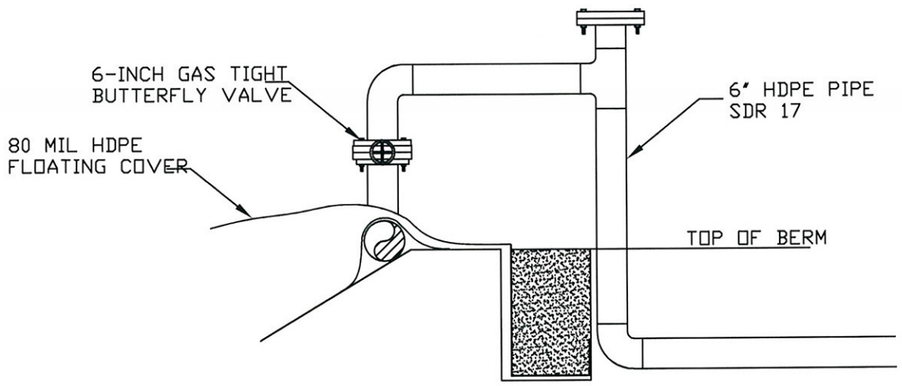


ANCHOR TRENCH DETAILS

NOT TO SCALE

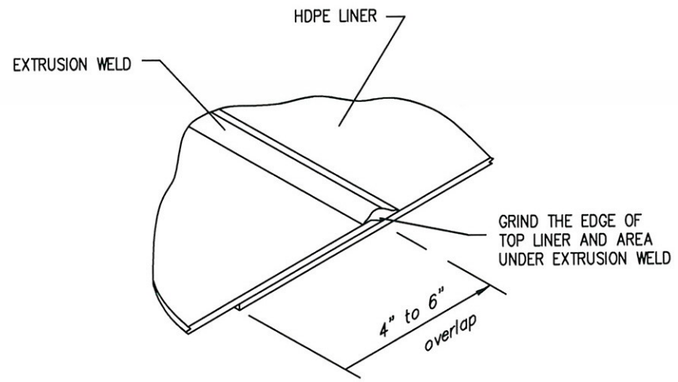


SEAM CROSS SECTION WIDE AIR CHANNEL WELDER



BIOGAS DRAW OFF PIPE

NOT TO SCALE



SEAM CROSS SECTION FOR THE EXTRUSION WELD

GENERAL NOTES

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No. 15552
NATHANA PESTA
Nathana Pesta
4/15/15

No.	Revision/Issue	Date

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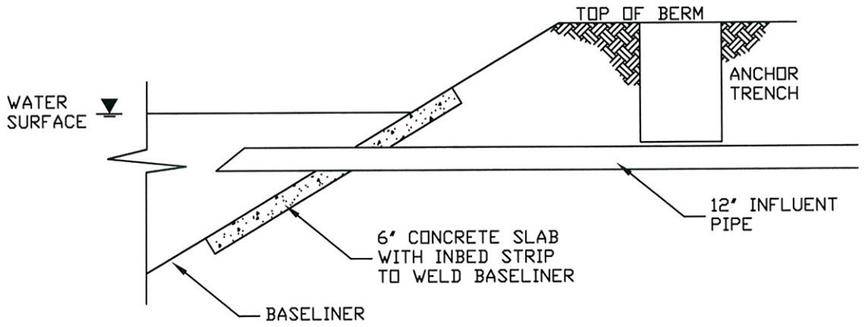
GESTATION-FARROWING FARM

SECTION 26, T 15 N, R 20 W
NEWTON COUNTY, AR

MISCELLANEOUS DETAILS

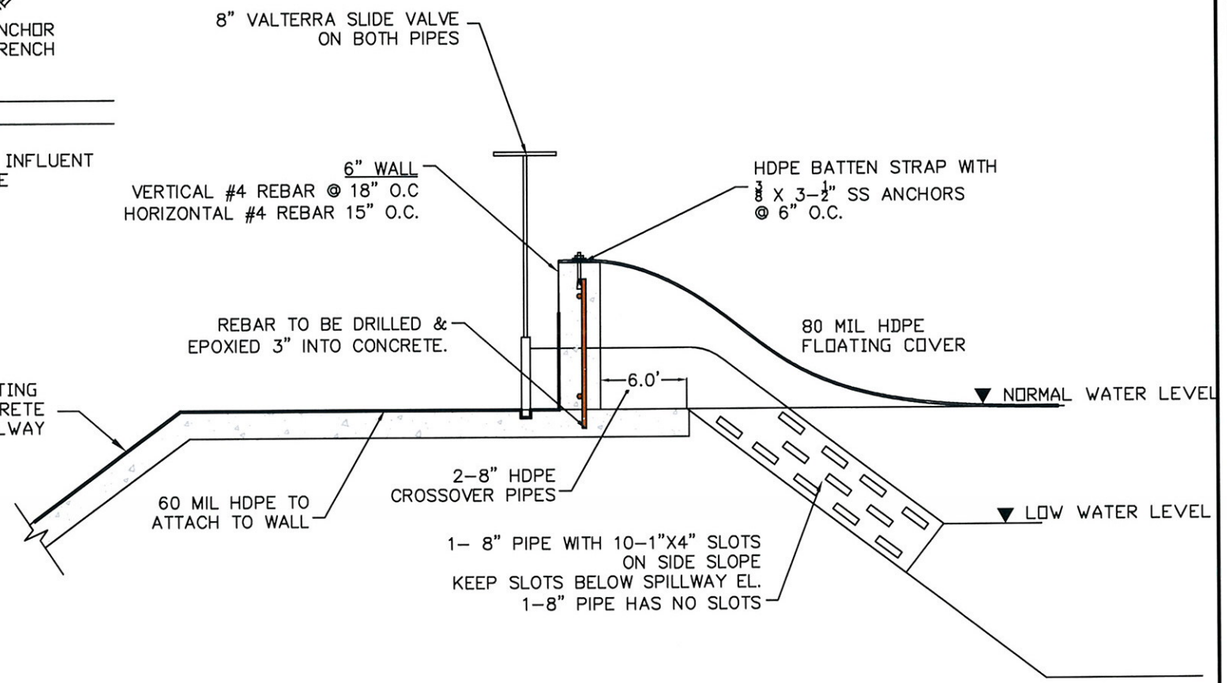
DATE: APR 7, 2015	SHEET:
SCALE: NOT TO SCALE	ADDENDUM 4
DRAWN BY: NAP	
CHECKED BY: DLD	

FILE NAME: OS PROJECT FILES/SWINE/HENSON/CFILES/PLAN



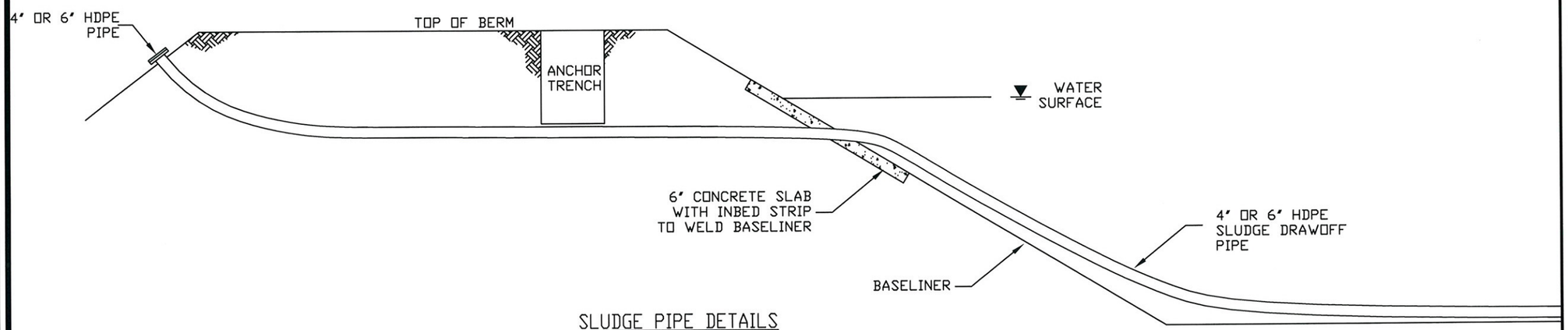
INFLUENT PIPE DETAILS

NOT TO SCALE



FLOATING COVER ANCHORING DETAILS NEAR SPILLWAY

NOT TO SCALE



SLUDGE PIPE DETAILS

NOT TO SCALE

GENERAL NOTES

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No 15552
NATHANA PESTA
4/15/15

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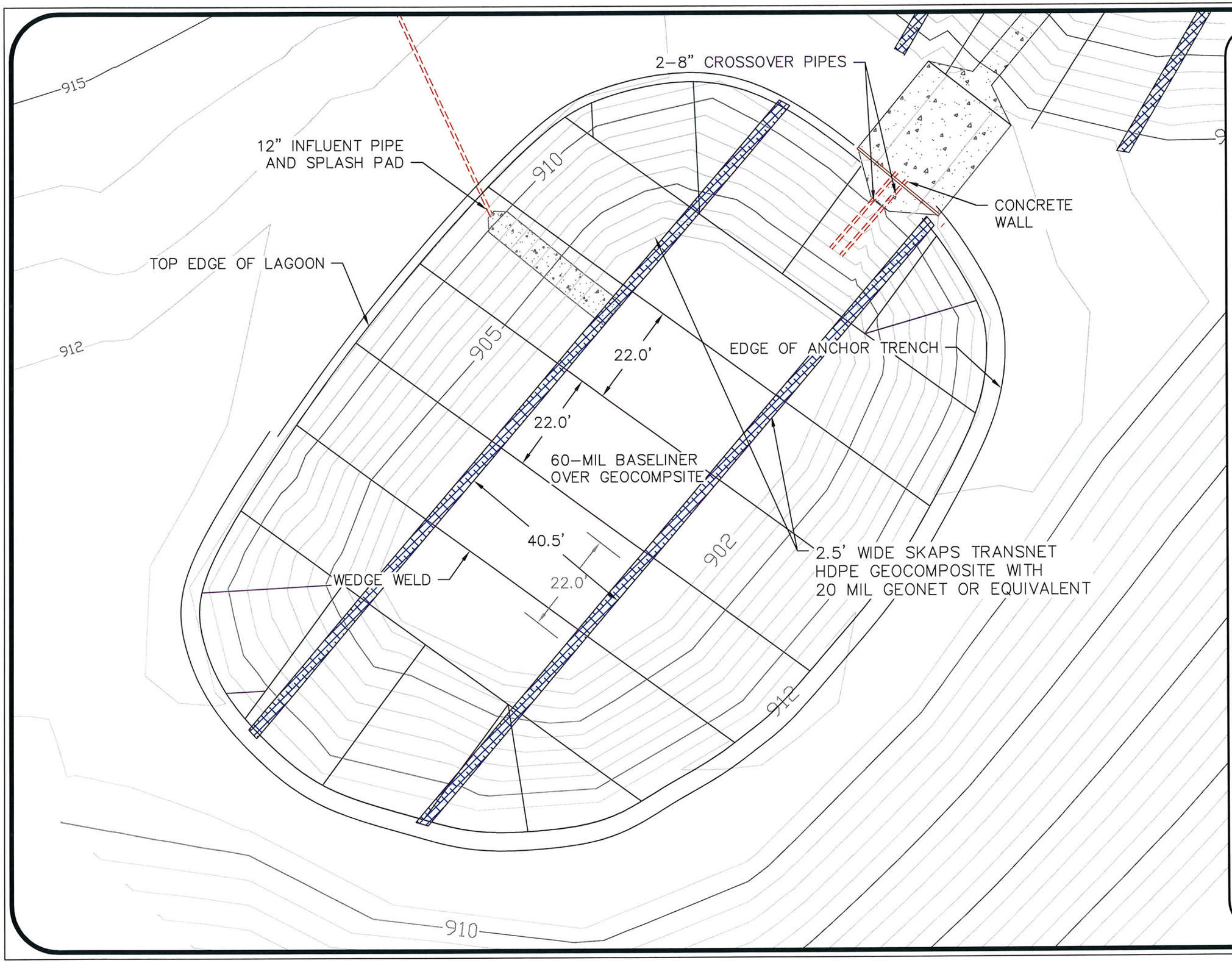
SECTION 26, T 15 N, R 20 W
NEWTON COUNTY, AR

MISCELLANEOUS DETAILS 2

DATE: APR 7, 2015	SHEET:
SCALE: NOT TO SCALE	ADDENDUM 5
DRAWN BY: NAP	
CHECKED BY: DLD	

FILE NAME: OS PROJECT FILES/SWINE/HENSON/CFILES/PLAN



GENERAL NOTES

LEGEND

GEOMAT VENT

CULVERT/PIPE

N

SCALE, FEET

0 10 20 30 40

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No 15552
NATHAN A PESTA
4/15/15

No.	Revision/Issue	Date

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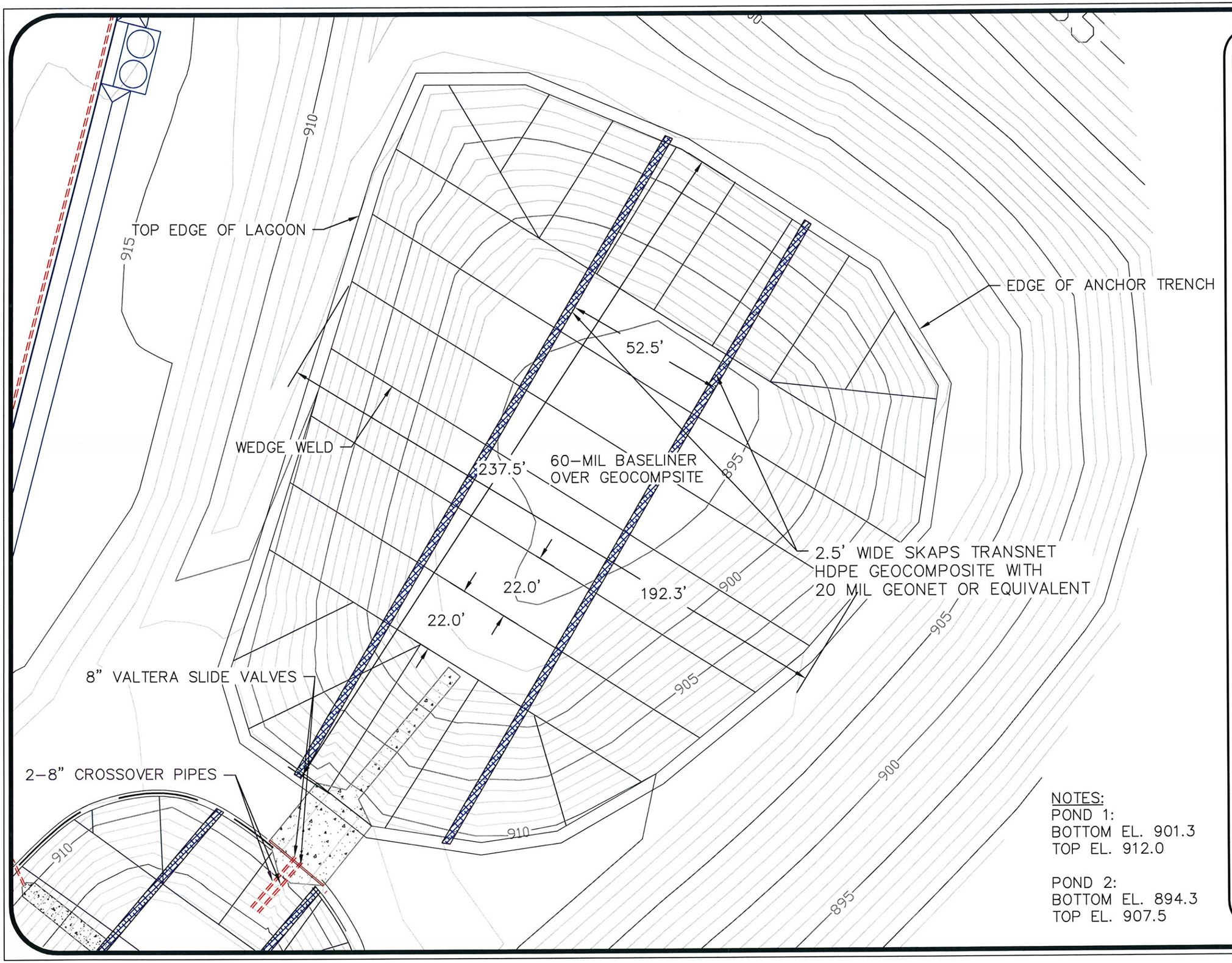
SECTION 26, T 15 N, R 20 W
NEWTON COUNTY, AR

WASTE STORAGE POND 1
BASELINER PANEL LAYOUT

DATE: APR 7, 2015	SHEET:
SCALE: 1" = 20'	
DRAWN BY: NAP	ADDENDUM 6
CHECKED BY: DLD	

FILE NAME: OS PROJECT FILES/SWINE/HENSON/CFILES/PLAN



NOTES:
POND 1:
BOTTOM EL. 901.3
TOP EL. 912.0

POND 2:
BOTTOM EL. 894.3
TOP EL. 907.5

GENERAL NOTES

LEGEND

GEOMAT VENT

CULVERT/PIPE

N

SCALE, FEET

0 15 30 45 60

STATE OF ARKANSAS
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No. 15552
NATHANA PESTA
4/15/15

No.	Revision/Issue	Date

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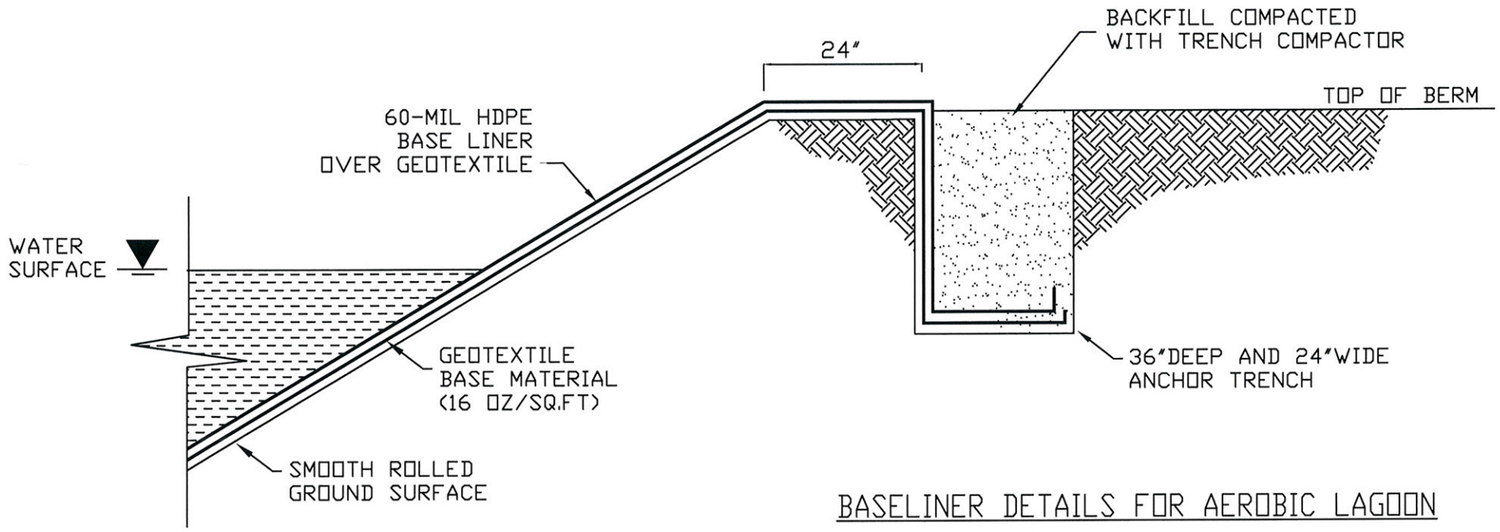
SECTION 26, T 15 N, R 20 W
NEWTON COUNTY, AR

WASTE STORAGE POND 2 BASELINER PANEL LAYOUT

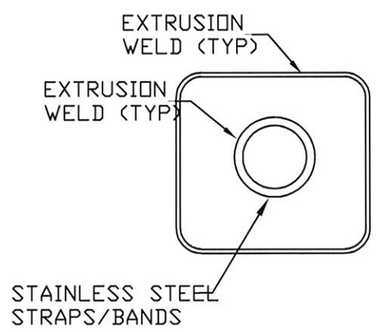
DATE: APR 7, 2015	SHEET:
SCALE: 1" = 30'	ADDENDUM 7
DRAWN BY: NAP	
CHECKED BY: DLD	

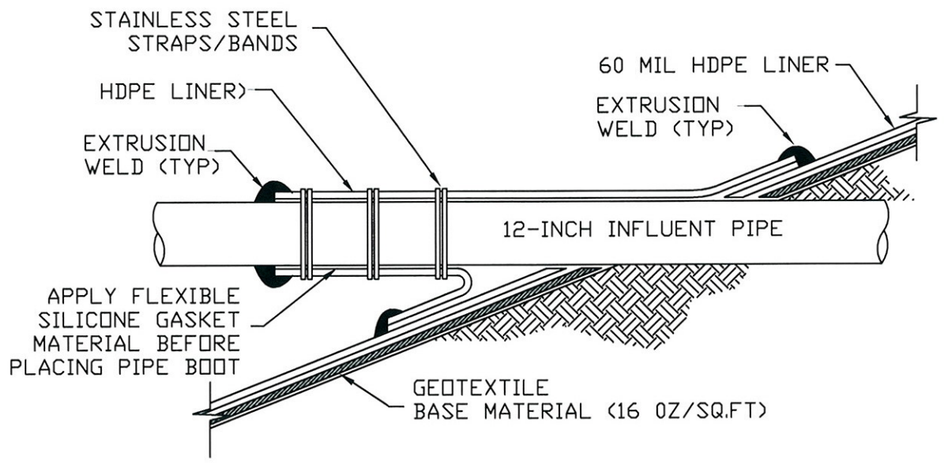
FILE NAME: OS PROJECT FILES/SWINE/HENSON/CFILES/PLAN



BASELINER DETAILS FOR AEROBIC LAGOON

NOT TO SCALE





PIPE PENETRATION DETAIL

NOT TO SCALE

GENERAL NOTES

LEGEND

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No 15552
NATHANA PESTA
4/15/15

No.	Revision/Issue	Date

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SECTION 26, T 15 N, R 20 W
NEWTON COUNTY, AR

BASELINER DETAILS

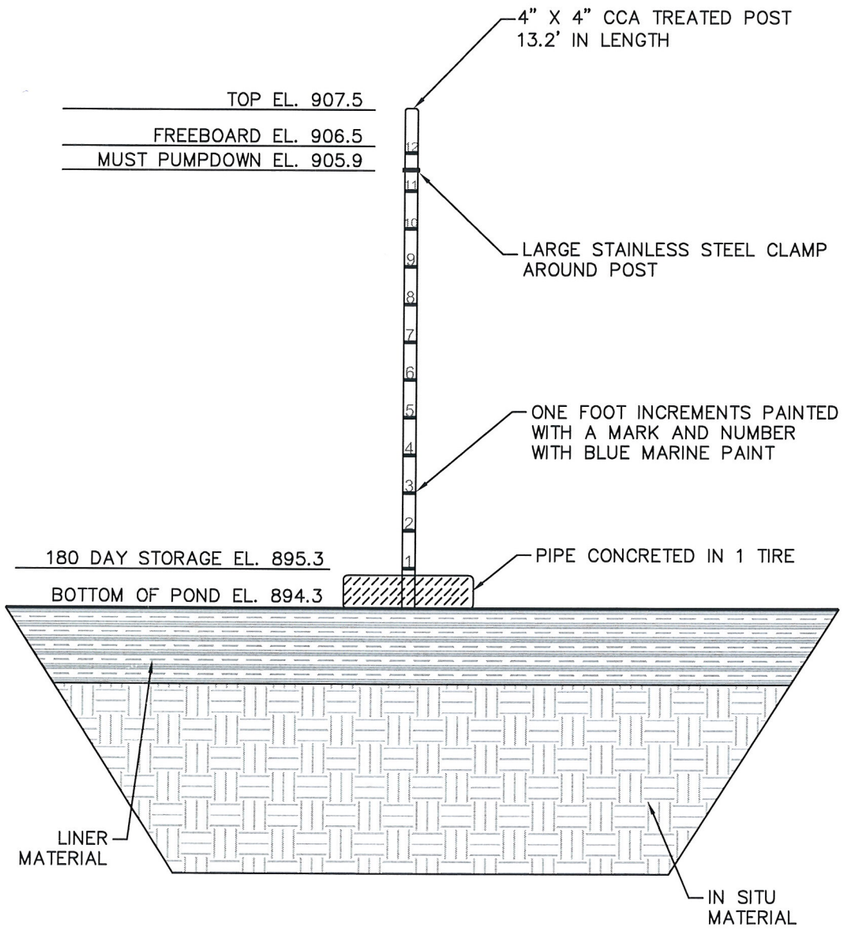
DATE: APR 7, 2015	SHEET:
SCALE: NOT TO SCALE	
DRAWN BY: NAP	ADDENDUM 8
CHECKED BY: DLD	

FILE NAME: OS PROJECT FILES/SWINE/HENSON/CFILES/PLAN

Waste Storage Pond 2 Stage Storage Table

Elevation (ft)	Stage (ft)	Area (ft^2)	Volume (ft^3)	Cum. Volume (ft^3)	Cum. Volume (acre-feet)	
907.5	13.2	32,950	16,166	246,200	5.7	**Top**
907.0	12.7	31,714	15,536	230,034	5.3	
906.5	12.2	30,430	17,828	214,498	4.9	**Freeboard**
905.9	11.6	28,996	16,963	196,670	4.5	**25 Year-24 Hour Stage/Must Pumpdown**
905.3	11.0	27,547	13,488	179,707	4.1	
904.8	10.5	26,405	12,914	166,219	3.8	
904.3	10.0	25,251	12,353	153,305	3.5	
903.8	9.5	24,161	11,805	140,952	3.2	
903.3	9.0	23,059	11,270	129,147	3.0	
902.8	8.5	22,021	10,755	117,877	2.7	
902.3	8.0	20,999	10,261	107,122	2.5	
901.8	7.5	20,045	9,786	96,861	2.2	
901.3	7.0	19,099	9,332	87,075	2.0	
900.8	6.5	18,229	8,894	77,743	1.8	
900.3	6.0	17,347	8,467	68,849	1.6	
899.8	5.5	16,521	8,049	60,382	1.4	
899.3	5.0	15,675	7,640	52,333	1.2	
898.8	4.5	14,885	7,239	44,693	1.0	
898.3	4.0	14,071	6,848	37,454	0.9	
897.8	3.5	13,321	6,464	30,606	0.7	
897.3	3.0	12,535	6,088	24,142	0.6	
896.8	2.5	11,817	5,638	18,054	0.4	
896.3	2.0	10,735	5,060	12,416	0.3	
895.8	1.5	9,505	4,240	7,356	0.2	
895.3	1.0	7,455	2,565	3,116	0.1	**180 Day Stage**
894.8	0.5	2,805	551	551	0.0	
894.3	0.0	0	0	0	0.0	**Bottom**

The drawing is believed to be correct to the best of the professional's knowledge but it cannot be guaranteed accurate.



WASTE STORAGE POND 2

GENERAL NOTES

INSITU MATERIAL

CLAY LINER

SCALE, FEET

0 2 4 6 8

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No. 15552
NATHANA PESTA
2/12/13

No.	Revision/Issue	Date
1	As Built	4/1/13

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GESTATION-FARROWING FARM

SECTION 26, T 15 N, R 20 W
NEWTON COUNTY, AR

WASTE STORAGE POND 2
STAGE STORAGE TABLE

DATE: MAY 30, 2012	SHEET: 15
SCALE: 1" = 4'	
DRAWN BY: CAS	
CHECKED BY: DLD	

FILE NAME: OS PROJECT FILES/SWINE/HENSON/CFILES/PLAN

TECHNICAL SPECIFICATIONS:

TECHNICAL SPECIFICATIONS:

TECHNICAL SPECIFICATIONS

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A. EARTHEN CONTROL STRUCTURES

1. SAFETY

The contractor is solely responsible for being aware of and meeting all safety requirements for work on this site. These may include but are not limited to requirements set forth by OSHA, the State or the County. The contractor is also responsible for locating any underground power lines, pipelines, phone lines, etc. in the area of excavation. This shall include notifying the Nebraska One-Call System at least two days prior to the start of excavation activities.

If at any time, the contractor feels that due to site conditions, the construction techniques outlined in the Plans and Technical Specifications are not safe, he shall immediately stop work and contact the engineer, and an alternative method shall be determined.

2. SITE PREPARATION

The foundation and borrow area of all proposed earthwork areas shall be cleared of all old equipment, old buildings, trees, stumps, roots, brush and boulders and stripped of all sod and topsoil. All channel banks and sharp breaks shall be sloped no steeper than 1:1. All topsoil containing substantial organic matter shall be removed and stockpiled. The surface of the foundation area will be thoroughly scarified to a minimum depth of 4 inches before placement of compacted backfill. All drainage channels crossing fill areas shall be cleaned and widened to accommodate compaction equipment. Such channels shall be backfilled with suitable material as specified for compacted earthfill and compacted to the same specifications as the overlying fill.

All waste material shall be buried away from the fill area.

3. EMBANKMENT CORE TRENCH

The core trench for the pond shall be excavated to the lines and grades shown on the plan or as revised by the Engineer due to conditions encountered during site preparation. Backfill for the core trench, as designated Zone 1 on the plans, shall be made with the most impervious material encountered during excavation of borrow areas. Material unsuitable for use as fill excavated from the core trench shall be treated as waste and disposed of away from the fill area. If no designation of Zones is shown on the plans, all material shall be considered equivalent to Zone 1 material. The contractor shall notify the engineer when core trench excavation begins.

4. EXCAVATION

Unless specified by the Engineer, no borrow material shall be taken from areas outside the lagoon impoundment area or designated borrow areas except for excavation of ditches or other structures shown on the plans or for the construction of building pads. All materials undesirable for fill purposes shall be stripped from the borrow areas and either stockpiled for later use as topsoil or disposed of properly. The impoundment area shall

be excavated to the lines and grades as shown on the plans. Any borrow areas outside the impoundment area shall be graded and left in a well-drained condition.

The contractor shall be responsible for the removal of excess water from any portion of the job site and all necessary equipment. In addition, the contractor is responsible for ensuring that all applicable permits have been obtained prior to any dewatering. Pumping of ponded water, if necessary during construction, shall be conducted in a timely manner to prevent saturation of large areas of the borrow pit and outletted to an acceptable drainage course as determined by the Engineer.
Excavation is considered integral to fill placement, therefore payment will be made for only one.

5. WASTE STORAGE POND EMBANKMENT

Fill shall be placed at the lowest point along the centerline of the embankment in horizontal layers not to exceed 6 inches in compacted depth to specified densities before placement of a successive layer. The fill shall be placed over the entire length and width of the embankment along one side of the holding pond except in areas where sectionalized construction is authorized by the Engineer. Where less impervious material is encountered in the borrow area, it shall be placed in the outer portions of the embankment (Zone 2 on Plans) as part of each lift and compacted the same as the rest of the embankment if authorized by the Engineer. Rocks larger than 6 inches in diameter shall not be used in the fill if their number and placement is such as to not allow adequate compaction.

The contractor shall be responsible for any water needed to raise the moisture content of fill material prior to compaction. The contractor shall also provide any equipment necessary to apply this water to fill. Care should be taken to prevent excessive cracking of compacted fill before a successive layer is applied.

Compaction shall be performed to each lift by means of controlled travel of compaction equipment so that each lift of the fill area has been uniformly compacted to a final density consistent with 95% Standard Proctor Density (ASTM D-698). Each pass of soil loading and compaction equipment should travel parallel to the centerline of the embankment. The moisture content at the time of compaction shall be consistent with the requirements of compaction to achieve final density.

6. WASTE STORAGE POND INLET STRUCTURES

The inlet structure shall be defined as beginning at Cell 1A and Cell 1B Risers and including the inlet pipe and splash pad or erosion control as shown on the plans as well as all supports and fasteners. The inlet structures shall be installed to the lines and grades as shown on the plans. The inlet pipe shall be a minimum of 1120 PVC SDR 51 pipe of the size shown in the plans, and shall meet ASTM D1785 or D2241. Pipe compound shall meet ASTM D1784, Class12454-B. Fittings and appurtenances shall be made of the same material as the pipe. The trench bottom must provide uniform support for the pipe at specified lines and grades. Clods, rocks and other hard objects that may contact the

pipe must be removed. Where rocks and other hard objects cannot be completely removed, the trench bottom must be over cut a minimum of four inches and backfilled to grade with compacted fine-grained soil. Initial backfill to six inches above the top of pipe shall consist of soil that is free of rocks, hard clods or other objects more than one inch in diameter. Portions of the trench that pass through a constructed berm shall have side slopes not steeper than 1:1 to allow for adequate compaction of backfill. Earth fill shall be worked and compacted under the haunches of the pipe to provide continuous support in layers not more than six inches thick. Final backfill shall consist of remaining earthfill from the top of the initial backfill to the ground surface, including mounding for settlement. Final backfill shall be free of debris, rocks or other objects with a three inch nominal diameter or larger. All backfill shall be compacted to the same specifications as that portion of the holding pond embankment or sideslope through which it is passing. Portions of the pipe that will be permanently exposed to sunlight must be primed with PVC solvent and painted with two coats of high-quality exterior latex paints.

7. FEED STORAGE PAD

Earthfill shall be placed to the lines and grades as shown on the plans on all areas for proposed construction. Compaction shall be performed to each 8 inch loose fill lift by means of a minimum of 4 passes of a standard sheepsfoot roller so that the sheepsfoot roller walks out of each lift to ensure the area has been uniformly compacted; or the compaction shall be performed to each lift by means of controlled travel of loaded rubber-tired compaction equipment or standard sheepsfoot roller so that the fill area has been uniformly compacted to 95% Standard Proctor Density (ASTM D-698) as determined by a testing lab approved by the Engineer. Each pass of soil loading and compaction equipment should travel parallel to the length of the pen lines or the compost pad. The moisture content at the time of compaction for cohesive soils shall be 0 ∀ 3 % of optimum moisture content .

If Proctor Density tests are to be performed on-site, a minimum of 2 field density tests per 8 inch lift per acre shall be performed during construction to verify compaction quality or as determined by the Engineer, based on compaction results. Nuclear or other standard field density test methods are acceptable for this project and shall be paid for by the Owner.

Grade tolerance on sand separator earthwork shall be 0±0.10 ft.

8. BUILDING PAD /DRIVEWAY/ SERVICE ROAD

Earthfill shall be placed to the lines and grades as shown on the plans on all areas for proposed building construction. Compaction shall be performed to each 8 inch loose fill lift by means of a minimum of 6 passes of a standard sheepsfoot roller so that the sheepsfoot roller walks out of each lift to ensure the area has been uniformly compacted; or the compaction shall be performed to each lift by means of controlled travel of loaded rubber-tired compaction equipment or standard sheepsfoot roller so that the fill area has been uniformly compacted to 95% Standard Proctor Density (ASTM D-698) as determined by a testing lab approved by the Engineer. Each pass of soil loading and compaction equipment should travel parallel to the length of the buildings. The moisture

content at the time of compaction for cohesive soils shall be consistent with the requirements of compaction at the optimum moisture content.

If Proctor Density tests are to be performed on-site, a minimum of 2 field density tests per 8 inch lift per building site shall be performed during construction to verify compaction quality or as determined by the Engineer based on compaction results. The compaction tests are to be paid for by the Owner. Nuclear or other standard field density test methods are acceptable for this project.
Grade tolerance on building site earthwork shall be -0.10 to +0.10 ft.

9. TOPSOIL

All pond cut and fill areas above the maximum operating elevation, and the entire back slope of the embankment, as well as the top and outside slopes of all settling basins and diversion channels shall be covered with a minimum of 6 inches of topsoil. The topsoil shall be placed during the normal fill operation, so no additional payment will be made for same. Topsoil shall be worked and bonded to the underlying fill and compacted to the same specifications as the underlying fill. All borrow areas should also be spread with 6 inches of topsoil before the contractor leaves the site.

10. GRAVEL

Gravel for access road areas to the locations, dimensions and grades shall be installed as shown on the drawings. Final elevation tolerances are ±0.1'. Contractor shall have the equipment and ability to transfer elevations from construction stakes and blue tops.

a) All gravel earthfills shall have a workmanlike finish (i.e. smoothed and graded with proper equipment).

b) The gravel fill materials, noted in drawings, for roads will have a 5" sub base and a 4" thick cap shall be:

   1) Pit Run Gravel Sub base

   Gravel shall have a screened base rock consisting of stones less than 6" in diameter.

   2) Screened Gravel Final Grade

   The road rock should meet the requirements as defined by owner.

c) The gravel shall be compacted in 6" lifts by 2 passes over entire surface with a vibratory roller or rubber tire type compactor.

d) Gravel shall be leveled and graded with a road grader.

e) The access road shall be shaped as shown on drawings.

11. GEOTEXTILE FOR RIP-RAP (OPTIONAL FOR ROAD)

A woven Geotextile shall be placed under the gravel fill as described as shown on the drawings and meet the following material specifications.

Woven geotextile shall have a minimum tensile strength of 300 lbs., conforming to ASTM Specification D 4632 (grab test method) and shall have an apparent opening size (AOS) ranging between 70 and 100 U.S. Standard sieve, conforming to ASTM Specification D 4751 for placement under the asphalt and the concrete.

The surface on which the geotextile is to be placed shall be graded to the neat lines and grades as shown on the drawings. It shall be reasonably smooth and free of loose rock and clods, holes, depressions, projections, muddy conditions, and standing or flowing water.

Before the geotextile is placed, the soil surface will be reviewed for quality assurance of the design and construction. The geotextile shall be placed on the approved prepared surface at the locations and in accordance with the details shown on the drawings. It shall be unrolled along the placement area and loosely laid, without stretching, in such a manner that it conforms to the surface irregularities when material or gabions are placed on or against it. The geotextile may be folded and overlapped to permit proper placement in designated area(s).

The geotextile shall be joined by overlapping a minimum of 18 inches (unless otherwise specified) and secured against the underlying foundation material. Securing pins, approved and provided by the geotextile manufacturer, shall be placed along the edge of the panel or roll material to adequately hold it in place during installation. Pins shall be steel or fiberglass formed as a U, L, or T shape or contain "ears" to prevent total penetration through the geotextile. Steel washers shall be provided on all but the U-shaped pins. The upstream or upslope geotextile shall overlap the abutting downslope geotextile. At vertical laps, securing pins shall be inserted through the bottom layers along a line through approximately the mid-point of the overlap. At horizontal laps and across slope labs, securing shall be inserted through the bottom layer only. Securing pins shall be placed along a line about 2 inches in from the edge of the placed geotextile at intervals not to exceed 12 feet unless otherwise specified. Additional pins shall be installed as necessary and where appropriate to prevent any undue slippage or movement of the geotextile. The use of securing pins will be held to the minimum necessary. Pins are to remain in place unless otherwise specified.

Should the geotextile be torn or punctured, or the overlaps or sewn joint disturbed, as evidenced by visible geotextile damage, subgrade pumping, intrusion, or grade distortion, the backfill around the damaged or displaced area shall be removed and restored to the original approved condition. The repair shall consist of a patch of the same type of geotextile being used and overlaying the existing geotextile. When the geotextile seams are required to be sewn, the overlay patch shall extend a minimum of 1 foot beyond the edge of any damaged area and joined by sewing as required for the original geotextile except that the sewing shall be a minimum of 6 inches from the edge of the damaged geotextile. Geotextile panels joined by overlap shall have the patch extend a minimum of 2 feet from the edge of any damaged area.

12. SEEDING

All pond cut and fill areas above the maximum operating elevation, and the entire back slope of the embankment, as well as the top and outside slopes of the settling basins and the diversions in their entirety shall be seeded to perennial grass as specified by the Natural Resource Conservation Service recommended guidelines for seeding in the area of the state the project is located. All borrow areas should be similarly seeded unless

their intended land use dictates otherwise (i.e. farmland).

13. LIQUID LEVEL GAGE

A liquid level gage shall be installed in the holding pond at a location that is readily visible. The gage should be constructed of pressure treated wood, noncorrosive metal or fiberglass and permanently anchored in concrete with divisions marked in one foot increments tied to the design water elevation. Another style of liquid level gage may be used upon approval by the engineer.

14. CULVERTS

The culvert structures shall be installed to the lines and grades as shown on the plans. The culverts shall be sized as according to the plans and they shall be HDPE smooth lined corrugated high density polyethylene pipe or equivalent. Fittings and appurtenances shall be made of the same material as the pipe. The culverts shall be bedded with a minimum of 3 inches of coarse grained material (sand, gravel or crushed rock) with a maximum diameter size of 1 inch. Initial backfill for 12 inches on both sides of the pipe and 12 inches above the top of the pipe shall consist of the same coarse grained material as the bedding. Initial backfill shall first be worked and compacted under the haunches of the pipe to provide continuous support up to the pipe centerline in layers not more than six inches thick. The remainder of the initial backfill shall then be placed in layers not more than six inches thick. Care must be taken during initial backfill to ensure that tamping or vibratory equipment does not deform or displace the culvert. Final backfill shall consist of the remaining earthfill from the top of the initial backfill to the ground surface, including mounding for settlement. Final backfill shall be free of debris, rocks or other objects with a three inch nominal diameter or larger.

15. CLEAN UP

During construction the Contractor shall keep the work site, areas adjacent to the work site and access roads in an orderly condition. Any spillage or debris resulting from the Contractor=s operations shall be immediately removed. Upon completion, all debris, etc. shall be removed from the area. All access roads, other than public, shall be graded, smoothed over and left in a well-drained condition prior to equipment removal.

B. POLYETHYLENE GEOMEMBRANE PRODUCT DETAILS (HDPE)

1. PURPOSE

This manual addresses the quality assurance and quality control of the installation of High Density Polyethylene (HDPE) geomembrane liners used by Colorado Lining Construction (CLC) in hazardous waste disposal landfills, surface impoundments or other installations as specified by the owner and/or engineer. This manual delineates the quality procedures and standards for installation.

1.1.0 Scope of Quality Assurance

The scope of this manual includes the quality assurance applicable to shipment, handling, and installation of High Density Polyethylene (HDPE) geomembrane liners also referred

to Flexible Membrane Liners (FML's).

1.2.0 Units

In this manual, all properties and dimensions are expressed in English units, with "equivalent" Système International (SI)/metric units in parentheses. It should be noted that the conversion is typically only accurate within ten percent. In cases of conflict or clarifications, the U.S. units shall be deemed to govern. Since most field geomembrane testing equipment manufactured in the United States are equipped to measure in English units, required test result data are tabulated herein with such units.

1.3.0 References

The manual includes references to test procedures of the American Society for Testing and Materials (ASTM), the Federal Test Method Standards (FTMS) and the "Standards for Flexible Membrane Liners" of the National Sanitation Foundation (NSF).

2. DELIVERY

2.1.0 Transportation and Handling

CLC through its own transportation or an independent trucking firm or other party as agreed upon by the Owner will perform transportation of the geomembrane. If the geomembrane arrives on site prior to CLC project personnel, the Owner is responsible for off-loading roll goods and any ancillary items shipped. The material received shall be matched against the freight bill of lading. Any discrepancies shall be immediately reported to CLC before the shipment is signed for. When off-loaded, geomembrane and any ancillary items should be placed on a smooth, well drained surface, free of rocks or any other protrusions which may damage the material. No special covering is necessary for geomembrane.

The following should be verified prior to and during off-loading geomembrane:

Handling equipment used on the site is adequate and does not pose any risk or damage to the geomembrane and that personnel handle the geomembrane with care. If slings are provided, the material should be lifted with such. In any event, materials shall be offloaded in a safe manner whereby the rolls are properly balanced and no personnel or property are at risk of being injured/damaged should loss of control of any roll(s) of material occur.

Upon arrival at the site, CLC shall conduct a surface observation of all rolls for defects and for damage. This inspection shall be conducted without unrolling rolls unless defects or damages are found or suspected. CLC shall indicate any damage to the Owner's Representative. The Owner shall immediately report to CLC any damage known to exist prior to delivery or that may have occurred during off-loading/handling.

2.2.0 Storage

The Owner shall provide storage in location (or several locations) such that on-site transportation and handling are minimized. Storage space should be protected from theft, vandalism, passage of vehicles, and be adjacent to the area to be lined.

2.2.1 Special Consideration for Welding Rod or GCL Liner

Should any welding rod or geoclay (GCL) liner be delivered to the site prior to CLC arrival, such materials shall be immediately secured in a sheltered/dry condition and maintained in such condition until deployed by CLC personnel.

3. SITE PREPARATION & INSPECTION

3.1.0 Anchor Trench Systems

All Anchor Trench Systems shall be excavated by others (unless otherwise specified) to the lines and widths shown on the design drawings, prior to geomembrane placement.

3.2.0 Site Inspection

Immediately prior to installation, the subgrade shall be jointly inspection walked by the Owner's Representative and CLC personnel to determine it's worthiness to accept the specified lining system. The decision to repair cracks, if any, should be made only by the Owner's Representative. Once properly prepared, CLC will sign acceptance of the surface condition of the subgrade. The integrity of the underlying soil shall remain the responsibility of the owner/earthwork contractor.

Subgrade Preparation Recommendations:

No liner shall be placed on surfaces not previously found acceptable by the CLC supervisor or his agent.

Surfaces to be lined shall be compacted, smooth, and free of all rocks greater than 3/8" in diameter, sharp angular stones, sticks, vegetation, roots, sharp objects, gravel, or debris of any kind. The surface shall provide a firm, unyielding foundation for the lining system with no sudden, sharp or abrupt changes or breaks in grade or geometry.

4. PANEL DEPOLYMENT AND TRACKING

4.1.0 Weather and Site Conditions

Panel placement shall not take place during precipitation or in the presence of excessive winds (unless wind barriers are provided). In addition, deployment shall not take place in any areas of ponded water.

4.2.0 Panel Identification

Panels are portions of roll stock membrane that are field cut to size as required for fitment and overlapped/welded in situ. In larger projects, a panel may consist of an entire uncut

roll.

At the time of installation, the CLC Field Supervisor shall give each field panel an "identification code" (Number or letter-number). This field panel identification code shall be as simple and logical as possible.

4.3.0 Panel Placement

Panels are located by the CLC Field Supervisor in a manner consistent with the specification and best suited to existing site conditions. Field Panels shall be placed one at a time and each shall be seamed immediately after its placement for protection against wind action or rainwater infiltration.

CLC shall record the identification code, location, and date of installation of each geomembrane field panel.

4.4.0 Precautions During Panel Placement

CLC shall ensure that:

Any equipment used will not damage the geomembrane by handling, trafficking, excessive heat, leakage of fluids, or other means.

The prepared surface underlying the geomembrane has not deteriorated since previous acceptance and is still acceptable immediately prior to liner placement.

Any geosynthetic elements immediately underlying the geomembrane are clean and free of debris.

All personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane.

Methods used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil.

Methods used to place the panels minimize wrinkles (especially differential wrinkles between adjacent panels).

Adequate temporary ballast is placed over deployed lining panel edges to prevent wind uplift and is not likely to damage the geomembrane. In the event of high winds, continuous loading such as sandbags shall be placed end to end along edges of panels to minimize risk of wind effects.

Direct contact with the geomembrane is minimized. Geotextiles, extra liner or other suitable materials shall be used as protective buffers in areas where excessive traffic may be expected.

4.5.0 Damaged Material

CLC shall inspect the geomembrane after placement and prior to seaming for damage. Any damaged membrane that cannot be reasonably repaired shall be removed and replaced. Repairs to geomembrane shall be made according to procedures described in section 8.2.0.

5. SEAMING

5.1.0 Required Weather Conditions for Seaming

No seaming shall be conducted during periods of excessive moisture, blowing dust, or in the presence of excessive winds (unless wind barriers are provided). Seaming shall not take place in areas of ponded water.

High temperature limits for welding are dependent upon crew safety and membrane material limits. Elevated temperatures can create conditions whereby seam strength maybe compromised and an inferior installation may result. When elevated temperature conditions exist over 95° F/35° C, weld quality shall be closely monitored during seaming operations.

No seaming shall be conducted during rain or snow, unless the seam is covered with an enclosure permitting favorable seaming conditions.

No seaming shall be attempted at ambient temperatures below 5° F without proper preheating of material promoting favorable seaming conditions.

In all cases, geomembrane shall be dry and protected from wind.

CLC shall verify that favorable weather conditions exist and advise the Owner's Representative if they are not favorable.

5.2.0 Seaming and Related Equipment

Unless otherwise specified, all field seaming procedures shall be limited to two methods: extrusion welding and fusion (via hot wedge/"wedge welding"). The bulk of all panel to panel seaming shall be performed using the wedge weld technique. Extrusion welding shall limited to areas where wedge welders cannot practically be deployed such as patching and pipe penetration sealing. These machines typically require gas or diesel fueled generators as power sources.

Each extrusion welding apparatus shall be equipped with gauges giving the temperature of the apparatus at the nozzle and extruder barrel.

Each wedge welding apparatus shall be equipped with gauges giving the applicable temperatures. Although welding over a frozen, wet or muddy subgrade is generally not

encouraged, fusion welding may be possible under such conditions by deployment of a movable plastic slip-sheet placed directly below the overlapped membranes being seamed. Properly designed and deployed slip-sheets serve to prevent moisture buildup between the sheets being welded while providing conditions whereby wedge welding machines may be propelled at an uninterrupted rate of speed.

5.2.1 Equipment Preparation

Generator(s) shall be fueled outside the extents of the lining system and be inspected for fluid leakage and mechanical damage that may result in damage to the lining system. Should it be necessary to place the generator over the lining system a suitable buffer strip shall be placed between the tires and the membrane. Generators without inflated rubber tires shall not be introduced over the lining system. Tires shall be pre-inspected to be free of foreign matter that may damage the membrane. Generators shall be positioned within close proximity of the seaming region and have adequate extension cords to complete an entire seam without the necessity to move the machine.

Wedge welders shall be calibrated for ambient conditions and the material type/thickness to be welded. The front part of the seaming device should be inspected for sharp corners and irregular details, which may damage the liner. The major point for inspection is that no sharp edges should exist where FML sheet surfaces must pass over the heated wedge element. If a dual, or split, hot wedge seam is being made, the recessed space for the air track should be examined. Knurled pressure rollers shall be inspected for sharp surfaces. All wedge welder adjustments shall be checked daily.

Cleaning of machine should be done at least daily. Extrusion welders shall have an initial inspection before warm up to confirm that the insulation and covers are in good condition and that the welding nozzles (or Teflon shoes) are correct for the FML to be seamed. Teflon shoes should be checked for proper weld bead geometry and excessive wear and replaced if necessary. They shall then be heated to the correct welding temperature for thickness of the material to be welded and then purged of all heat-degraded resin from within the barrel. During the purge process temperature controllers shall be monitored for proper function and that the welding rod feed systems and rotating tips are operating properly.

5.2.2 Trial Seams

Before any welding is performed by either method on the actual membrane lining system, trial seam welds must first be performed yielding passing results.

CLC shall prepare trial seams made with test strips of the actual membrane being installed to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period (start of the day and midday) for each seaming apparatus used. Trial seams shall be made under the same conditions as actual seams.

The trial seam sample shall be approximately 3 feet/1.0 m long by 1 foot/0.3 m wide

(after seaming) with the seam centered lengthwise. Seam overlap shall be nominally 4 inches/10.2 cm, 3 inches/7.6 cm minimum.

Unless otherwise specified, five (5) seam sample coupons each measuring 1"/25mm wide x 6"/150mm long shall be cut from the trial seam sample in increments to span its length. The specimens shall be tested in peel (3 ea.) and shear (2 ea.) modes using a field tensiometer. No seaming apparatus shall be used for seaming until deficiencies are corrected and two consecutive trial welds are successfully achieved.

5.3.0 Seam Layout

In general, seams should be oriented parallel to the line of maximum slope, in the direction of slope, not across the slope (horizontal to slopes). Horizontal to slope seams should be no less than 5 feet (1.5 m) from the toe of the slope or areas of potential stress concentrations unless otherwise approved by The Owner's Representative. When full roll lengths do not extend past the toe of the slope, panel ends may be seamed provided the panel end is cut at an angle greater than 45° to minimize seam stress. In corners and areas of irregular geometry, the number of seams should be minimized.

A seam numbering system compatible with a panel numbering system shall be employed.

5.4.0 Panel Overlap for Seaming

Controlled overlapping of adjacent sheets shall produce approximately 3 inches of overlap for extrusion welds and 4 inches of overlap between sheets for wedge welded seams.

5.5.0 Seam Preparation

CLC shall verify that:

Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material, and seams are aligned with the fewest possible number of wrinkles or "fishmouths".

All areas to receive extrusion welds shall first be lightly/evenly ground with a hand held grinder with a 60 or 80 grit disc to roughen the surface while removing all surface shine. The grinding is performed parallel to the seam and controlled such that grinding marks do not extend more than 0.25 inches outside the area of the weld bead area. Sixty mil or thicker liners should have the edge of the top sheet beveled by grinding to approximately a 45° angle. This grinding preparation shall be completed no more than one (1) hour prior to extrusion welding. Grinding preparation does not apply to wedge welding.

5.6.0 Wedge Welder Seaming Procedure

A smooth insulating plate or fabric is shall be placed beneath the hot welding apparatus both before and after usage.

Unless otherwise specified, the general seaming procedure used by CLC shall be as follows:

The rolls of geomembrane shall be overlapped by approximately four inches (100 mm) for fusion welding and three inches for extrusion welding.

Welding can occur once the panels to be joined have been brought into their exact plan position for final installation.

"Fishmouths" or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut "fishmouths" or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions.

Power to the drive motor shall remain switched-off off when positioning the machine to make a seam.

When starting a new weld, the machine shall be manually placed into the overlapped sheet of material. The sheets shall then be guided between the idlers and the wedge element, and into the drive/nip rollers.
When starting a weld in the middle of two sheets, the material must be loaded from the sides. The machine is to be picked up a few inches, loading the bottom sheet first and top sheet second.

As soon as the wedge is in position and the nip rollers are engaged, the drive motor should be energized and the hot wedge moved into position and locked.

Welder alignment and temperature shall be monitored during the seaming process and any adjustments be made as necessary.

Should the machine tend to bulldoze the subgrade due to soil conditions, the operator shall take some of the weight off the front of the machine by lifting it slightly. Alternatively, a base for the machine to travel on could be provided consisting of strips of geotextile or geomembrane.

To avoid damaging membrane material, once the end of a seam is reached the drive and/or pressure rollers shall be immediately disengaged before the material runs completely out of the machine. The machine shall be withdrawn as quickly as possible to avoid damaging the membrane.

Seaming shall span the full panel length extend well into the anchor trench.

All cross seams or "T" intersections are to be extrusion welded where they intersect. The top flap of geomembrane shall be removed in the area to be extrusion welded and the

weld area is ground prior to welding.

5.7.0 Extrusion Welder Seaming Procedure

A smooth insulating plate or fabric is shall be placed beneath the hot welding apparatus both before and after usage.

Using a hot air welders or hand held heat guns with seam rollers the overlapping materials to be welded must first be pre-bonded to hold the materials in place before actual extruding.

Welding operations should be observed to assure that the machines are properly aligned resulting in weld beads that are centered over the edges of the top FML sheets and that weld bead appearances are smooth and uniform.

6. Non-Destructive Seam Continuity Testing

CLC shall non-destructively test all field seams over their full length using a vacuum test unit, air pressure testing, or other approved method. The purpose of non-destructive tests is to check the continuity of seams. It does not provide information on seam strength. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

6.1.0 Vacuum Box Testing

This test method is almost exclusively used for evaluating extrusion weld bead quality. In areas where vacuum boxes cannot practically be deployed, the welds shall be visually inspected and manually probed over their full length to check adhesion.

The equipment shall be comprised of the following:

A vacuum box assembly constructed from clear transparent plastic with a soft neoprene gasket attached to the bottom and a gauge to indicate vacuum chamber pressure.

A vacuum motor capable of creating a vacuum of 2.5 to 3 psi.

A bucket and wide brush, mop or spray assembly.

A soapy solution.

Procedure:
Wet a strip of geomembrane approximately 12 inches by 48 inches (0.3 m by 1.2 m) with the soapy solution;

Place the box over the wetted area.

Energize the vacuum apparatus; confirm 2.5 to 3psi.

Ensure that a leak tight seal is created.

For a period of approximately 5 to 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.

All areas where soap bubbles appear shall be marked and repaired in accordance with Section 3.4.

If no bubbles appear, the vacuum shall be disengaged and the box indexed to the next test area with a minimum 6" overlap between indexes, and the process repeated.

Vacuum tested seams are recorded on Daily Progress Reports.

6.2.0 Air Channel Pressure Testing

This method is only applicable to seam continuity testing of air channels produced using dual track hot wedge welding equipment.

Testing equipment shall be comprised of the following:

An air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi (160 and 200 kPa).

A air hose with fittings and connections.

A sharp hollow needle or other approved pressure feed device.

Procedure:
Seal both ends of the seam to be tested by tack welding and clamping with Vise Grips;

Insert needle into the air test channel created by the fusion weld.

Inflate the channel as applicable to pressure between 25 and 30 psi (160 and 200 kPa), close pressurized air source valve and monitor air pressure drop for five (5) minutes.

Remove needle or other approved pressure feed device and seal.

If pressure drop exceeds values tabulated herein or does not stabilize, locate faulty area and repair and re-test until defects are corrected and test values are passing.

Pressure tested seams are recorded on Daily Progress Reports.

TABLE 6.2
SEAM PRESSURE TEST ALLOWANCE

Material Thickness	Minimum psi Test Pressure	Maximum psi Test Pressure	Maximum psi Drop Allowed After 5 Minutes

30 mil	24	30	3 PSI
40 mil	24	30	3 PSI
60 mil	27	30	3 PSI
80 mil	27	30	3 PSI
100 mil & Thicker	30	32	3 PSI

6.2.1 Pressure Test Failure

Should excessive pressure drop occur, both ends of seam shall be checked to insure proper seal and be re-tested. Should failure reoccur, the top fusion seam shall be checked by applying a constant air pressure to the air channel and applying a soapy water solution over the weld length. Any failure or leak will be indicated by continuous bubbles appearing.

If no failure appears in the top fusion seam area the seam shall then be systematically isolated into in one hundred and fifty linear foot sections of seam which shall each be retested by pressure testing until the leak is located. Failed seam areas shall be repaired by extrusion welding the outside edge of the top fusion weld between areas of failure. The extruded edge shall be vacuum tested in accordance with this manual.

7. Destructive Seam Testing

Destructive seam tests (if required by the project specification) shall be performed at random selected locations at a frequency of one sample per every 500 lineal feet of seam or as otherwise specified. Seam testing shall be conducted concurrent to the seaming work progress. The Owner's Representative if required, may select locations where seam samples are to be cut. If destructive seam tests are not required, representative seam samples may be substituted at a similar frequency using material samples of the actual material being installed so that no "damage" is done to the actual lining system requiring patching and testing, etc.

Procedure
Samples shall be cut by CLC as the seaming progresses. CLC shall:

Cut samples.

Assign a number to each sample, which is to be based upon seam and sample number and mark it accordingly.

Record sample location on daily report.

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in Section 8.2.0.

7.1.0 Sample and Coupon Size and Extraction

Unless otherwise specified, the following sample preparation guidelines shall govern:

Trial, representative or destructive seam samples cut from the installed liner shall measure 12"/30cm in width x 3'/1m in length with the width of the seam centered in the long axis of the sample. Coupons shall measure 1"/25mm wide by 6"/150mm long with the seam centered perpendicular to the length.

Coupon extractions shall occur in three paired locations along the length of the seam sample:

2 coupons at the beginning, 2 coupons in the center and 2 coupons at the end of the sample for a total of six (6) extractions. Coupons may be extracted and evaluated incrementally.

Sample Distribution

Remnant 12"/30 cm square samples shall be cut into parts, labeled as specified and distributed as applicable:

One portion for independent geosynthetic laboratory testing if previously specified

And

One portion to the Owner for archive storage

7.2.0 Coupon Field Testing

Coupons shall be tested with a tensiometer and evaluated for bonded seam strength (shear) and peel using methods ASTM D4437. Tensiometer jaw separation rate for bonded seam strength/shear and peel test shall be 2"/minute (5cm/min.)

All shear strength samples shall yield Film Tearing Bond (FTB) as defined in NSF 54 Annex A,

If the initial sample coupon test passes shear analysis yielding a FTB, the sample qualifies for further testing to obtain quantitative results until three (3) each peel samples and three (3) each shear samples are evaluated from the beginning middle and end of each sample.

If more than one (1) of six coupons per sample fails, the seam should be repaired in accordance with Section 7.3.0.

TABLE 7.2
REQUIRED FUSION AND EXTRUSION SEAM TEST RESULTS
Per NSF 54 1993 Standards
Minimum Values Required (In Units of Pounds per inch of Width)

Material Thickness	Peel Extrusion	Peel Fusion	Shear Extrusion	Shear Fusion
30 mil HDPE	35	49	63	63

40 mil HDPE	48	86	86	86
60 mil HDPE	70	98	126	126
80 mil HDPE	92	115	166	166
100 mil HDPE	115	143	207	207
Textured 30 mil HDPE	31	44	56	56
Textured 40 mil HDPE	42	60	76	76
Textured 60 mil HDPE	63	88	113	113
Textured 80 mil HDPE	84	115	151	151
Textured 100 mil HDPE	105	143	189	189

Notes: Textured values are applicable to membranes textured on one side of the sheet only.
Only the inner weld track is peeled apart in this destructive test. The outer track (directly at sheet edge) is for the purpose of air pressure testing capabilities.

7.3.0 Procedures for Test Failure

Should a sample fail a destructive test, the defect may be remedied by:

Capping the respective seam in its entirety as described in this section,

or

If a defect is suspected to be local to a certain area it may be further investigated to isolate the defective are by:

Taking small coupon test samples located 10' on either side of the defective sample seam void area. If these additional samples pass tensiometer testing, then full samples are to be taken. If these samples pass the tests, then the seam is capped between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed. All acceptable seam areas must be bounded by two locations from which samples passing destructive tests have been taken.

Cap stripping of defective seams or isolated areas shall be performed using either wedge or extrusion welding techniques or combination thereof and re-testing the repaired area with applicable methods as described herein. Cap strips shall cover the defective seam by no less than 6"/15cm On either side of the original weld. Wider patches will be required to cover seam sample void areas.

CLC shall document all actions taken in conjunction with destructive test failures; e.g., capping of failed seam area.

8. Defects and Repairs

8.1.0 Identification

All seams and non-seam areas of the geomembrane shall be examined by CLC for identification of defects, holes, blisters, un-dispersed raw materials and any sign of contamination by foreign matter.

Defective/damaged materials shall be identified via a deficiency report, either separately

or on the Daily Report. Actions taken to resolve or correct the problem will also be recorded on the similar form.

Defects, holes, blisters, un-dispersed raw materials, signs of contamination by foreign matter, unacceptable welds in geomembranes and other unsatisfactory conditions will be identified on the Daily Report form. The repair/corrective action to "fix" the problem will also be recorded on a similar form.

8.2.0 Repair Procedures

Available methods include:

Patching - used to repair large holes, tears, and contamination by foreign matter.
Grinding and re-welding - used to repair small sections of extruded seams.

Spot welding or seaming - used to repair pinholes or other minor localized flaws;

Capping - used to repair large lengths of failed seams;

Methods for patching lining system defects shall consist of welding patches or caps over such areas using the same membrane lining material as used on the specific project. Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches.

Seaming, preparation and welding equipment deployment procedures previously addressed in this manual shall be adhered to during patching operations.

8.2.1 Verification of Repairs

Each repair shall be non-destructively tested using the methods described in Section 6 as appropriate. Repairs which pass the non-destructive test, shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be redone and re-tested until
a passing test result is obtained.

9. Ancillary Items

9.1.0 Pipe Penetrations

Pipes penetrating through the lined area shall be sealed using pipe boot details that are welded to the lining system via extrusion weld method and sealed the pipe with double stainless steel banding clamps and butyl sealant tape. Pipe boots shall be fabricated from the membrane material being installed and shall fit snugly over the pipe and pipe to grade interface without undue slack or bridging. In instances where piping is manufactured from HDPE, the pipe boot sleeve may be extrusion welded directly to the pipe foregoing the need for banding clamps.

9.2.0 Backfilling of Anchor Trenches

Anchor trenches, if any, shall be adequately drained by others to prevent ponding or

otherwise softening the adjacent soils while the trench is open. The anchor trench shall be back-filled by others or as outlined in the specifications and bid documents. Since back-filling the anchor trench can affect material bridging at toe of slope, consideration should be given to backfill the liner at its most contracted state; preferably during the cool of the morning or extended period of overcast skies. Care shall be taken when back-filling the trenches to prevent any damage to the lining system.

C. ETHYLENE PROPYLENE DIENE TERPOLYMER (EPDM) LINING

PART 1. GENERAL

1.1 SCOPE OF WORK

A. The work covered by this specification consists of providing and installing a non-reinforced vulcanized rubber sheet made from ethylene propylene diene terpolymer (EPDM) for use as a geomembrane liner.

1.2 REFERENCES

A. ASTM International:

1. ASTM D 412 – Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
2. ASTM D 471 – Test Method for Rubber Property – Effect of Liquids
3. ASTM D 792 – Test Method for Density and Specific Gravity of Plastics by Displacement
4. ASTM D 1149 – Test Method for Rubber Deterioration – Surface Ozone Cracking in a Chamber.
5. ASTM D 1204 – Test Method for Liner Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
6. ASTM D 2240 –Test Methods for Rubber Property – Durometer Hardness
7. ASTM D 4437 – Standard Practice for Non-destructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes
8. ASTM D 4833 – Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
9. ASTM D 5617 – Test Method for Multi-Axial Tension Test for Geosynthetics
10. ASTM D 7272 – Test Method for Determining the Integrity of Seams Used in Joining Geomembranes by Pre-manufactured Taped Methods
11. ASTM D 7465 – Stand Specification for Ethylene Propylene Diene Terpolymer (EPDM) Sheet Used in Geomembrane Applications
12. ASTM E 96 – Test Method for Water Vapor Transmission of Materials
13. ASTM E 729 – Standard Practice for Conducting Acute Toxicity Tests on Test Materials with Fishes, Macroinvertebrates, and Amphibians

14. ASTM G151 – Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources
15. ASTM G155 - Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

B. United States Environmental Protection Agency

1. EPA/600/4-89/001 Method 1000.0 – Chronic Toxicity Screening Report Survival and Growth Effects on *Pimephales promelas* Flathead Minnows

1.3 SUBMITTALS TO OWNER OR OWNER'S REPRESENTATIVE

A. Sheet Layout and Detail Drawings: Submit geomembrane panel layout, anchor trench and penetration detail drawings a minimum of 30 days prior to delivery of Firestone EPDM Geomembrane to jobsite.

B. Record "As-Built" Drawings: Provide final record "As-Built" Drawings of geomembrane installation showing panel/sheet numbers, seam numbers, and location of patches, destructive and /or non-destructive seaming samples, and any penetrations.

C. Other Submittals:

1. Submit manufacturer's specifications and details.
2. Submit certification from the installer of the acceptability of the substrate on which the Firestone EPDM Geomembrane is to be placed prior to the geomembrane placement.
3. Submit one sample measuring 12" x 12" of the appropriate thickness Firestone EPDM Geomembrane with one factory seam.

1.4 QUALITY ASSURANCE

A. Manufacturer to possess a minimum of ten years or more experience in the manufacturing of Firestone EPDM Geomembrane for the purpose of general containment linings.

B. Installer is responsible for field handling, deploying, seaming, anchoring, and field quality control testing of Firestone EPDM Geomembrane and shall have installed a similar geomembrane material. At least one installing individual shall have experience equal to the seaming of a minimum of 100,000 square feet of Firestone EPDM Geomembrane material.

C. Equipment used in the performance of inspection, installation and seaming shall be in accordance with the Firestone EPDM Geomembrane manufacturer's recommendations and all such equipment should be continuously maintained in a satisfactory working condition.

1.5 DELIVERIES, STORAGE AND HANDLING

A. Protect Firestone EPDM Geomembrane from punctures, abrasions, vandalism, excessive heat or cold or other damaging conditions.

B. Deliver materials to the job site in their original containers or wrappings and as labeled by the manufacturer. Follow the manufacturer's directions for protection of materials before and during installation. Do not use damaged materials. Remove damaged Firestone EPDM Geomembrane from the project site at no additional cost to the owner.

C. Store Firestone EPDM Geomembrane and accessories in accordance with the manufacturer's recommendations.

1.6 SITE INSPECTION

A. The installer shall visit the site to check whether the excavation work has been performed as per the contract agreement.

B. In no event shall the Firestone EPDM Geomembrane be placed over rocks or other materials, which are capable of puncturing or stressing the Firestone EPDM Geomembrane. In some instances, a protection geotextile should be installed under the Firestone EPDM Geomembrane. The project engineer should determine the type and mass per unit area of the geotextile. In the absence of a project engineer, the installer should determine the type and mass per unit area of the geotextile. The ground surface shall be free of all organic debris and sharp objects before placement of the Firestone EPDM Geomembrane. The Firestone EPDM Geomembrane shall be overlapped and field-seamed when Firestone EPDM Geomembrane and substrate is dry.

PART 2 PRODUCTS

2.1 MATERIALS

A. The membrane shall be Firestone EPDM Geomembrane.

Firestone Non-Reinforced
EPDM Geomembrane (Black)

PHYSICAL PROPERTIES

SECTION 6. Property	Test Method	SECTION 7. Units	Minimum ASTM D7465	
			SI	Eng
Specific Gravity	ASTM D792	gm/cc	1.1	1.1
Unit Weight	ASTM D751	kg/m^2 (lb/ft^2)	1.3	.28
Thickness, Type 1	ASTM D412	mm (in)	1.14 +15/- 10%	.045 +15/- 10%
Tensile Strength, Die C	ASTM D412	MPa (lb/in^2)	9.0	1305
Ultimate Elongation, Die C	ASTM D412	%	300	300
Tear Resistance, Die C	ASTM D624	kN/m (lbf/in)	26.7	150
Puncture Resistance	ASTM D4833	N (lbs)	133	30
Shore A Durometer	ASTM D2240		65-10	65-10
Ozone Resistance	ASTM D1149		No Cracks	No Cracks
Multiaxial Elongation	ASTM D5617	%	100	100
Heat Aging	ASTM D573			
Tensile Strength, Die C	ASTM D412	MPa (lb/in^2)	8.3	1205
Ultimate Elongation, Die C	ASTM D412	%	200	200
Tear Resistance, Die C	ASTM D412	kN/m (lbf/in)	21.9	125
Accelerated Aging: Xenon Arc	ASTM G155/G151		Pass	Pass
Brittleness Point	ASTM D2137		-45°C	-49°F
Water Absorption	ASTM D471	%	+8,-2	+8,-2
Water Vapor Permeability (max.)	ASTM E96	Perm mils	2.0	2.0
Linear Dimensional Change (max	ASTM D1204	%	+/-1.0	+/-1.0
Chronic Toxicity Screening	EPA/600/4-89/001 ASTM E729	Method 1000.0	passes passes	passes passes

Notes:

1. Certified Firestone EPDM Geomembrane production materials are special order items requiring a minimum of two weeks as production lead-time
2. Following all testing conditions outlined in the standards document, Firestone EPDM Geomembrane meets or exceeds the minimum requirements set forth by ASTM D7465 for Type I non-reinforced EPDM geomembrane.

Firestone geomembrane meets or exceeds the minimum requirements set forth by ASTM D4637 for Type II scrim-reinforced EPDM single-ply pond lining geomembranes.

B. Accessories including but not limited to seaming materials shall be as supplied or approved by Firestone Specialty Products.

2.2 WARRANTY

Upon notice of completion from the installer the manufacturer shall issue a written twenty-year Firestone EPDM limited material warranty.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

A. Surface Preparation: Perform in accordance with project specifications. Loose rock larger than one half inch in diameter and other debris that could damage the Firestone EPDM Geomembrane shall be removed from the substrate. Construction equipment track deformations shall not be greater than one inch in depth. Installer shall observe subgrade surface daily and shall evaluate the surface conditions for the installation of the Firestone EPDM Geomembrane. Before installing Firestone EPDM Geomembrane, the installer shall certify in writing to the owner that the substrate upon which the Firestone EPDM Geomembrane is to rest is acceptable.

B. Anchor Trenches: On a daily basis excavate only the length of anchor trench, which can be overlain with the Firestone EPDM Geomembrane and properly backfilled. Anchor trench corners toward the containment shall be rounded and free of protrusions to avoid sharp bends in the Firestone EPDM Geomembrane. Loose soil, rocks larger than one half inch in diameter, and other debris that could damage the Firestone EPDM Geomembrane shall be removed from upper edge of trench toward the containment. Backfill anchor trench material shall meet the same requirements as the substrate.

3.2 FIRESTONE EPDM GEOMEMBRANE PLACEMENT

A. Firestone EPDM Geomembrane shall be placed with a minimum of handling and in accordance with the manufacturer's current specifications. All procedures and

equipment shall ensure that no damage occurs to the Firestone EPDM Geomembrane. Any Firestone EPDM Geomembrane damaged during installation shall be removed or repaired by the installer as specified in section 3.5 of this specification. Any replacement work required by this specification will be completed at no additional cost to the owner. Daily installation is limited to the number of Firestone EPDM Geomembrane panels that can be anchored and seamed together on the same day without damaging the Firestone EPDM Geomembrane and with placement of adequate ballast on the Firestone EPDM Geomembrane to prevent, wind-uplift. The method or equipment used to unroll or place Firestone EPDM Geomembrane panels shall not stress or damage the Firestone EPDM Geomembrane. All non-vulcanized seams shall run parallel to the line of MAXIMUM slope or they must rest without tension in the bottom of the containment.

B. Wrinkles: The method or equipment used to place the Firestone EPDM Geomembrane panels shall seek to minimize wrinkles. The installer during installation, ballasting and coverage must seek to provide sufficient slack in the installed Firestone EPDM Geomembrane to prevent tensile stresses in the Firestone EPDM Geomembrane and its seams.

3.3 FIELD SEAMING

A. All field seaming shall be in accordance with the manufacturer's current approved methods. The manufacturer must manufacture or approve all materials and accessories.

B. Field Seams – General Requirements: Firestone EPDM Geomembrane panels shall be overlapped a minimum of four inches. Seaming shall extend to the outside edge of panels to be placed in anchor trenches. Seaming shall not be conducted in the presence of moisture, dust, dirt, standing water or soft subgrade as determined by the installer. Wet surfaces shall be thoroughly dried and soft subgrade should be compacted and approved by project engineer before seaming. Seam area shall be cleaned of dust, dirt, and other foreign material before and during seaming.

3.4 FIELD SAMPLING AND TESTING

A. Non-Destructive Field Seam Testing: All field seams shall be non-destructively tested over their full length in accordance with ASTM D 4437 (high pressure air lance) to ensure seam continuity. Seam testing shall be performed as the seaming work progresses, not at the completion of field seaming. Seams that fail shall be documented and repaired in accordance with the manufacturer's specifications and details.

3.5 REPAIRS

A. Defective Seam Test Repairs: Defective seam areas shall be thoroughly cleaned and covered with a strip of new cover strip tape, cover strip tape and a Firestone EPDM patch or a patch fashioned from Firestone EPDM Geomembrane and double-face splice tape. After adding the repair strip or patch, the entire repaired seam area shall be tested in accordance with ASTM D 4437 (high pressure air lance) non-destructive testing methodology.

B. Installer certified test results on repaired seams shall be submitted for all defective seamed areas.

C. Repair Patches: Tears, holes, blisters, and areas with undispersed raw materials or foreign material contamination shall be repaired with patches. Patches shall have rounded corners, be made of Firestone EPDM Geomembrane and extend a minimum of six inches beyond the edge of the defect. All repairs shall be tested in accordance with ASTM D 4437 (high pressure air lance) non-destructive testing methodology.

3.6 PENETRATIONS, DETAILS AND ACCESSORY PRODUCTS

A. Firestone EPDM Geomembrane penetration details shall be as shown on the drawings and as recommended by the Firestone EPDM Geomembrane manufacturer. Factory fabricated boots shall be used wherever possible. Field seams shall be tested in a non-destructive manner in accordance with ASTM D4437. Seams that fail non-destructive testing shall be repaired and the repaired seams shall be re-tested using a non-destructive method.

3.7 COVER SOILS

A. Firestone EPDM Geomembrane may be covered with a geosynthetic or soil cover material in accordance with the project engineer's specifications.

D. CELL 1A AND CELL 1B SOLID SEPARATOR/CONCRETE TANK DETAILS

1. SUBGRADE PREPARATION

Site grading work is to be done to provide accurate and compacted earth and subgrades where practical for all building sites. However, some amount of fine excavation and/or placement of subgrade fill is to be expected. Material used for subgrade backfill shall be non-settling, clean sand or gravel or suitable earthfill with adequate compactive effort utilized wherever depths demand same. Sub-grade fill gravel will be a pay item but will not be utilized to avoid accurate grading and proper compaction of sub-grade nor as a substitute for inaccurate excavation of pits, gutters, manholes, sumps and other subterranean features.

2. CURING

All concrete shall be protected from premature or too rapid curing by the use of covering, the spraying of compounds or the frequent and sustained wetting with water.

3. FORMING

All forms shall be of a type and quality suited to the finished dimensions and grades to be provided. Forms shall be at the proper elevation, true to line, plum and square as required. All forms shall be securely anchored to maintain concrete alignment and slope.

E. SUPPLEMENTAL CONCRETE SPECIFICATIONS

1. FORMWORK

a. CONCRETE FORMS

1) Boards, plank, plywood or metal forms: Use where concrete is not exposed.

Use APA - BB Plyform (Class I or II acceptable)

2) Form Coating: Non-staining, shall be suitable for the type of form material used.

3) Form Ties, Spreaders and Other Form Accessories: Commercial brands subject to the approval of the Engineer. Wire ties shall not be used. Arrangement and spacing of ties as approved by Engineer.

b. CONCRETE FORMWORK CONSTRUCTION

1) Construct forms to shapes, lines and dimensions called for on Drawing, true to line, plumb and level with joints mortar tight. Provide proper bracing and supports of sufficient strength to carry, without appreciable deflection and with absolute safety, the dead load of concrete as a liquid together with live loads of men, equipment and materials.

Provide sufficient forms so that work can be carried out without delay. Build forms of materials of sufficient strength to hold concrete without bulging or sagging between supports. For concrete to be exposed to the weather, the edges shall be glued or otherwise sealed to prevent loss of any of the matrix.

2) Edge Forms and Screeds: Set edge forms and screeds accurately to produce the designed elevations, slopes in the finished surfaces. Provide required slope to drains.
3) Securely place in forms all accessories specified and shown on the drawings. This includes anchor bolts, anchoring items, reglets, guards, curb angles, dock nosings, etc. These items are furnished by others. Sleeves, etc. for mechanical and electrical will be furnished and set by Contractor requiring same. Cooperate with all trades for installation of inserts.
4) Openings: Form all openings, chases, recesses, etc. required by the design.
5) Joints: Provide expansion and contraction joints where shown on the drawings. Provide construction joints as detailed and where required. Construction joints in accordance with ACI 301.
6) Cleaning and Coating: Sweep, clean and coat forms before reinforcing

is placed.

7) Wetting Forms: In hot weather, wet down forms with hose immediately before placing concrete.
8) Formwork not supporting concrete may be removed after cumulatively curing at not less than 50 degrees F for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operation, and provided that curing and protection operations are maintained.
9) Form facing material may be removed four days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.
10) Re-Use of Forms: Clean and repair surfaces of forms to be re-used in the Work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork. When forms are reused for successive concrete placement, thoroughly clean surfaces, remove fines and laitance and tighten forms to close all joints. Align and secure joints to avoid offsets.

2. REINFORCEMENT

a. MATERIALS

1) Standard Bars: New Billet stock, deformed, ASTM A615, grade 60 or as shown on the Drawings. Free of mill scale, excessive rust or other coating that would prohibit proper bond with concrete.
2) Welded Steel Wire Fabric: ASTM A185.
3) Tie Wire: FS QQ-w-461, annealed steel, blank, 16 gauge minimum.
4) Welding Electrodes: A WS A.5.1, low hydrogen, E70 series.
5) Supports and Accessories: Conform to ACI 315. Where concrete surface is exposed to view or weather, or to be painted, use plastic supports. Individual and continuous slab bolsters and chairs shall be of a type to compliment the various conditions encountered.

b. FABRICATION

0) Shop fabricate to size, dimension and shape shown on approved shop drawings and within tolerances specified in ACI 301 and in accord with CRSI Manual of Standard Practice.
1) After fabrication, sort, bundle and metal tag reinforcement before delivery to the job site.

c. PLACEMENT

1) Place concrete reinforcement in accordance with the approved placing drawings, and CRSI 63 (Reinforcing Bars), and CRSI 65 (Bar Supports), and in accordance with tolerances specified in ACI 301.

2) Place only reinforcement that is free of mill scale, excessive rust, or other coating that would prohibit proper bond with the concrete.
3) Support reinforcement and guard against displacement during concreting.
4) Continue reinforcement through construction joints but do not continue reinforcement through expansion joints unless so detailed.
5) Move within allowable tolerances to avoid interference with other reinforcing steel, conduits or embedded items.
6) Do not heat, bend or cut bars without concurrence of the Engineer.
7) Tie securely or use splice devises to prevent displacement of splices during concrete placement
8) Install wire fabric in longest practicable length. Lap adjoining pieces one full mesh minimum, and lay splices with 16 gauge wire. Do not make end laps midway between supporting beams or directly over beams of continuous structures. Offset end laps in adjacent widths to prevent continuous laps.

d. FIELD QUALITY CONTROL

0) Inspection of Forms and Reinforcing: At least 24 hours prior to placing of concrete notify the Engineer so that he may inspect forms and reinforcing in place and secure his approval for the placement of concrete.
1) Allow no placing of concrete until the Engineer has inspected concrete reinforcement in place in forms.

e. CONCRETE COVER

Thickness	Condition of Concrete in Use
:"	Slabs not exposed to ground or weather
1"	Walls not exposed to ground or weather
1-2"	Beams not exposed to ground or weather
2"	Concrete exposed to earth
2"	Concrete placed against earth

3. CAST-IN-PLACE CONCRETE

a. SUBMITTALS

1) Mix Design: Submit reports in duplicate of all concrete mix design and aggregate reports to the Engineer for approval at least five days prior to pouring concrete.
2) Test Reports: Submit information copies in duplicate of all test reports to the Engineer.
3) Material Certificates: Provide materials certificates in lieu of materials

laboratory test reports only when permitted by the Engineer. Material certificates shall be signed by the material manufacturer and the Contractor, certifying that each material item complies with, or exceeds, the specified requirements.

4) Ready-mix delivery tickets: ASTM C94-74.

b. CONCRETE MATERIALS

1) Concrete: Ready-mixes per ASTM C94-74

a) Portland Cement: ASTM C 150, Type 1, only one brand of cement shall be used throughout the work. The Contractor shall be responsible for whatever steps are necessary to insure that no visual variations in color will result in exposed concrete, and shall place on order a sufficient quantity of this cement to complete the concrete work.

2) Aggregates: ASTM C 33

a) Maximum sizes: Footings 1-2"
All other concrete :"

Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to the Engineer.

b) Fine Aggregate: Clean, sharp, natural sand free from loam, clay lumps or other deleterious substances.

c) Dune sand, bank-run sand and manufactured sand are not acceptable.

d) Maximum Aggregate Size: Not larger than 1/5 of the narrowest dimension between sides of forms, a of the depth of slabs, nor : of the minimum clear spacing between individual reinforcing bars or bundles of bars. These limitations may be waived if, in the judgement of the Engineer, workability and methods of consolidation are such that concrete can be placed without honeycomb or voids.

e) Water: Clean, free of deleterious amounts of acids, alkalies or organic materials.

f) Admixtures:

Air Entraining Admixture: Conform to ASTM C 260.

c. CONCRETE RELATED MATERIALS

1) Joint Material: Pre-formed, non-extruding type ASTM C 1751.

2) Curing Compounds

a) Curing and Sealing Compound: The compound shall be a clear styrene acrylate type, 30% solids content minimum, and have test data from an independent testing laboratory indicating a maximum moisture loss of 0.030 grams per sq. cm. when

applied at a coverage rate of 300 sq. ft. per gallon. Compound shall be ASuper Floor Coat@ or ASuper Pliocure@ by the Euclid Chemical Company or equivalent.

b) Slab Joint Key: Pre-formed asphalt hardboard, Brock-White 1/4".
c) Vapor Barrier: Sisalkraft Moistop.
d) Absorptive Cover: Burlap cloth made from jute or Kenaf, weighing approximately 8 ounces per square yard, complying with AASHD H182, Class 3.
e) Bonding and Repair Materials:
Bonding Materials: The compound shall be a polyvinyl acetate, rewettable type, AEuco Weld@ by The Euclid Chemical Company or AWeldcrete@ by The Larsen Company.

d. CONCRETE MIXING

1) Mix Design:
   a) Employ the services of an independent testing laboratory to test the proposed aggregate and design mixes for each type of concrete required.
   b) Make available to the testing agency all materials required for the concrete mix design as well as for qualitative acceptance tests. Present materials acceptance tests, trial mix date and recommended job mixtures to the Engineer at least five working days prior to the proposed beginning concreting.
   c) Sample and test each type of aggregate in accordance with applicable ASTM procedures.
   d) Design mixes in accordance with ACI 301, Method 2.
   e) Deliver no materials to the site until the samples have been approved, and use only materials equal to the approved samples.
2) Type and Strength:
   a) Compressive Strength: In place, at 28 days, minimum as follows (unless indicated otherwise by structural drawings):
      Footings, walls, interior slabs on grade: 4,000 psi.
   b) Air Content: All concrete exposed to freezing and thawing and/or required to be watertight shall have an air content as specified in 2.03.G. All interior slabs subject to abrasion shall have a maximum air content of 3%.
   c) Water/Cement Ratio: All concrete subjected to freezing and thawing shall have a maximum water/cement ratio of 0.50. All concrete subjected to deicers and/or required to be watertight shall have a maximum water/cement ratio of 0.45.
   d) Admixture Usage: All concrete must contain the specified water-reducing admixture and/or the specified high-range water-reducing admixture (superplasticizer). All concrete slabs placed at air temperatures below 50 degrees F shall contain the specified non-corrosive, non-chloride accelerator. All concrete

required to be air entrained shall contain an approved air entraining admixture. All pumped concrete, concrete for industrial slabs, architectural concrete, concrete required to be watertight and concrete with a water/cement ratio below 0.50 shall contain the specified high-range water-reducing admixture (superplasticizer).

e) Slump and Workability:
   i. Slump: As determined by ASTM C 143 as follows:

Footing	3" - 4"
Walls	5"
Slabs on grade	3" - 4"
Structural slabs, beams	3" - 4"
Columns	3" - 5"

   ii. Workability: So that concrete will completely fill forms without voids and embed and bond to reinforcing without separation of materials.

a) Mixing: Mix and deliver concrete in accordance with ASTM C 94-74.
b) Cooled or heated water shall be used in accordance with ACI 306 and 305.
c) Ready mixed concrete shall be transported to the site in watertight agitator or mixer trucks loaded not in excess of rated capacities.Discharge at the site shall be within one hour after charging.
d) Attention is called to the importance of scheduling and dispatching trucks from the batching point so that they arrive at the site of the work just before the concrete is required, thus avoiding excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms.
e) If, during the progress of the work, the Contractor desires to use materials other than those approved (originally) or if the materials from the source originally approved change in characteristics, additional tests shall be made with new materials which will produce concrete meeting with the stated requirements and not cause objectionable change in the color or appearance of the structure. These additional tests shall be made by the testing agency, at the expense of the Contractor. No concrete made from such different materials shall be used in the work until the Engineer has given his approval.
f) If during the progress of the work, it is impossible to secure concrete of the required workability and strength with the

materials being furnished by the Vendor, the Engineer may order such changes in the proportions or materials, or both, as may be necessary to secure the desired properties, subject to the stated requirements. Any changes so ordered shall be made at the Contractor=s expense, and no extra compensation will be allowed by reason of such changes.

3) Admixtures:
   a) Use air-entraining admixture in exterior exposed concrete. Add air-entraining admixture at the manufacturer=s prescribed rate to result in concrete at the point of placement having air content within the following limits. Concrete structures and slabs exposed to freezing and thawing:
      5% for maximum 2" aggregate
      5-1/2% for maximum 1- 2@ aggregate
      6% for maximum :" aggregate
      7% for maximum 2" aggregate
   b) Use admixtures for water-reducing and set-control in strict compliance with the manufacturer=s directions.
   c) Use amounts of admixtures as recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and types of admixtures as required to maintain quality control.

e. WEATHER PROTECTION
1) Cold Weather: Apply recommendations of ACI 306 - latest issue
2) Hot Weather: Apply recommendations of ACI 305 - latest issue. Employ suitable means to prevent drying too rapidly. Shade fresh concrete as soon as possible without marring surface.
3) Wet Weather: Unless adequate protection is provided, do not place concrete in rain, sleet or snow.

f. INSTALLATION OF EMBEDDED ITEMS
1) The installation of all inserts required by other trades shall be coordinated with, or shall be in place prior to, the placing of reinforcing steel.
2) The Contractor shall place anchor bolts, adjustable anchor slots, etc., furnished by other Sections.
3) Coordination with other trades:
   a) Include installation of anchors, sleeves, tiles, angles, etc., furnished by subcontractors responsible for the facilities to be attached to these devices. Leave openings for pipes, ducts, etc., required for the ventilation, heating, electrical and plumbing work. Provide concrete pads for outside pipes and utilities as required. Notify all trades concerned with sleeves, inserts, etc., to check their work before concrete is cast.

b) Embed no pipes other than electrical conduit in any structural concrete. Provide sleeves or holes for pipes passing through footing and foundations. Refer to AC 318.

g. INSPECTION

1) Assure that excavations and form work are completed and that ice and excess water are removed.
2) Check that reinforcement is secured in place.
3) Verify that expansion joint material, anchors and other embedded items are secured in position.

h. JOINTS

1) Construction Joints: Locate and install construction joints, which are not shown on the drawings, so as not to impair the strength and appearance of the structure, as acceptable to the Engineer.
2) Provide keyways at least 1- 2" deep in all construction joints in walls, slabs and between walls and footings; accepted bulkheads designed for this purpose may be used for slabs.
3) Place construction joints perpendicular to the main reinforcement. Continue all reinforcement across construction joints.

i. CONCRETE INSTALLATION

1) Placing Concrete:
   a) Convey concrete from mixer to final position by method which will prevent separation or loss of material.
   b) Maximum height of concrete free fall, three feet
   c) Regulate rate of placement so concrete remains plastic and flows into position.
   d) Deposit concrete in continuous operation until panel or section is completed.
   e) Place concrete in horizontal layers 18 inch maximum thickness.
2) Consolidating Concrete:
   a) Use mechanical vibrating equipment for consolidation.
   b) Vertically insert and remove hand-held vibrators at points 18 inches to 30 inches apart.
   c) Do not use vibrators to transport concrete in forms.
   d) Vibrate concrete minimum amount required for consolidation.
3) Finishing
   a) Float Finish: Apply float finish to monolithic slab surfaces that are to receive trowel finish and other finishes as hereinafter specified.After screeding and consolidating concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared and concrete has stiffened sufficiently to permit operation of power driven floats. Consolidate surface with power driven floats, or by hand

floating if area is small or inaccessible to power units. Check and level surface plane to a tolerance not exceeding 3 inch in 10 ft. when tested with a 10 ft. straightedge. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

b) Trowel Finish: Apply trowel finish to monolithic slab surfaces that are to be exposed to view, unless otherwise shown, and slab surfaces that are to be covered with resilient flooring, paint or other thin-film finish coating system. After floating, begin first trowel finish operation using a power-driven trowel. Consolidate concrete surface by final handtroweling operation, free of trowel marks, uniform in texture and appearance and with a surface plane tolerance not exceeding c inch in 10 ft. when tested with a 10 ft. straightedge. Grind smooth surface defects which would telegraph through applied floor covering system.

c) Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete platforms and walkways and corridors. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with the Engineer before application.

4) Curing and Protection

a) General: Protect freshly placed concrete from premature drying and excessive cold or hot temperature, and maintain without drying at a relatively constant temperature for a period of time necessary for hydration of cement and proper hardening.

i. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 72 hours.

ii. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue curing for at least 7 days and in accordance with ACI 301 procedures. Avoid rapid drying at end of curing period.

b) Curing Methods: Perform curing of concrete by moist curing by moisture-retaining cover curing, by membrane curing, and by combinations thereof, as herein specified. For curing, use only water that is free of impurities which could etch or discolor exposed, natural concrete surfaces.

i. Provide moisture curing by any of the following methods:

ii. Keeping surface of the concrete continuously we by covering with water.

iii. Continuous water-fog spray.
iv. Covering the concrete surface with the specified absorptive cover, thoroughly saturating the cover with water, and keeping the absorptive cover continuously wet. Place absorptive cover so as to provide coverage of the concrete surfaces and edges, with a 4" lap over adjacent absorptive covers.
v. Provide moisture-cover curing as follows: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape of adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
vi. Provide liquid membrane curing as follows: Apply the specified membrane-forming curing compound to damp concrete surfaces as soon as water film has disappeared. Apply uniformly in two-coat continuous operation by powerspray equipment in accordance with manufacturer=s directions. Maintain continuity of coating and repair damage during the entire curing period.
vii.

j. MISCELLANEOUS CONCRETE ITEMS

1) Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete the work.
2) Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of the manufacturer furnishing machines and equipment.
3) Reinforced Masonry: Provide concrete grout for reinforced masonry lintels vertical wall reinforcements and bond beams where indicated on drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.

k. CONCRETE SURFACE REPAIRS

1) Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, but only when acceptable to the Engineer.
2) Cut out honeycomb, rock pockets, voids over 2 inch diameter and holes left by tie rods and bolts, down to solid concrete but, in no case

to a depth of less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Before placing cement mortar, thoroughly clean, dampen with water and brush-coat the area to be patched with neat cement grout. Proprietary patching compounds may be used when acceptable to the Engineer.

3) For exposed-to-view surfaces, blend white portland cement and standard portland cement so that, when dry, patching mortar will match color of surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

I. COMPACTION OF BACKFILL

1) Hand compaction or suitable mechanical compaction shall be provided to backfill around, adjacent to and above all concrete footings, foundations and walls which are below grade.
2) Dry density of compacted backfill shall be at least 950% of Standard Proctor Density.
3) Moisture content of backfill material shall be maintained or adjusted to allow proper compaction.

F. PLASTIC SEWER PIPE AND FITTINGS

1. SCOPE.

The work specified under this section includes the manufacture, construction, and installation of polyvinyl chloride (PVC) pipe and fittings for gravity and pressure animal waste collection and transfer pipeline systems.

2. BASIN INLET STRUCTURES.

The inlet structures shall be defined as beginning at the final clean out and continuing through the inlet support in the lagoon as shown on the plans. The inlet structures shall be installed to the lines and grades as shown on the plans. The inlets shall be constructed of ADS-N:12. Pipe shall be hand back-filled and compacted a minimum of 3 feet from the basin interior finish line to preclude any seepage path along the pipe.

3. PIPELINE.

a. MATERIALS. Pipe used in all mains and services shall be rigid extruded Polyvinyl Chloride (PVC) pipe. All pipe used shall conform to Commercial Standard 256-63 for Polyvinyl Chloride (PVC) Pressure pipe, and ASAE Standard S376, Design, Installation and Performance of Underground Thermoplastic Irrigation Pipelines. All pipe shall have the following minimum strengths: SDR35 for gravity drains and SDR26 for pressure lines.

b. INSTALLATION. All pipe shall be clean on the inside and free of any foreign material. If the Engineer deems it necessary, the pipe shall be cleaned by passing a swab of the proper size through the pipe before joining. Once cleaned, the pipe shall be kept clean during and after installation. A tight cap shall be placed over the open end of the installed pipeline after each workday.

c. TRENCHING AND BACKFILL. Where possible the pipe trench shall be excavated to a depth sufficient to provide a minimum cover of 48 inches above the top of the pipe for pressure lines and 30 inches for gravity lines. Backfill immediately adjoining the pipe to 12 inches above the pipe shall be loose soils or sand free from stone. Where possible this shall be obtained from the site, but if suitable material is not available on site, an acceptable borrow area, as determined by the Engineer, shall be supplied by the Owner. In areas where any rock is encountered, backfill pipe to avoid damage to the pipe and eliminate the presence of potentially damaging rock. The remainder of the backfill may be placed by hand or machine. This material shall contain no rock larger than 6 inches in it=s longest dimension except in areas where rip rap is needed in the top 6 inches of fill. Any rock incorporated as backfill must first be approved by the Engineer. In areas where no rock is encountered, all backfill may be machine placed. All waste rock and brush caused by the installation of the

waterline shall be disposed of. Backfill shall be mounded over the trench to allow for future settlement. Vegetative reseeding shall be required only on large disturbed areas such as around the manhole site.

d. PIPE LAYING. Pipe routes shall be as shown on the plans. Pipe may be strung along in advance of trenching but only as may be reasonably installed in one work day.
Trenches shall be allowed to nearly reach the temperature of the surrounding earth before attachment to fixed structures or back filling operations commence as outlined in ASAE Standard S376 for placement in extremely hot or cold weather.

e. PRESSURE SEWER LINES. All pressure sewer lines shall be installed to the lines and grades as shown on the plans. Tolerance for sewer grades shall to +0.5% in any 100 foot section. No slope reversals shall be tolerated. All sewer pipe shall be SDR 51 PVC plastic with bell and gasket joints for gravity lines and SDR 26 PVC plastic with bell and gasket joints for pressure lines. All pipe shall be installed according to the ASTM Recommended Practice for the Installation of PVC Sewer Pipe ASTM 2341. Proper safety precautions for installations in deep trenches shall be followed at all times. Cleanouts shall be installed every 200 feet as shown on the plans. Earthfill over the sewer lines shall be compacted to the same density as is required in adjacent fill.

f. SEWER LINE ROUTES. Placement of fill over sewer lines shall follow procedures outlined in the waste storage pond embankment section of these specifications. Minimum 50 inch cover depths shall be obtained over all pressure sewer lines and gravity lines by placement of additional fill in areas needed. Compaction of this fill where not located under proposed buildings shall be to the same levels as specified for earthfill placed in the waste storage pond embankment. Where the sewer line is to be buried on the pond dike, adequate excess fill above design height shall be place to maintain 50 inch of cover there also. The fill required to do this shall be placed on the top of the berm and blended in with the design slopes of the berm. Adequate measures shall be taken to insure drainage paths are not obstructed by earthfill placed to insure adequate sewer line cover. Grade on fill placed over sewer line routes shall be adequate to maintain proper surface drainage.

g. THRUST BLOCKING. Thrust blocking prevents line movement and is required primarily with rubber gasket joints. Thrust blocks are required at the following locations:

1) Where the pipe changes the direction of the water (tees, elbows, crosses, etc.)
2) Where the pipe size changes (reduces)
3) At the end of the pipeline (clean outs, plugs, etc.)
4) Where there is an in line valve.

Thrust blocks shall be placed against a solid wall, usually hand excavated. Sizing and placement shall be determined as shown in the plans and ASAE S376 or a minimum of 2000 psi compressive strength at 28 days.

Thrust blocking shall be provided similarly wherever needed in all suspended piping in the unit. Blocking shall provide neat, secure, and serviceable installation using suspension strapping, joint ties and other appropriate means as reviewed and approved by the Engineer.

h. INSPECTION. Each phase of construction of the lines shall be inspected and approved by the Engineer or a qualified representative of the Engineer.

The inspector shall examine and determine the adequacy of the following construction steps:

1) Trenching - minimum depth and condition of the bottom of trench.
2) Placement of bedding material (if required).
3) Installation of pipe (cleaning, joint testing, snaking, thrust blocks).
4) Supervised backfill to 12 inches over pipe.
5) Mechanical placed backfill in areas without rocks and above 12 inches over pipe.
6) Testing - (pressure check, leak repair).

In areas where rock is encountered, the bedding together with the first 12 inches of carefully placed fill shall be done only with the inspector present.

i. ORDER OF WORK. Work shall commence at the point of connection to the source and commence in an orderly manner so that each section of line is tied together and tested in sequence. More than one section of line may be constructed at the same time, but work shall commence toward joining together all sections to be tested in sequence. Priority of construction shall be determined by the Engineer.

j. SYSTEM TESTING. All pressure lines shall be hydrostatically tested at the pressure rating of the pipe or 160 psi, whichever is less.
The system shall be tested in segments that can be isolated by valving or dead ends in the finished system. Sufficient backfilling shall be carried out prior to testing to prevent damage to fittings caused by excessive pipe movement. Testing shall be conducted in the following manner:

1) Slowly fill the pipe with water until all air is exhausted from the system. Bleed each meter site until all air is removed.
2) Raise pressure to working strength of the pipe or 160 psi, whichever is less, based upon the lowest elevation of the pipe adjusted to the elevation of the pressure gauge. This should be done by controlled pumping from a container of known volume.
3) Pressure must be maintained for 2 hours without additional pumping. A chart should be kept for each test performed showing pressure changes as a function of time. This can be manually recorded or recorded by appropriate instrumentation under the supervision of the inspector.

If constant pressure cannot be maintained for 2 hours without additional pumping, a leak may be indicated in the segment. The leak shall be located and repaired and the segment retested. Entrapped air can cause pressure drops of up to 10 psi without a leak being present under certain conditions so a longer test period may be needed if air is believed to be in the system.
If all means of finding a leak have been exhausted without success, the Engineer may use the following method to determine leakage:
1) Fill containers of known volume and maintain pressure in segment for 2 hours by pumping from these containers.
2) Measure water required to refill containers after 2 hour test period.
3) Leakage shall not exceed 10 gallon per inch of pipe diameter per mile of pipe over 24 hours.

The inspector shall be present at times of testing and record results. The inspector shall make results of the tests available to the Owner.
All defective materials found during testing shall be removed and replaced at the Contractor=s expense. No segment of the line shall be approved by the Engineer until it has been successfully tested. The contractor shall furnish all the necessary equipment for testing and make the test at his own expense.

4. VALVE AND CLEANOUTS.

a. CHECK VALVES. Where the check flow meters are shown on the final plans, the check valve shall be an 8" diameter check valve or equivalent.
b. VALVE BOXES. Valve boxes shall either be a CMP pipe sized and cut to the appropriate length for the valve installed or a typical valve box as

shown on the plans. Boxes shall be of a length compatible with the depth of trench required. Boxes for all gate valves and cleanouts shall use 8 or 10 inch SDR 26 PVC pipe. Lids shall be either a standard PVC caps or a typical valve box as shown on the plans.

c. SETTING VALVES. Valves shall be located according to the instructions of the Engineer. The valve boxes shall be set directly over the valve, plumbed and top brought level with the ground and backfilled. The backfill shall be thoroughly tamped around the box.

d. CLEANOUTS. Cleanouts shall be located on all gravity sewer lines that extend longer than 200 feet. Cleanouts shall be spaced no more than 200 feet apart and shall be located on any corners. They shall be constructed as shown on the plans.

5. PUMP STATION.

a. FLUME PUMP. The flume pump is a floating pump on Cell 2 and will be used to move the solids out of the freestall barn through an 18" flush flume. The pump will be a Daritech 250 Flush Floater 40 HP 8x16x14 or equivalent. The pump is to be capable of pumping 1250 gpm @ 65 feet of total dynamic head (TDH). The pump shall be installed on the pontoon as shown on the plans. Valving and fixtures shall be as shown on the final plans and as specified in the specifications.

b. FLUME PUMP CONTROLS. The pump will be controlled using a manual switch. Nema 1 enclosure will be used, size 1 with disconnect, 110 volt control power transformer, H-O-A selector switch, run light, hour meter, alarm, magnetic starter and beaters.

QUALITY ASSURANCE PLAN:

QUALITY ASSURANCE PROGRAM

TABLE OF CONTENTS

1. LINES OF AUTHORITY

2. SPECIALIZED SKILLS OR WORK QUALIFICATIONS

3. OBSERVATION AND OVERSIGHT DUTIES

4. TEST PROCEDURES, FREQUENCIES AND REPORTING

QUALITY ASSURANCE PROGRAM

1. LINES OF AUTHORITY

a. The ENGINEER will act in the capacity of the OWNER and will ensure the project is completed according to the DRAWINGS and SPECIFICATIONS.

b. The CONTRACTOR shall keep on the work site a copy of current DRAWINGS and SPECIFICATIONS.

c. In case of conflict between the DRAWINGS and SPECIFICATIONS, the SPECIFICATIONS shall govern. Figured dimensions on DRAWINGS shall govern over general DRAWINGS.

d. Any discrepancies found between the DRAWINGS and SPECIFICATIONS and site conditions or any inconsistencies or ambiguities in the DRAWINGS or SPECIFICATIONS shall be immediately reported to the ENGINEER, who shall promptly correct such inconsistencies or ambiguities.

2. SPECIALIZED SKILLS OR WORK QUALIFICATIONS

a. Any testing or inspection conducted will be under the approval of the ENGINEER.

b. All sampling and testing will be conducted by an authorized representative of the ENGINEER or by a testing company approved to conduct tests as specified in the SPECIFICATIONS.

3. OBSERVATION AND OVERSIGHT DUTIES

a. The ENGINEER or his representative will stake out the construction of the facility.

b. The construction will be inspected by the ENGINEER or his assigned representative.

c. During the construction of the following components the ENGINEER will have an opportunity to have a representative on site.

1) Core Trench
2) Pond Liner
3) Staff Gage.
4) Transfer Line and Pump Installation.

d. After finished construction, the site will be measured by the ENGINEER to ensure it was constructed as planned.

4. TEST PROCEDURES, FREQUENCIES AND REPORTING

a. The Construction of the Site will meet the SPECIFICATIONS identified in this section.

b. The berm fill will be tested at the ENGINEER=s discretion to ensure it is being constructed according to the SPECIFICATIONS.

c. The constructed liner shall have a maximum seepage rate no greater than 0.125 inch per day. To verify that the seepage requirement is met, the following option of procedures will be followed:

1) Non-Destructive Seam Continuity Testing on HDPE Liner

The installation company shall non-destructively test all field seams over their full length using a vacuum test unit, air pressure testing, or other approved method. The purpose of non-destructive tests is to check the continuity of seams. It does not provide information on seam strength. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

2) FIELD SAMPLING AND TESTING ON EDPM Liner

Non-Destructive Field Seam Testing: All field seams shall be non-destructively tested over their full length in accordance with ASTM D 4437 (high pressure air lance) to ensure seam continuity. Seam testing shall be performed as the seaming work progresses, not at the completion of field seaming. Seams that fail shall be documented and repaired in accordance with the manufacturer's specifications and details.

d. A final certification and report will be conducted by the ENGINEER to ensure that the facility is within $\pm$ 5 % in dimensions and that the liner as well as all critical components were constructed according to the DRAWINGS and SPECIFICATIONS.

STATE OF ARKANSAS
REPORT ON WATER WELL CONSTRUCTION & PUMP INSTALLATION

MAIN MENU | RESET | SUBMIT

A

1. Contractor Name & Number: 1077 ARNOLD WELL DRILLING & PUMP SE
2. Driller Name & Number: 2819 JOSHUA ARNOLD
3. Pump Installer Name & Number:
4. Date Well Completed: 02/15/2013 New Well

5. COUNTY : NEWTON (101)
6 FRACTION ¼ of ¼
7 SECTION:
8 TOWNSHIP
9 RANGE

11. LONGITUDE 93-04-23 12. LATITUDE 35-55-27

B

DESCRIPTION OF FORMATION	DEPTHS IN FEET FROM	TO	WATER BEARING	IF YES.. DEPTH
Red Clay	0	54	No	
Gray Limestone	54	310	Yes	145
White Limestone	310	320	No	
Gray Limestone	320	325	No	
			Yes	285
			No	
			Yes	265
			No	

2. TOTAL DEPTH OF WELL 325
3. STATIC WATER LEVEL 138 Ft. below land surface
4. YIELD 30 gallons per
5. DIAMETER OF BORE HOLE 6.06 IN

C PUMP REPORT

1 TYPE PUMP
2 SETTING DEPTH FEET
3 BRAND NAME AND SERIAL NUMBERS:
4 RATED CAPACITY gallons per minute
5 TYPE LUBRICATION
6 DROP PIPE OR COLUMN PIPE SIZE
7 WIRE SIZE
8 PRESSURE TANK:
SIZE: MAKE: MODEL:
9 DATE OF INSTALLATION OR REPAIR
10 Is there an abandoned water well on the property?

FT TO: FT

D

1 LAND OWNER OR OTHER CONTACT PERSON
NAME JASON HENSON (C & H FARM)
STREET ADDRESS HC 72 BOX 10
CITY MT JUDEA

CASING FROM 0 TO 74 W/ 6.25 Inner Diameter
CASING FROM TO W/ Inner Diameter
TYPE CASING STEEL

3. SCREEN
TYPE: DIA SLOT/GA
SET FROM FT TO FT
TYPE: DIA SLOT/GA
SET FROM FT TO FT

4. GRAVEL PACK FROM: FT TO: FT
5. BACK FILLED WITH: CUTTINGS
FROM: 0 FT TO: 69 FT
6. SEALED WITH: BENTONITE
FROM: 69 FT TO: 74 FT
FROM: FT TO: FT
7. DISINFECTED WITH: CHLORINE
8. USE OF WELL:
COMMERCIAL
OTHER
A/C HEATPUMP TYPE WELLS

(For A/C only)Will system also be used for purposes other than Heating and Air Conditioning?
If yes, name use:
(For A/C open-loop only) Into what medium is water returned?
11. REMARKS
12. SIGNED DATE

STATE OF ARKANSAS
REPORT ON WATER WELL CONSTRUCTION & PUMP INSTALLATION

MAIN MENU | RESET | SUBMIT

A

1. Contractor Name & Number: 1077 ARNOLD WELL DRILLING & PUMP SE
2. Driller Name & Number: 2819 JOSHUA ARNOLD
3. Pump Installer Name & Number:
4. Date Well Completed: 06/12/2015 New Well

5. COUNTY : NEWTON (101)
6 FRACTION ¼ of ¼
7 SECTION:
8 TOWNSHIP
9 RANGE

11. LONGITUDE 93-04-25 12. LATITUDE 35-55-23

B

DESCRIPTION OF FORMATION	DEPTHS IN FEET FROM	TO	WATER BEARING	IF YES.. DEPTH
Red Clay	0	45	No	
Gray Limestone	45	320	Yes	180
White Limestone	320	345	Yes	345
Gray Limestone	345	355	No	
Gray Limestone	355	488	No	
Gray Sand	488	665	Yes	660
			Yes	230
			No	
			No	
			Yes	320

2. TOTAL DEPTH OF WELL 665
3. STATIC WATER LEVEL 120 Ft. below land surface
4. YIELD 30 gallons per
5. DIAMETER OF BORE HOLE 6 IN

C PUMP REPORT

1 TYPE PUMP
2 SETTING DEPTH FEET
3 BRAND NAME AND SERIAL NUMBERS:
4 RATED CAPACITY gallons per minute
5 TYPE LUBRICATION
6 DROP PIPE OR COLUMN PIPE SIZE
7 WIRE SIZE
8 PRESSURE TANK:
SIZE: MAKE: MODEL:
9 DATE OF INSTALLATION OR REPAIR
10 Is there an abandoned water well on the property?

FT TO: FT

D

1 LAND OWNER OR OTHER CONTACT PERSON
NAME C & H FARMS
STREET ADDRESS HC 72 BOX 10
CITY MT. JUDEA

CASING FROM 0 TO 85 W/ 6.25 Inner Diameter
CASING FROM TO W/ Inner Diameter
TYPE CASING STEEL

3. SCREEN
TYPE: DIA SLOT/GA
SET FROM FT TO FT
TYPE: DIA SLOT/GA
SET FROM FT TO FT

4. GRAVEL PACK FROM: FT TO: FT
5. BACK FILLED WITH: CUTTINGS
FROM: 0 FT TO: 80 FT
6. SEALED WITH: BENTONITE
FROM: 80 FT TO: 85 FT
FROM: FT TO: FT
7. DISINFECTED WITH: CHLORINE
8. USE OF WELL:
COMMERCIAL
OTHER
A/C HEATPUMP TYPE WELLS

(For A/C only)Will system also be used for purposes other than Heating and Air Conditioning?
If yes, name use:
(For A/C open-loop only) Into what medium is water returned?
11. REMARKS
12. SIGNED DATE

Hogan, Stephen

From: Nathan Pesta <Nathanpdga@btinet.net>
Sent: Friday, July 06, 2012 5:24 PM
To: Hogan, Stephen; jasonh@rittermail.com
Cc: danddga@btinet.net; 'Geoffrey Bates'
Subject: C & H Hog Farm Update

Follow Up Flag: Follow up
Flag Status: Flagged

Stephen,
The SPAW software results for the calculations is in the below link. In addition the update to the Geological Investigations and Quality Assurance Plan.
https://dl.dropbox.com/u/31768078/Henson%2C%20Jason/Submittal/Geological%20Investigation%20and%20Quality%20Assurance%20Update.pdf
https://dl.dropbox.com/u/31768078/Henson%2C%20Jason/Submittal/SPAW%20Results%20Ponds%20Combined.pdf
https://dl.dropbox.com/u/31768078/Henson%2C%20Jason/Submittal/SPAW%20Results%20Pond1-Pond%202%20in%20series.pdf

A hard copy will be in the mail.

Cordially,

Nathan A.Pesta P.E.
Senior Project Engineer
DeHaan, Grabs and Associates, LLC
Bus 701-663-1116
Cell 701-400-3950
Fax 701-667-1356
www.dgaengineering.com

3. Geologic Investigation

The USDA Soil Survey predicts that the soil in the location of the storage structures is primarily a Noark very cherty silt loam, 3 to 8% slopes, (42). The soil profile for 42 from 0 to 14 inches is very gravelly silt loam, from 14-43 inches is very gravelly silty clay, and from 43-72 inches is very gravelly clay.

The holding ponds will be constructed with an 18-inch thick liner.

Geotechnical & Testing Services conducted laboratory tests on some of the samples. Atterburg limits were run on the soil samples for the sandy lean clay. The results were as follows:

Boring #	Depth (ft)	Description	LL	PL	PI
2	3.0– 4.5'	Silty Lean Clay	38	22	16
2	4.5 – 6.0'	Sandy Lean Clay	44	24	20
2	7.0 – 8.5'	Fat Clay w/sand	93	38	55
2	9.5-11'	Sandy Fat Clay	64	23	41
3	7-8.5'	Fat Clay w/sand	58	36	22
3	9.5-11'	Clayey Gravel with Sand	81	44	37

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

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

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

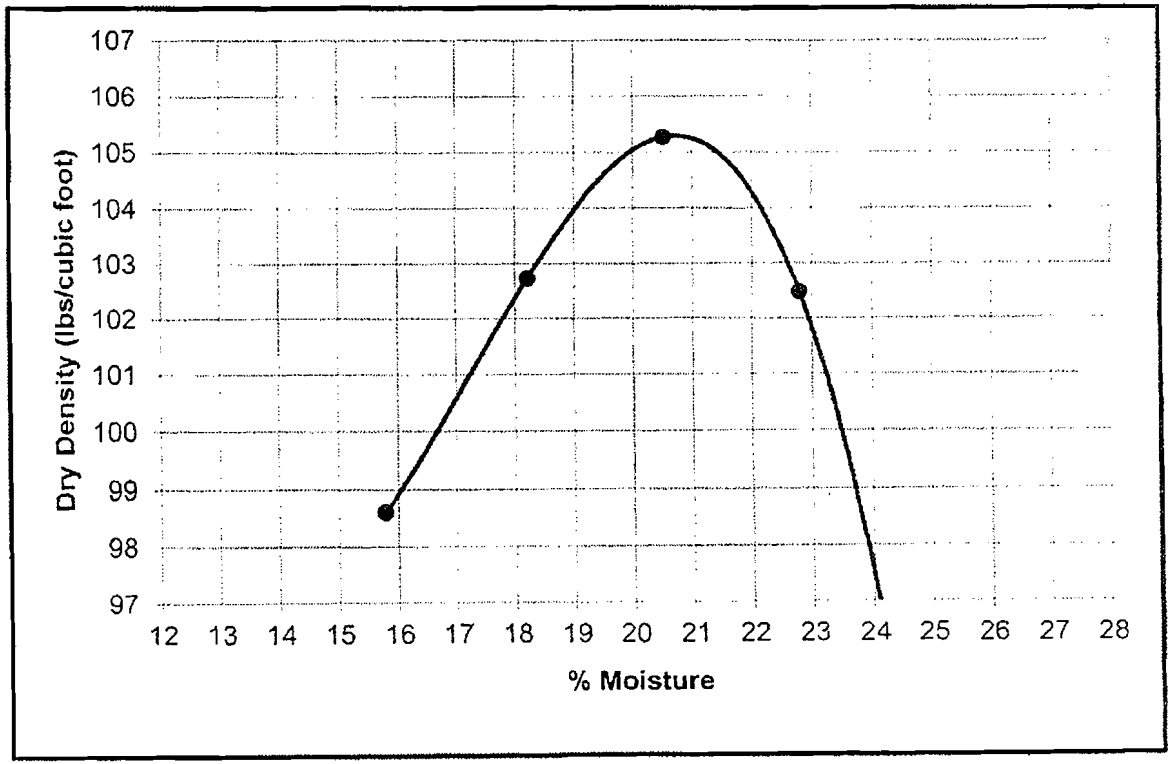
Currently it is recommended that the liner be constructed at 98% compaction +-2% Optimum Moisture to meet seepage requirements.
The seepage rate of any compacted liner that will be used will be less than the maximum allowable seepage rate of 5,000 Gallons/acre/per day as required by Arkansas Department of Environment Quality.

GTS, Inc.
Geotechnical & Testing Services

LABORATORY COMPACTION CHARACTERISTICS OF SOIL

CLIENT:	DeHaan, Grabs & Associates, LLC	DATE:	6/14/12	SAMPLE LOCATION:	8-2. Bulk Grab Sample	LL=	64
PROJECT NUMBER:	12-15049	LAB NO.	1	SAMPLE DESCRIPTION:	Red with Light Gray Streaks	PL=	23
PROJECT NAME:	Proposed Pond and Building Pads	TEST METHOD:	ASTM D698	AASHTO CLASS.:	N/A	PI=	41
				VISUAL CLASSIFICATION:	Fat Clay, with Sand		

Maximum Dry Density (lbs./cubic foot)	105.2
Optimum Moisture (percent)	20.7



1915 North Shiloh Drive, Suite 1
Fayetteville, Arkansas 72704
Office: (479) 521-7645
Fax: (479) 521-6232

GTS, Inc.
Geotechnical & Testing Services

Hydraulic Conductivity Test Procedures Performed
In Accordance With ASTM D 5084 Method C
(Flexible Wall - Falling Head - Rising Tail)

HYDRAULIC CONDUCTIVITY TEST RESULTS

PROJECT: Mt. Judea -
Proposed Pond and Building Pads

PROJECT NUMBER: 12-15049

SAMPLE: N/A

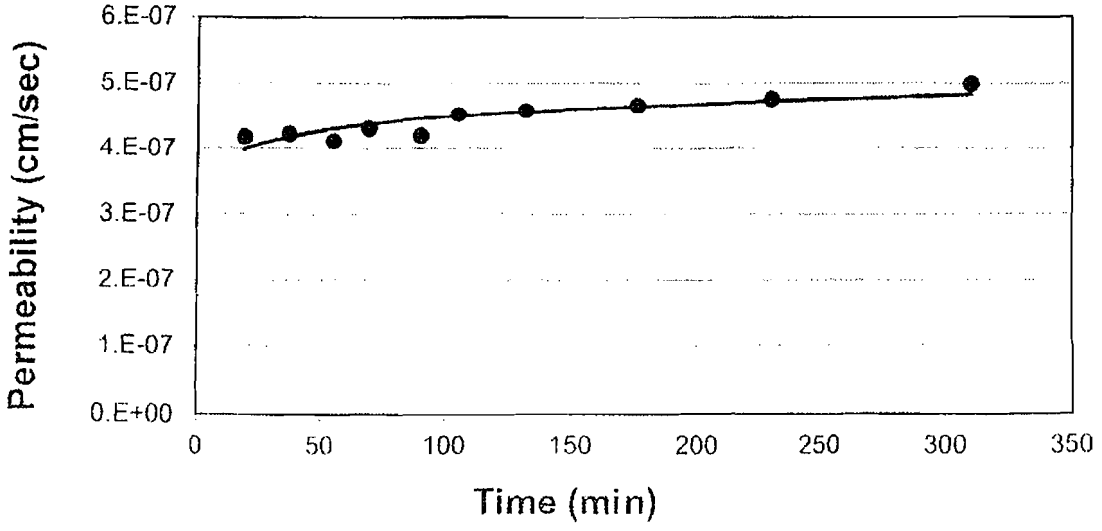
BORING: B-2

SAMPLE TYPE: Recompacted

DEPTH (ft): 7 - 11

Hyrdraulic Conductivity, k (cm/s): 5.E-07

Test Parameters	*Initial Sample Data*	*Final Sample Data* (after consolidation and testing)
Cell Pressure (psi): 8	**Diameter (in):** 2.57	**Diameter (in):** 2.55
Inflow Pressure (psi): 4	**Length (in):** 4.58	**Length (in):** 4.54
Outflow Pressure (psi): 3	**Moisture Content:** 21.3%	**Moisture Content:** 25.3%
Back Pressure (psi): 3	**Wet Unit Weight (pcf):** 125.2	**Wet Unit Weight (pcf):** 130.3
Confining Pressure (psi): 4	**Dry Unit Weight (pcf):** 103.2	**Dry Unit Weight (pcf):** 103.9
	Initial Hydraulic Gradient: 5.29	**Final Hydraulic Gradient:** 5.03



Notes: Sample was recompacted at 98.1% of MDD at a moisture content of 21.2% (at OMC +0.5%)

4. QUALITY ASSURANCE PROGRAM

4.1 LINES OF AUTHORITY

4.1.1 The ENGINEER will act in the capacity of the OWNER and will ensure the project is completed according to the DRAWINGS and SPECIFICATIONS.

4.1.2 The CONTRACTOR shall keep on the work site a copy of current DRAWINGS and SPECIFICATIONS.

4.1.3 In case of conflict between the DRAWINGS and SPECIFICATIONS, the SPECIFICATIONS shall govern. Figured dimensions on DRAWINGS shall govern over general DRAWINGS.

4.1.4 Any discrepancies found between the DRAWINGS and SPECIFICATIONS and site conditions or any inconsistencies or ambiguities in the DRAWINGS or SPECIFICATIONS shall be immediately reported to the ENGINEER, who shall promptly correct such inconsistencies or ambiguities.

4.2 SPECIALIZED SKILLS OR WORK QUALIFICATIONS

4.2.1 Any testing or inspection conducted will be under the approval of the ENGINEER.

4.2.2 All sampling and testing will be conducted by an authorized representative of the ENGINEER or by a testing company approved to conduct tests as specified in the SPECIFICATIONS.

4.3 OBSERVATION AND OVERSIGHT DUTIES

4.3.1 The ENGINEER or his representative will stake out the construction of the facility.

4.3.2 The construction will be inspected by the ENGINEER or his assigned representative.

4.3.3 During the construction of the following components the ENGINEER will have a representative on site.

4.3.3.1 Placement of Reinforcement in floor
4.3.3.2 Pouring of concrete floor
4.3.3.3 Reinforcement of concrete wall and columns.

4.3.3.4 Pouring of concrete wall and columns.

4.3.4 After finished construction, the site will be measured by the ENGINEER to ensure it was constructed as planned.

4.4 TEST PROCEDURES, FREQUENCIES AND REPORTING

4.4.1 The Construction of the Site will meet the SPECIFICATIONS identified in this section.

4.4.2 The Concrete placement will be tested as identified in the SPECIFICATIONS under section F.2.6.
Slump and a minimum of 3 cylinders shall be taken at an interval of no more that once each 100 CY of concrete or once per pour, whichever is greater. If the slump is not between 3 to 5 inches the concrete should be refused until it is the correct slump. One cylinder of each set shall be tested at 7 days and one at 28 days. The third shall be kept for re-testing if necessary. If any of the 28-day tests fail to meet the minimum compressive strength specified on the construction plans, the extra cylinder shall be tested. If the both the 28-day and the extra cylinder fail to meet the minimum required compressive strength, a minimum of 3 concrete cores shall be taken of the area in question and tested for compressive strength at the contractor's expense

4.4.3 The Waste Storage Pond 1 liner as installed shall be tested at a minimum rate of four tests per lift. Waste Storage Pond 2 liner as designed shall be tested at a minimum rate of four tests per lift. The tests will be conducted using ASTM Standard D-2292 (Nuclear Methods) and the fill area shall be uniformly compacted to 98.0% Standard Proctor Density as determined by a testing lab approved by the Engineer. The moisture content at the time of compaction for cohesive soils shall be 0 ± 2% of optimum moisture content. In the event that one or more tests fail, the area of failure will be reworked and tested at a rate of two tests per acre of failed area. Test locations should be randomly and equally distributed over the failed area. The test locations will be documented on a plan view, which will be included with a report of the test results.

In lieu of the density/moisture tests, Permeability tests could be conducted instead. Waste Storage Pond 1 would require two permeability tests, and Waste Storage Pond 2 would require 2 per pond that meet the ADEQ maximum seepage rate of 5,000 Gallons/Acre/Day at liquid level depth may be conducted on the completed liner, upon approval by the ENGINEER.

4.4.4 A final certification and report will be conducted by the ENGINEER to ensure that the facility is within + 5 % in dimensions and that the liner as

well as all critical components were constructed according to the DRAWINGS and SPECIFICATIONS.

A SUMMARY OF ACCUMULATIVE MONTHLY POND VOLUMES FOR COMBINED POND STORAGE

Info: The ponds were combined in storage

SIMULATION BY:

Nathan A. Pesta
Senior Project Engineer
DeHaan, Grabs & Associates, LLC
PO Box 522
Mandan, ND, 58554

SIMULATION FOR:

File : C:\Program Files\SPAW Hydrology\SPAW\Projects\Ponds\Examples\Henson, Jason\Henson, Jason.pnd
File Creation Date : Jul 03, 2012 16:15:58
File Last Modified Date : Jul 06, 2012 16:09:22
Description : Combined Waste Storage Pond
Simulation Start Date : Jan 01, 1960
Simulation End Date : Dec 31, 2006
Simulation Run Date : Jul 06, 2012 16:09
SPAW Interface Version : Jul 06, 2012 16:09:21
Pond Model Version : 6.02.71

WATERSHED FIELDS:

DESCRIPTION/FILE (DATE)	AREA (AC)
Pasture -Rainfed (Sample)	0.00
C:\Program Files\SPAW Hydrology\SPAW\Projects\Fields\Examples\Pasture_Henson\Pasture_Henson.fpin Dec 30, 1899 00:00	

IRRIGATED FIELDS:

DESCRIPTION/FILE (DATE)	AREA (AC)
Pasture -Rainfed (Sample)	630.70
C:\Program Files\SPAW Hydrology\SPAW\Projects\Fields\Examples\Pasture\Pasture.fpin Dec 30, 1899 00:00	

POND PROFILE:

DEPTH (FT)	AREA (AC)	VOLUME (AC-FT)
0.00	0.28	0.00
1.00	0.47	0.38

2.00	0.53	0.88
3.00	0.60	1.44
4.00	0.66	2.07
5.00	0.73	2.77
6.00	0.80	3.53
7.00	0.88	4.37
8.00	0.96	5.29
9.00	1.04	6.29
10.20	0.68	7.32
11.00	0.72	7.88
11.70	0.76	8.40
12.70	0.81	9.19

POND PROFILE
MAX AREA (AC) = 0.81
MAX DEPTH (FT) = 12.70
MAX VOLUME (AC-FT) = 9.19
IRRIGATION LIMIT (FT) = 0.00
EXTERNAL INPUT UPPER LIMIT (FT)= 0.00
EXTERNAL INPUT LOWER LIMIT (FT)= 0.00
SUPPLY PUMP LOWER LIMIT (FT) = 0.00
DRAWDOWN PUMP UPPER LIMIT (FT) = 0.00
DRAWDOWN PUMP LOWER LIMIT (FT) = 1.00
SPILLWAY CREST (FT) = 12.70
INITIAL DEPTH (FT) = 1.00
INFIL. INTO DRY SOIL (IN) = 0.50

SEEPAGE RATE (IN/DAY)

DATE	RATE
Jun 14	0.15

MONTHLY VOLUMES BY MAJOR IMPOUNDMENT PROCESSES

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drawdown Pump ac·ft	Spillway ac·ft
Jan	1960	0.82	0.23	0.59	0.1	0.03	0.69	0.03	0	0.204	0	0
Feb	1960	0.87	0.27	0.59	0.14	0.03	0.69	0.06	0	0.215	0	0
Mar	1960	1	0.35	0.65	0.1	0.02	0.88	0.1	0	0.249	0	0
Apr	1960	0.82	2.11	-1.29	0.11	0.02	0.69	0.15	0	0.189	1.77	0
May	1960	1.43	0.46	0.96	0.43	0.11	0.88	0.24	0	0.222	0	0
Jun	1960	0.34	0.58	-0.24	0.14	0.01	0.19	0.34	0	0.235	0	0
Jul	1960	1.28	0.71	0.57	0.37	0.03	0.88	0.45	0	0.258	0	0
Aug	1960	0.78	0.72	0.06	0.09	0	0.69	0.45	0	0.269	0	0
Sep	1960	1.34	0.6	0.73	0.15	0	1.18	0.34	0	0.265	0	0
Oct	1960	0.29	2.9	-2.61	0.1	0	0.19	0.14	0	0.196	2.56	0
Nov	1960	0.97	0.27	0.69	0.07	0.01	0.88	0.07	0	0.202	0	0
Dec	1960	0.98	0.27	0.71	0.22	0.07	0.69	0.03	0	0.238	0	0
Jan	1961	0.74	0.29	0.45	0.05	0	0.69	0.03	0	0.26	0	0
Feb	1961	0.89	0.32	0.57	0.19	0.02	0.69	0.07	0	0.251	0	0
Mar	1961	1.28	0.42	0.86	0.39	0.01	0.88	0.12	0	0.299	0	0
Apr	1961	0.85	3.61	-2.77	0.14	0.02	0.69	0.16	0	0.204	3.24	0
May	1961	1.66	0.48	1.17	0.59	0.18	0.88	0.25	0	0.233	0	0
Jun	1961	0.29	0.6	-0.31	0.09	0	0.19	0.36	0	0.243	0	0
Jul	1961	1.21	0.72	0.49	0.32	0.01	0.88	0.45	0	0.262	0	0
Aug	1961	0.99	0.73	0.26	0.29	0.01	0.69	0.46	0	0.274	0	0
Sep	1961	1.39	0.63	0.77	0.2	0	1.18	0.35	0	0.275	0	0
Oct	1961	0.29	3.18	-2.89	0.1	0	0.19	0.15	0	0.199	2.84	0
Nov	1961	1.18	0.28	0.9	0.21	0.08	0.88	0.07	0	0.207	0	0
Dec	1961	0.94	0.28	0.66	0.2	0.05	0.69	0.03	0	0.245	0	0
Jan	1962	0.9	0.3	0.59	0.18	0.02	0.69	0.04	0	0.269	0	0
Feb	1962	0.84	0.33	0.51	0.15	0.01	0.69	0.07	0	0.259	0	0
Mar	1962	1.05	0.43	0.62	0.17	0	0.88	0.12	0	0.303	0	0
Apr	1962	0.8	3.57	-2.76	0.11	0	0.69	0.16	0	0.204	3.2	0
May	1962	1.02	0.44	0.58	0.12	0.02	0.88	0.22	0	0.21	0	0
Jun	1962	0.46	0.55	-0.09	0.26	0.01	0.19	0.33	0	0.224	0	0

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	awdown Pun ac·ft	Spillway ac·ft
Jul	1962	1.13	0.67	0.46	0.24	0.01	0.88	0.43	0	0.245	0	0
Aug	1962	1	0.69	0.31	0.28	0.03	0.69	0.43	0	0.258	0	0
Sep	1962	1.52	0.6	0.92	0.33	0.01	1.18	0.34	0	0.265	0	0
Oct	1962	0.46	3.09	-2.63	0.22	0.05	0.19	0.15	0	0.199	2.75	0
Nov	1962	0.94	0.28	0.67	0.06	0	0.88	0.07	0	0.205	0	0
Dec	1962	0.75	0.27	0.49	0.06	0	0.69	0.03	0	0.233	0	0
Jan	1963	0.72	0.29	0.43	0.02	0	0.69	0.03	0	0.253	0	0
Feb	1963	0.73	0.31	0.42	0.04	0	0.69	0.06	0	0.241	0	0
Mar	1963	1.09	0.4	0.69	0.19	0.01	0.88	0.11	0	0.285	0	0
Apr	1963	0.77	3.04	-2.27	0.07	0.01	0.69	0.16	0	0.197	2.68	0
May	1963	1.14	0.44	0.7	0.2	0.05	0.88	0.23	0	0.211	0	0
Jun	1963	0.35	0.56	-0.2	0.15	0.01	0.19	0.33	0	0.226	0	0
Jul	1963	1	0.67	0.33	0.11	0	0.88	0.42	0	0.244	0	0
Aug	1963	0.78	0.67	0.11	0.09	0	0.69	0.42	0	0.25	0	0
Sep	1963	1.29	0.57	0.72	0.1	0	1.18	0.32	0	0.25	0	0
Oct	1963	0.21	2.42	-2.22	0.01	0	0.19	0.14	0	0.19	2.09	0
Nov	1963	1.08	0.27	0.81	0.15	0.05	0.88	0.07	0	0.199	0	0
Dec	1963	0.8	0.27	0.53	0.09	0.02	0.69	0.03	0	0.234	0	0
Jan	1964	0.74	0.29	0.45	0.05	0	0.69	0.03	0	0.255	0	0
Feb	1964	0.86	0.33	0.53	0.15	0.02	0.69	0.07	0	0.257	0	0
Mar	1964	1.35	0.42	0.93	0.44	0.02	0.88	0.12	0	0.298	0	0
Apr	1964	0.94	3.64	-2.7	0.23	0.02	0.69	0.16	0	0.204	3.27	0
May	1964	1.09	0.45	0.65	0.17	0.04	0.88	0.23	0	0.214	0	0
Jun	1964	0.29	0.55	-0.26	0.09	0	0.19	0.33	0	0.222	0	0
Jul	1964	0.97	0.66	0.32	0.09	0	0.88	0.42	0	0.239	0	0
Aug	1964	1.07	0.67	0.4	0.37	0.01	0.69	0.42	0	0.25	0	0
Sep	1964	1.44	0.58	0.86	0.25	0.01	1.18	0.32	0	0.256	0	0
Oct	1964	0.21	2.72	-2.5	0.02	0	0.19	0.14	0	0.193	2.38	0
Nov	1964	1.08	0.27	0.8	0.15	0.04	0.88	0.07	0	0.201	0	0
Dec	1964	0.76	0.27	0.49	0.06	0.01	0.69	0.03	0	0.234	0	0
Jan	1965	0.86	0.29	0.56	0.14	0.03	0.69	0.03	0	0.258	0	0
Feb	1965	0.88	0.32	0.56	0.17	0.01	0.69	0.07	0	0.249	0	0

Mar	1965	1.07	0.41	0.66	0.18	0	0.88	0.12	0	0.293	0	0
Mon	Year	Inflow	Outflow	Change	Precip Vol	Bank Runoff	Ext Input	Vol Evap	Vol Infil	Vol Seep	awdown Pun	Spillway
		ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft
Apr	1965	0.94	3.46	-2.53	0.23	0.02	0.69	0.16	0	0.202	3.1	0
May	1965	1.2	0.45	0.75	0.27	0.05	0.88	0.23	0	0.215	0	0
Jun	1965	0.42	0.57	-0.14	0.22	0.01	0.19	0.34	0	0.229	0	0
Jul	1965	1.11	0.69	0.42	0.23	0	0.88	0.43	0	0.251	0	0
Aug	1965	0.84	0.69	0.15	0.15	0	0.69	0.43	0	0.258	0	0
Sep	1965	1.56	0.6	0.96	0.34	0.03	1.18	0.33	0	0.261	0	0
Oct	1965	0.22	2.9	-2.67	0.03	0	0.19	0.14	0	0.195	2.56	0
Nov	1965	0.95	0.27	0.68	0.06	0	0.88	0.07	0	0.2	0	0
Dec	1965	0.81	0.26	0.55	0.11	0.02	0.69	0.03	0	0.23	0	0
Jan	1966	1.04	0.3	0.75	0.29	0.07	0.69	0.03	0	0.262	0	0
Feb	1966	1.1	0.33	0.78	0.38	0.04	0.69	0.07	0	0.259	0	0
Mar	1966	0.98	0.43	0.55	0.1	0	0.88	0.12	0	0.305	0	0
Apr	1966	1.01	3.54	-2.53	0.25	0.07	0.69	0.17	0	0.207	3.16	0
May	1966	1.02	0.46	0.56	0.13	0.01	0.88	0.24	0	0.223	0	0
Jun	1966	0.23	0.56	-0.33	0.03	0	0.19	0.33	0	0.228	0	0
Jul	1966	1.07	0.67	0.4	0.19	0	0.88	0.42	0	0.244	0	0
Aug	1966	0.9	0.68	0.22	0.21	0	0.69	0.42	0	0.254	0	0
Sep	1966	1.3	0.58	0.72	0.11	0	1.18	0.32	0	0.254	0	0
Oct	1966	0.27	2.59	-2.32	0.07	0	0.19	0.14	0	0.193	2.25	0
Nov	1966	0.98	0.27	0.71	0.09	0.01	0.88	0.07	0	0.201	0	0
Dec	1966	0.89	0.26	0.63	0.16	0.04	0.69	0.03	0	0.233	0	0
Jan	1967	0.79	0.29	0.5	0.09	0.01	0.69	0.03	0	0.257	0	0
Feb	1967	0.77	0.32	0.45	0.07	0.01	0.69	0.07	0	0.249	0	0
Mar	1967	0.97	0.41	0.56	0.09	0	0.88	0.12	0	0.289	0	0
Apr	1967	0.91	3.11	-2.2	0.18	0.04	0.69	0.16	0	0.202	2.75	0
May	1967	1.12	0.46	0.66	0.21	0.03	0.88	0.24	0	0.221	0	0
Jun	1967	0.54	0.57	-0.03	0.32	0.03	0.19	0.34	0	0.23	0	0
Jul	1967	1.14	0.71	0.43	0.24	0.02	0.88	0.45	0	0.258	0	0
Aug	1967	0.85	0.71	0.14	0.16	0	0.69	0.44	0	0.266	0	0
Sep	1967	1.48	0.61	0.87	0.28	0.01	1.18	0.34	0	0.267	0	0
Oct	1967	0.69	3	-2.31	0.35	0.15	0.19	0.15	0	0.203	2.65	0

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drawdown Pump ac·ft	Spillway ac·ft
Nov	1967	0.93	0.29	0.64	0.04	0	0.88	0.07	0	0.219	0	0
Dec	1967	1.04	0.28	0.75	0.29	0.06	0.69	0.03	0	0.251	0	0
Jan	1968	0.85	0.31	0.54	0.15	0.01	0.69	0.04	0	0.275	0	0
Feb	1968	0.81	0.35	0.46	0.12	0.01	0.69	0.07	0	0.276	0	0
Mar	1968	1.34	0.44	0.9	0.46	0	0.88	0.13	0	0.314	0	0
Apr	1968	0.92	4.03	-3.1	0.2	0.03	0.69	0.17	0	0.211	3.64	0
May	1968	1.22	0.46	0.76	0.29	0.05	0.88	0.24	0	0.221	0	0
Jun	1968	0.52	0.57	-0.05	0.3	0.03	0.19	0.34	0	0.232	0	0
Jul	1968	1.05	0.7	0.35	0.16	0.01	0.88	0.44	0	0.256	0	0
Aug	1968	0.85	0.71	0.14	0.16	0	0.69	0.44	0	0.264	0	0
Sep	1968	1.54	0.61	0.93	0.33	0.02	1.18	0.34	0	0.265	0	0
Oct	1968	0.33	3.03	-2.7	0.12	0.01	0.19	0.15	0	0.198	2.69	0
Nov	1968	1.43	0.28	1.15	0.4	0.15	0.88	0.07	0	0.213	0	0
Dec	1968	1.11	0.29	0.82	0.35	0.06	0.69	0.03	0	0.253	0	0
Jan	1969	1.04	0.32	0.72	0.33	0.02	0.69	0.04	0	0.283	0	0
Feb	1969	0.85	0.35	0.5	0.16	0	0.69	0.07	0	0.278	0	0
Mar	1969	1.11	0.45	0.65	0.23	-0.01	0.88	0.13	0	0.323	0	0
Apr	1969	0.93	4.2	-3.26	0.21	0.03	0.69	0.17	0	0.212	3.81	0
May	1969	0.98	0.45	0.53	0.09	0	0.88	0.23	0	0.214	0	0
Jun	1969	0.38	0.55	-0.17	0.19	0	0.19	0.33	0	0.224	0	0
Jul	1969	1.01	0.67	0.35	0.13	0	0.88	0.42	0	0.242	0	0
Aug	1969	0.78	0.67	0.11	0.09	0	0.69	0.42	0	0.25	0	0
Sep	1969	1.26	0.57	0.69	0.07	0	1.18	0.31	0	0.248	0	0
Oct	1969	0.56	2.41	-1.85	0.25	0.11	0.19	0.15	0	0.199	2.06	0
Nov	1969	0.96	0.29	0.67	0.06	0.01	0.88	0.07	0	0.213	0	0
Dec	1969	0.95	0.27	0.67	0.22	0.04	0.69	0.03	0	0.242	0	0
Jan	1970	0.76	0.3	0.46	0.06	0.01	0.69	0.04	0	0.268	0	0
Feb	1970	0.8	0.33	0.48	0.11	0.01	0.69	0.07	0	0.257	0	0
Mar	1970	1.14	0.42	0.71	0.24	0.01	0.88	0.12	0	0.302	0	0
Apr	1970	1.16	3.54	-2.38	0.36	0.12	0.69	0.17	0	0.208	3.16	0
May	1970	1.01	0.47	0.53	0.12	0.01	0.88	0.24	0	0.228	0	0

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drawdown Pump ac·ft	Spillway ac·ft
Jun	1970	0.59	0.59	0	0.36	0.04	0.19	0.35	0	0.24	0	0
Jul	1970	0.94	0.71	0.24	0.06	0	0.88	0.45	0	0.258	0	0
Aug	1970	0.89	0.71	0.18	0.2	0	0.69	0.44	0	0.265	0	0
Sep	1970	1.76	0.62	1.14	0.54	0.04	1.18	0.35	0	0.272	0	0
Oct	1970	0.57	3.28	-2.71	0.27	0.1	0.19	0.15	0	0.205	2.93	0
Nov	1970	1.03	0.29	0.74	0.12	0.03	0.88	0.07	0	0.216	0	0
Dec	1970	0.78	0.28	0.5	0.08	0.01	0.69	0.03	0	0.243	0	0
Jan	1971	0.83	0.3	0.53	0.12	0.02	0.69	0.04	0	0.266	0	0
Feb	1971	0.91	0.33	0.59	0.21	0.01	0.69	0.07	0	0.257	0	0
Mar	1971	0.95	0.42	0.53	0.07	0	0.88	0.12	0	0.3	0	0
Apr	1971	0.81	3.41	-2.6	0.11	0.01	0.69	0.16	0	0.201	3.05	0
May	1971	1.09	0.45	0.64	0.18	0.02	0.88	0.23	0	0.214	0	0
Jun	1971	0.33	0.55	-0.22	0.14	0	0.19	0.33	0	0.224	0	0
Jul	1971	1.11	0.67	0.44	0.21	0.01	0.88	0.42	0	0.243	0	0
Aug	1971	0.77	0.68	0.09	0.08	0	0.69	0.42	0	0.253	0	0
Sep	1971	1.31	0.57	0.74	0.12	0	1.18	0.32	0	0.25	0	0
Oct	1971	0.36	2.53	-2.17	0.14	0.03	0.19	0.14	0	0.193	2.19	0
Nov	1971	1	0.28	0.72	0.1	0.01	0.88	0.07	0	0.204	0	0
Dec	1971	1.35	0.28	1.07	0.52	0.15	0.69	0.03	0	0.25	0	0
Jan	1972	0.76	0.31	0.44	0.06	0	0.69	0.04	0	0.277	0	0
Feb	1972	0.76	0.35	0.41	0.07	0	0.69	0.07	0	0.273	0	0
Mar	1972	1	0.43	0.57	0.11	0	0.88	0.12	0	0.303	0	0
Apr	1972	0.97	3.56	-2.59	0.23	0.05	0.69	0.16	0	0.206	3.19	0
May	1972	1.03	0.45	0.57	0.14	0.01	0.88	0.23	0	0.218	0	0
Jun	1972	0.35	0.56	-0.21	0.16	0	0.19	0.33	0	0.227	0	0
Jul	1972	0.97	0.67	0.3	0.08	0	0.88	0.43	0	0.246	0	0
Aug	1972	0.84	0.67	0.16	0.15	0	0.69	0.42	0	0.252	0	0
Sep	1972	1.5	0.57	0.93	0.3	0.02	1.18	0.32	0	0.252	0	0
Oct	1972	0.54	2.7	-2.16	0.25	0.1	0.19	0.14	0	0.194	2.36	0
Nov	1972	1.26	0.3	0.96	0.29	0.08	0.88	0.07	0	0.223	0	0
Dec	1972	0.85	0.29	0.56	0.14	0.02	0.69	0.03	0	0.253	0	0

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drawdown Pump ac·ft	Spillway ac·ft
Jan	1973	0.94	0.31	0.63	0.23	0.03	0.69	0.04	0	0.278	0	0
Feb	1973	0.87	0.34	0.53	0.17	0.01	0.69	0.07	0	0.271	0	0
Mar	1973	1.6	0.45	1.15	0.74	-0.02	0.88	0.13	0	0.323	0	0
Apr	1973	1.3	4.45	-3.15	0.46	0.14	0.69	0.18	0	0.221	4.05	0
May	1973	1.26	0.49	0.77	0.34	0.04	0.88	0.25	0	0.237	0	0
Jun	1973	0.44	0.61	-0.17	0.23	0.02	0.19	0.36	0	0.248	0	0
Jul	1973	1.07	0.73	0.34	0.19	0	0.88	0.46	0	0.265	0	0
Aug	1973	0.78	0.73	0.06	0.09	0	0.69	0.45	0	0.272	0	0
Sep	1973	1.63	0.62	1	0.41	0.03	1.18	0.35	0	0.274	0	0
Oct	1973	0.47	3.22	-2.76	0.2	0.07	0.19	0.15	0	0.205	2.87	0
Nov	1973	1.5	0.29	1.22	0.47	0.15	0.88	0.07	0	0.215	0	0
Dec	1973	1.06	0.3	0.76	0.32	0.06	0.69	0.04	0	0.267	0	0
Jan	1974	0.79	0.33	0.46	0.09	0	0.69	0.04	0	0.289	0	0
Feb	1974	0.82	0.35	0.47	0.13	0	0.69	0.07	0	0.274	0	0
Mar	1974	1.13	0.45	0.68	0.25	0	0.88	0.13	0	0.322	0	0
Apr	1974	0.88	4.08	-3.2	0.18	0.01	0.69	0.17	0	0.211	3.7	0
May	1974	1.22	0.46	0.76	0.29	0.05	0.88	0.23	0	0.22	0	0
Jun	1974	0.54	0.59	-0.05	0.3	0.05	0.19	0.35	0	0.238	0	0
Jul	1974	1.05	0.7	0.34	0.16	0.01	0.88	0.44	0	0.255	0	0
Aug	1974	0.9	0.71	0.19	0.21	0	0.69	0.44	0	0.264	0	0
Sep	1974	1.59	0.62	0.97	0.39	0.02	1.18	0.34	0	0.27	0	0
Oct	1974	0.35	3.09	-2.75	0.13	0.02	0.19	0.15	0	0.199	2.75	0
Nov	1974	1.3	0.29	1.01	0.3	0.11	0.88	0.07	0	0.215	0	0
Dec	1974	0.81	0.28	0.53	0.1	0.02	0.69	0.03	0	0.247	0	0
Jan	1975	0.93	0.31	0.63	0.22	0.03	0.69	0.04	0	0.27	0	0
Feb	1975	0.97	0.34	0.64	0.27	0.01	0.69	0.07	0	0.264	0	0
Mar	1975	1.41	0.44	0.97	0.54	-0.01	0.88	0.13	0	0.315	0	0
Apr	1975	0.78	4.09	-3.31	0.09	0	0.69	0.17	0	0.211	3.71	0
May	1975	1.05	0.44	0.61	0.17	0	0.88	0.23	0	0.213	0	0
Jun	1975	0.41	0.55	-0.14	0.21	0	0.19	0.33	0	0.225	0	0
Jul	1975	0.99	0.67	0.32	0.11	0	0.88	0.42	0	0.244	0	0

C H Hog Farms
Newton County, AR

Date: July 6, 2012

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drawdown Pump ac·ft	Spillway ac·ft
Aug	1975	0.99	0.68	0.31	0.29	0.02	0.69	0.42	0	0.253	0	0
Sep	1975	1.5	0.59	0.91	0.3	0.01	1.18	0.33	0	0.259	0	0
Oct	1975	0.25	2.81	-2.56	0.05	0.01	0.19	0.14	0	0.194	2.47	0
Nov	1975	1.07	0.27	0.8	0.16	0.03	0.88	0.07	0	0.202	0	0
Dec	1975	1.02	0.27	0.75	0.26	0.07	0.69	0.03	0	0.24	0	0
Jan	1976	0.74	0.3	0.44	0.04	0	0.69	0.04	0	0.264	0	0
Feb	1976	0.77	0.33	0.44	0.08	0	0.69	0.07	0	0.262	0	0
Mar	1976	1.13	0.42	0.71	0.24	0.01	0.88	0.12	0	0.297	0	0
Apr	1976	0.87	3.38	-2.51	0.14	0.04	0.69	0.16	0	0.203	3.01	0
May	1976	1.24	0.45	0.79	0.3	0.06	0.88	0.23	0	0.218	0	0
Jun	1976	0.63	0.58	0.05	0.38	0.05	0.19	0.35	0	0.236	0	0
Jul	1976	1.07	0.72	0.36	0.18	0.01	0.88	0.45	0	0.262	0	0
Aug	1976	0.79	0.72	0.08	0.1	0	0.69	0.45	0	0.268	0	0
Sep	1976	1.27	0.6	0.67	0.09	0	1.18	0.33	0	0.264	0	0
Oct	1976	0.35	2.84	-2.49	0.13	0.02	0.19	0.14	0	0.196	2.5	0
Nov	1976	0.98	0.28	0.7	0.08	0.01	0.88	0.07	0	0.205	0	0
Dec	1976	0.81	0.27	0.54	0.09	0.03	0.69	0.03	0	0.236	0	0
Jan	1977	0.82	0.29	0.53	0.12	0.01	0.69	0.03	0	0.256	0	0
Feb	1977	0.78	0.32	0.47	0.09	0	0.69	0.07	0	0.248	0	0
Mar	1977	1.35	0.41	0.94	0.45	0.01	0.88	0.12	0	0.294	0	0
Apr	1977	0.88	3.51	-2.62	0.16	0.03	0.69	0.16	0	0.204	3.14	0
May	1977	1.01	0.45	0.56	0.12	0	0.88	0.23	0	0.216	0	0
Jun	1977	0.36	0.55	-0.2	0.16	0	0.19	0.33	0	0.223	0	0
Jul	1977	1.1	0.67	0.43	0.21	0.01	0.88	0.42	0	0.245	0	0
Aug	1977	1.03	0.69	0.34	0.31	0.03	0.69	0.43	0	0.258	0	0
Sep	1977	1.63	0.6	1.03	0.42	0.02	1.18	0.33	0	0.263	0	0
Oct	1977	0.31	3.05	-2.74	0.09	0.02	0.19	0.14	0	0.198	2.7	0
Nov	1977	1.2	0.28	0.92	0.24	0.08	0.88	0.07	0	0.21	0	0
Dec	1977	0.88	0.28	0.6	0.15	0.04	0.69	0.03	0	0.245	0	0
Jan	1978	0.77	0.3	0.46	0.07	0.01	0.69	0.04	0	0.265	0	0
Feb	1978	0.85	0.32	0.52	0.15	0.01	0.69	0.07	0	0.256	0	0

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drawdown Pump ac·ft	Spillway ac·ft
Mar	1978	1.33	0.43	0.9	0.44	0.01	0.88	0.12	0	0.304	0	0
Apr	1978	0.81	3.73	-2.92	0.12	0	0.69	0.16	0	0.206	3.36	0
May	1978	1.3	0.46	0.84	0.34	0.08	0.88	0.24	0	0.222	0	0
Jun	1978	0.42	0.58	-0.16	0.22	0.01	0.19	0.34	0	0.235	0	0
Jul	1978	1.15	0.69	0.45	0.25	0.01	0.88	0.44	0	0.253	0	0
Aug	1978	0.83	0.7	0.13	0.14	0	0.69	0.44	0	0.263	0	0
Sep	1978	1.33	0.6	0.73	0.14	0	1.18	0.33	0	0.262	0	0
Oct	1978	0.35	2.79	-2.44	0.11	0.04	0.19	0.15	0	0.199	2.44	0
Nov	1978	1.26	0.28	0.98	0.29	0.09	0.88	0.07	0	0.211	0	0
Dec	1978	0.94	0.28	0.66	0.2	0.05	0.69	0.03	0	0.247	0	0
Jan	1979	0.84	0.31	0.54	0.14	0.02	0.69	0.04	0	0.273	0	0
Feb	1979	1.02	0.34	0.68	0.32	0.01	0.69	0.07	0	0.264	0	0
Mar	1979	1.27	0.44	0.82	0.39	-0.01	0.88	0.13	0	0.315	0	0
Apr	1979	1	4.12	-3.12	0.24	0.07	0.69	0.17	0	0.213	3.73	0
May	1979	1.4	0.47	0.92	0.42	0.09	0.88	0.24	0	0.228	0	0
Jun	1979	0.37	0.59	-0.22	0.17	0	0.19	0.35	0	0.239	0	0
Jul	1979	1.14	0.71	0.44	0.24	0.02	0.88	0.45	0	0.257	0	0
Aug	1979	0.89	0.72	0.17	0.2	0	0.69	0.45	0	0.268	0	0
Sep	1979	1.33	0.61	0.71	0.14	0	1.18	0.34	0	0.268	0	0
Oct	1979	0.36	2.92	-2.56	0.13	0.03	0.19	0.14	0	0.196	2.58	0
Nov	1979	1.08	0.28	0.8	0.15	0.04	0.88	0.07	0	0.21	0	0
Dec	1979	0.95	0.28	0.67	0.21	0.04	0.69	0.03	0	0.242	0	0
Jan	1980	0.74	0.3	0.44	0.05	0	0.69	0.04	0	0.266	0	0
Feb	1980	0.76	0.33	0.43	0.07	0	0.69	0.07	0	0.263	0	0
Mar	1980	1.13	0.42	0.71	0.24	0.01	0.88	0.12	0	0.296	0	0
Apr	1980	0.81	3.45	-2.64	0.12	0	0.69	0.16	0	0.202	3.08	0
May	1980	1.17	0.45	0.72	0.24	0.05	0.88	0.23	0	0.215	0	0
Jun	1980	0.45	0.56	-0.12	0.22	0.03	0.19	0.33	0	0.228	0	0
Jul	1980	0.92	0.68	0.24	0.04	0	0.88	0.43	0	0.247	0	0
Aug	1980	0.71	0.67	0.04	0.02	0	0.69	0.42	0	0.25	0	0
Sep	1980	1.45	0.57	0.88	0.25	0.01	1.18	0.32	0	0.25	0	0

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drawdown Pump ac·ft	Spillway ac·ft
Oct	1980	0.35	2.55	-2.2	0.12	0.04	0.19	0.14	0	0.194	2.21	0
Nov	1980	1.01	0.28	0.74	0.11	0.02	0.88	0.07	0	0.206	0	0
Dec	1980	0.76	0.27	0.49	0.06	0.02	0.69	0.03	0	0.237	0	0
Jan	1981	0.74	0.29	0.45	0.05	0	0.69	0.03	0	0.256	0	0
Feb	1981	0.84	0.31	0.53	0.14	0.01	0.69	0.07	0	0.247	0	0
Mar	1981	1.08	0.41	0.67	0.19	0.01	0.88	0.12	0	0.291	0	0
Apr	1981	0.81	3.24	-2.43	0.11	0.02	0.69	0.16	0	0.2	2.88	0
May	1981	1.39	0.46	0.93	0.43	0.08	0.88	0.24	0	0.221	0	0
Jun	1981	0.43	0.58	-0.15	0.23	0.01	0.19	0.35	0	0.237	0	0
Jul	1981	1.11	0.7	0.41	0.22	0.01	0.88	0.45	0	0.257	0	0
Aug	1981	1.19	0.73	0.46	0.47	0.03	0.69	0.46	0	0.274	0	0
Sep	1981	1.22	0.63	0.59	0.03	0	1.18	0.35	0	0.274	0	0
Oct	1981	0.44	3.05	-2.61	0.19	0.05	0.19	0.15	0	0.201	2.7	0
Nov	1981	0.98	0.28	0.7	0.08	0.01	0.88	0.07	0	0.208	0	0
Dec	1981	0.74	0.27	0.47	0.04	0.01	0.69	0.03	0	0.238	0	0
Jan	1982	1.13	0.29	0.83	0.38	0.06	0.69	0.03	0	0.26	0	0
Feb	1982	0.82	0.33	0.49	0.12	0	0.69	0.07	0	0.26	0	0
Mar	1982	1.03	0.43	0.6	0.14	0	0.88	0.12	0	0.303	0	0
Apr	1982	0.8	3.56	-2.77	0.11	0	0.69	0.16	0	0.203	3.19	0
May	1982	1.09	0.44	0.65	0.2	0.01	0.88	0.23	0	0.211	0	0
Jun	1982	0.57	0.56	0.01	0.34	0.04	0.19	0.33	0	0.228	0	0
Jul	1982	1.03	0.68	0.34	0.14	0	0.88	0.43	0	0.249	0	0
Aug	1982	1	0.7	0.3	0.29	0.02	0.69	0.43	0	0.26	0	0
Sep	1982	1.25	0.6	0.65	0.06	0	1.18	0.33	0	0.261	0	0
Oct	1982	0.36	2.74	-2.37	0.14	0.03	0.19	0.14	0	0.197	2.39	0
Nov	1982	1.17	0.28	0.89	0.22	0.07	0.88	0.07	0	0.208	0	0
Dec	1982	1.42	0.3	1.12	0.58	0.15	0.69	0.04	0	0.263	0	0
Jan	1983	0.73	0.32	0.41	0.04	0	0.69	0.04	0	0.285	0	0
Feb	1983	0.78	0.34	0.43	0.08	0	0.69	0.07	0	0.271	0	0
Mar	1983	1.06	0.44	0.62	0.18	0	0.88	0.13	0	0.313	0	0
Apr	1983	1	3.92	-2.92	0.29	0.02	0.69	0.17	0	0.21	3.54	0

Mon	Year	Inflow	Outflow	Change	Precip Vol	Bank Runoff	Ext Input	Vol Evap	Vol Infil	Vol Seep	Drawdown Pump	Spillway
		ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft
May	1983	1.14	0.46	0.68	0.23	0.02	0.88	0.23	0	0.22	0	0
Jun	1983	0.43	0.57	-0.14	0.22	0.01	0.19	0.34	0	0.23	0	0
Jul	1983	0.97	0.69	0.29	0.09	0	0.88	0.43	0	0.25	0	0
Aug	1983	0.8	0.68	0.11	0.11	0	0.69	0.43	0	0.255	0	0
Sep	1983	1.23	0.58	0.66	0.05	0	1.18	0.32	0	0.253	0	0
Oct	1983	0.3	2.51	-2.21	0.09	0.01	0.19	0.14	0	0.193	2.17	0
Nov	1983	1.25	0.28	0.97	0.28	0.09	0.88	0.07	0	0.207	0	0
Dec	1983	0.86	0.28	0.58	0.14	0.03	0.69	0.03	0	0.246	0	0
Jan	1984	0.74	0.3	0.44	0.05	0	0.69	0.04	0	0.266	0	0
Feb	1984	0.91	0.34	0.57	0.21	0.01	0.69	0.07	0	0.265	0	0
Mar	1984	1.19	0.42	0.77	0.3	0.01	0.88	0.12	0	0.303	0	0
Apr	1984	0.89	3.7	-2.8	0.18	0.02	0.69	0.16	0	0.205	3.33	0
May	1984	1.3	0.46	0.84	0.33	0.08	0.88	0.24	0	0.221	0	0
Jun	1984	0.34	0.57	-0.23	0.14	0.01	0.19	0.34	0	0.232	0	0
Jul	1984	0.98	0.69	0.3	0.1	0	0.88	0.43	0	0.25	0	0
Aug	1984	0.78	0.68	0.09	0.09	0	0.69	0.42	0	0.255	0	0
Sep	1984	1.53	0.58	0.94	0.32	0.02	1.18	0.32	0	0.256	0	0
Oct	1984	0.86	2.85	-1.99	0.48	0.18	0.19	0.15	0	0.205	2.49	0
Nov	1984	1.3	0.3	0.99	0.33	0.08	0.88	0.08	0	0.227	0	0
Dec	1984	1.05	0.3	0.75	0.32	0.04	0.69	0.04	0	0.266	0	0
Jan	1985	0.8	0.33	0.47	0.1	0	0.69	0.04	0	0.291	0	0
Feb	1985	0.99	0.35	0.63	0.3	0	0.69	0.07	0	0.277	0	0
Mar	1985	1.37	0.46	0.91	0.51	-0.03	0.88	0.13	0	0.329	0	0
Apr	1985	0.9	4.49	-3.58	0.18	0.04	0.69	0.17	0	0.218	4.1	0
May	1985	1.06	0.45	0.61	0.16	0.02	0.88	0.23	0	0.217	0	0
Jun	1985	0.29	0.56	-0.27	0.1	0	0.19	0.33	0	0.228	0	0
Jul	1985	1.05	0.67	0.38	0.16	0	0.88	0.42	0	0.244	0	0
Aug	1985	0.91	0.68	0.23	0.21	0.01	0.69	0.43	0	0.256	0	0
Sep	1985	1.32	0.58	0.74	0.14	0	1.18	0.32	0	0.255	0	0
Oct	1985	0.39	2.61	-2.22	0.16	0.04	0.19	0.14	0	0.196	2.27	0
Nov	1985	1.46	0.29	1.17	0.44	0.14	0.88	0.07	0	0.214	0	0

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drawdown Pump ac·ft	Spillway ac·ft
Dec	1985	0.77	0.29	0.48	0.07	0.01	0.69	0.03	0	0.255	0	0
Jan	1986	0.72	0.31	0.41	0.03	0	0.69	0.04	0	0.273	0	0
Feb	1986	0.82	0.33	0.49	0.12	0.01	0.69	0.07	0	0.262	0	0
Mar	1986	0.98	0.43	0.56	0.1	0	0.88	0.12	0	0.303	0	0
Apr	1986	1.03	3.69	-2.66	0.29	0.05	0.69	0.16	0	0.205	3.32	0
May	1986	1.13	0.45	0.68	0.22	0.02	0.88	0.23	0	0.216	0	0
Jun	1986	0.36	0.57	-0.2	0.16	0.01	0.19	0.34	0	0.229	0	0
Jul	1986	0.93	0.67	0.26	0.05	0	0.88	0.42	0	0.244	0	0
Aug	1986	0.93	0.68	0.25	0.24	0	0.69	0.42	0	0.254	0	0
Sep	1986	1.37	0.58	0.79	0.18	0.01	1.18	0.32	0	0.253	0	0
Oct	1986	0.4	2.69	-2.3	0.18	0.03	0.19	0.14	0	0.196	2.35	0
Nov	1986	1.01	0.28	0.73	0.1	0.02	0.88	0.07	0	0.206	0	0
Dec	1986	0.73	0.27	0.47	0.04	0	0.69	0.03	0	0.234	0	0
Jan	1987	0.86	0.29	0.57	0.15	0.02	0.69	0.03	0	0.257	0	0
Feb	1987	1.04	0.32	0.72	0.33	0.03	0.69	0.07	0	0.251	0	0
Mar	1987	1.14	0.42	0.72	0.25	0.01	0.88	0.12	0	0.3	0	0
Apr	1987	0.73	3.51	-2.79	0.04	0	0.69	0.16	0	0.203	3.15	0
May	1987	1.21	0.44	0.77	0.27	0.05	0.88	0.23	0	0.211	0	0
Jun	1987	0.33	0.56	-0.23	0.13	0	0.19	0.33	0	0.226	0	0
Jul	1987	1.02	0.67	0.35	0.14	0	0.88	0.42	0	0.244	0	0
Aug	1987	0.89	0.67	0.21	0.19	0.01	0.69	0.42	0	0.252	0	0
Sep	1987	1.45	0.58	0.87	0.25	0.01	1.18	0.32	0	0.256	0	0
Oct	1987	0.39	2.7	-2.32	0.14	0.05	0.19	0.14	0	0.196	2.36	0
Nov	1987	1.21	0.29	0.92	0.25	0.07	0.88	0.07	0	0.212	0	0
Dec	1987	1.28	0.29	1	0.5	0.1	0.69	0.03	0	0.252	0	0
Jan	1988	0.79	0.32	0.47	0.09	0.01	0.69	0.04	0	0.285	0	0
Feb	1988	0.86	0.36	0.51	0.17	0	0.69	0.07	0	0.281	0	0
Mar	1988	1.39	0.45	0.94	0.52	-0.01	0.88	0.13	0	0.321	0	0
Apr	1988	0.83	4.28	-3.45	0.13	0.01	0.69	0.17	0	0.213	3.89	0
May	1988	1.08	0.44	0.64	0.16	0.04	0.88	0.23	0	0.212	0	0
Jun	1988	0.28	0.55	-0.27	0.08	0.01	0.19	0.32	0	0.221	0	0

Mon	Year	Inflow ac-ft	Outflow ac-ft	Change ac-ft	Precip Vol ac-ft	Bank Runoff ac-ft	Ext Input ac-ft	Vol Evap ac-ft	Vol Infil ac-ft	Vol Seep ac-ft	Drawdown Pump ac-ft	Spillway ac-ft
Jul	1988	1.14	0.66	0.48	0.24	0.02	0.88	0.42	0	0.242	0	0
Aug	1988	0.82	0.67	0.14	0.13	0	0.69	0.42	0	0.252	0	0
Sep	1988	1.4	0.57	0.82	0.21	0	1.18	0.32	0	0.252	0	0
Oct	1988	0.29	2.59	-2.29	0.09	0.01	0.19	0.14	0	0.193	2.25	0
Nov	1988	1.37	0.28	1.09	0.36	0.12	0.88	0.07	0	0.21	0	0
Dec	1988	0.85	0.28	0.57	0.14	0.02	0.69	0.03	0	0.248	0	0
Jan	1989	0.86	0.31	0.55	0.15	0.02	0.69	0.04	0	0.271	0	0
Feb	1989	1.22	0.34	0.87	0.51	0.02	0.69	0.07	0	0.27	0	0
Mar	1989	1.19	0.45	0.74	0.31	-0.01	0.88	0.13	0	0.321	0	0
Apr	1989	0.73	4.1	-3.37	0.04	0	0.69	0.17	0	0.21	3.71	0
May	1989	1.23	0.44	0.79	0.29	0.06	0.88	0.23	0	0.213	0	0
Jun	1989	0.42	0.57	-0.14	0.22	0.01	0.19	0.34	0	0.23	0	0
Jul	1989	1.18	0.69	0.49	0.28	0.01	0.88	0.43	0	0.25	0	0
Aug	1989	0.82	0.7	0.12	0.13	0	0.69	0.43	0	0.26	0	0
Sep	1989	1.34	0.59	0.74	0.15	0	1.18	0.33	0	0.261	0	0
Oct	1989	0.21	2.74	-2.53	0.02	0	0.19	0.14	0	0.193	2.4	0
Nov	1989	0.9	0.27	0.64	0.02	0	0.88	0.07	0.01	0.197	0	0
Dec	1989	0.72	0.26	0.46	0.03	0	0.69	0.03	0	0.226	0	0
Jan	1990	1.05	0.28	0.76	0.29	0.06	0.69	0.03	0	0.251	0	0
Feb	1990	1.04	0.32	0.72	0.31	0.03	0.69	0.07	0	0.253	0	0
Mar	1990	1.34	0.43	0.91	0.44	0.01	0.88	0.12	0	0.304	0	0
Apr	1990	1	3.74	-2.75	0.24	0.06	0.69	0.17	0	0.209	3.36	0
May	1990	1.66	0.49	1.17	0.62	0.15	0.88	0.25	0	0.238	0	0
Jun	1990	0.29	0.61	-0.32	0.09	0	0.19	0.36	0	0.247	0	0
Jul	1990	1	0.72	0.28	0.12	0	0.88	0.46	0	0.263	0	0
Aug	1990	0.88	0.73	0.15	0.18	0.01	0.69	0.45	0	0.271	0	0
Sep	1990	1.43	0.61	0.82	0.24	0.01	1.18	0.34	0	0.269	0	0
Oct	1990	0.53	3.3	-2.77	0.23	0.1	0.19	0.15	0	0.2	2.95	0
Nov	1990	1.05	0.27	0.78	0.14	0.03	0.88	0.07	0	0.204	0	0
Dec	1990	0.99	0.27	0.72	0.24	0.06	0.69	0.03	0	0.239	0	0
Jan	1991	0.95	0.31	0.65	0.23	0.03	0.69	0.04	0	0.27	0	0

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drawdown Pump ac·ft	Spillway ac·ft
Feb	1991	0.74	0.33	0.42	0.05	0	0.69	0.07	0	0.258	0	0
Mar	1991	1.09	0.42	0.67	0.21	0	0.88	0.12	0	0.3	0	0
Apr	1991	1.17	3.57	-2.4	0.36	0.12	0.69	0.17	0	0.211	3.19	0
May	1991	1.21	0.48	0.73	0.29	0.04	0.88	0.25	0	0.231	0	0
Jun	1991	0.28	0.59	-0.31	0.09	0	0.19	0.35	0	0.238	0	0
Jul	1991	1.04	0.7	0.34	0.15	0	0.88	0.44	0	0.254	0	0
Aug	1991	0.83	0.7	0.13	0.14	0	0.69	0.43	0	0.261	0	0
Sep	1991	1.41	0.6	0.81	0.22	0.01	1.18	0.33	0	0.263	0	0
Oct	1991	0.78	2.83	-2.06	0.39	0.19	0.19	0.14	0	0.198	2.49	0
Nov	1991	1.21	0.3	0.91	0.27	0.06	0.88	0.08	0	0.226	0	0
Dec	1991	0.97	0.3	0.67	0.24	0.04	0.69	0.04	0	0.264	0	0
Jan	1992	0.77	0.32	0.44	0.07	0	0.69	0.04	0	0.286	0	0
Feb	1992	0.82	0.36	0.46	0.13	0	0.69	0.07	0	0.281	0	0
Mar	1992	1.05	0.44	0.6	0.16	0	0.88	0.13	0	0.315	0	0
Apr	1992	0.77	3.83	-3.07	0.07	0.01	0.69	0.17	0	0.208	3.46	0
May	1992	1.12	0.44	0.67	0.21	0.02	0.88	0.23	0	0.213	0	0
Jun	1992	0.65	0.58	0.08	0.41	0.05	0.19	0.34	0	0.233	0	0
Jul	1992	1.14	0.7	0.44	0.26	0	0.88	0.44	0	0.256	0	0
Aug	1992	0.87	0.71	0.16	0.18	0	0.69	0.45	0	0.267	0	0
Sep	1992	1.52	0.61	0.91	0.31	0.02	1.18	0.34	0	0.27	0	0
Oct	1992	0.26	3.04	-2.77	0.06	0.01	0.19	0.14	0	0.197	2.69	0
Nov	1992	1.25	0.28	0.97	0.28	0.09	0.88	0.07	0	0.208	0	0
Dec	1992	1.03	0.28	0.75	0.28	0.07	0.69	0.03	0	0.249	0	0
Jan	1993	1.01	0.32	0.69	0.28	0.04	0.69	0.04	0	0.28	0	0
Feb	1993	0.92	0.34	0.57	0.22	0	0.69	0.07	0	0.269	0	0
Mar	1993	1.05	0.44	0.6	0.16	0	0.88	0.13	0	0.315	0	0
Apr	1993	0.95	3.91	-2.97	0.22	0.04	0.69	0.17	0	0.21	3.53	0
May	1993	1.28	0.47	0.81	0.34	0.05	0.88	0.24	0	0.224	0	0
Jun	1993	0.39	0.58	-0.19	0.19	0	0.19	0.34	0	0.235	0	0
Jul	1993	0.96	0.69	0.27	0.08	0	0.88	0.44	0	0.252	0	0
Aug	1993	0.87	0.69	0.18	0.17	0.01	0.69	0.43	0	0.26	0	0

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drawdown Pump ac·ft	Spillway ac·ft
Sep	1993	1.64	0.6	1.04	0.43	0.02	1.18	0.33	0	0.264	0	0
Oct	1993	0.38	3.05	-2.67	0.15	0.03	0.19	0.15	0	0.199	2.7	0
Nov	1993	1.21	0.28	0.93	0.26	0.07	0.88	0.07	0	0.211	0	0
Dec	1993	0.84	0.28	0.56	0.12	0.03	0.69	0.03	0	0.247	0	0
Jan	1994	0.93	0.3	0.62	0.21	0.02	0.69	0.04	0	0.268	0	0
Feb	1994	0.89	0.33	0.56	0.2	0.01	0.69	0.07	0	0.261	0	0
Mar	1994	1.21	0.44	0.77	0.32	0	0.88	0.12	0	0.31	0	0
Apr	1994	1	3.84	-2.84	0.26	0.05	0.69	0.17	0	0.209	3.46	0
May	1994	0.97	0.45	0.51	0.08	0	0.88	0.23	0	0.218	0	0
Jun	1994	0.35	0.56	-0.21	0.15	0.01	0.19	0.33	0	0.227	0	0
Jul	1994	1.05	0.67	0.38	0.17	0	0.88	0.42	0	0.244	0	0
Aug	1994	0.89	0.67	0.22	0.19	0.01	0.69	0.42	0	0.253	0	0
Sep	1994	1.23	0.58	0.65	0.04	0	1.18	0.32	0	0.253	0	0
Oct	1994	0.3	2.5	-2.2	0.1	0.01	0.19	0.14	0	0.195	2.16	0
Nov	1994	1.71	0.3	1.4	0.6	0.23	0.88	0.08	0	0.228	0	0
Dec	1994	0.91	0.3	0.62	0.19	0.04	0.69	0.04	0	0.264	0	0
Jan	1995	1.01	0.33	0.68	0.29	0.02	0.69	0.04	0	0.289	0	0
Feb	1995	0.78	0.35	0.43	0.09	0	0.69	0.07	0	0.277	0	0
Mar	1995	1.09	0.45	0.64	0.21	0	0.88	0.13	0	0.323	0	0
Apr	1995	1.04	4.13	-3.09	0.27	0.08	0.69	0.17	0	0.212	3.74	0
May	1995	1.19	0.47	0.72	0.27	0.04	0.88	0.24	0	0.226	0	0
Jun	1995	0.48	0.59	-0.11	0.27	0.02	0.19	0.35	0	0.238	0	0
Jul	1995	1.05	0.71	0.34	0.16	0	0.88	0.45	0	0.257	0	0
Aug	1995	0.73	0.7	0.03	0.04	0	0.69	0.44	0	0.262	0	0
Sep	1995	1.48	0.6	0.88	0.28	0.02	1.18	0.33	0	0.262	0	0
Oct	1995	0.36	2.93	-2.57	0.15	0.02	0.19	0.14	0	0.196	2.59	0
Nov	1995	1.03	0.28	0.75	0.12	0.03	0.88	0.07	0	0.205	0	0
Dec	1995	0.91	0.27	0.64	0.18	0.04	0.69	0.03	0	0.237	0	0
Jan	1996	0.92	0.3	0.62	0.19	0.03	0.69	0.04	0	0.264	0	0
Feb	1996	0.73	0.34	0.39	0.04	0	0.69	0.07	0	0.263	0	0
Mar	1996	1.13	0.41	0.72	0.24	0	0.88	0.12	0	0.296	0	0

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drawdown Pump ac·ft	Spillway ac·ft
Apr	1996	0.99	3.41	-2.43	0.22	0.07	0.69	0.16	0	0.206	3.04	0
May	1996	1.02	0.46	0.56	0.13	0.01	0.88	0.23	0	0.219	0	0
Jun	1996	0.37	0.57	-0.2	0.17	0.01	0.19	0.34	0	0.23	0	0
Jul	1996	1.05	0.68	0.37	0.16	0	0.88	0.43	0	0.247	0	0
Aug	1996	0.8	0.68	0.12	0.11	0	0.69	0.42	0	0.254	0	0
Sep	1996	1.89	0.59	1.3	0.64	0.06	1.18	0.33	0	0.259	0	0
Oct	1996	0.29	3.12	-2.83	0.09	0.01	0.19	0.15	0	0.198	2.77	0
Nov	1996	1.46	0.29	1.17	0.43	0.14	0.88	0.07	0	0.214	0	0
Dec	1996	0.82	0.29	0.53	0.11	0.02	0.69	0.03	0	0.253	0	0
Jan	1997	0.76	0.31	0.45	0.06	0	0.69	0.04	0	0.273	0	0
Feb	1997	1.04	0.33	0.71	0.34	0.02	0.69	0.07	0	0.263	0	0
Mar	1997	1.16	0.44	0.71	0.27	0	0.88	0.13	0	0.315	0	0
Apr	1997	0.91	4.03	-3.12	0.21	0.02	0.69	0.17	0	0.209	3.65	0
May	1997	1.04	0.44	0.61	0.15	0.01	0.88	0.22	0	0.21	0	0
Jun	1997	0.38	0.55	-0.16	0.18	0.01	0.19	0.32	0	0.222	0	0
Jul	1997	0.98	0.66	0.32	0.1	0	0.88	0.42	0	0.241	0	0
Aug	1997	0.86	0.67	0.19	0.17	0.01	0.69	0.42	0	0.25	0	0
Sep	1997	1.35	0.57	0.78	0.16	0.01	1.18	0.32	0	0.249	0	0
Oct	1997	0.32	2.51	-2.19	0.1	0.02	0.19	0.14	0	0.195	2.17	0
Nov	1997	1.02	0.28	0.75	0.12	0.02	0.88	0.07	0	0.205	0	0
Dec	1997	0.89	0.27	0.62	0.16	0.04	0.69	0.03	0	0.238	0	0
Jan	1998	1.11	0.31	0.8	0.36	0.06	0.69	0.04	0	0.271	0	0
Feb	1998	1	0.34	0.67	0.3	0.01	0.69	0.07	0	0.265	0	0
Mar	1998	1.4	0.44	0.95	0.52	-0.01	0.88	0.13	0	0.317	0	0
Apr	1998	0.87	4.12	-3.25	0.15	0.02	0.69	0.17	0	0.212	3.73	0
May	1998	1.06	0.45	0.62	0.16	0.02	0.88	0.23	0	0.216	0	0
Jun	1998	0.28	0.56	-0.27	0.09	0	0.19	0.33	0	0.226	0	0
Jul	1998	1.01	0.67	0.35	0.13	0	0.88	0.42	0	0.242	0	0
Aug	1998	0.86	0.67	0.19	0.17	0	0.69	0.42	0	0.252	0	0
Sep	1998	1.34	0.57	0.76	0.14	0.01	1.18	0.32	0	0.251	0	0
Oct	1998	0.49	2.68	-2.2	0.22	0.07	0.19	0.14	0	0.194	2.35	0

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drawdown Pump ac·ft	Spillway ac·ft
Nov	1998	1.05	0.28	0.78	0.14	0.03	0.88	0.07	0	0.206	0	0
Dec	1998	0.9	0.27	0.63	0.17	0.04	0.69	0.03	0	0.239	0	0
Jan	1999	0.95	0.3	0.65	0.22	0.04	0.69	0.04	0	0.266	0	0
Feb	1999	0.79	0.33	0.46	0.09	0.01	0.69	0.07	0	0.258	0	0
Mar	1999	1.19	0.43	0.77	0.3	0.01	0.88	0.12	0	0.303	0	0
Apr	1999	0.93	3.7	-2.77	0.22	0.02	0.69	0.16	0	0.206	3.33	0
May	1999	1.15	0.45	0.69	0.24	0.03	0.88	0.23	0	0.217	0	0
Jun	1999	0.51	0.56	-0.05	0.29	0.03	0.19	0.33	0	0.227	0	0
Jul	1999	0.96	0.69	0.27	0.08	0	0.88	0.43	0	0.251	0	0
Aug	1999	0.77	0.68	0.09	0.08	0	0.69	0.42	0	0.255	0	0
Sep	1999	1.25	0.58	0.67	0.06	0	1.18	0.32	0	0.252	0	0
Oct	1999	0.26	2.49	-2.23	0.06	0	0.19	0.14	0	0.193	2.15	0
Nov	1999	0.98	0.27	0.71	0.08	0.02	0.88	0.07	0	0.201	0	0
Dec	1999	1.05	0.27	0.78	0.28	0.08	0.69	0.03	0	0.241	0	0
Jan	2000	0.82	0.3	0.52	0.11	0.01	0.69	0.04	0	0.265	0	0
Feb	2000	0.83	0.33	0.5	0.14	0.01	0.69	0.07	0	0.263	0	0
Mar	2000	1.05	0.42	0.63	0.16	0	0.88	0.12	0	0.298	0	0
Apr	2000	0.77	3.39	-2.61	0.08	0	0.69	0.16	0	0.202	3.02	0
May	2000	1.25	0.44	0.81	0.3	0.06	0.88	0.23	0	0.214	0	0
Jun	2000	0.64	0.58	0.06	0.4	0.05	0.19	0.34	0	0.235	0	0
Jul	2000	1.05	0.71	0.35	0.17	0	0.88	0.45	0	0.258	0	0
Aug	2000	0.7	0.71	0	0.01	0	0.69	0.44	0	0.263	0	0
Sep	2000	1.32	0.59	0.73	0.13	0	1.18	0.33	0	0.259	0	0
Oct	2000	0.31	2.73	-2.42	0.11	0.01	0.19	0.14	0	0.194	2.39	0
Nov	2000	1.26	0.28	0.98	0.27	0.11	0.88	0.07	0	0.213	0	0
Dec	2000	0.82	0.28	0.54	0.11	0.02	0.69	0.03	0	0.245	0	0
Jan	2001	0.84	0.3	0.54	0.13	0.02	0.69	0.04	0	0.267	0	0
Feb	2001	1.11	0.33	0.78	0.4	0.02	0.69	0.07	0	0.261	0	0
Mar	2001	0.97	0.43	0.53	0.08	0	0.88	0.12	0	0.309	0	0
Apr	2001	0.74	3.66	-2.92	0.05	0	0.69	0.16	0	0.205	3.28	0
May	2001	1.09	0.44	0.65	0.19	0.02	0.88	0.23	0	0.211	0	0

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drawdown Pump ac·ft	Spillway ac·ft
Jun	2001	0.38	0.55	-0.17	0.17	0.02	0.19	0.33	0	0.224	0	0
Jul	2001	1.1	0.67	0.42	0.21	0	0.88	0.42	0	0.244	0	0
Aug	2001	0.81	0.68	0.13	0.12	0	0.69	0.42	0	0.254	0	0
Sep	2001	1.46	0.58	0.88	0.25	0.03	1.18	0.32	0	0.256	0	0
Oct	2001	0.37	2.7	-2.33	0.14	0.04	0.19	0.15	0	0.198	2.36	0
Nov	2001	1.17	0.28	0.9	0.23	0.06	0.88	0.07	0	0.207	0	0
Dec	2001	1.09	0.28	0.81	0.32	0.08	0.69	0.03	0	0.249	0	0
Jan	2002	0.94	0.31	0.63	0.23	0.02	0.69	0.04	0	0.275	0	0
Feb	2002	0.85	0.34	0.51	0.15	0.01	0.69	0.07	0	0.268	0	0
Mar	2002	1.62	0.45	1.17	0.76	-0.02	0.88	0.13	0	0.322	0	0
Apr	2002	1	4.53	-3.53	0.28	0.03	0.69	0.17	0	0.216	4.14	0
May	2002	1.13	0.45	0.69	0.23	0.02	0.88	0.23	0	0.215	0	0
Jun	2002	0.4	0.57	-0.17	0.2	0.01	0.19	0.34	0	0.229	0	0
Jul	2002	1.1	0.68	0.42	0.22	0	0.88	0.43	0	0.249	0	0
Aug	2002	0.91	0.69	0.22	0.2	0.03	0.69	0.43	0	0.259	0	0
Sep	2002	1.28	0.59	0.69	0.09	0	1.18	0.33	0	0.258	0	0
Oct	2002	0.32	2.66	-2.35	0.11	0.01	0.19	0.14	0	0.194	2.33	0
Nov	2002	0.95	0.27	0.68	0.05	0.01	0.88	0.07	0	0.204	0	0
Dec	2002	1.03	0.27	0.76	0.27	0.07	0.69	0.03	0	0.236	0	0
Jan	2003	0.72	0.3	0.42	0.03	0	0.69	0.03	0	0.262	0	0
Feb	2003	0.89	0.32	0.57	0.19	0.01	0.69	0.07	0	0.252	0	0
Mar	2003	1.06	0.42	0.64	0.18	0	0.88	0.12	0	0.297	0	0
Apr	2003	0.8	3.39	-2.59	0.09	0.01	0.69	0.16	0	0.201	3.02	0
May	2003	1.3	0.45	0.85	0.35	0.07	0.88	0.23	0	0.219	0	0
Jun	2003	0.41	0.58	-0.17	0.2	0.01	0.19	0.34	0	0.235	0	0
Jul	2003	1.05	0.69	0.36	0.16	0.01	0.88	0.44	0	0.252	0	0
Aug	2003	0.84	0.7	0.14	0.15	0	0.69	0.43	0	0.261	0	0
Sep	2003	1.34	0.59	0.75	0.15	0	1.18	0.33	0	0.26	0	0
Oct	2003	0.38	2.76	-2.37	0.15	0.04	0.19	0.15	0	0.199	2.41	0
Nov	2003	1.23	0.28	0.95	0.27	0.08	0.88	0.07	0	0.212	0	0
Dec	2003	0.86	0.28	0.59	0.15	0.03	0.69	0.03	0	0.247	0	0

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drawdown Pump ac·ft	Spillway ac·ft
Jan	2004	0.84	0.31	0.53	0.13	0.02	0.69	0.04	0	0.269	0	0
Feb	2004	0.8	0.34	0.46	0.1	0.01	0.69	0.07	0	0.269	0	0
Mar	2004	1.1	0.43	0.67	0.21	0	0.88	0.12	0	0.303	0	0
Apr	2004	1.18	3.56	-2.37	0.36	0.13	0.69	0.17	0	0.208	3.18	0
May	2004	1.01	0.48	0.54	0.12	0.01	0.88	0.24	0	0.229	0	0
Jun	2004	0.41	0.58	-0.17	0.21	0	0.19	0.34	0	0.235	0	0
Jul	2004	1.08	0.7	0.38	0.2	0	0.88	0.44	0	0.255	0	0
Aug	2004	0.83	0.7	0.12	0.14	0	0.69	0.44	0	0.263	0	0
Sep	2004	1.19	0.59	0.6	0.01	0	1.18	0.33	0	0.259	0	0
Oct	2004	0.74	2.84	-2.11	0.38	0.16	0.19	0.15	0	0.199	2.5	0
Nov	2004	1.28	0.29	0.99	0.31	0.09	0.88	0.07	0	0.218	0	0
Dec	2004	0.78	0.29	0.5	0.08	0.01	0.69	0.03	0	0.254	0	0
Jan	2005	1.09	0.32	0.77	0.35	0.05	0.69	0.04	0	0.283	0	0
Feb	2005	0.86	0.34	0.51	0.16	0	0.69	0.07	0	0.272	0	0
Mar	2005	1.1	0.44	0.66	0.22	0	0.88	0.13	0	0.316	0	0
Apr	2005	0.88	4.02	-3.14	0.17	0.02	0.69	0.17	0	0.21	3.64	0
May	2005	0.98	0.44	0.54	0.09	0	0.88	0.23	0	0.212	0	0
Jun	2005	0.26	0.54	-0.28	0.06	0	0.19	0.32	0	0.218	0	0
Jul	2005	1.01	0.65	0.36	0.12	0	0.88	0.41	0	0.237	0	0
Aug	2005	0.89	0.66	0.23	0.2	0	0.69	0.41	0	0.246	0	0
Sep	2005	1.45	0.57	0.89	0.25	0.02	1.18	0.31	0	0.249	0	0
Oct	2005	0.2	2.53	-2.33	0	0	0.19	0.14	0	0.19	2.2	0
Nov	2005	1.05	0.27	0.78	0.13	0.03	0.88	0.07	0.01	0.199	0	0
Dec	2005	0.7	0.26	0.44	0.01	0	0.69	0.03	0	0.231	0	0
Jan	2006	0.87	0.29	0.58	0.15	0.02	0.69	0.03	0	0.251	0	0
Feb	2006	0.74	0.31	0.43	0.05	0	0.69	0.07	0	0.245	0	0
Mar	2006	1.17	0.41	0.76	0.27	0.01	0.88	0.12	0	0.289	0	0
Apr	2006	0.99	3.23	-2.24	0.24	0.06	0.69	0.16	0	0.2	2.86	0
May	2006	1.04	0.46	0.58	0.14	0.02	0.88	0.24	0	0.222	0	0
Jun	2006	0.36	0.57	-0.21	0.16	0.01	0.19	0.34	0	0.229	0	0
Jul	2006	1.01	0.68	0.33	0.12	0	0.88	0.43	0	0.247	0	0

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drawdown Pump ac·ft	Spillway ac·ft
Aug	2006	0.91	0.68	0.23	0.21	0	0.69	0.42	0	0.254	0	0
Sep	2006	1.51	0.59	0.92	0.3	0.02	1.18	0.33	0	0.257	0	0
Oct	2006	0.55	2.81	-2.26	0.26	0.1	0.19	0.15	0	0.202	2.46	0
Nov	2006	1.34	0.3	1.05	0.37	0.09	0.88	0.07	0	0.219	0	0
Dec	2006	0.98	0.29	0.69	0.25	0.04	0.69	0.03	0	0.257	0	0

AVERAGE MONTHLY VOLUMES BY MAJOR IMPOUNDMENT PROCESSES

Mon	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runoff ac·ft	Ext Input ac·ft	Vol Evap ac·ft	Vol Infil ac·ft	Vol Seep ac·ft	Drdn Pump ac·ft	Spillway ac·ft
Jan	0.86	0.3	0.55	0.15	0.02	0.69	0.04	0	0.268	0	0
Feb	0.88	0.34	0.54	0.18	0.01	0.69	0.07	0	0.268	0	0
Mar	1.17	0.43	0.74	0.28	0	0.88	0.12	0	0.305	0	0
Apr	0.91	3.71	-2.79	0.19	0.03	0.69	0.17	0	0.207	3.33	0
May	1.17	0.46	0.71	0.24	0.04	0.88	0.23	0	0.219	0	0
Jun	0.41	0.57	-0.16	0.2	0.01	0.19	0.34	0	0.231	0	0
Jul	1.05	0.69	0.37	0.17	0	0.88	0.43	0	0.25	0	0
Aug	0.87	0.69	0.17	0.17	0.01	0.69	0.43	0	0.259	0	0
Sep	1.42	0.59	0.82	0.22	0.01	1.18	0.33	0	0.26	0	0
Oct	0.39	2.81	-2.42	0.15	0.04	0.19	0.14	0	0.197	2.47	0
Nov	1.15	0.28	0.87	0.21	0.06	0.88	0.07	0	0.21	0	0
Dec	0.92	0.28	0.64	0.19	0.04	0.69	0.03	0	0.245	0	0

A SUMMARY OF ACCUMULATIVE MONTHLY POND VOLUMES
Info: This is the simulation that of Pond 1 that is used in Series with the Pond 2 simulation.
SIMULATION BY:

Nathan A. Pesta
Senior Project Engineer
DeHaan, Grabs & Associates, LLC
PO Box 522
Mandan, ND, 58554

SIMULATION FOR:

File : C:\Program Files\SPAW Hydrology\SPAW\Projects\Ponds\Examples\Henson, Jason_Pond 1\Henson, Jason_Pond 1.pnd
File Creation Date : Jul 06, 2012 14:17:29
File Last Modified Date : Jul 06, 2012 15:37:13
Description : `Waste Storage Pond 1
Simulation Start Date : Jan 01, 1960
Simulation End Date : Dec 31, 2006
Simulation Run Date : Jul 06, 2012 15:37
SPAW Interface Version : Jul 06, 2012 15:37:13
Pond Model Version : 6.02.71

WATERSHED FIELDS:

DESCRIPTION/FILE (DATE)	AREA (AC)
Brookings Pasture -Rainfed (Sample)	0.00
C:\Program Files\SPAW Hydrology\SPAW\Projects\Fields\Examples\Pasture_Henson\Pasture_Henson.fpin Dec 30, 1899 00:00	

IRRIGATED FIELDS:

DESCRIPTION/FILE (DATE)	AREA (AC)
Brookings Pasture -Rainfed (Sample)	630.70
C:\Program Files\SPAW Hydrology\SPAW\Projects\Fields\Examples\Pasture\Pasture.fpin Dec 30, 1899 00:00	

POND PROFILE:

DEPTH (FT)	AREA (AC)	VOLUME (AC-FT)
0.00	0.00	0.00
1.00	0.16	0.08

2.00	0.19	0.26
3.00	0.21	0.46
4.00	0.24	0.68
5.00	0.27	0.94
6.00	0.31	1.23
7.00	0.34	1.55
8.00	0.38	1.91
9.00	0.41	2.31
10.70	0.48	3.06

POND PROFILE
MAX AREA (AC) = 0.41
MAX DEPTH (FT) = 9.00
MAX VOLUME (AC-FT) = 2.31
IRRIGATION LIMIT (FT) = 0.00
EXTERNAL INPUT UPPER LIMIT (FT)= 0.00
EXTERNAL INPUT LOWER LIMIT (FT)= 0.00
SUPPLY PUMP LOWER LIMIT (FT) = 0.00
DRAWDOWN PUMP UPPER LIMIT (FT) = 0.00
DRAWDOWN PUMP LOWER LIMIT (FT) = 2.00
SPILLWAY CREST (FT) = 9.00
INITIAL DEPTH (FT) = 0.00
INFIL. INTO DRY SOIL (IN) = 0.50

SEEPAGE RATE (IN/DAY)

DATE	RATE
Jun 14	0.15

MONTHLY VOLUMES BY MAJOR IMPOUNDMENT PROCESSES

Mon	Year	Inflow	Outflow	Change	Precip Vol	Bank Runoff	Ext Input	Vol Evap	Vol Infil	Vol Seep	Drdn Pump	Spillway
		ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft	ac·ft
Jan	1960	0.88	0.11	0.77	0.04	0.02	0.82	0.01	0.01	0.089	0	0
Feb	1960	0.77	0.63	0.14	0.05	0.03	0.69	0.02	0	0.09	0.51	0
Mar	1960	0.94	0.17	0.77	0.05	0.01	0.88	0.05	0	0.121	0	0

Apr	1960	0.77	0.91	-0.14	0.07	0.01	0.69	0.09	0	0.112	0.71	0
May	1960	1.18	0.42	0.76	0.27	0.02	0.88	0.15	0	0.141	0	0.12
Jun	1960	0.27	1.02	-0.75	0.07	0	0.19	0.19	0	0.129	0.71	0
Jul	1960	1.1	0.42	0.68	0.22	0	0.88	0.26	0	0.153	0	0
Aug	1960	0.71	2.64	-1.93	0.02	0	0.69	0.14	0	0.083	2.42	0
Sep	1960	1.24	0.21	1.03	0.05	0	1.18	0.12	0	0.093	0	0
Oct	1960	0.23	1.21	-0.98	0.04	0	0.19	0.06	0	0.077	1.08	0
Nov	1960	0.93	0.14	0.78	0.04	0	0.88	0.03	0	0.103	0	0
Dec	1960	0.83	0.83	0	0.09	0.05	0.69	0.01	0	0.107	0.71	0
Jan	1961	0.85	0.16	0.69	0.03	0	0.82	0.02	0	0.139	0	0
Feb	1961	0.79	0.86	-0.07	0.09	0.01	0.69	0.03	0	0.121	0.71	0
Mar	1961	1.08	0.55	0.53	0.2	0	0.88	0.06	0	0.152	0	0.34
Apr	1961	0.79	0.95	-0.17	0.09	0	0.69	0.11	0	0.137	0.71	0
May	1961	1.3	1.17	0.13	0.41	0	0.88	0.17	0	0.157	0	0.85
Jun	1961	0.24	1.02	-0.78	0.05	0	0.19	0.19	0	0.128	0.71	0
Jul	1961	1.07	0.41	0.65	0.18	0	0.88	0.26	0	0.151	0	0
Aug	1961	0.79	2.55	-1.75	0.08	0.02	0.69	0.14	0	0.084	2.32	0
Sep	1961	1.27	0.22	1.05	0.08	0.01	1.18	0.12	0.01	0.096	0	0
Oct	1961	0.23	1.31	-1.08	0.04	0	0.19	0.06	0	0.077	1.17	0
Nov	1961	1.03	0.14	0.89	0.1	0.05	0.88	0.04	0	0.105	0	0
Dec	1961	0.81	0.83	-0.02	0.08	0.04	0.69	0.01	0	0.11	0.71	0
Jan	1962	0.93	0.16	0.76	0.1	0.01	0.82	0.02	0	0.143	0	0
Feb	1962	0.77	0.87	-0.1	0.07	0	0.69	0.03	0	0.125	0.71	0
Mar	1962	0.97	0.57	0.4	0.08	0	0.88	0.06	0	0.153	0	0.35
Apr	1962	0.77	0.95	-0.18	0.08	0	0.69	0.11	0	0.135	0.71	0
May	1962	0.97	0.78	0.18	0.08	0	0.88	0.16	0	0.155	0	0.46
Jun	1962	0.35	1.03	-0.68	0.15	0	0.19	0.19	0	0.13	0.71	0
Jul	1962	1.03	0.42	0.61	0.15	0	0.88	0.26	0	0.153	0	0
Aug	1962	0.82	2.66	-1.84	0.11	0.03	0.69	0.14	0	0.084	2.44	0
Sep	1962	1.32	0.22	1.1	0.12	0.01	1.18	0.12	0	0.097	0	0
Oct	1962	0.32	1.36	-1.04	0.09	0.04	0.19	0.06	0	0.08	1.22	0
Nov	1962	0.92	0.14	0.77	0.03	0	0.88	0.04	0	0.107	0	0
Dec	1962	0.72	0.83	-0.11	0.03	0	0.69	0.01	0	0.105	0.71	0
Jan	1963	0.84	0.16	0.68	0.01	0	0.82	0.02	0	0.137	0	0

Feb	1963	0.71	0.86	-0.15	0.02	0	0.69	0.03	0	0.117	0.71	0
Mar	1963	0.99	0.36	0.63	0.1	0.01	0.88	0.06	0	0.149	0	0.15
Apr	1963	0.74	0.95	-0.21	0.05	0	0.69	0.11	0	0.134	0.71	0
May	1963	1.04	0.83	0.21	0.15	0	0.88	0.16	0	0.154	0	0.51
Jun	1963	0.28	1.02	-0.74	0.09	0	0.19	0.19	0	0.128	0.71	0
Jul	1963	0.95	0.41	0.54	0.07	0	0.88	0.26	0	0.15	0	0
Aug	1963	0.72	2.47	-1.75	0.03	0	0.69	0.14	0	0.082	2.25	0
Sep	1963	1.22	0.21	1	0.03	0	1.18	0.12	0	0.093	0	0
Oct	1963	0.2	1.19	-0.99	0	0	0.19	0.06	0	0.077	1.06	0
Nov	1963	0.98	0.14	0.84	0.07	0.02	0.88	0.03	0	0.102	0	0
Dec	1963	0.74	0.83	-0.08	0.04	0.01	0.69	0.01	0	0.104	0.71	0
Jan	1964	0.85	0.16	0.69	0.03	0	0.82	0.02	0	0.136	0	0
Feb	1964	0.77	0.86	-0.09	0.07	0.02	0.69	0.03	0	0.124	0.71	0
Mar	1964	1.12	0.55	0.57	0.23	0.01	0.88	0.06	0	0.152	0	0.33
Apr	1964	0.83	0.95	-0.13	0.13	0.01	0.69	0.11	0	0.137	0.71	0
May	1964	1.01	0.88	0.13	0.13	0	0.88	0.17	0	0.156	0	0.55
Jun	1964	0.25	1.02	-0.77	0.05	0	0.19	0.19	0	0.127	0.71	0
Jul	1964	0.94	0.41	0.53	0.06	0	0.88	0.26	0	0.149	0	0
Aug	1964	0.82	2.44	-1.62	0.11	0.02	0.69	0.14	0	0.083	2.22	0
Sep	1964	1.29	0.23	1.07	0.1	0.01	1.18	0.12	0.01	0.097	0	0
Oct	1964	0.2	1.35	-1.14	0.01	0	0.19	0.06	0	0.077	1.21	0
Nov	1964	0.98	0.14	0.84	0.08	0.02	0.88	0.03	0	0.103	0	0
Dec	1964	0.72	0.82	-0.1	0.02	0.01	0.69	0.01	0	0.104	0.71	0
Jan	1965	0.9	0.16	0.75	0.07	0.01	0.82	0.02	0	0.138	0	0
Feb	1965	0.78	0.86	-0.08	0.08	0.01	0.69	0.03	0	0.12	0.71	0
Mar	1965	0.98	0.44	0.54	0.09	0	0.88	0.06	0	0.151	0	0.22
Apr	1965	0.83	0.96	-0.13	0.13	0.01	0.69	0.11	0	0.138	0.71	0
May	1965	1.08	0.97	0.11	0.2	0	0.88	0.17	0	0.157	0	0.64
Jun	1965	0.32	1.02	-0.7	0.13	0	0.19	0.19	0	0.129	0.71	0
Jul	1965	1.02	0.42	0.6	0.14	0	0.88	0.26	0	0.152	0	0
Aug	1965	0.73	2.58	-1.84	0.04	0	0.69	0.14	0	0.083	2.35	0
Sep	1965	1.36	0.22	1.13	0.13	0.04	1.18	0.12	0.01	0.095	0	0
Oct	1965	0.21	1.33	-1.13	0.01	0	0.19	0.06	0	0.077	1.2	0
Nov	1965	0.91	0.14	0.78	0.03	0	0.88	0.03	0	0.102	0	0

Dec	1965	0.75	0.82	-0.07	0.05	0.01	0.69	0.01	0	0.101	0.71	0
Jan	1966	1	0.16	0.84	0.14	0.04	0.82	0.02	0	0.14	0	0
Feb	1966	0.9	0.86	0.03	0.18	0.03	0.69	0.03	0	0.126	0.71	0
Mar	1966	0.93	0.59	0.35	0.05	0	0.88	0.06	0	0.154	0	0.37
Apr	1966	0.88	0.95	-0.07	0.18	0.01	0.69	0.11	0	0.136	0.71	0
May	1966	0.98	0.9	0.07	0.09	0	0.88	0.17	0	0.157	0	0.58
Jun	1966	0.21	1.02	-0.81	0.02	0	0.19	0.19	0	0.127	0.71	0
Jul	1966	1	0.41	0.59	0.12	0	0.88	0.26	0	0.148	0	0
Aug	1966	0.75	2.46	-1.7	0.06	0	0.69	0.14	0	0.082	2.24	0
Sep	1966	1.23	0.22	1.01	0.04	0	1.18	0.12	0	0.093	0	0
Oct	1966	0.23	1.23	-1.01	0.03	0	0.19	0.06	0	0.077	1.1	0
Nov	1966	0.93	0.14	0.79	0.05	0	0.88	0.03	0	0.102	0	0
Dec	1966	0.79	0.82	-0.03	0.07	0.03	0.69	0.01	0	0.103	0.71	0
Jan	1967	0.87	0.16	0.72	0.05	0	0.82	0.02	0	0.137	0	0
Feb	1967	0.73	0.86	-0.13	0.04	0	0.69	0.03	0	0.12	0.71	0
Mar	1967	0.93	0.36	0.57	0.04	0	0.88	0.06	0	0.15	0	0.14
Apr	1967	0.83	0.95	-0.12	0.13	0.01	0.69	0.11	0	0.136	0.71	0
May	1967	1.03	0.9	0.14	0.15	0	0.88	0.17	0	0.157	0	0.57
Jun	1967	0.38	1.02	-0.64	0.18	0.01	0.19	0.19	0	0.129	0.71	0
Jul	1967	1.03	0.43	0.59	0.14	0	0.88	0.27	0	0.155	0	0.01
Aug	1967	0.76	2.66	-1.91	0.06	0.01	0.69	0.14	0	0.084	2.44	0
Sep	1967	1.3	0.22	1.09	0.1	0.02	1.18	0.12	0	0.095	0	0
Oct	1967	0.43	1.29	-0.86	0.15	0.09	0.19	0.06	0	0.08	1.15	0
Nov	1967	0.91	0.15	0.76	0.02	0	0.88	0.04	0	0.112	0	0
Dec	1967	0.86	0.83	0.03	0.13	0.04	0.69	0.02	0	0.114	0.71	0
Jan	1968	0.9	0.17	0.74	0.08	0	0.82	0.02	0	0.146	0	0
Feb	1968	0.75	0.88	-0.13	0.06	0	0.69	0.04	0	0.134	0.71	0
Mar	1968	1.11	0.8	0.32	0.23	0	0.88	0.06	0	0.155	0	0.58
Apr	1968	0.82	0.95	-0.13	0.12	0.01	0.69	0.11	0	0.136	0.71	0
May	1968	1.09	0.96	0.13	0.21	0	0.88	0.17	0	0.157	0	0.63
Jun	1968	0.37	1.02	-0.66	0.16	0.01	0.19	0.19	0	0.129	0.71	0
Jul	1968	0.98	0.42	0.56	0.1	0	0.88	0.27	0	0.153	0	0
Aug	1968	0.73	2.58	-1.85	0.04	0	0.69	0.14	0	0.084	2.36	0
Sep	1968	1.34	0.22	1.12	0.12	0.03	1.18	0.12	0.01	0.095	0	0

Oct	1968	0.25	1.33	-1.08	0.05	0.01	0.19	0.06	0	0.078	1.19	0
Nov	1968	1.16	0.15	1.01	0.2	0.08	0.88	0.04	0	0.109	0	0
Dec	1968	0.9	0.84	0.06	0.17	0.04	0.69	0.02	0	0.115	0.71	0
Jan	1969	1	0.17	0.83	0.18	0	0.82	0.02	0	0.15	0	0
Feb	1969	0.77	0.88	-0.11	0.08	0	0.69	0.04	0	0.135	0.71	0
Mar	1969	1	0.9	0.09	0.11	0	0.88	0.06	0	0.158	0	0.68
Apr	1969	0.83	0.95	-0.12	0.14	0	0.69	0.11	0	0.136	0.71	0
May	1969	0.95	0.83	0.12	0.07	0	0.88	0.17	0	0.156	0	0.51
Jun	1969	0.3	1.02	-0.72	0.11	0	0.19	0.19	0	0.129	0.71	0
Jul	1969	0.97	0.41	0.55	0.08	0	0.88	0.26	0	0.15	0	0
Aug	1969	0.72	2.5	-1.78	0.03	0	0.69	0.14	0	0.082	2.28	0
Sep	1969	1.21	0.22	0.99	0.02	0	1.18	0.12	0.01	0.092	0	0
Oct	1969	0.37	1.19	-0.82	0.1	0.07	0.19	0.06	0	0.08	1.05	0
Nov	1969	0.92	0.15	0.77	0.03	0	0.88	0.04	0	0.109	0	0
Dec	1969	0.82	0.83	-0.01	0.1	0.03	0.69	0.01	0	0.109	0.71	0
Jan	1970	0.86	0.16	0.69	0.03	0	0.82	0.02	0	0.143	0	0
Feb	1970	0.75	0.86	-0.12	0.05	0	0.69	0.03	0	0.125	0.71	0
Mar	1970	1.01	0.56	0.45	0.12	0	0.88	0.06	0	0.153	0	0.35
Apr	1970	0.95	0.95	0	0.25	0.01	0.69	0.11	0	0.137	0.71	0
May	1970	0.96	0.95	0.02	0.08	0	0.88	0.17	0	0.157	0	0.62
Jun	1970	0.41	1.03	-0.63	0.2	0.01	0.19	0.19	0	0.133	0.71	0
Jul	1970	0.92	0.42	0.5	0.04	0	0.88	0.27	0	0.154	0	0
Aug	1970	0.76	2.59	-1.83	0.07	0	0.69	0.14	0	0.083	2.37	0
Sep	1970	1.44	0.23	1.21	0.19	0.06	1.18	0.12	0.01	0.099	0	0
Oct	1970	0.37	1.41	-1.04	0.11	0.06	0.19	0.06	0	0.08	1.27	0
Nov	1970	0.96	0.15	0.81	0.06	0.01	0.88	0.04	0	0.111	0	0
Dec	1970	0.73	0.83	-0.1	0.04	0	0.69	0.01	0	0.11	0.71	0
Jan	1971	0.89	0.16	0.73	0.06	0.01	0.82	0.02	0	0.142	0	0
Feb	1971	0.8	0.86	-0.06	0.1	0.01	0.69	0.03	0	0.125	0.71	0
Mar	1971	0.92	0.52	0.4	0.03	0	0.88	0.06	0	0.153	0	0.31
Apr	1971	0.77	0.95	-0.18	0.08	0	0.69	0.11	0	0.134	0.71	0
May	1971	1.02	0.83	0.19	0.13	0	0.88	0.17	0	0.155	0	0.51
Jun	1971	0.27	1.02	-0.75	0.08	0	0.19	0.19	0	0.128	0.71	0
Jul	1971	1.02	0.41	0.6	0.13	0	0.88	0.26	0	0.15	0	0

Aug	1971	0.72	2.54	-1.83	0.03	0	0.69	0.14	0	0.082	2.32	0
Sep	1971	1.23	0.21	1.02	0.05	0	1.18	0.12	0.01	0.092	0	0
Oct	1971	0.27	1.19	-0.93	0.06	0.02	0.19	0.06	0	0.078	1.06	0
Nov	1971	0.94	0.14	0.8	0.05	0.01	0.88	0.03	0	0.104	0	0
Dec	1971	1.02	0.83	0.19	0.22	0.11	0.69	0.02	0	0.114	0.71	0
Jan	1972	0.85	0.17	0.69	0.03	0	0.82	0.02	0	0.147	0	0
Feb	1972	0.72	0.87	-0.15	0.03	0	0.69	0.04	0	0.133	0.71	0
Mar	1972	0.94	0.58	0.36	0.06	0	0.88	0.06	0	0.154	0	0.37
Apr	1972	0.85	0.95	-0.1	0.16	0.01	0.69	0.11	0	0.136	0.71	0
May	1972	0.98	0.88	0.1	0.1	0	0.88	0.17	0	0.156	0	0.55
Jun	1972	0.28	1.02	-0.74	0.09	0	0.19	0.19	0	0.128	0.71	0
Jul	1972	0.94	0.41	0.52	0.05	0	0.88	0.26	0	0.151	0	0
Aug	1972	0.74	2.48	-1.74	0.05	0	0.69	0.14	0	0.082	2.27	0
Sep	1972	1.32	0.22	1.11	0.12	0.02	1.18	0.12	0	0.093	0	0
Oct	1972	0.36	1.3	-0.94	0.11	0.06	0.19	0.06	0	0.078	1.16	0
Nov	1972	1.07	0.15	0.92	0.15	0.04	0.88	0.04	0	0.114	0	0
Dec	1972	0.77	0.84	-0.07	0.06	0.01	0.69	0.02	0	0.115	0.71	0
Jan	1973	0.95	0.17	0.78	0.12	0.01	0.82	0.02	0	0.147	0	0
Feb	1973	0.78	0.87	-0.09	0.08	0.01	0.69	0.03	0	0.131	0.71	0
Mar	1973	1.25	0.97	0.27	0.36	0	0.88	0.06	0	0.157	0	0.75
Apr	1973	1.01	1.05	-0.04	0.31	0.02	0.69	0.11	0	0.138	0.71	0.1
May	1973	1.11	1.1	0.01	0.23	0	0.88	0.17	0	0.157	0	0.77
Jun	1973	0.32	1.03	-0.7	0.12	0.01	0.19	0.19	0	0.13	0.71	0
Jul	1973	0.99	0.42	0.57	0.11	0	0.88	0.26	0	0.152	0	0
Aug	1973	0.72	2.55	-1.83	0.02	0	0.69	0.14	0	0.083	2.32	0
Sep	1973	1.37	0.22	1.15	0.13	0.05	1.18	0.12	0	0.097	0	0
Oct	1973	0.32	1.34	-1.02	0.08	0.05	0.19	0.06	0	0.08	1.2	0
Nov	1973	1.2	0.15	1.05	0.24	0.07	0.88	0.04	0	0.109	0	0
Dec	1973	0.88	0.84	0.03	0.14	0.05	0.69	0.02	0	0.122	0.71	0
Jan	1974	0.87	0.17	0.7	0.05	0	0.82	0.02	0	0.152	0	0
Feb	1974	0.75	0.88	-0.12	0.06	0	0.69	0.04	0	0.133	0.71	0
Mar	1974	1.01	0.85	0.15	0.12	0	0.88	0.06	0	0.158	0	0.63
Apr	1974	0.81	0.95	-0.14	0.12	0	0.69	0.11	0	0.135	0.71	0
May	1974	1.09	0.94	0.16	0.21	0	0.88	0.17	0	0.157	0	0.61

Jun	1974	0.37	1.03	-0.66	0.16	0.02	0.19	0.19	0	0.132	0.71	0
Jul	1974	0.98	0.42	0.56	0.09	0	0.88	0.26	0	0.153	0	0
Aug	1974	0.75	2.59	-1.83	0.06	0	0.69	0.14	0	0.084	2.36	0
Sep	1974	1.35	0.23	1.13	0.14	0.03	1.18	0.12	0.01	0.098	0	0
Oct	1974	0.26	1.35	-1.09	0.05	0.01	0.19	0.06	0	0.078	1.21	0
Nov	1974	1.09	0.15	0.95	0.15	0.06	0.88	0.04	0	0.11	0	0
Dec	1974	0.75	0.83	-0.08	0.04	0.02	0.69	0.01	0	0.112	0.71	0
Jan	1975	0.94	0.16	0.78	0.12	0.01	0.82	0.02	0	0.144	0	0
Feb	1975	0.83	0.87	-0.04	0.13	0.01	0.69	0.03	0	0.128	0.71	0
Mar	1975	1.15	0.85	0.3	0.26	0	0.88	0.06	0	0.156	0	0.63
Apr	1975	0.75	0.95	-0.2	0.06	0	0.69	0.11	0	0.135	0.71	0
May	1975	1.01	0.82	0.19	0.12	0	0.88	0.17	0	0.155	0	0.5
Jun	1975	0.32	1.02	-0.71	0.12	0	0.19	0.19	0	0.129	0.71	0
Jul	1975	0.95	0.42	0.53	0.07	0	0.88	0.26	0	0.151	0	0
Aug	1975	0.81	2.53	-1.72	0.09	0.02	0.69	0.14	0	0.083	2.3	0
Sep	1975	1.32	0.23	1.09	0.12	0.02	1.18	0.12	0.01	0.098	0	0
Oct	1975	0.22	1.35	-1.13	0.02	0	0.19	0.06	0	0.077	1.22	0
Nov	1975	0.98	0.14	0.84	0.08	0.02	0.88	0.03	0	0.103	0	0
Dec	1975	0.86	0.83	0.03	0.11	0.05	0.69	0.01	0	0.108	0.71	0
Jan	1976	0.84	0.16	0.68	0.02	0	0.82	0.02	0	0.141	0	0
Feb	1976	0.73	0.87	-0.14	0.04	0	0.69	0.03	0	0.127	0.71	0
Mar	1976	1.01	0.48	0.53	0.12	0	0.88	0.06	0	0.152	0	0.27
Apr	1976	0.8	0.95	-0.15	0.1	0.01	0.69	0.11	0	0.135	0.71	0
May	1976	1.1	0.95	0.15	0.22	0	0.88	0.17	0	0.156	0	0.63
Jun	1976	0.42	1.03	-0.6	0.21	0.02	0.19	0.19	0	0.13	0.71	0
Jul	1976	0.99	0.43	0.57	0.11	0	0.88	0.27	0	0.155	0	0
Aug	1976	0.72	2.65	-1.92	0.03	0	0.69	0.14	0	0.084	2.42	0
Sep	1976	1.22	0.21	1	0.03	0	1.18	0.12	0.01	0.092	0	0
Oct	1976	0.26	1.19	-0.93	0.05	0.01	0.19	0.06	0	0.077	1.05	0
Nov	1976	0.93	0.14	0.79	0.04	0.01	0.88	0.03	0	0.105	0	0
Dec	1976	0.75	0.83	-0.08	0.04	0.02	0.69	0.01	0	0.105	0.71	0
Jan	1977	0.89	0.16	0.73	0.06	0	0.82	0.02	0	0.137	0	0
Feb	1977	0.74	0.86	-0.12	0.04	0	0.69	0.03	0	0.119	0.71	0
Mar	1977	1.12	0.54	0.58	0.23	0.01	0.88	0.06	0	0.151	0	0.33

Apr	1977	0.81	0.95	-0.14	0.11	0.01	0.69	0.11	0	0.135	0.71	0
May	1977	0.97	0.84	0.13	0.09	0	0.88	0.17	0	0.156	0	0.52
Jun	1977	0.29	1.02	-0.73	0.09	0	0.19	0.19	0	0.127	0.71	0
Jul	1977	1.01	0.41	0.6	0.13	0	0.88	0.26	0	0.151	0	0
Aug	1977	0.83	2.56	-1.73	0.1	0.04	0.69	0.14	0	0.085	2.33	0
Sep	1977	1.38	0.23	1.16	0.16	0.03	1.18	0.12	0	0.098	0	0
Oct	1977	0.25	1.43	-1.19	0.04	0.01	0.19	0.06	0	0.078	1.3	0
Nov	1977	1.04	0.14	0.9	0.11	0.04	0.88	0.04	0	0.107	0	0
Dec	1977	0.79	0.83	-0.05	0.07	0.03	0.69	0.01	0	0.111	0.71	0
Jan	1978	0.86	0.16	0.7	0.04	0	0.82	0.02	0	0.142	0	0
Feb	1978	0.77	0.86	-0.09	0.07	0	0.69	0.03	0	0.124	0.71	0
Mar	1978	1.11	0.68	0.43	0.22	0	0.88	0.06	0	0.153	0	0.46
Apr	1978	0.77	0.95	-0.18	0.08	0	0.69	0.11	0	0.134	0.71	0
May	1978	1.13	0.94	0.19	0.24	0	0.88	0.17	0	0.157	0	0.61
Jun	1978	0.32	1.03	-0.71	0.12	0	0.19	0.19	0	0.13	0.71	0
Jul	1978	1.04	0.42	0.62	0.15	0	0.88	0.26	0	0.152	0	0
Aug	1978	0.73	2.59	-1.86	0.04	0	0.69	0.14	0	0.083	2.37	0
Sep	1978	1.24	0.22	1.02	0.05	0.01	1.18	0.12	0.01	0.093	0	0
Oct	1978	0.27	1.22	-0.96	0.05	0.03	0.19	0.06	0	0.079	1.09	0
Nov	1978	1.08	0.15	0.93	0.15	0.04	0.88	0.04	0	0.107	0	0
Dec	1978	0.81	0.83	-0.02	0.09	0.03	0.69	0.01	0	0.112	0.71	0
Jan	1979	0.9	0.16	0.73	0.07	0	0.82	0.02	0	0.145	0	0
Feb	1979	0.86	0.87	-0.01	0.16	0.01	0.69	0.03	0	0.128	0.71	0
Mar	1979	1.08	0.8	0.28	0.19	0	0.88	0.06	0	0.156	0	0.58
Apr	1979	0.86	0.96	-0.09	0.16	0.01	0.69	0.11	0	0.138	0.71	0
May	1979	1.18	1.1	0.08	0.3	0	0.88	0.17	0	0.158	0	0.78
Jun	1979	0.29	1.03	-0.74	0.1	0	0.19	0.19	0	0.129	0.71	0
Jul	1979	1.03	0.42	0.61	0.14	0	0.88	0.26	0	0.151	0	0
Aug	1979	0.75	2.57	-1.83	0.06	0	0.69	0.14	0	0.083	2.35	0
Sep	1979	1.24	0.22	1.02	0.05	0.01	1.18	0.12	0.01	0.094	0	0
Oct	1979	0.27	1.23	-0.96	0.06	0.02	0.19	0.06	0	0.077	1.1	0
Nov	1979	0.98	0.14	0.84	0.08	0.02	0.88	0.04	0	0.107	0	0
Dec	1979	0.82	0.83	-0.01	0.1	0.03	0.69	0.01	0	0.109	0.71	0
Jan	1980	0.85	0.16	0.69	0.02	0	0.82	0.02	0	0.142	0	0

Feb	1980	0.72	0.87	-0.14	0.03	0	0.69	0.03	0	0.127	0.71	0
Mar	1980	1.01	0.49	0.52	0.12	0	0.88	0.06	0	0.152	0	0.28
Apr	1980	0.77	0.95	-0.18	0.08	0	0.69	0.11	0	0.136	0.71	0
May	1980	1.06	0.9	0.17	0.18	0	0.88	0.17	0	0.156	0	0.57
Jun	1980	0.33	1.02	-0.69	0.12	0.01	0.19	0.19	0	0.129	0.71	0
Jul	1980	0.91	0.41	0.49	0.02	0	0.88	0.26	0	0.151	0	0
Aug	1980	0.7	2.47	-1.77	0.01	0	0.69	0.14	0	0.082	2.25	0
Sep	1980	1.29	0.21	1.08	0.09	0.01	1.18	0.12	0	0.093	0	0
Oct	1980	0.27	1.25	-0.98	0.05	0.02	0.19	0.06	0	0.078	1.11	0
Nov	1980	0.95	0.14	0.81	0.06	0.01	0.88	0.04	0	0.105	0	0
Dec	1980	0.72	0.83	-0.1	0.02	0.01	0.69	0.01	0	0.106	0.71	0
Jan	1981	0.85	0.16	0.69	0.03	0	0.82	0.02	0	0.136	0	0
Feb	1981	0.77	0.86	-0.09	0.07	0.01	0.69	0.03	0	0.118	0.71	0
Mar	1981	0.98	0.4	0.59	0.1	0	0.88	0.06	0	0.15	0	0.18
Apr	1981	0.77	0.95	-0.18	0.08	0	0.69	0.11	0	0.135	0.71	0
May	1981	1.19	0.99	0.2	0.3	0	0.88	0.17	0	0.157	0	0.67
Jun	1981	0.32	1.03	-0.7	0.12	0.01	0.19	0.19	0	0.13	0.71	0
Jul	1981	1.02	0.42	0.6	0.13	0	0.88	0.26	0	0.153	0	0
Aug	1981	0.9	2.67	-1.77	0.15	0.05	0.69	0.14	0	0.086	2.44	0
Sep	1981	1.2	0.23	0.97	0.01	0	1.18	0.12	0.01	0.097	0	0
Oct	1981	0.31	1.27	-0.96	0.08	0.03	0.19	0.06	0	0.079	1.13	0
Nov	1981	0.93	0.14	0.79	0.04	0.01	0.88	0.04	0	0.106	0	0
Dec	1981	0.71	0.83	-0.11	0.02	0	0.69	0.01	0	0.106	0.71	0
Jan	1982	1.04	0.16	0.89	0.2	0.02	0.82	0.02	0	0.139	0	0
Feb	1982	0.75	0.87	-0.11	0.06	0	0.69	0.03	0	0.126	0.71	0
Mar	1982	0.96	0.57	0.39	0.07	0	0.88	0.06	0	0.154	0	0.35
Apr	1982	0.76	0.95	-0.19	0.07	0	0.69	0.11	0	0.135	0.71	0
May	1982	1.03	0.82	0.21	0.15	0	0.88	0.17	0	0.155	0	0.5
Jun	1982	0.4	1.03	-0.63	0.2	0.01	0.19	0.19	0	0.131	0.71	0
Jul	1982	0.97	0.42	0.55	0.09	0	0.88	0.27	0	0.154	0	0
Aug	1982	0.8	2.62	-1.81	0.09	0.03	0.69	0.14	0	0.085	2.39	0
Sep	1982	1.21	0.22	0.99	0.02	0	1.18	0.12	0.01	0.095	0	0
Oct	1982	0.27	1.25	-0.98	0.06	0.02	0.19	0.06	0	0.078	1.12	0
Nov	1982	1.03	0.14	0.89	0.11	0.03	0.88	0.04	0	0.106	0	0

Dec	1982	1.06	0.84	0.22	0.25	0.11	0.69	0.02	0	0.121	0.71	0
Jan	1983	0.84	0.17	0.67	0.02	0	0.82	0.02	0	0.151	0	0
Feb	1983	0.73	0.87	-0.14	0.04	0	0.69	0.04	0	0.131	0.71	0
Mar	1983	0.97	0.72	0.25	0.09	0	0.88	0.06	0	0.156	0	0.5
Apr	1983	0.88	0.95	-0.08	0.18	0	0.69	0.11	0	0.137	0.71	0
May	1983	1.05	0.99	0.07	0.17	0	0.88	0.17	0	0.158	0	0.66
Jun	1983	0.32	1.02	-0.7	0.12	0	0.19	0.19	0	0.128	0.71	0
Jul	1983	0.94	0.41	0.52	0.05	0	0.88	0.26	0	0.151	0	0
Aug	1983	0.72	2.5	-1.77	0.03	0	0.69	0.14	0	0.082	2.28	0
Sep	1983	1.2	0.21	0.99	0.02	0	1.18	0.12	0.01	0.092	0	0
Oct	1983	0.24	1.18	-0.94	0.04	0.01	0.19	0.06	0	0.078	1.04	0
Nov	1983	1.07	0.14	0.93	0.14	0.04	0.88	0.04	0	0.105	0	0
Dec	1983	0.77	0.83	-0.06	0.06	0.02	0.69	0.01	0	0.112	0.71	0
Jan	1984	0.85	0.16	0.68	0.02	0	0.82	0.02	0	0.142	0	0
Feb	1984	0.8	0.87	-0.07	0.1	0.01	0.69	0.03	0	0.129	0.71	0
Mar	1984	1.04	0.6	0.44	0.15	0	0.88	0.06	0	0.153	0	0.38
Apr	1984	0.81	0.95	-0.14	0.12	0.01	0.69	0.11	0	0.137	0.71	0
May	1984	1.13	1.01	0.12	0.24	0	0.88	0.17	0	0.156	0	0.69
Jun	1984	0.27	1.02	-0.75	0.08	0	0.19	0.19	0	0.128	0.71	0
Jul	1984	0.94	0.41	0.53	0.06	0	0.88	0.26	0	0.15	0	0
Aug	1984	0.72	2.46	-1.74	0.03	0	0.69	0.14	0	0.082	2.24	0
Sep	1984	1.32	0.22	1.11	0.12	0.02	1.18	0.12	0	0.094	0	0
Oct	1984	0.51	1.29	-0.78	0.2	0.12	0.19	0.06	0	0.083	1.15	0
Nov	1984	1.09	0.16	0.94	0.17	0.04	0.88	0.04	0	0.117	0	0
Dec	1984	0.87	0.85	0.02	0.15	0.03	0.69	0.02	0	0.123	0.71	0
Jan	1985	0.88	0.18	0.69	0.05	0	0.82	0.02	0	0.154	0	0.01
Feb	1985	0.84	0.88	-0.04	0.15	0	0.69	0.04	0	0.135	0.71	0
Mar	1985	1.12	1.07	0.05	0.24	0	0.88	0.06	0	0.158	0	0.85
Apr	1985	0.82	0.95	-0.13	0.13	0	0.69	0.11	0	0.136	0.71	0
May	1985	1	0.88	0.12	0.11	0	0.88	0.17	0	0.156	0	0.56
Jun	1985	0.25	1.02	-0.77	0.05	0	0.19	0.19	0	0.128	0.71	0
Jul	1985	0.98	0.41	0.57	0.1	0	0.88	0.26	0	0.149	0	0
Aug	1985	0.77	2.53	-1.76	0.07	0.01	0.69	0.14	0	0.082	2.31	0
Sep	1985	1.24	0.22	1.02	0.05	0	1.18	0.12	0.01	0.093	0	0

Oct	1985	0.28	1.21	-0.93	0.06	0.03	0.19	0.06	0	0.078	1.08	0
Nov	1985	1.18	0.15	1.03	0.23	0.06	0.88	0.04	0	0.109	0	0
Dec	1985	0.73	0.84	-0.11	0.03	0.01	0.69	0.02	0	0.117	0.71	0
Jan	1986	0.83	0.17	0.67	0.01	0	0.82	0.02	0	0.146	0	0
Feb	1986	0.75	0.87	-0.12	0.05	0.01	0.69	0.03	0	0.127	0.71	0
Mar	1986	0.93	0.56	0.38	0.05	0	0.88	0.06	0	0.154	0	0.34
Apr	1986	0.88	0.95	-0.08	0.18	0.01	0.69	0.11	0	0.138	0.71	0
May	1986	1.04	0.94	0.1	0.16	0	0.88	0.17	0	0.157	0	0.62
Jun	1986	0.29	1.03	-0.74	0.09	0	0.19	0.19	0	0.13	0.71	0
Jul	1986	0.91	0.41	0.5	0.03	0	0.88	0.26	0	0.15	0	0
Aug	1986	0.78	2.5	-1.72	0.09	0	0.69	0.14	0	0.083	2.28	0
Sep	1986	1.26	0.22	1.05	0.07	0.01	1.18	0.12	0	0.094	0	0
Oct	1986	0.29	1.29	-1	0.07	0.02	0.19	0.06	0	0.078	1.15	0
Nov	1986	0.95	0.14	0.8	0.05	0.01	0.88	0.03	0	0.105	0	0
Dec	1986	0.71	0.82	-0.12	0.02	0	0.69	0.01	0	0.104	0.71	0
Jan	1987	0.91	0.16	0.75	0.08	0.01	0.82	0.02	0	0.137	0	0
Feb	1987	0.87	0.86	0.01	0.16	0.01	0.69	0.03	0	0.121	0.71	0
Mar	1987	1.01	0.56	0.45	0.13	0	0.88	0.06	0	0.152	0	0.35
Apr	1987	0.71	0.95	-0.23	0.03	0	0.69	0.11	0	0.134	0.71	0
May	1987	1.08	0.84	0.24	0.2	0	0.88	0.16	0	0.154	0	0.52
Jun	1987	0.27	1.02	-0.75	0.07	0	0.19	0.19	0	0.128	0.71	0
Jul	1987	0.97	0.41	0.56	0.09	0	0.88	0.26	0	0.15	0	0
Aug	1987	0.76	2.49	-1.73	0.06	0.01	0.69	0.14	0	0.082	2.26	0
Sep	1987	1.3	0.22	1.08	0.1	0.02	1.18	0.12	0	0.096	0	0
Oct	1987	0.29	1.31	-1.02	0.06	0.03	0.19	0.06	0	0.078	1.17	0
Nov	1987	1.05	0.15	0.9	0.13	0.04	0.88	0.04	0	0.108	0	0
Dec	1987	0.99	0.84	0.15	0.23	0.07	0.69	0.02	0	0.114	0.71	0
Jan	1988	0.87	0.17	0.7	0.05	0	0.82	0.02	0	0.15	0	0
Feb	1988	0.78	0.88	-0.1	0.08	0	0.69	0.04	0	0.136	0.71	0
Mar	1988	1.14	0.9	0.24	0.25	0	0.88	0.06	0	0.158	0	0.68
Apr	1988	0.77	0.95	-0.18	0.08	0	0.69	0.11	0	0.137	0.71	0
May	1988	1	0.85	0.15	0.12	0	0.88	0.17	0	0.156	0	0.53
Jun	1988	0.24	1.02	-0.78	0.05	0	0.19	0.19	0	0.127	0.71	0
Jul	1988	1.04	0.41	0.62	0.15	0	0.88	0.26	0	0.15	0	0

Aug	1988	0.73	2.53	-1.8	0.04	0	0.69	0.14	0	0.082	2.31	0
Sep	1988	1.27	0.21	1.05	0.08	0	1.18	0.12	0	0.093	0	0
Oct	1988	0.24	1.24	-1.01	0.04	0.01	0.19	0.06	0	0.077	1.11	0
Nov	1988	1.13	0.15	0.98	0.19	0.06	0.88	0.04	0	0.107	0	0
Dec	1988	0.77	0.83	-0.07	0.06	0.01	0.69	0.02	0	0.113	0.71	0
Jan	1989	0.91	0.16	0.74	0.08	0	0.82	0.02	0	0.144	0	0
Feb	1989	0.96	0.87	0.08	0.25	0.02	0.69	0.03	0	0.131	0.71	0
Mar	1989	1.04	0.85	0.19	0.15	0	0.88	0.06	0	0.158	0	0.63
Apr	1989	0.71	0.95	-0.24	0.02	0	0.69	0.11	0	0.135	0.71	0
May	1989	1.1	0.9	0.2	0.21	0	0.88	0.17	0	0.155	0	0.58
Jun	1989	0.32	1.02	-0.7	0.12	0	0.19	0.19	0	0.129	0.71	0
Jul	1989	1.06	0.42	0.64	0.17	0	0.88	0.26	0	0.152	0	0
Aug	1989	0.73	2.6	-1.87	0.04	0	0.69	0.14	0	0.083	2.38	0
Sep	1989	1.24	0.22	1.03	0.05	0	1.18	0.12	0	0.094	0	0
Oct	1989	0.2	1.23	-1.03	0.01	0	0.19	0.06	0	0.077	1.09	0
Nov	1989	0.89	0.14	0.76	0.01	0	0.88	0.03	0	0.1	0	0
Dec	1989	0.7	0.82	-0.12	0.01	0	0.69	0.01	0	0.099	0.71	0
Jan	1990	1	0.15	0.85	0.16	0.02	0.82	0.02	0	0.134	0	0
Feb	1990	0.86	0.86	0	0.16	0.02	0.69	0.03	0	0.122	0.71	0
Mar	1990	1.11	0.64	0.48	0.22	0.01	0.88	0.06	0	0.153	0	0.42
Apr	1990	0.87	0.95	-0.08	0.17	0.01	0.69	0.11	0	0.137	0.71	0
May	1990	1.31	1.23	0.08	0.43	0	0.88	0.17	0	0.158	0	0.91
Jun	1990	0.24	1.02	-0.78	0.05	0	0.19	0.19	0	0.128	0.71	0
Jul	1990	0.95	0.41	0.54	0.07	0	0.88	0.26	0	0.149	0	0
Aug	1990	0.76	2.47	-1.72	0.05	0.01	0.69	0.14	0	0.083	2.25	0
Sep	1990	1.29	0.22	1.07	0.09	0.01	1.18	0.12	0	0.094	0	0
Oct	1990	0.35	1.29	-0.94	0.09	0.07	0.19	0.06	0	0.082	1.14	0
Nov	1990	0.97	0.15	0.82	0.07	0.01	0.88	0.04	0	0.109	0	0
Dec	1990	0.84	0.83	0.01	0.12	0.04	0.69	0.01	0	0.112	0.71	0
Jan	1991	0.95	0.17	0.79	0.13	0.01	0.82	0.02	0	0.147	0	0
Feb	1991	0.72	0.87	-0.15	0.03	0	0.69	0.03	0	0.129	0.71	0
Mar	1991	0.99	0.64	0.34	0.11	0	0.88	0.06	0	0.154	0	0.43
Apr	1991	0.95	0.96	0	0.24	0.02	0.69	0.11	0	0.138	0.71	0
May	1991	1.08	1.1	-0.02	0.2	0	0.88	0.17	0	0.158	0	0.77

Jun	1991	0.24	1.02	-0.78	0.05	0	0.19	0.19	0	0.127	0.71	0
Jul	1991	0.97	0.41	0.56	0.09	0	0.88	0.26	0	0.149	0	0
Aug	1991	0.73	2.45	-1.72	0.04	0	0.69	0.14	0	0.082	2.23	0
Sep	1991	1.27	0.22	1.05	0.08	0.01	1.18	0.12	0.01	0.094	0	0
Oct	1991	0.48	1.25	-0.77	0.16	0.12	0.19	0.06	0	0.079	1.12	0
Nov	1991	1.05	0.16	0.9	0.14	0.03	0.88	0.04	0	0.115	0	0
Dec	1991	0.83	0.84	-0.01	0.11	0.03	0.69	0.02	0	0.121	0.71	0
Jan	1992	0.86	0.17	0.69	0.04	0	0.82	0.02	0	0.151	0	0
Feb	1992	0.76	0.88	-0.12	0.06	0	0.69	0.04	0	0.137	0.71	0
Mar	1992	0.97	0.75	0.22	0.08	0	0.88	0.06	0	0.157	0	0.53
Apr	1992	0.74	0.95	-0.21	0.05	0	0.69	0.11	0	0.134	0.71	0
May	1992	1.04	0.83	0.21	0.15	0	0.88	0.16	0	0.154	0	0.51
Jun	1992	0.44	1.03	-0.59	0.24	0.01	0.19	0.19	0	0.132	0.71	0
Jul	1992	1.04	0.44	0.6	0.16	0	0.88	0.27	0	0.155	0	0.01
Aug	1992	0.76	2.72	-1.96	0.07	0	0.69	0.14	0	0.084	2.49	0
Sep	1992	1.33	0.22	1.11	0.1	0.04	1.18	0.12	0	0.096	0	0
Oct	1992	0.22	1.3	-1.08	0.03	0	0.19	0.06	0	0.077	1.17	0
Nov	1992	1.07	0.14	0.93	0.14	0.05	0.88	0.04	0	0.106	0	0
Dec	1992	0.86	0.83	0.03	0.12	0.05	0.69	0.02	0	0.113	0.71	0
Jan	1993	0.98	0.17	0.81	0.14	0.02	0.82	0.02	0	0.149	0	0
Feb	1993	0.8	0.87	-0.07	0.11	0	0.69	0.03	0	0.13	0.71	0
Mar	1993	0.96	0.73	0.24	0.08	0	0.88	0.06	0	0.156	0	0.51
Apr	1993	0.84	0.95	-0.11	0.14	0.01	0.69	0.11	0	0.137	0.71	0
May	1993	1.12	1.01	0.11	0.24	0	0.88	0.17	0	0.158	0	0.69
Jun	1993	0.3	1.02	-0.72	0.11	0	0.19	0.19	0	0.129	0.71	0
Jul	1993	0.93	0.42	0.52	0.05	0	0.88	0.26	0	0.151	0	0
Aug	1993	0.76	2.52	-1.77	0.06	0.01	0.69	0.14	0	0.082	2.3	0
Sep	1993	1.38	0.22	1.16	0.16	0.04	1.18	0.12	0	0.095	0	0
Oct	1993	0.27	1.36	-1.09	0.06	0.02	0.19	0.06	0	0.078	1.22	0
Nov	1993	1.05	0.14	0.9	0.13	0.04	0.88	0.04	0	0.108	0	0
Dec	1993	0.77	0.83	-0.07	0.05	0.02	0.69	0.01	0	0.112	0.71	0
Jan	1994	0.94	0.16	0.78	0.11	0.01	0.82	0.02	0	0.143	0	0
Feb	1994	0.79	0.87	-0.08	0.1	0	0.69	0.03	0	0.127	0.71	0
Mar	1994	1.05	0.71	0.34	0.16	0	0.88	0.06	0	0.155	0	0.49

Apr	1994	0.87	0.95	-0.08	0.17	0	0.69	0.11	0	0.136	0.71	0
May	1994	0.94	0.87	0.08	0.06	0	0.88	0.17	0	0.157	0	0.54
Jun	1994	0.28	1.02	-0.74	0.08	0	0.19	0.19	0	0.128	0.71	0
Jul	1994	0.99	0.41	0.57	0.1	0	0.88	0.26	0	0.15	0	0
Aug	1994	0.76	2.51	-1.75	0.06	0.01	0.69	0.14	0	0.082	2.29	0
Sep	1994	1.2	0.22	0.98	0.02	0	1.18	0.12	0.01	0.093	0	0
Oct	1994	0.24	1.2	-0.96	0.04	0.01	0.19	0.06	0	0.078	1.06	0
Nov	1994	1.3	0.16	1.14	0.29	0.13	0.88	0.04	0	0.116	0	0
Dec	1994	0.8	0.84	-0.04	0.08	0.03	0.69	0.02	0	0.121	0.71	0
Jan	1995	0.98	0.19	0.79	0.16	0	0.82	0.02	0	0.152	0	0.02
Feb	1995	0.74	0.88	-0.14	0.05	0	0.69	0.04	0	0.133	0.71	0
Mar	1995	0.99	0.83	0.15	0.1	0	0.88	0.06	0	0.158	0	0.61
Apr	1995	0.89	0.95	-0.06	0.19	0.01	0.69	0.11	0	0.136	0.71	0
May	1995	1.07	1.01	0.06	0.19	0	0.88	0.17	0	0.157	0	0.68
Jun	1995	0.35	1.03	-0.68	0.15	0.01	0.19	0.19	0	0.131	0.71	0
Jul	1995	0.98	0.42	0.56	0.1	0	0.88	0.26	0	0.152	0	0
Aug	1995	0.7	2.56	-1.85	0.01	0	0.69	0.14	0	0.082	2.34	0
Sep	1995	1.31	0.22	1.09	0.1	0.02	1.18	0.12	0.01	0.094	0	0
Oct	1995	0.27	1.29	-1.02	0.05	0.02	0.19	0.06	0	0.078	1.15	0
Nov	1995	0.96	0.14	0.81	0.06	0.01	0.88	0.04	0	0.105	0	0
Dec	1995	0.8	0.83	-0.03	0.09	0.02	0.69	0.01	0	0.106	0.71	0
Jan	1996	0.94	0.16	0.78	0.1	0.02	0.82	0.02	0	0.142	0	0
Feb	1996	0.71	0.87	-0.16	0.02	0	0.69	0.03	0	0.128	0.71	0
Mar	1996	1.01	0.5	0.51	0.12	0	0.88	0.06	0	0.152	0	0.29
Apr	1996	0.86	0.95	-0.09	0.16	0.01	0.69	0.11	0	0.136	0.71	0
May	1996	0.97	0.86	0.11	0.09	0	0.88	0.17	0	0.156	0	0.54
Jun	1996	0.29	1.03	-0.73	0.1	0	0.19	0.19	0	0.13	0.71	0
Jul	1996	0.98	0.42	0.57	0.1	0	0.88	0.26	0	0.151	0	0
Aug	1996	0.72	2.54	-1.81	0.03	0	0.69	0.14	0	0.082	2.31	0
Sep	1996	1.52	0.22	1.3	0.25	0.08	1.18	0.12	0.01	0.097	0	0
Oct	1996	0.24	1.49	-1.25	0.04	0.01	0.19	0.06	0	0.078	1.36	0
Nov	1996	1.17	0.15	1.03	0.22	0.07	0.88	0.04	0	0.109	0	0
Dec	1996	0.75	0.84	-0.08	0.05	0.02	0.69	0.02	0	0.115	0.71	0
Jan	1997	0.85	0.17	0.69	0.03	0	0.82	0.02	0	0.145	0	0

Feb	1997	0.87	0.87	0	0.16	0.01	0.69	0.03	0	0.128	0.71	0
Mar	1997	1.02	0.75	0.27	0.13	0	0.88	0.06	0	0.156	0	0.53
Apr	1997	0.81	0.95	-0.14	0.11	0.01	0.69	0.11	0	0.137	0.71	0
May	1997	0.99	0.83	0.16	0.11	0	0.88	0.17	0	0.156	0	0.51
Jun	1997	0.3	1.02	-0.72	0.1	0	0.19	0.19	0	0.129	0.71	0
Jul	1997	0.95	0.41	0.53	0.06	0	0.88	0.26	0	0.151	0	0
Aug	1997	0.75	2.51	-1.76	0.05	0.01	0.69	0.14	0	0.083	2.28	0
Sep	1997	1.26	0.22	1.04	0.06	0.01	1.18	0.12	0.01	0.094	0	0
Oct	1997	0.25	1.25	-1	0.04	0.01	0.19	0.06	0	0.078	1.12	0
Nov	1997	0.95	0.14	0.81	0.06	0.01	0.88	0.03	0	0.105	0	0
Dec	1997	0.79	0.83	-0.04	0.07	0.03	0.69	0.01	0	0.106	0.71	0
Jan	1998	1.03	0.16	0.87	0.19	0.03	0.82	0.02	0	0.144	0	0
Feb	1998	0.85	0.87	-0.02	0.15	0.01	0.69	0.03	0	0.128	0.71	0
Mar	1998	1.14	0.85	0.3	0.26	0	0.88	0.06	0	0.156	0	0.63
Apr	1998	0.79	0.95	-0.16	0.1	0	0.69	0.11	0	0.136	0.71	0
May	1998	1	0.88	0.12	0.12	0	0.88	0.17	0	0.156	0	0.55
Jun	1998	0.24	1.02	-0.78	0.05	0	0.19	0.19	0	0.127	0.71	0
Jul	1998	0.96	0.41	0.55	0.08	0	0.88	0.26	0	0.149	0	0
Aug	1998	0.75	2.47	-1.72	0.06	0	0.69	0.14	0	0.082	2.25	0
Sep	1998	1.25	0.22	1.03	0.06	0.01	1.18	0.12	0.01	0.093	0	0
Oct	1998	0.33	1.23	-0.9	0.08	0.05	0.19	0.06	0	0.081	1.09	0
Nov	1998	0.97	0.15	0.82	0.07	0.01	0.88	0.04	0	0.109	0	0
Dec	1998	0.79	0.83	-0.04	0.08	0.03	0.69	0.01	0	0.111	0.71	0
Jan	1999	0.95	0.16	0.79	0.12	0.02	0.82	0.02	0	0.145	0	0
Feb	1999	0.74	0.87	-0.13	0.04	0.01	0.69	0.03	0	0.128	0.71	0
Mar	1999	1.04	0.66	0.38	0.15	0	0.88	0.06	0	0.155	0	0.44
Apr	1999	0.83	0.95	-0.12	0.13	0.01	0.69	0.11	0	0.137	0.71	0
May	1999	1.06	0.94	0.11	0.17	0	0.88	0.17	0	0.157	0	0.62
Jun	1999	0.37	1.02	-0.66	0.16	0.01	0.19	0.19	0	0.128	0.71	0
Jul	1999	0.93	0.42	0.51	0.05	0	0.88	0.26	0	0.152	0	0
Aug	1999	0.71	2.53	-1.81	0.02	0	0.69	0.14	0	0.082	2.31	0
Sep	1999	1.21	0.21	0.99	0.02	0	1.18	0.12	0.01	0.092	0	0
Oct	1999	0.22	1.18	-0.95	0.03	0	0.19	0.06	0	0.077	1.04	0
Nov	1999	0.93	0.14	0.8	0.04	0.01	0.88	0.03	0	0.102	0	0

Dec	1999	0.87	0.83	0.04	0.12	0.06	0.69	0.01	0	0.109	0.71	0
Jan	2000	0.88	0.16	0.72	0.06	0.01	0.82	0.02	0	0.142	0	0
Feb	2000	0.76	0.87	-0.11	0.07	0	0.69	0.03	0	0.128	0.71	0
Mar	2000	0.97	0.5	0.47	0.08	0	0.88	0.06	0	0.152	0	0.28
Apr	2000	0.75	0.95	-0.2	0.06	0	0.69	0.11	0	0.135	0.71	0
May	2000	1.11	0.92	0.19	0.22	0	0.88	0.17	0	0.155	0	0.6
Jun	2000	0.43	1.03	-0.6	0.22	0.02	0.19	0.19	0	0.131	0.71	0
Jul	2000	0.99	0.42	0.56	0.1	0	0.88	0.27	0	0.154	0	0
Aug	2000	0.69	2.63	-1.93	0	0	0.69	0.14	0	0.083	2.4	0
Sep	2000	1.24	0.21	1.02	0.05	0.01	1.18	0.12	0.01	0.092	0	0
Oct	2000	0.24	1.19	-0.95	0.04	0.01	0.19	0.06	0	0.077	1.06	0
Nov	2000	1.08	0.15	0.93	0.13	0.06	0.88	0.04	0	0.109	0	0
Dec	2000	0.75	0.83	-0.08	0.05	0.01	0.69	0.01	0	0.111	0.71	0
Jan	2001	0.9	0.16	0.73	0.07	0.01	0.82	0.02	0	0.142	0	0
Feb	2001	0.9	0.87	0.04	0.2	0.01	0.69	0.03	0	0.127	0.71	0
Mar	2001	0.93	0.65	0.28	0.04	0	0.88	0.06	0	0.155	0	0.43
Apr	2001	0.72	0.95	-0.22	0.04	0	0.69	0.11	0	0.135	0.71	0
May	2001	1.02	0.77	0.25	0.13	0	0.88	0.16	0	0.154	0	0.45
Jun	2001	0.3	1.02	-0.73	0.1	0.01	0.19	0.19	0	0.129	0.71	0
Jul	2001	1.01	0.42	0.6	0.13	0	0.88	0.26	0	0.152	0	0
Aug	2001	0.73	2.56	-1.83	0.03	0.01	0.69	0.14	0	0.083	2.34	0
Sep	2001	1.31	0.22	1.09	0.08	0.04	1.18	0.12	0	0.096	0	0
Oct	2001	0.28	1.29	-1.02	0.05	0.03	0.19	0.06	0	0.079	1.15	0
Nov	2001	1.03	0.14	0.89	0.12	0.03	0.88	0.04	0	0.106	0	0
Dec	2001	0.89	0.83	0.06	0.15	0.05	0.69	0.02	0	0.113	0.71	0
Jan	2002	0.95	0.17	0.78	0.12	0	0.82	0.02	0	0.147	0	0
Feb	2002	0.77	0.87	-0.1	0.07	0.01	0.69	0.03	0	0.13	0.71	0
Mar	2002	1.26	1.01	0.25	0.37	0	0.88	0.06	0	0.157	0	0.79
Apr	2002	0.87	0.96	-0.09	0.16	0.01	0.69	0.11	0	0.137	0.71	0
May	2002	1.05	0.95	0.09	0.16	0	0.88	0.17	0	0.157	0	0.63
Jun	2002	0.31	1.02	-0.72	0.11	0	0.19	0.19	0	0.129	0.71	0
Jul	2002	1.02	0.42	0.6	0.13	0	0.88	0.26	0	0.152	0	0
Aug	2002	0.79	2.56	-1.77	0.06	0.04	0.69	0.14	0	0.085	2.33	0
Sep	2002	1.22	0.22	1	0.04	0	1.18	0.12	0.01	0.095	0	0

Oct	2002	0.25	1.25	-1	0.05	0.01	0.19	0.06	0	0.077	1.12	0
Nov	2002	0.92	0.14	0.78	0.02	0.01	0.88	0.03	0	0.104	0	0
Dec	2002	0.86	0.83	0.03	0.12	0.05	0.69	0.01	0	0.105	0.71	0
Jan	2003	0.84	0.16	0.68	0.01	0	0.82	0.02	0	0.14	0	0
Feb	2003	0.79	0.86	-0.07	0.09	0.01	0.69	0.03	0	0.122	0.71	0
Mar	2003	0.97	0.5	0.47	0.09	0	0.88	0.06	0	0.152	0	0.29
Apr	2003	0.76	0.95	-0.19	0.07	0	0.69	0.11	0	0.134	0.71	0
May	2003	1.14	0.94	0.2	0.25	0	0.88	0.17	0	0.156	0	0.62
Jun	2003	0.31	1.03	-0.71	0.12	0	0.19	0.19	0	0.13	0.71	0
Jul	2003	0.98	0.42	0.56	0.09	0	0.88	0.26	0	0.151	0	0
Aug	2003	0.75	2.56	-1.81	0.06	0	0.69	0.14	0	0.082	2.34	0
Sep	2003	1.25	0.22	1.03	0.05	0.01	1.18	0.12	0.01	0.093	0	0
Oct	2003	0.28	1.21	-0.93	0.06	0.03	0.19	0.06	0	0.079	1.07	0
Nov	2003	1.06	0.15	0.91	0.14	0.04	0.88	0.04	0	0.108	0	0
Dec	2003	0.78	0.83	-0.06	0.07	0.02	0.69	0.01	0	0.112	0.71	0
Jan	2004	0.9	0.16	0.73	0.07	0	0.82	0.02	0	0.144	0	0
Feb	2004	0.75	0.87	-0.13	0.05	0.01	0.69	0.03	0	0.131	0.71	0
Mar	2004	0.99	0.58	0.41	0.11	0	0.88	0.06	0	0.154	0	0.37
Apr	2004	0.96	0.96	0	0.26	0.01	0.69	0.11	0	0.136	0.71	0.01
May	2004	0.97	0.96	0	0.08	0	0.88	0.17	0	0.157	0	0.64
Jun	2004	0.31	1.02	-0.71	0.12	0	0.19	0.19	0	0.129	0.71	0
Jul	2004	1	0.42	0.58	0.12	0	0.88	0.26	0	0.152	0	0
Aug	2004	0.73	2.56	-1.83	0.04	0	0.69	0.14	0	0.083	2.34	0
Sep	2004	1.19	0.21	0.97	0	0	1.18	0.12	0.01	0.092	0	0
Oct	2004	0.46	1.18	-0.72	0.16	0.1	0.19	0.06	0	0.082	1.04	0
Nov	2004	1.08	0.15	0.93	0.16	0.04	0.88	0.04	0	0.115	0	0
Dec	2004	0.74	0.84	-0.1	0.04	0.01	0.69	0.02	0	0.119	0.71	0
Jan	2005	1.02	0.17	0.85	0.18	0.02	0.82	0.02	0	0.152	0	0
Feb	2005	0.77	0.88	-0.1	0.08	0	0.69	0.04	0	0.134	0.71	0
Mar	2005	0.99	0.86	0.13	0.11	0	0.88	0.06	0	0.158	0	0.64
Apr	2005	0.8	0.95	-0.15	0.11	0.01	0.69	0.11	0	0.136	0.71	0
May	2005	0.95	0.82	0.14	0.07	0	0.88	0.17	0	0.155	0	0.49
Jun	2005	0.23	1.02	-0.79	0.04	0	0.19	0.19	0	0.127	0.71	0
Jul	2005	0.96	0.41	0.55	0.08	0	0.88	0.26	0	0.148	0	0

Aug	2005	0.75	2.45	-1.7	0.06	0	0.69	0.14	0	0.082	2.23	0
Sep	2005	1.31	0.22	1.09	0.1	0.02	1.18	0.12	0.01	0.094	0	0
Oct	2005	0.2	1.29	-1.1	0	0	0.19	0.06	0	0.077	1.16	0
Nov	2005	0.97	0.14	0.83	0.07	0.02	0.88	0.03	0	0.102	0	0
Dec	2005	0.7	0.82	-0.13	0.01	0	0.69	0.01	0	0.102	0.71	0
Jan	2006	0.91	0.16	0.76	0.08	0.01	0.82	0.02	0	0.134	0	0
Feb	2006	0.72	0.86	-0.14	0.03	0	0.69	0.03	0	0.117	0.71	0
Mar	2006	1.03	0.39	0.64	0.14	0.01	0.88	0.06	0	0.149	0	0.18
Apr	2006	0.86	0.95	-0.09	0.17	0	0.69	0.11	0	0.135	0.71	0
May	2006	0.98	0.91	0.08	0.1	0	0.88	0.17	0	0.157	0	0.58
Jun	2006	0.29	1.02	-0.74	0.09	0	0.19	0.19	0	0.129	0.71	0
Jul	2006	0.96	0.41	0.54	0.07	0	0.88	0.26	0	0.15	0	0
Aug	2006	0.76	2.48	-1.72	0.07	0.01	0.69	0.14	0	0.082	2.26	0
Sep	2006	1.33	0.22	1.11	0.12	0.03	1.18	0.12	0.01	0.095	0	0
Oct	2006	0.37	1.34	-0.97	0.11	0.07	0.19	0.06	0	0.081	1.2	0
Nov	2006	1.12	0.15	0.96	0.19	0.04	0.88	0.04	0	0.112	0	0
Dec	2006	0.84	0.84	0	0.12	0.03	0.69	0.02	0	0.117	0.71	0

AVERAGE MONTHLY VOLUMES BY MAJOR IMPOUNDMENT PROCESSES

Mon	Inflow	Outflow	Change	Precip Vol	Bank Runoff	Ext Input	Vol Evap	Vol Infil	Vol Seep	Drdn Pump	Spillway
	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft
Jan	0.91	0.16	0.74	0.08	0.01	0.82	0.02	0	0.142	0	0
Feb	0.78	0.87	-0.08	0.09	0.01	0.69	0.03	0	0.13	0.7	0
Mar	1.03	0.65	0.38	0.14	0	0.88	0.06	0	0.153	0	0.43
Apr	0.82	0.95	-0.13	0.12	0.01	0.69	0.11	0	0.136	0.71	0
May	1.06	0.91	0.14	0.17	0	0.88	0.17	0	0.156	0	0.59
Jun	0.31	1.02	-0.71	0.11	0	0.19	0.19	0	0.129	0.71	0
Jul	0.98	0.42	0.57	0.1	0	0.88	0.26	0	0.151	0	0
Aug	0.75	2.55	-1.79	0.05	0.01	0.69	0.14	0	0.083	2.32	0
Sep	1.28	0.22	1.06	0.08	0.02	1.18	0.12	0	0.094	0	0
Oct	0.28	1.27	-0.99	0.06	0.03	0.19	0.06	0	0.078	1.14	0
Nov	1.02	0.14	0.87	0.11	0.03	0.88	0.04	0	0.107	0	0
Dec	0.8	0.83	-0.03	0.09	0.03	0.69	0.01	0	0.111	0.71	0

A SUMMARY OF ACCUMULATIVE MONTHLY POND VOLUMES
Info: This Simulation is conducted on Pond 2 in series with Pond 1.
SIMULATION BY:

Nathan A. Pesta
Senior Project Engineer
DeHaan, Grabs & Associates, LLC
PO Box 522
Mandan, ND, 58554

SIMULATION FOR:

File : C:\Program Files\SPAW Hydrology\SPAW\Projects\Ponds\Examples\Henson, Jason_Pond 2\Henson, Jason_Pond 2.pnd
File Creation Date : Jul 06, 2012 14:52:33
File Last Modified Date : Jul 06, 2012 15:04:42
Description : Waste Storage Pond 2
Simulation Start Date : Jan 01, 1960
Simulation End Date : Dec 31, 2006
Simulation Run Date : Jul 06, 2012 15:04
SPAW Interface Version : Jul 06, 2012 15:04:42
Pond Model Version : 6.02.71

WATERSHED FIELDS:

DESCRIPTION/FILE (DATE) AREA (AC)
Pasture -Rainfed (Sample) 0.00
C:\Program Files\SPAW Hydrology\SPAW\Projects\Fields\Examples\Pasture_Henson\Pasture_Henson.fpin Dec 30, 1899 00:00

IRRIGATED FIELDS:

DESCRIPTION/FILE (DATE) AREA (AC)
Pasture -Rainfed (Sample) 630.70
C:\Program Files\SPAW Hydrology\SPAW\Projects\Fields\Examples\Pasture\Pasture.fpin Dec 30, 1899 00:00

INPUT PONDS:

DESCRIPTION/FILE (DATE)
`Waste Storage Pond 2
C:\Program Files\SPAW Hydrology\SPAW\Projects\Ponds\Examples\Henson, Jason_Pond 1\Henson, Jason_Pond 1.ppin Jul 06, 2012 14:17

POND PROFILE:

DEPTH (FT)	AREA (AC)	VOLUME (AC-FT)
0.00	0.28	0.00
1.10	0.32	0.33
2.10	0.35	0.67
3.10	0.38	1.03
4.10	0.42	1.43
5.10	0.46	1.87
6.10	0.50	2.35
7.10	0.54	2.87
8.10	0.58	3.43
9.10	0.63	4.04
10.20	0.68	4.76
11.00	0.72	5.32
11.70	0.76	5.83
12.70	0.81	6.62

POND PROFILE
MAX AREA (AC) = 0.81
MAX DEPTH (FT) = 12.70
MAX VOLUME (AC-FT) = 6.62
IRRIGATION LIMIT (FT) = 0.00
EXTERNAL INPUT UPPER LIMIT (FT)= 0.00
EXTERNAL INPUT LOWER LIMIT (FT)= 0.00
SUPPLY PUMP LOWER LIMIT (FT) = 0.00
DRAWDOWN PUMP UPPER LIMIT (FT) = 0.00
DRAWDOWN PUMP LOWER LIMIT (FT) = 2.00
SPILLWAY CREST (FT) = 12.70
INITIAL DEPTH (FT) = 1.00
INFIL. INTO DRY SOIL (IN) = 0.50

SEEPAGE RATE (IN/DAY)

DATE	RATE

Jun 14 0.15

MONTHLY VOLUMES BY MAJOR IMPOUNDMENT PROCESSES

Mon	Year	Inflow ac·ft	Outflow ac·ft	Change ac·ft	Precip Vol ac·ft	Bank Runo ac·ft	Drwdwn In ac·ft	Spill In ac·ft	Vol Evap ac·ft	Vol Seep ac·ft	Drdn Pump ac·ft	Spillway ac·ft
Jan	1960	0.2	0.14	0.06	0.06	0.06	0	0	0.02	0.124	0	0
Feb	1960	0.75	0.17	0.58	0.09	0.06	0.51	0	0.04	0.135	0	0
Mar	1960	0.22	0.2	0.02	0.06	0.04	0	0	0.06	0.145	0	0
Apr	1960	0.92	1.26	-0.34	0.08	0.02	0.71	0	0.1	0.13	1.02	0
May	1960	0.75	0.29	0.46	0.27	0.21	0	0.12	0.15	0.141	0	0
Jun	1960	0.95	0.41	0.55	0.09	0.02	0.71	0	0.24	0.165	0	0
Jul	1960	0.47	0.46	0.01	0.24	0.08	0	0	0.29	0.169	0	0
Aug	1960	2.58	0.62	1.96	0.08	0	2.42	0	0.38	0.23	0	0
Sep	1960	0.22	0.49	-0.27	0.13	0	0	0	0.28	0.218	0	0
Oct	1960	1.23	3.97	-2.74	0.08	0	1.08	0	0.11	0.153	3.7	0
Nov	1960	0.16	0.17	-0.01	0.05	0.01	0	0	0.04	0.128	0	0
Dec	1960	1.09	0.19	0.9	0.16	0.12	0.71	0	0.02	0.162	0	0
Jan	1961	0.18	0.19	-0.01	0.03	0.01	0	0	0.02	0.164	0	0
Feb	1961	1	0.22	0.79	0.13	0.05	0.71	0	0.05	0.17	0	0
Mar	1961	0.85	0.28	0.57	0.25	0.1	0	0.34	0.08	0.197	0	0
Apr	1961	0.97	3.15	-2.18	0.09	0.03	0.71	0	0.11	0.142	2.89	0
May	1961	1.73	0.33	1.4	0.39	0.33	0	0.85	0.17	0.16	0	0
Jun	1961	0.91	0.48	0.43	0.07	0	0.71	0	0.29	0.195	0	0
Jul	1961	0.42	0.54	-0.12	0.24	0.03	0	0	0.34	0.196	0	0
Aug	1961	2.69	0.67	2.02	0.27	0.01	2.32	0	0.42	0.25	0	0
Sep	1961	0.28	0.55	-0.26	0.18	0.01	0	0	0.31	0.241	0	0
Oct	1961	1.33	4.87	-3.53	0.08	0	1.17	0	0.12	0.163	4.58	0
Nov	1961	0.38	0.18	0.2	0.14	0.14	0	0	0.04	0.132	0	0
Dec	1961	1.05	0.19	0.86	0.14	0.1	0.71	0	0.02	0.168	0	0
Jan	1962	0.33	0.2	0.14	0.12	0.08	0	0	0.02	0.173	0	0
Feb	1962	0.96	0.23	0.74	0.1	0.03	0.71	0	0.05	0.177	0	0
Mar	1962	0.63	0.28	0.35	0.11	0.02	0	0.35	0.08	0.201	0	0
Apr	1962	0.92	3.15	-2.23	0.08	0	0.71	0	0.11	0.142	2.9	0
May	1962	0.72	0.28	0.44	0.07	0.03	0	0.46	0.14	0.135	0	0

Jun	1962	1.05	0.41	0.64	0.19	0.02	0.71	0	0.24	0.167	0	0
Jul	1962	0.33	0.46	-0.13	0.16	0.02	0	0	0.29	0.169	0	0
Aug	1962	2.82	0.62	2.2	0.24	0.05	2.44	0	0.38	0.23	0	0
Sep	1962	0.4	0.51	-0.11	0.28	0.02	0	0	0.29	0.226	0	0
Oct	1962	1.54	4.57	-3.02	0.18	0.06	1.22	0	0.12	0.16	4.29	0
Nov	1962	0.15	0.17	-0.02	0.04	0.01	0	0	0.04	0.13	0	0
Dec	1962	0.86	0.18	0.68	0.04	0.01	0.71	0	0.02	0.157	0	0
Jan	1963	0.16	0.18	-0.02	0.02	0.01	0	0	0.02	0.158	0	0
Feb	1963	0.85	0.21	0.64	0.03	0	0.71	0	0.04	0.162	0	0
Mar	1963	0.48	0.26	0.22	0.12	0.05	0	0.15	0.07	0.183	0	0
Apr	1963	0.9	2.43	-1.53	0.05	0.02	0.71	0	0.11	0.136	2.18	0
May	1963	0.88	0.28	0.6	0.13	0.09	0	0.51	0.15	0.136	0	0
Jun	1963	0.96	0.42	0.54	0.12	0.01	0.71	0	0.25	0.171	0	0
Jul	1963	0.23	0.46	-0.23	0.08	0	0	0	0.29	0.17	0	0
Aug	1963	2.42	0.6	1.82	0.08	0	2.25	0	0.37	0.222	0	0
Sep	1963	0.18	0.48	-0.3	0.09	0	0	0	0.27	0.212	0	0
Oct	1963	1.14	3.65	-2.51	0.01	0	1.06	0	0.11	0.15	3.39	0
Nov	1963	0.28	0.17	0.11	0.09	0.08	0	0	0.04	0.128	0	0
Dec	1963	0.91	0.18	0.72	0.06	0.03	0.71	0	0.02	0.159	0	0
Jan	1964	0.17	0.18	-0.01	0.03	0	0	0	0.02	0.16	0	0
Feb	1964	0.98	0.22	0.76	0.1	0.05	0.71	0	0.05	0.174	0	0
Mar	1964	0.91	0.28	0.63	0.29	0.13	0	0.33	0.08	0.196	0	0
Apr	1964	1.06	3.2	-2.15	0.16	0.05	0.71	0	0.11	0.142	2.95	0
May	1964	0.88	0.29	0.6	0.11	0.07	0	0.55	0.15	0.138	0	0
Jun	1964	0.9	0.42	0.49	0.07	0	0.71	0	0.25	0.169	0	0
Jul	1964	0.21	0.46	-0.25	0.06	0	0	0	0.29	0.167	0	0
Aug	1964	2.65	0.6	2.06	0.33	0.02	2.22	0	0.37	0.222	0	0
Sep	1964	0.32	0.49	-0.17	0.21	0.02	0	0	0.27	0.216	0	0
Oct	1964	1.3	4.09	-2.78	0.01	0	1.21	0	0.11	0.154	3.82	0
Nov	1964	0.27	0.17	0.09	0.1	0.07	0	0	0.04	0.128	0	0
Dec	1964	0.86	0.18	0.68	0.04	0.02	0.71	0	0.02	0.159	0	0
Jan	1965	0.29	0.18	0.11	0.09	0.06	0	0	0.02	0.162	0	0
Feb	1965	0.99	0.22	0.77	0.12	0.05	0.71	0	0.05	0.169	0	0
Mar	1965	0.52	0.27	0.25	0.12	0.03	0	0.22	0.08	0.191	0	0

Apr	1965	1.06	2.9	-1.84	0.16	0.05	0.71	0	0.11	0.14	2.65	0
May	1965	1.06	0.29	0.77	0.17	0.09	0	0.64	0.15	0.141	0	0
Jun	1965	1.02	0.44	0.58	0.17	0.01	0.71	0	0.26	0.177	0	0
Jul	1965	0.31	0.49	-0.17	0.16	0	0	0	0.31	0.179	0	0
Aug	1965	2.57	0.63	1.94	0.13	0	2.35	0	0.39	0.233	0	0
Sep	1965	0.45	0.51	-0.06	0.29	0.06	0	0	0.28	0.225	0	0
Oct	1965	1.29	4.41	-3.12	0.02	0	1.2	0	0.12	0.158	4.14	0
Nov	1965	0.15	0.17	-0.02	0.04	0	0	0	0.04	0.127	0	0
Dec	1965	0.91	0.18	0.74	0.07	0.04	0.71	0	0.02	0.154	0	0
Jan	1966	0.48	0.19	0.29	0.19	0.15	0	0	0.02	0.167	0	0
Feb	1966	1.22	0.22	1	0.26	0.13	0.71	0	0.05	0.177	0	0
Mar	1966	0.6	0.29	0.32	0.07	0.01	0	0.37	0.08	0.203	0	0
Apr	1966	1.13	3.16	-2.04	0.17	0.11	0.71	0	0.12	0.144	2.9	0
May	1966	0.84	0.3	0.54	0.09	0.02	0	0.58	0.15	0.145	0	0
Jun	1966	0.86	0.43	0.43	0.03	0	0.71	0	0.25	0.174	0	0
Jul	1966	0.28	0.47	-0.19	0.13	0	0	0	0.3	0.172	0	0
Aug	1966	2.5	0.61	1.89	0.18	0	2.24	0	0.38	0.226	0	0
Sep	1966	0.19	0.49	-0.3	0.09	0	0	0	0.27	0.215	0	0
Oct	1966	1.23	3.87	-2.64	0.05	0.01	1.1	0	0.11	0.152	3.61	0
Nov	1966	0.17	0.17	0	0.05	0.02	0	0	0.04	0.128	0	0
Dec	1966	1	0.18	0.82	0.11	0.08	0.71	0	0.02	0.157	0	0
Jan	1967	0.23	0.18	0.05	0.06	0.03	0	0	0.02	0.161	0	0
Feb	1967	0.89	0.21	0.68	0.05	0.01	0.71	0	0.04	0.168	0	0
Mar	1967	0.35	0.26	0.09	0.06	0	0	0.14	0.07	0.186	0	0
Apr	1967	1.03	2.49	-1.46	0.13	0.06	0.71	0	0.11	0.139	2.24	0
May	1967	0.92	0.3	0.62	0.14	0.05	0	0.57	0.15	0.143	0	0
Jun	1967	1.13	0.43	0.69	0.25	0.05	0.71	0	0.26	0.175	0	0
Jul	1967	0.37	0.5	-0.13	0.17	0.04	0	0.01	0.32	0.183	0	0
Aug	1967	2.67	0.65	2.02	0.14	0.01	2.44	0	0.4	0.24	0	0
Sep	1967	0.36	0.52	-0.16	0.24	0.02	0	0	0.29	0.231	0	0
Oct	1967	1.7	4.51	-2.81	0.26	0.21	1.15	0	0.12	0.163	4.22	0
Nov	1967	0.14	0.19	-0.04	0.03	0	0	0	0.05	0.14	0	0
Dec	1967	1.16	0.2	0.96	0.2	0.14	0.71	0	0.02	0.174	0	0
Jan	1968	0.3	0.2	0.09	0.1	0.05	0	0	0.02	0.179	0	0

Feb	1968	0.95	0.24	0.71	0.08	0.03	0.71	0	0.05	0.191	0	0
Mar	1968	1.15	0.3	0.85	0.31	0.11	0	0.58	0.09	0.214	0	0
Apr	1968	1.04	3.89	-2.85	0.14	0.06	0.71	0	0.12	0.15	3.62	0
May	1968	1.06	0.3	0.76	0.19	0.09	0	0.63	0.15	0.143	0	0
Jun	1968	1.11	0.44	0.67	0.23	0.05	0.71	0	0.26	0.179	0	0
Jul	1968	0.28	0.5	-0.22	0.12	0.01	0	0	0.32	0.183	0	0
Aug	1968	2.58	0.64	1.94	0.15	0	2.36	0	0.4	0.237	0	0
Sep	1968	0.42	0.52	-0.09	0.28	0.05	0	0	0.29	0.228	0	0
Oct	1968	1.38	4.57	-3.18	0.11	0.01	1.19	0	0.12	0.159	4.29	0
Nov	1968	0.63	0.18	0.45	0.26	0.26	0	0	0.05	0.135	0	0
Dec	1968	1.23	0.2	1.03	0.24	0.17	0.71	0	0.02	0.175	0	0
Jan	1969	0.49	0.21	0.28	0.21	0.12	0	0	0.02	0.185	0	0
Feb	1969	0.98	0.24	0.74	0.11	0.03	0.71	0	0.05	0.193	0	0
Mar	1969	1.03	0.31	0.72	0.16	0.03	0	0.68	0.09	0.222	0	0
Apr	1969	1.04	4.14	-3.1	0.15	0.05	0.71	0	0.12	0.151	3.87	0
May	1969	0.72	0.29	0.44	0.06	0	0	0.51	0.15	0.138	0	0
Jun	1969	0.98	0.42	0.56	0.14	0	0.71	0	0.25	0.168	0	0
Jul	1969	0.24	0.46	-0.22	0.09	0	0	0	0.29	0.167	0	0
Aug	1969	2.45	0.6	1.85	0.08	0	2.28	0	0.37	0.221	0	0
Sep	1969	0.16	0.48	-0.32	0.06	0	0	0	0.27	0.211	0	0
Oct	1969	1.48	3.65	-2.17	0.19	0.15	1.05	0	0.11	0.154	3.38	0
Nov	1969	0.17	0.18	-0.01	0.04	0.02	0	0	0.05	0.136	0	0
Dec	1969	1.06	0.19	0.87	0.15	0.1	0.71	0	0.02	0.166	0	0
Jan	1970	0.2	0.19	0.01	0.04	0.02	0	0	0.02	0.172	0	0
Feb	1970	0.92	0.22	0.7	0.07	0.02	0.71	0	0.05	0.176	0	0
Mar	1970	0.71	0.28	0.43	0.16	0.05	0	0.35	0.08	0.2	0	0
Apr	1970	1.27	3.12	-1.85	0.24	0.19	0.71	0	0.12	0.145	2.86	0
May	1970	0.87	0.31	0.55	0.08	0.01	0	0.62	0.16	0.151	0	0
Jun	1970	1.19	0.46	0.73	0.27	0.08	0.71	0	0.27	0.185	0	0
Jul	1970	0.2	0.51	-0.31	0.04	0	0	0	0.32	0.186	0	0
Aug	1970	2.63	0.65	1.99	0.18	0	2.37	0	0.4	0.24	0	0
Sep	1970	0.64	0.53	0.11	0.47	0.07	0	0	0.3	0.236	0	0
Oct	1970	1.71	5.01	-3.3	0.22	0.13	1.27	0	0.12	0.165	4.72	0
Nov	1970	0.24	0.18	0.06	0.08	0.05	0	0	0.05	0.135	0	0

Dec	1970	0.88	0.19	0.7	0.05	0.02	0.71	0	0.02	0.164	0	0
Jan	1971	0.27	0.19	0.08	0.07	0.05	0	0	0.02	0.167	0	0
Feb	1971	1.03	0.22	0.81	0.14	0.06	0.71	0	0.05	0.174	0	0
Mar	1971	0.5	0.28	0.23	0.04	0	0	0.31	0.08	0.197	0	0
Apr	1971	0.93	2.91	-1.98	0.07	0.01	0.71	0	0.11	0.14	2.66	0
May	1971	0.82	0.28	0.53	0.12	0.04	0	0.51	0.15	0.137	0	0
Jun	1971	0.93	0.42	0.52	0.1	0	0.71	0	0.25	0.168	0	0
Jul	1971	0.32	0.46	-0.14	0.15	0.03	0	0	0.29	0.168	0	0
Aug	1971	2.47	0.61	1.87	0.07	0	2.32	0	0.37	0.224	0	0
Sep	1971	0.2	0.48	-0.29	0.11	0	0	0	0.27	0.213	0	0
Oct	1971	1.28	3.77	-2.49	0.11	0.04	1.06	0	0.11	0.152	3.51	0
Nov	1971	0.19	0.17	0.02	0.06	0.03	0	0	0.04	0.13	0	0
Dec	1971	1.47	0.2	1.28	0.37	0.29	0.71	0	0.02	0.174	0	0
Jan	1972	0.2	0.2	-0.01	0.04	0.01	0	0	0.02	0.18	0	0
Feb	1972	0.89	0.24	0.65	0.05	0.01	0.71	0	0.05	0.188	0	0
Mar	1972	0.61	0.28	0.32	0.07	0.01	0	0.37	0.08	0.203	0	0
Apr	1972	1.08	3.2	-2.13	0.16	0.08	0.71	0	0.11	0.144	2.95	0
May	1972	0.81	0.29	0.52	0.09	0.01	0	0.55	0.15	0.141	0	0
Jun	1972	0.96	0.43	0.53	0.12	0	0.71	0	0.25	0.172	0	0
Jul	1972	0.22	0.47	-0.25	0.06	0.01	0	0	0.3	0.173	0	0
Aug	1972	2.48	0.6	1.87	0.13	0	2.27	0	0.37	0.224	0	0
Sep	1972	0.38	0.49	-0.11	0.25	0.04	0	0	0.27	0.214	0	0
Oct	1972	1.56	4.04	-2.48	0.18	0.14	1.16	0	0.11	0.154	3.77	0
Nov	1972	0.46	0.19	0.27	0.19	0.17	0	0	0.05	0.144	0	0
Dec	1972	0.97	0.2	0.77	0.1	0.05	0.71	0	0.02	0.176	0	0
Jan	1973	0.39	0.21	0.18	0.15	0.09	0	0	0.02	0.181	0	0
Feb	1973	1.01	0.24	0.77	0.12	0.05	0.71	0	0.05	0.188	0	0
Mar	1973	1.58	0.31	1.27	0.51	0.16	0	0.75	0.09	0.223	0	0
Apr	1973	1.51	4.47	-2.96	0.33	0.24	0.71	0.1	0.13	0.16	4.18	0
May	1973	1.24	0.34	0.9	0.23	0.07	0	0.77	0.17	0.164	0	0
Jun	1973	1.05	0.49	0.56	0.18	0.03	0.71	0	0.29	0.198	0	0
Jul	1973	0.29	0.54	-0.25	0.14	0	0	0	0.34	0.197	0	0
Aug	1973	2.5	0.67	1.83	0.09	0	2.32	0	0.41	0.248	0	0
Sep	1973	0.51	0.55	-0.03	0.37	0.05	0	0	0.3	0.241	0	0

Oct	1973	1.54	5.09	-3.55	0.16	0.1	1.2	0	0.12	0.164	4.81	0
Nov	1973	0.71	0.18	0.53	0.29	0.31	0	0	0.04	0.132	0	0
Dec	1973	1.19	0.21	0.98	0.22	0.14	0.71	0	0.02	0.182	0	0
Jan	1974	0.23	0.21	0.02	0.06	0.02	0	0	0.02	0.186	0	0
Feb	1974	0.95	0.24	0.71	0.09	0.02	0.71	0	0.05	0.187	0	0
Mar	1974	1	0.3	0.7	0.17	0.04	0	0.63	0.09	0.217	0	0
Apr	1974	0.99	3.85	-2.87	0.13	0.02	0.71	0	0.12	0.149	3.59	0
May	1974	1.03	0.29	0.74	0.19	0.08	0	0.61	0.15	0.142	0	0
Jun	1974	1.15	0.45	0.7	0.23	0.08	0.71	0	0.27	0.182	0	0
Jul	1974	0.28	0.5	-0.22	0.11	0.01	0	0	0.32	0.182	0	0
Aug	1974	2.64	0.64	1.99	0.19	0	2.36	0	0.4	0.237	0	0
Sep	1974	0.47	0.53	-0.06	0.33	0.04	0	0	0.29	0.232	0	0
Oct	1974	1.42	4.61	-3.19	0.1	0.03	1.21	0	0.12	0.161	4.33	0
Nov	1974	0.5	0.18	0.31	0.2	0.19	0	0	0.05	0.138	0	0
Dec	1974	0.93	0.19	0.74	0.07	0.04	0.71	0	0.02	0.171	0	0
Jan	1975	0.37	0.2	0.18	0.14	0.09	0	0	0.02	0.174	0	0
Feb	1975	1.1	0.23	0.87	0.18	0.08	0.71	0	0.05	0.182	0	0
Mar	1975	1.28	0.3	0.97	0.37	0.12	0	0.63	0.09	0.215	0	0
Apr	1975	0.9	3.99	-3.09	0.06	0	0.71	0	0.12	0.15	3.72	0
May	1975	0.76	0.28	0.48	0.11	0	0	0.5	0.15	0.136	0	0
Jun	1975	1	0.42	0.59	0.16	0.01	0.71	0	0.25	0.167	0	0
Jul	1975	0.23	0.46	-0.23	0.07	0	0	0	0.29	0.167	0	0
Aug	1975	2.66	0.6	2.06	0.25	0.02	2.3	0	0.37	0.224	0	0
Sep	1975	0.38	0.49	-0.12	0.25	0.03	0	0	0.28	0.218	0	0
Oct	1975	1.34	4.17	-2.83	0.04	0.01	1.22	0	0.11	0.155	3.9	0
Nov	1975	0.26	0.17	0.09	0.1	0.06	0	0	0.04	0.129	0	0
Dec	1975	1.14	0.19	0.95	0.18	0.14	0.71	0	0.02	0.164	0	0
Jan	1976	0.17	0.19	-0.02	0.03	0.01	0	0	0.02	0.169	0	0
Feb	1976	0.89	0.23	0.67	0.05	0.01	0.71	0	0.05	0.178	0	0
Mar	1976	0.62	0.27	0.35	0.16	0.05	0	0.27	0.08	0.195	0	0
Apr	1976	0.99	2.89	-1.9	0.1	0.06	0.71	0	0.11	0.141	2.64	0
May	1976	1.08	0.29	0.79	0.19	0.1	0	0.63	0.15	0.141	0	0
Jun	1976	1.23	0.45	0.78	0.3	0.1	0.71	0	0.27	0.182	0	0
Jul	1976	0.3	0.51	-0.21	0.13	0.02	0	0	0.33	0.188	0	0

Aug	1976	2.6	0.65	1.95	0.09	0	2.42	0	0.4	0.242	0	0
Sep	1976	0.17	0.52	-0.35	0.08	0	0	0	0.29	0.23	0	0
Oct	1976	1.26	4.29	-3.03	0.1	0.03	1.05	0	0.12	0.157	4.02	0
Nov	1976	0.18	0.17	0.01	0.05	0.02	0	0	0.04	0.131	0	0
Dec	1976	0.92	0.18	0.74	0.07	0.04	0.71	0	0.02	0.16	0	0
Jan	1977	0.25	0.18	0.07	0.07	0.04	0	0	0.02	0.161	0	0
Feb	1977	0.9	0.21	0.68	0.06	0.01	0.71	0	0.04	0.168	0	0
Mar	1977	0.92	0.27	0.65	0.3	0.14	0	0.33	0.08	0.192	0	0
Apr	1977	1	3.07	-2.07	0.11	0.05	0.71	0	0.11	0.142	2.81	0
May	1977	0.76	0.29	0.47	0.08	0	0	0.52	0.15	0.139	0	0
Jun	1977	0.95	0.42	0.54	0.12	0	0.71	0	0.25	0.168	0	0
Jul	1977	0.31	0.46	-0.15	0.14	0.01	0	0	0.29	0.17	0	0
Aug	1977	2.74	0.62	2.12	0.28	0.04	2.33	0	0.38	0.229	0	0
Sep	1977	0.51	0.5	0	0.35	0.06	0	0	0.28	0.222	0	0
Oct	1977	1.48	4.54	-3.06	0.07	0.03	1.3	0	0.12	0.159	4.26	0
Nov	1977	0.39	0.18	0.21	0.16	0.13	0	0	0.04	0.134	0	0
Dec	1977	1	0.19	0.81	0.11	0.08	0.71	0	0.02	0.169	0	0
Jan	1978	0.2	0.19	0.01	0.04	0.02	0	0	0.02	0.169	0	0
Feb	1978	0.97	0.22	0.74	0.1	0.04	0.71	0	0.05	0.175	0	0
Mar	1978	1.03	0.28	0.74	0.29	0.12	0	0.46	0.08	0.203	0	0
Apr	1978	0.93	3.44	-2.51	0.08	0.01	0.71	0	0.12	0.144	3.18	0
May	1978	1.13	0.3	0.83	0.22	0.14	0	0.61	0.15	0.145	0	0
Jun	1978	1.02	0.44	0.58	0.16	0.02	0.71	0	0.26	0.18	0	0
Jul	1978	0.36	0.49	-0.13	0.18	0.03	0	0	0.31	0.18	0	0
Aug	1978	2.58	0.64	1.94	0.13	0	2.37	0	0.39	0.236	0	0
Sep	1978	0.22	0.51	-0.29	0.12	0.01	0	0	0.29	0.226	0	0
Oct	1978	1.31	4.27	-2.96	0.09	0.05	1.09	0	0.11	0.156	4	0
Nov	1978	0.46	0.18	0.28	0.18	0.17	0	0	0.04	0.132	0	0
Dec	1978	1.05	0.19	0.86	0.14	0.1	0.71	0	0.02	0.168	0	0
Jan	1979	0.29	0.2	0.09	0.09	0.05	0	0	0.02	0.174	0	0
Feb	1979	1.14	0.23	0.91	0.21	0.09	0.71	0	0.05	0.18	0	0
Mar	1979	1.08	0.3	0.78	0.26	0.09	0	0.58	0.09	0.213	0	0
Apr	1979	1.12	3.86	-2.75	0.17	0.1	0.71	0	0.12	0.151	3.59	0
May	1979	1.38	0.32	1.06	0.28	0.16	0	0.78	0.16	0.154	0	0

Jun	1979	0.97	0.47	0.51	0.14	0	0.71	0	0.28	0.19	0	0
Jul	1979	0.36	0.52	-0.16	0.18	0.03	0	0	0.33	0.189	0	0
Aug	1979	2.62	0.66	1.96	0.18	0	2.35	0	0.41	0.244	0	0
Sep	1979	0.22	0.53	-0.31	0.12	0.01	0	0	0.3	0.235	0	0
Oct	1979	1.32	4.47	-3.15	0.1	0.05	1.1	0	0.12	0.159	4.2	0
Nov	1979	0.28	0.18	0.1	0.1	0.08	0	0	0.04	0.134	0	0
Dec	1979	1.06	0.19	0.87	0.14	0.1	0.71	0	0.02	0.166	0	0
Jan	1980	0.17	0.19	-0.02	0.03	0	0	0	0.02	0.17	0	0
Feb	1980	0.89	0.23	0.66	0.05	0.01	0.71	0	0.05	0.179	0	0
Mar	1980	0.64	0.27	0.36	0.16	0.05	0	0.28	0.08	0.195	0	0
Apr	1980	0.92	2.97	-2.04	0.08	0	0.71	0	0.11	0.14	2.72	0
May	1980	0.97	0.29	0.68	0.16	0.08	0	0.57	0.15	0.138	0	0
Jun	1980	1.06	0.43	0.63	0.17	0.06	0.71	0	0.26	0.174	0	0
Jul	1980	0.18	0.48	-0.3	0.03	0	0	0	0.3	0.174	0	0
Aug	1980	2.35	0.6	1.75	0.02	0	2.25	0	0.37	0.224	0	0
Sep	1980	0.32	0.48	-0.16	0.21	0.02	0	0	0.27	0.213	0	0
Oct	1980	1.33	3.87	-2.54	0.09	0.05	1.11	0	0.11	0.153	3.6	0
Nov	1980	0.22	0.18	0.04	0.07	0.04	0	0	0.04	0.132	0	0
Dec	1980	0.88	0.18	0.69	0.04	0.03	0.71	0	0.02	0.161	0	0
Jan	1981	0.17	0.18	-0.01	0.03	0	0	0	0.02	0.161	0	0
Feb	1981	0.96	0.21	0.74	0.1	0.04	0.71	0	0.04	0.167	0	0
Mar	1981	0.49	0.26	0.23	0.12	0.03	0	0.18	0.08	0.189	0	0
Apr	1981	0.94	2.66	-1.72	0.08	0.03	0.71	0	0.11	0.138	2.41	0
May	1981	1.25	0.3	0.95	0.28	0.15	0	0.67	0.15	0.144	0	0
Jun	1981	1.03	0.45	0.58	0.18	0.02	0.71	0	0.27	0.183	0	0
Jul	1981	0.33	0.5	-0.17	0.16	0.02	0	0	0.32	0.185	0	0
Aug	1981	2.99	0.66	2.33	0.42	0.05	2.44	0	0.41	0.247	0	0
Sep	1981	0.12	0.54	-0.42	0.03	0	0	0	0.3	0.239	0	0
Oct	1981	1.43	4.62	-3.19	0.14	0.08	1.13	0	0.12	0.162	4.34	0
Nov	1981	0.18	0.18	0.01	0.05	0.03	0	0	0.04	0.132	0	0
Dec	1981	0.85	0.18	0.67	0.03	0.01	0.71	0	0.02	0.161	0	0
Jan	1982	0.56	0.19	0.37	0.24	0.18	0	0	0.02	0.164	0	0
Feb	1982	0.94	0.23	0.72	0.08	0.03	0.71	0	0.05	0.178	0	0
Mar	1982	0.62	0.28	0.34	0.09	0.02	0	0.35	0.08	0.202	0	0

Apr	1982	0.91	3.15	-2.24	0.07	0	0.71	0	0.11	0.141	2.9	0
May	1982	0.8	0.28	0.52	0.13	0.01	0	0.5	0.14	0.136	0	0
Jun	1982	1.16	0.42	0.74	0.26	0.06	0.71	0	0.25	0.17	0	0
Jul	1982	0.25	0.47	-0.22	0.1	0	0	0	0.3	0.173	0	0
Aug	1982	2.76	0.63	2.14	0.26	0.02	2.39	0	0.39	0.232	0	0
Sep	1982	0.15	0.5	-0.35	0.05	0	0	0	0.28	0.222	0	0
Oct	1982	1.35	4.18	-2.83	0.12	0.03	1.12	0	0.11	0.155	3.91	0
Nov	1982	0.37	0.17	0.19	0.14	0.12	0	0	0.04	0.131	0	0
Dec	1982	1.54	0.21	1.34	0.41	0.31	0.71	0	0.02	0.182	0	0
Jan	1983	0.18	0.21	-0.03	0.03	0	0	0	0.02	0.185	0	0
Feb	1983	0.91	0.24	0.67	0.06	0.02	0.71	0	0.05	0.186	0	0
Mar	1983	0.79	0.3	0.49	0.12	0.01	0	0.5	0.08	0.211	0	0
Apr	1983	1.11	3.64	-2.53	0.2	0.07	0.71	0	0.12	0.147	3.38	0
May	1983	1.01	0.3	0.72	0.15	0.04	0	0.66	0.15	0.143	0	0
Jun	1983	1.03	0.44	0.59	0.17	0.02	0.71	0	0.26	0.177	0	0
Jul	1983	0.21	0.49	-0.27	0.06	0	0	0	0.31	0.178	0	0
Aug	1983	2.45	0.62	1.84	0.1	0	2.28	0	0.38	0.229	0	0
Sep	1983	0.13	0.49	-0.36	0.04	0	0	0	0.27	0.217	0	0
Oct	1983	1.2	3.83	-2.63	0.07	0.01	1.04	0	0.11	0.152	3.57	0
Nov	1983	0.44	0.18	0.27	0.18	0.16	0	0	0.04	0.131	0	0
Dec	1983	0.97	0.19	0.78	0.09	0.06	0.71	0	0.02	0.169	0	0
Jan	1984	0.18	0.19	-0.02	0.03	0.01	0	0	0.02	0.17	0	0
Feb	1984	1.03	0.23	0.8	0.14	0.06	0.71	0	0.05	0.181	0	0
Mar	1984	0.81	0.28	0.52	0.2	0.07	0	0.38	0.08	0.202	0	0
Apr	1984	1.01	3.32	-2.3	0.13	0.04	0.71	0	0.11	0.143	3.06	0
May	1984	1.21	0.3	0.9	0.22	0.15	0	0.69	0.16	0.146	0	0
Jun	1984	0.96	0.45	0.51	0.11	0.02	0.71	0	0.27	0.181	0	0
Jul	1984	0.22	0.49	-0.27	0.07	0	0	0	0.31	0.18	0	0
Aug	1984	2.4	0.62	1.78	0.08	0	2.24	0	0.38	0.23	0	0
Sep	1984	0.41	0.5	-0.09	0.28	0.03	0	0	0.28	0.22	0	0
Oct	1984	1.86	4.3	-2.43	0.36	0.26	1.15	0	0.12	0.162	4.01	0
Nov	1984	0.51	0.2	0.31	0.21	0.18	0	0	0.05	0.147	0	0
Dec	1984	1.17	0.21	0.96	0.22	0.13	0.71	0	0.02	0.187	0	0
Jan	1985	0.26	0.22	0.04	0.07	0.03	0	0.01	0.03	0.193	0	0

Feb	1985	1.12	0.24	0.87	0.2	0.07	0.71	0	0.05	0.193	0	0
Mar	1985	1.45	0.32	1.13	0.36	0.08	0	0.85	0.09	0.231	0	0
Apr	1985	1.02	4.63	-3.61	0.12	0.06	0.71	0	0.13	0.158	4.35	0
May	1985	0.85	0.29	0.56	0.1	0.03	0	0.56	0.15	0.14	0	0
Jun	1985	0.91	0.43	0.48	0.07	0	0.71	0	0.25	0.172	0	0
Jul	1985	0.27	0.47	-0.2	0.11	0.01	0	0	0.3	0.17	0	0
Aug	1985	2.6	0.61	1.99	0.19	0.02	2.31	0	0.38	0.228	0	0
Sep	1985	0.21	0.49	-0.28	0.11	0	0	0	0.27	0.217	0	0
Oct	1985	1.33	3.92	-2.59	0.11	0.06	1.08	0	0.11	0.154	3.65	0
Nov	1985	0.66	0.18	0.47	0.28	0.27	0	0	0.05	0.137	0	0
Dec	1985	0.9	0.2	0.7	0.05	0.03	0.71	0	0.02	0.178	0	0
Jan	1986	0.16	0.2	-0.04	0.02	0	0	0	0.02	0.177	0	0
Feb	1986	0.94	0.23	0.71	0.09	0.02	0.71	0	0.05	0.18	0	0
Mar	1986	0.57	0.28	0.29	0.06	0.01	0	0.34	0.08	0.202	0	0
Apr	1986	1.14	3.3	-2.16	0.21	0.09	0.71	0	0.11	0.143	3.04	0
May	1986	0.96	0.29	0.66	0.14	0.04	0	0.62	0.15	0.14	0	0
Jun	1986	0.98	0.43	0.54	0.12	0.02	0.71	0	0.26	0.175	0	0
Jul	1986	0.18	0.47	-0.29	0.03	0	0	0	0.3	0.173	0	0
Aug	1986	2.57	0.61	1.96	0.21	0.01	2.28	0	0.38	0.228	0	0
Sep	1986	0.25	0.49	-0.24	0.15	0.01	0	0	0.27	0.217	0	0
Oct	1986	1.41	4.11	-2.7	0.14	0.04	1.15	0	0.11	0.155	3.84	0
Nov	1986	0.21	0.17	0.03	0.07	0.03	0	0	0.04	0.131	0	0
Dec	1986	0.84	0.18	0.66	0.03	0.01	0.71	0	0.02	0.158	0	0
Jan	1987	0.29	0.18	0.11	0.09	0.06	0	0	0.02	0.161	0	0
Feb	1987	1.15	0.22	0.94	0.22	0.11	0.71	0	0.05	0.17	0	0
Mar	1987	0.73	0.28	0.45	0.17	0.06	0	0.35	0.08	0.198	0	0
Apr	1987	0.87	3.09	-2.22	0.03	0	0.71	0	0.11	0.141	2.83	0
May	1987	0.94	0.28	0.66	0.18	0.09	0	0.52	0.14	0.136	0	0
Jun	1987	0.93	0.42	0.51	0.1	0	0.71	0	0.25	0.171	0	0
Jul	1987	0.25	0.46	-0.22	0.1	0	0	0	0.29	0.17	0	0
Aug	1987	2.53	0.6	1.93	0.17	0.01	2.26	0	0.37	0.223	0	0
Sep	1987	0.34	0.49	-0.15	0.21	0.03	0	0	0.27	0.216	0	0
Oct	1987	1.42	4.03	-2.61	0.1	0.07	1.17	0	0.11	0.155	3.76	0
Nov	1987	0.41	0.18	0.23	0.16	0.14	0	0	0.05	0.135	0	0

Dec	1987	1.4	0.2	1.2	0.34	0.24	0.71	0	0.02	0.175	0	0
Jan	1988	0.24	0.21	0.02	0.06	0.03	0	0	0.02	0.187	0	0
Feb	1988	0.99	0.25	0.74	0.12	0.03	0.71	0	0.05	0.195	0	0
Mar	1988	1.3	0.31	0.99	0.36	0.11	0	0.68	0.09	0.22	0	0
Apr	1988	0.96	4.23	-3.28	0.1	0.02	0.71	0	0.12	0.152	3.96	0
May	1988	0.85	0.28	0.56	0.1	0.06	0	0.53	0.15	0.136	0	0
Jun	1988	0.9	0.42	0.49	0.06	0.01	0.71	0	0.25	0.167	0	0
Jul	1988	0.35	0.46	-0.11	0.17	0.03	0	0	0.29	0.169	0	0
Aug	1988	2.5	0.61	1.9	0.11	0	2.31	0	0.37	0.225	0	0
Sep	1988	0.28	0.49	-0.21	0.18	0.01	0	0	0.27	0.214	0	0
Oct	1988	1.27	3.9	-2.63	0.06	0.02	1.11	0	0.11	0.153	3.64	0
Nov	1988	0.57	0.18	0.39	0.23	0.23	0	0	0.04	0.134	0	0
Dec	1988	0.96	0.2	0.77	0.09	0.05	0.71	0	0.02	0.171	0	0
Jan	1989	0.3	0.2	0.1	0.1	0.06	0	0	0.02	0.175	0	0
Feb	1989	1.34	0.24	1.1	0.35	0.16	0.71	0	0.05	0.187	0	0
Mar	1989	1.05	0.31	0.74	0.21	0.05	0	0.63	0.09	0.22	0	0
Apr	1989	0.87	3.99	-3.13	0.03	0	0.71	0	0.12	0.149	3.72	0
May	1989	1.02	0.28	0.73	0.19	0.1	0	0.58	0.15	0.138	0	0
Jun	1989	1.02	0.43	0.58	0.17	0.01	0.71	0	0.26	0.175	0	0
Jul	1989	0.37	0.48	-0.11	0.2	0.02	0	0	0.31	0.177	0	0
Aug	1989	2.57	0.63	1.95	0.12	0	2.38	0	0.39	0.233	0	0
Sep	1989	0.23	0.51	-0.28	0.13	0.01	0	0	0.28	0.223	0	0
Oct	1989	1.18	4.1	-2.92	0.01	0	1.09	0	0.11	0.154	3.84	0
Nov	1989	0.11	0.17	-0.05	0.01	0	0	0	0.04	0.126	0	0
Dec	1989	0.83	0.17	0.65	0.02	0	0.71	0	0.02	0.151	0	0
Jan	1990	0.47	0.18	0.3	0.18	0.16	0	0	0.02	0.156	0	0
Feb	1990	1.15	0.22	0.93	0.21	0.12	0.71	0	0.05	0.172	0	0
Mar	1990	0.99	0.28	0.71	0.3	0.12	0	0.42	0.08	0.203	0	0
Apr	1990	1.11	3.38	-2.27	0.17	0.09	0.71	0	0.12	0.146	3.11	0
May	1990	1.78	0.34	1.43	0.43	0.29	0	0.91	0.18	0.165	0	0
Jun	1990	0.91	0.49	0.42	0.07	0.01	0.71	0	0.29	0.199	0	0
Jul	1990	0.24	0.54	-0.3	0.09	0	0	0	0.34	0.198	0	0
Aug	1990	2.51	0.67	1.84	0.17	0.01	2.25	0	0.41	0.248	0	0
Sep	1990	0.32	0.54	-0.22	0.21	0.02	0	0	0.3	0.237	0	0

Oct	1990	1.55	4.97	-3.42	0.23	0.09	1.14	0	0.12	0.163	4.69	0
Nov	1990	0.25	0.17	0.08	0.09	0.05	0	0	0.04	0.129	0	0
Dec	1990	1.11	0.18	0.93	0.16	0.13	0.71	0	0.02	0.162	0	0
Jan	1991	0.4	0.2	0.2	0.14	0.11	0	0	0.02	0.173	0	0
Feb	1991	0.87	0.22	0.65	0.04	0	0.71	0	0.05	0.177	0	0
Mar	1991	0.76	0.28	0.48	0.14	0.04	0	0.43	0.08	0.2	0	0
Apr	1991	1.28	3.23	-1.95	0.25	0.18	0.71	0	0.12	0.147	2.96	0
May	1991	1.2	0.32	0.88	0.19	0.08	0	0.77	0.16	0.154	0	0
Jun	1991	0.9	0.47	0.43	0.07	0	0.71	0	0.28	0.188	0	0
Jul	1991	0.26	0.51	-0.25	0.11	0	0	0	0.32	0.186	0	0
Aug	1991	2.44	0.64	1.8	0.13	0	2.23	0	0.39	0.236	0	0
Sep	1991	0.3	0.51	-0.21	0.19	0.01	0	0	0.29	0.227	0	0
Oct	1991	1.76	4.28	-2.52	0.28	0.28	1.12	0	0.12	0.158	4	0
Nov	1991	0.42	0.2	0.22	0.17	0.13	0	0	0.05	0.147	0	0
Dec	1991	1.1	0.21	0.89	0.17	0.11	0.71	0	0.02	0.186	0	0
Jan	1992	0.22	0.21	0	0.05	0.02	0	0	0.03	0.189	0	0
Feb	1992	0.95	0.25	0.7	0.09	0.02	0.71	0	0.05	0.196	0	0
Mar	1992	0.81	0.3	0.51	0.11	0.02	0	0.53	0.09	0.215	0	0
Apr	1992	0.91	3.68	-2.78	0.05	0.02	0.71	0	0.12	0.147	3.42	0
May	1992	0.83	0.28	0.55	0.13	0.04	0	0.51	0.15	0.137	0	0
Jun	1992	1.23	0.43	0.8	0.3	0.09	0.71	0	0.26	0.175	0	0
Jul	1992	0.35	0.49	-0.14	0.18	0.01	0	0.01	0.31	0.179	0	0
Aug	1992	2.74	0.64	2.09	0.16	0	2.49	0	0.4	0.239	0	0
Sep	1992	0.41	0.53	-0.12	0.28	0.04	0	0	0.29	0.233	0	0
Oct	1992	1.3	4.53	-3.23	0.04	0.01	1.17	0	0.12	0.159	4.25	0
Nov	1992	0.45	0.18	0.27	0.17	0.17	0	0	0.04	0.133	0	0
Dec	1992	1.15	0.2	0.96	0.19	0.14	0.71	0	0.02	0.172	0	0
Jan	1993	0.45	0.21	0.25	0.18	0.12	0	0	0.02	0.183	0	0
Feb	1993	1.04	0.24	0.8	0.15	0.05	0.71	0	0.05	0.186	0	0
Mar	1993	0.79	0.3	0.49	0.11	0.02	0	0.51	0.09	0.214	0	0
Apr	1993	1.05	3.69	-2.64	0.16	0.05	0.71	0	0.12	0.148	3.42	0
May	1993	1.16	0.31	0.86	0.22	0.1	0	0.69	0.16	0.147	0	0
Jun	1993	0.99	0.45	0.54	0.15	0.01	0.71	0	0.27	0.182	0	0
Jul	1993	0.21	0.5	-0.29	0.06	0	0	0	0.31	0.181	0	0

Aug	1993	2.55	0.63	1.92	0.15	0.01	2.3	0	0.39	0.235	0	0
Sep	1993	0.52	0.51	0	0.37	0.05	0	0	0.29	0.227	0	0
Oct	1993	1.46	4.57	-3.11	0.12	0.04	1.22	0	0.12	0.161	4.29	0
Nov	1993	0.41	0.18	0.23	0.16	0.14	0	0	0.04	0.135	0	0
Dec	1993	0.96	0.19	0.77	0.09	0.06	0.71	0	0.02	0.17	0	0
Jan	1994	0.36	0.19	0.17	0.13	0.08	0	0	0.02	0.172	0	0
Feb	1994	1.01	0.23	0.79	0.13	0.05	0.71	0	0.05	0.179	0	0
Mar	1994	0.94	0.29	0.64	0.21	0.08	0	0.49	0.08	0.209	0	0
Apr	1994	1.1	3.57	-2.47	0.18	0.08	0.71	0	0.12	0.146	3.31	0
May	1994	0.75	0.29	0.46	0.05	0	0	0.54	0.15	0.141	0	0
Jun	1994	0.96	0.43	0.54	0.11	0.02	0.71	0	0.25	0.172	0	0
Jul	1994	0.27	0.47	-0.2	0.12	0	0	0	0.3	0.171	0	0
Aug	1994	2.56	0.61	1.95	0.17	0.01	2.29	0	0.37	0.225	0	0
Sep	1994	0.13	0.49	-0.36	0.04	0	0	0	0.27	0.215	0	0
Oct	1994	1.24	3.84	-2.6	0.08	0.02	1.06	0	0.11	0.151	3.57	0
Nov	1994	0.91	0.2	0.71	0.4	0.4	0	0	0.05	0.147	0	0
Dec	1994	1.04	0.21	0.83	0.14	0.08	0.71	0	0.02	0.184	0	0
Jan	1995	0.47	0.22	0.26	0.19	0.11	0	0.02	0.03	0.191	0	0
Feb	1995	0.91	0.24	0.67	0.06	0.01	0.71	0	0.05	0.192	0	0
Mar	1995	0.95	0.31	0.64	0.14	0.03	0	0.61	0.09	0.222	0	0
Apr	1995	1.16	4.02	-2.87	0.19	0.13	0.71	0	0.12	0.15	3.75	0
May	1995	1.09	0.31	0.78	0.17	0.08	0	0.68	0.16	0.149	0	0
Jun	1995	1.08	0.46	0.63	0.21	0.04	0.71	0	0.27	0.185	0	0
Jul	1995	0.28	0.51	-0.23	0.12	0.01	0	0	0.32	0.186	0	0
Aug	1995	2.46	0.64	1.82	0.04	0	2.34	0	0.39	0.237	0	0
Sep	1995	0.37	0.51	-0.15	0.24	0.03	0	0	0.29	0.227	0	0
Oct	1995	1.38	4.42	-3.05	0.12	0.03	1.15	0	0.12	0.158	4.15	0
Nov	1995	0.23	0.17	0.05	0.07	0.05	0	0	0.04	0.131	0	0
Dec	1995	1.02	0.19	0.83	0.12	0.08	0.71	0	0.02	0.161	0	0
Jan	1996	0.36	0.19	0.17	0.13	0.09	0	0	0.02	0.169	0	0
Feb	1996	0.86	0.23	0.63	0.02	0	0.71	0	0.05	0.179	0	0
Mar	1996	0.64	0.27	0.37	0.16	0.05	0	0.29	0.08	0.194	0	0
Apr	1996	1.11	2.95	-1.84	0.16	0.11	0.71	0	0.11	0.142	2.69	0
May	1996	0.79	0.3	0.49	0.08	0.01	0	0.54	0.15	0.143	0	0

Jun	1996	0.98	0.43	0.55	0.13	0.02	0.71	0	0.26	0.174	0	0
Jul	1996	0.27	0.47	-0.21	0.11	0	0	0	0.3	0.174	0	0
Aug	1996	2.5	0.61	1.89	0.1	0	2.31	0	0.38	0.227	0	0
Sep	1996	0.77	0.5	0.27	0.53	0.14	0	0	0.28	0.221	0	0
Oct	1996	1.51	4.7	-3.19	0.06	0.01	1.36	0	0.12	0.161	4.42	0
Nov	1996	0.65	0.18	0.47	0.27	0.27	0	0	0.05	0.137	0	0
Dec	1996	0.94	0.2	0.74	0.08	0.05	0.71	0	0.02	0.176	0	0
Jan	1997	0.2	0.2	0	0.04	0.01	0	0	0.02	0.177	0	0
Feb	1997	1.16	0.23	0.93	0.23	0.1	0.71	0	0.05	0.181	0	0
Mar	1997	0.92	0.3	0.62	0.18	0.05	0	0.53	0.09	0.214	0	0
Apr	1997	1.04	3.82	-2.78	0.15	0.05	0.71	0	0.12	0.147	3.56	0
May	1997	0.78	0.28	0.5	0.1	0.02	0	0.51	0.14	0.135	0	0
Jun	1997	0.99	0.41	0.58	0.13	0.02	0.71	0	0.24	0.166	0	0
Jul	1997	0.22	0.46	-0.24	0.07	0	0	0	0.29	0.167	0	0
Aug	1997	2.52	0.6	1.93	0.15	0.01	2.28	0	0.37	0.222	0	0
Sep	1997	0.24	0.48	-0.24	0.13	0.01	0	0	0.27	0.212	0	0
Oct	1997	1.3	3.81	-2.51	0.08	0.03	1.12	0	0.11	0.152	3.55	0
Nov	1997	0.22	0.17	0.04	0.07	0.04	0	0	0.04	0.13	0	0
Dec	1997	1.01	0.18	0.82	0.11	0.08	0.71	0	0.02	0.161	0	0
Jan	1998	0.55	0.2	0.35	0.23	0.17	0	0	0.02	0.174	0	0
Feb	1998	1.12	0.23	0.89	0.2	0.09	0.71	0	0.05	0.182	0	0
Mar	1998	1.26	0.3	0.96	0.35	0.12	0	0.63	0.09	0.216	0	0
Apr	1998	0.99	3.98	-3	0.11	0.04	0.71	0	0.12	0.15	3.71	0
May	1998	0.85	0.29	0.56	0.1	0.04	0	0.55	0.15	0.139	0	0
Jun	1998	0.9	0.42	0.48	0.07	0	0.71	0	0.25	0.171	0	0
Jul	1998	0.24	0.46	-0.22	0.09	0	0	0	0.29	0.169	0	0
Aug	1998	2.48	0.6	1.88	0.15	0	2.25	0	0.37	0.223	0	0
Sep	1998	0.23	0.48	-0.26	0.12	0.01	0	0	0.27	0.213	0	0
Oct	1998	1.45	3.95	-2.5	0.19	0.09	1.09	0	0.11	0.153	3.68	0
Nov	1998	0.25	0.18	0.07	0.09	0.05	0	0	0.04	0.131	0	0
Dec	1998	1.02	0.19	0.83	0.12	0.08	0.71	0	0.02	0.164	0	0
Jan	1999	0.39	0.19	0.2	0.14	0.1	0	0	0.02	0.17	0	0
Feb	1999	0.93	0.22	0.7	0.07	0.03	0.71	0	0.05	0.177	0	0
Mar	1999	0.86	0.28	0.57	0.2	0.06	0	0.44	0.08	0.203	0	0

Apr	1999	1.05	3.4	-2.35	0.16	0.05	0.71	0	0.12	0.144	3.14	0
May	1999	0.98	0.29	0.68	0.15	0.05	0	0.62	0.15	0.141	0	0
Jun	1999	1.11	0.43	0.68	0.22	0.06	0.71	0	0.25	0.174	0	0
Jul	1999	0.21	0.49	-0.28	0.05	0	0	0	0.31	0.178	0	0
Aug	1999	2.46	0.62	1.84	0.07	0	2.31	0	0.38	0.229	0	0
Sep	1999	0.15	0.49	-0.35	0.05	0	0	0	0.27	0.217	0	0
Oct	1999	1.17	3.85	-2.68	0.05	0	1.04	0	0.11	0.151	3.59	0
Nov	1999	0.19	0.17	0.02	0.05	0.03	0	0	0.04	0.127	0	0
Dec	1999	1.17	0.19	0.98	0.19	0.16	0.71	0	0.02	0.164	0	0
Jan	2000	0.25	0.19	0.06	0.07	0.03	0	0	0.02	0.168	0	0
Feb	2000	0.95	0.23	0.73	0.09	0.03	0.71	0	0.05	0.179	0	0
Mar	2000	0.56	0.27	0.28	0.11	0.01	0	0.28	0.08	0.196	0	0
Apr	2000	0.9	2.9	-1.99	0.06	0	0.71	0	0.11	0.14	2.64	0
May	2000	1.06	0.29	0.77	0.2	0.11	0	0.6	0.15	0.138	0	0
Jun	2000	1.23	0.45	0.79	0.31	0.09	0.71	0	0.26	0.18	0	0
Jul	2000	0.28	0.5	-0.23	0.12	0	0	0	0.32	0.184	0	0
Aug	2000	2.5	0.64	1.86	0.01	0	2.4	0	0.4	0.237	0	0
Sep	2000	0.21	0.51	-0.3	0.11	0.01	0	0	0.28	0.224	0	0
Oct	2000	1.23	4.13	-2.9	0.08	0.01	1.06	0	0.11	0.155	3.86	0
Nov	2000	0.47	0.18	0.29	0.18	0.18	0	0	0.05	0.136	0	0
Dec	2000	0.93	0.19	0.74	0.08	0.04	0.71	0	0.02	0.168	0	0
Jan	2001	0.28	0.19	0.08	0.08	0.05	0	0	0.02	0.171	0	0
Feb	2001	1.23	0.23	1.01	0.27	0.13	0.71	0	0.05	0.18	0	0
Mar	2001	0.64	0.29	0.35	0.06	0	0	0.43	0.08	0.208	0	0
Apr	2001	0.88	3.35	-2.48	0.04	0	0.71	0	0.11	0.143	3.1	0
May	2001	0.77	0.28	0.49	0.12	0.04	0	0.45	0.14	0.135	0	0
Jun	2001	0.99	0.41	0.58	0.13	0.03	0.71	0	0.24	0.167	0	0
Jul	2001	0.3	0.46	-0.16	0.14	0	0	0	0.29	0.168	0	0
Aug	2001	2.53	0.61	1.93	0.11	0.01	2.34	0	0.37	0.224	0	0
Sep	2001	0.36	0.49	-0.13	0.22	0.04	0	0	0.27	0.217	0	0
Oct	2001	1.4	4.12	-2.72	0.11	0.06	1.15	0	0.11	0.154	3.85	0
Nov	2001	0.36	0.17	0.19	0.14	0.12	0	0	0.04	0.129	0	0
Dec	2001	1.21	0.19	1.02	0.22	0.17	0.71	0	0.02	0.17	0	0
Jan	2002	0.37	0.2	0.18	0.14	0.08	0	0	0.02	0.176	0	0

Feb	2002	0.98	0.23	0.74	0.11	0.03	0.71	0	0.05	0.184	0	0
Mar	2002	1.64	0.31	1.33	0.52	0.18	0	0.79	0.09	0.221	0	0
Apr	2002	1.11	4.52	-3.4	0.2	0.07	0.71	0	0.12	0.154	4.24	0
May	2002	0.98	0.29	0.69	0.15	0.05	0	0.63	0.15	0.139	0	0
Jun	2002	1	0.43	0.56	0.15	0.01	0.71	0	0.26	0.175	0	0
Jul	2002	0.31	0.48	-0.17	0.15	0	0	0	0.31	0.176	0	0
Aug	2002	2.63	0.63	2.01	0.18	0.04	2.33	0	0.39	0.232	0	0
Sep	2002	0.17	0.5	-0.33	0.08	0	0	0	0.28	0.221	0	0
Oct	2002	1.3	4.07	-2.77	0.08	0.02	1.12	0	0.11	0.154	3.8	0
Nov	2002	0.16	0.17	-0.01	0.04	0.02	0	0	0.04	0.13	0	0
Dec	2002	1.13	0.18	0.95	0.19	0.14	0.71	0	0.02	0.16	0	0
Jan	2003	0.16	0.19	-0.03	0.02	0	0	0	0.02	0.167	0	0
Feb	2003	1.01	0.22	0.79	0.13	0.05	0.71	0	0.05	0.171	0	0
Mar	2003	0.58	0.27	0.31	0.11	0.03	0	0.29	0.08	0.195	0	0
Apr	2003	0.93	2.91	-1.98	0.06	0.02	0.71	0	0.11	0.14	2.66	0
May	2003	1.13	0.29	0.83	0.22	0.13	0	0.62	0.15	0.141	0	0
Jun	2003	1.01	0.44	0.56	0.15	0.02	0.71	0	0.26	0.18	0	0
Jul	2003	0.28	0.49	-0.21	0.11	0.02	0	0	0.31	0.18	0	0
Aug	2003	2.55	0.63	1.92	0.12	0	2.34	0	0.39	0.234	0	0
Sep	2003	0.23	0.51	-0.27	0.13	0.01	0	0	0.28	0.224	0	0
Oct	2003	1.33	4.22	-2.89	0.13	0.05	1.07	0	0.11	0.155	3.95	0
Nov	2003	0.43	0.18	0.25	0.17	0.15	0	0	0.04	0.133	0	0
Dec	2003	0.98	0.19	0.79	0.1	0.06	0.71	0	0.02	0.167	0	0
Jan	2004	0.28	0.19	0.08	0.08	0.05	0	0	0.02	0.171	0	0
Feb	2004	0.93	0.23	0.7	0.07	0.03	0.71	0	0.05	0.183	0	0
Mar	2004	0.7	0.28	0.42	0.14	0.03	0	0.37	0.08	0.2	0	0
Apr	2004	1.3	3.12	-1.82	0.25	0.21	0.71	0.01	0.12	0.145	2.86	0
May	2004	0.89	0.32	0.57	0.08	0.02	0	0.64	0.16	0.152	0	0
Jun	2004	1	0.45	0.55	0.16	0	0.71	0	0.27	0.182	0	0
Jul	2004	0.3	0.5	-0.2	0.14	0	0	0	0.32	0.184	0	0
Aug	2004	2.55	0.64	1.91	0.13	0	2.34	0	0.4	0.237	0	0
Sep	2004	0.1	0.51	-0.41	0.01	0	0	0	0.28	0.224	0	0
Oct	2004	1.63	4.33	-2.69	0.32	0.19	1.04	0	0.11	0.156	4.06	0
Nov	2004	0.48	0.18	0.3	0.19	0.18	0	0	0.05	0.137	0	0

Dec	2004	0.91	0.2	0.71	0.06	0.03	0.71	0	0.02	0.173	0	0
Jan	2005	0.53	0.21	0.33	0.23	0.15	0	0	0.02	0.183	0	0
Feb	2005	0.98	0.24	0.75	0.11	0.03	0.71	0	0.05	0.186	0	0
Mar	2005	0.99	0.3	0.68	0.15	0.03	0	0.64	0.09	0.214	0	0
Apr	2005	1	3.86	-2.87	0.12	0.03	0.71	0	0.12	0.148	3.59	0
May	2005	0.72	0.28	0.43	0.06	0.01	0	0.49	0.14	0.136	0	0
Jun	2005	0.88	0.41	0.47	0.05	0	0.71	0	0.24	0.164	0	0
Jul	2005	0.24	0.44	-0.21	0.09	0	0	0	0.28	0.163	0	0
Aug	2005	2.48	0.59	1.9	0.18	0	2.23	0	0.36	0.217	0	0
Sep	2005	0.34	0.48	-0.13	0.2	0.05	0	0	0.27	0.21	0	0
Oct	2005	1.24	3.81	-2.57	0	0	1.16	0	0.11	0.151	3.55	0
Nov	2005	0.24	0.17	0.07	0.08	0.06	0	0	0.04	0.127	0	0
Dec	2005	0.82	0.18	0.64	0.01	0	0.71	0	0.02	0.156	0	0
Jan	2006	0.29	0.18	0.11	0.09	0.06	0	0	0.02	0.156	0	0
Feb	2006	0.86	0.21	0.65	0.03	0	0.71	0	0.04	0.165	0	0
Mar	2006	0.57	0.26	0.31	0.17	0.07	0	0.18	0.07	0.186	0	0
Apr	2006	1.1	2.62	-1.52	0.16	0.1	0.71	0	0.11	0.138	2.37	0
May	2006	0.87	0.3	0.56	0.09	0.04	0	0.58	0.15	0.145	0	0
Jun	2006	0.97	0.43	0.53	0.12	0.01	0.71	0	0.26	0.175	0	0
Jul	2006	0.24	0.48	-0.23	0.09	0.01	0	0	0.3	0.175	0	0
Aug	2006	2.54	0.61	1.93	0.19	0.01	2.26	0	0.38	0.227	0	0
Sep	2006	0.39	0.5	-0.1	0.25	0.05	0	0	0.28	0.219	0	0
Oct	2006	1.62	4.24	-2.62	0.19	0.15	1.2	0	0.12	0.161	3.96	0
Nov	2006	0.54	0.19	0.35	0.23	0.2	0	0	0.05	0.14	0	0
Dec	2006	1.1	0.2	0.9	0.17	0.11	0.71	0	0.02	0.179	0	0

AVERAGE MONTHLY VOLUMES BY MAJOR IMPOUNDMENT PROCESSES

Mon	Inflow	Outflow	Change	Precip Vol	Bank Runo	Drwdwn In	Spill In	Vol Evap	Vol Seep	Drdn Pump	Spillway
	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft
Jan	0.3	0.19	0.1	0.09	0.06	0	0	0.02	0.171	0	0
Feb	1	0.23	0.77	0.12	0.05	0.7	0	0.05	0.183	0	0
Mar	0.83	0.29	0.55	0.19	0.06	0	0.43	0.08	0.204	0	0
Apr	1.03	3.37	-2.34	0.13	0.06	0.71	0	0.12	0.145	3.11	0
May	0.98	0.3	0.68	0.16	0.07	0	0.59	0.15	0.143	0	0

Jun	1.01	0.44	0.57	0.15	0.02	0.71	0	0.26	0.176	0	0
Jul	0.28	0.48	-0.2	0.12	0.01	0	0	0.31	0.177	0	0
Aug	2.57	0.62	1.94	0.15	0.01	2.32	0	0.39	0.232	0	0
Sep	0.31	0.5	-0.2	0.19	0.02	0	0	0.28	0.222	0	0
Oct	1.39	4.24	-2.84	0.12	0.06	1.14	0	0.11	0.157	3.96	0
Nov	0.35	0.18	0.17	0.13	0.11	0	0	0.04	0.133	0	0
Dec	1.04	0.19	0.84	0.13	0.09	0.71	0	0.02	0.168	0	0

Hogan, Stephen

From: Nathan Pesta <Nathanpdga@btinet.net>
Sent: Tuesday, July 10, 2012 8:31 AM
To: Hogan, Stephen
Cc: 'Daniel L. DeHaan'; jasonh@rittermail.com
Subject: RE: Update to Submittal
Attachments: C-2 Update.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

Stephen,
Sorry you are correct.

Thanks,
Nathan

From: Hogan, Stephen [mailto:HOGAN@adeq.state.ar.us]
Sent: Tuesday, July 10, 2012 8:24 AM
To: 'Nathan Pesta'
Subject: RE: Update to Submittal

Nathan,

Was it supposed to be attached?

Stephen Hogan, P.E.
(501) 682-0651

From: Nathan Pesta [mailto:Nathanpdga@btinet.net]
Sent: Monday, July 09, 2012 11:31 AM
To: Hogan, Stephen
Cc: 'Geoffrey Bates'; jasonh@rittermail.com; danddga@btinet.net
Subject: Update to Submittal

Stephen,
I have included an update to the SPAW calculations as a part of Section C2.

Thanks,

Nathan A.Pesta P.E.
Senior Project Engineer
DeHaan, Grabs and Associates, LLC
Bus 701-663-1116
Cell 701-400-3950
Fax 701-667-1356
www.dgaengineering.com

SPAW Calculations

A. Facility SPAW Information

SPAW software was used to evaluate the previous weather data to analyze the current proposed design. Weather data used was from weather station AR1900 (Deer, AR). The weather data started in 1960.

1. Pond Depths
   - Spillway Crest: 12.7'
   - Initial Water Depth: 1.0'
   - Infiltration into Dry Pond Bottom: 0.5"
   - Irrigation Lower Limit: 0.00'
2. Pond Depth-Area (See Page 14 and 15 of the Plans).
3. Pond Seepage: Rate 0.15 in/day
4. Water Table: Depth: 189 ft
5. External Input (Outflow from the Confinement Barns): The Farrowing barn is pulled once every three weeks for an average of 63,180 gallons. The Gestation barn is pulled once every five weeks for an average of 161,460 gallons.
6. Drawdown Pump (Irrigation for Land Application): The ponds are planned to be pumped April 1 and October 1. The pumping rate is set for 250 GPM and the ponds will be pumped down to 1' of depth.

B. Facility SPAW Summary

The results were summed up using two different simulations.

1. Simulation 1
   - Pond 1 and Pond 2 were treated as combined storage and as one pond.
   - Results showed that the ponds did not overtop.
2. Simulation 2
   - Pond 1 and Pond 2 were modeled in Series.
   - Results showed that the ponds did not overtop.

C. Facility SPAW Results

The results are attached:

From:	C H Hog Farms Inc
To:	Water Permit Application
Cc:	"William A. Waddell, Jr."
Subject:	C & H response to letter dated 12-27-17
Date:	Thursday, December 28, 2017 12:00:53 PM
Attachments:	Cover Letter.pdf

Please see attached:

Due to the size of attachments, 11 separate emails will be sent relevant to this response. Included in this email is the cover letter. If the Department does not receive all of the documents addressed in the cover letter, please notify us immediately.

From:	C H Hog Farms Inc
To:	Water Permit Application
Cc:	"William A. Waddell, Jr."
Subject:	1 of 11 emails
Date:	Thursday, December 28, 2017 12:13:29 PM
Attachments:	1 Reg 5 NMP 4_1_16_Revised 12_19-17_Revised 12_28_2017_Compressed.pdf

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Please see attachment.

From: C H Hog Farms Inc
To: Water Permit Application
Cc: "William A. Waddell, Jr."
Subject: 2 of 11 emails
Date: Thursday, December 28, 2017 12:15:52 PM
Attachments: 2013 BCRET Quarterly Reports - Sharpley.pdf

Please see attached.

From: C H Hog Farms Inc
To: Water Permit Application
Cc: "William A. Waddell, Jr."
Subject: 3 of 11 emails
Date: Thursday, December 28, 2017 12:16:30 PM
Attachments: 2014 BCRET Quarterly Reports - Sharpley.pdf

Please see attached.

From:	C H Hog Farms Inc
To:	Water Permit Application
Cc:	"William A. Waddell, Jr."
Subject:	4 of 11 emails
Date:	Thursday, December 28, 2017 12:19:26 PM
Attachments:	2015 BCRET Quarterly Reports - Sharpley.pdf

Please see attached.

From:	C H Hog Farms Inc
To:	Water Permit Application
Cc:	"William A. Waddell, Jr."
Subject:	5 0f 11 emails
Date:	Thursday, December 28, 2017 12:20:58 PM
Attachments:	2016 BCRET Quarterly Reports - Sharpley.pdf

Please see attached.

From: C H Hog Farms Inc
To: Water Permit Application
Cc: "William A. Waddell, Jr."
Subject: 6 of 11 emails
Date: Thursday, December 28, 2017 12:24:42 PM
Attachments: 2017 BCRET Quarterly Reports - Sharpley.pdf

Please see attached.

From: C H Hog Farms Inc
To: Water Permit Application
Cc: "William A. Waddell, Jr."
Subject: 7 of 11 emails
Date: Thursday, December 28, 2017 12:30:23 PM
Attachments: pond liner .pdf

Please see attached.

From:	C H Hog Farms Inc
To:	Water Permit Application
Cc:	"William A. Waddell, Jr."
Subject:	8 of 11 emails
Date:	Thursday, December 28, 2017 12:30:42 PM
Attachments:	sheet 15.pdf

Please see attached.

From: C H Hog Farms Inc
To: Water Permit Application
Cc: "William A. Waddell, Jr."
Subject: 9 of 11 emails
Date: Thursday, December 28, 2017 12:32:25 PM
Attachments: Technical Specifications, Quality Assurance Plan pond liner.pdf

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Please see attached.

From: C H Hog Farms Inc
To: Water Permit Application
Cc: "William A. Waddell, Jr."
Subject: 10 of 11 emails
Date: Thursday, December 28, 2017 12:32:43 PM
Attachments: wells on farm.pdf

Please see attached.

From:	C H Hog Farms Inc
To:	Water Permit Application
Cc:	"William A. Waddell, Jr."
Subject:	Another Document
Date:	Thursday, December 28, 2017 4:02:54 PM
Attachments:	ARG590001_Additional Information Waste Management Plan_20120712.pdf

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Here's another document you might need.

Thanks,
Jason Henson
C & H Hog Farms, Inc.