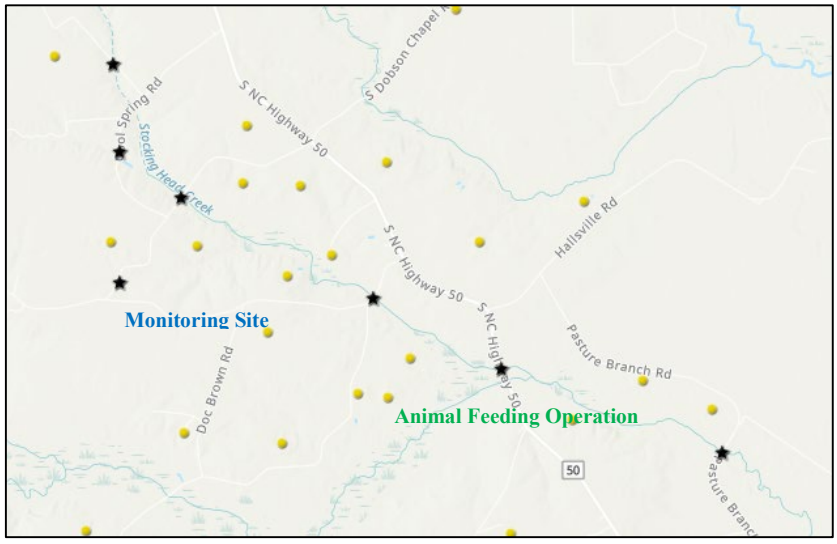
North Carolina Department of Environmental Quality

May 4, 2020

Title VI: Increasing Equity, Transparency, and Environmental Protection in the Permitting of Swine Operations in North Carolina

Attachment G: Cape Fear River Animal Feeding Operations Monitoring Study: Preliminary Report

NORTH CAROLINA
Department of Environmental Quality



CAPE FEAR RIVER ANIMAL FEEDING OPERATIONS MONITORING STUDY: PRELIMINARY REPORT

North Carolina Department of Environmental Quality

May 2020

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Introduction

The Cape Fear River Animal Feeding Operations Monitoring Study (CFRAFOMS) is an ongoing surface water quality monitoring study that evaluates water quality in watersheds adjacent to high concentrations of permitted animal feeding operations utilizing lagoon and spray fields for waste management. This report evaluates the analytical data obtained from water samples collected from surface water quality monitoring stations. The data presented in this report is from eleven monitoring stations in Duplin and Pender Counties (see Figure 1 and Table 1) and represents monitoring results from April 2018 to October 2019. Ten of the eleven monitoring stations are test stations located in Duplin County in watersheds with high concentrations of animal feeding operations. The monitoring station in Pender County is a reference/background station and no registered animal feeding operations are present in the drainage area of this station.

The CFRAFOMS was conducted as part of a settlement agreement between North Carolina Department of Environmental Quality (NCDEQ) and multiple parties that include the North Carolina Environmental Justice Network (NCEJN), The Rural Empowerment Association for Community Help (REACH), and The Waterkeeper Alliance, Inc. The CFRAFOMS was intended to provide NCDEQ an opportunity to evaluate surface water conditions in areas with a high concentration of animal feeding operations, and if surface water impacts were found, then to evaluate potential sources. The study also helps the NCEJN, REACH, and Waterkeeper Alliance Inc. to evaluate the terms discussed in the settlement agreement (Settlement Agreement.pdf).

Program Background

Animal waste management systems in North Carolina (NC) are regulated by the Animal Feeding Operations (AFO program in the Department of Environmental Quality's. The AFO Program is responsible for issuing permits and enforcing compliance activities on animal feeding operation facilities across the state. Animal operations are defined by General Statute 143-215.10B as feedlots involving more than 250 swine, 100 confined cattle, 75 horses, 1,000 sheep, or 30,000 poultry with a liquid waste management system. NCDEQ AFO Program has some of the most stringent permit requirements for AFOs in the country and is one of the few states that requires annual inspections of every permitted facility. Permitting requirements for animal feeding operations in North Carolina can be found at:
/about/divisions/water-resources/water-resources-permits/wastewater-branch/animal-feeding-operation-permits/permits.

The majority of NC swine AFOs are covered by the N.C. Swine State General Permit. The general permit contains performance standards, operation and maintenance requirements, monitoring and reporting requirements, policy for inspections and entry to the farms, general conditions and the penalty assessment policy. A Certificate of Coverage (CoC) is issued with each permit that is permittee-specific and designates the permitted number of animals and type of animal operation. All permitted animal operations are required to have a Certified Animal Waste Management Plan (CAWMP) that has been developed by a Certified Technical Specialist. The CAWMP identifies the fields to which the waste is applied, the crops to be grown and other operational details of the waste management system. Animal waste must be applied at no greater than agronomic rates – an amount that can be used productively by the crops planted.

North Carolina contains approximately 2,100 permitted swine farms and is the nation's second highest producer of swine. The CFRAFOMS was conducted primarily in Duplin County where there are 483 permitted animal farming facilities, which accounts for approximately 23% of the state's permitted swine facilities.

Methods

Surface Water Quality Monitoring Study Plan

The CFRAFOMS was designed to investigate potential water quality impacts in highly concentrated areas of AFOs. Ten (10) water quality monitoring stations and one reference/background station were included in this study (Figure 1). General information on the selected monitoring stations including their location, stream index number, and watershed characteristics can be found in Table 1. The station locations were selected to provide a picture of the surface water quality adjacent to animal feeding operations.

The Stocking Head Creek watershed has 22,353 acres of land mass and is located in the Cape Fear River basin. Seven of the eleven water quality monitoring stations are located in this watershed. Murphey's Creek monitoring site is located in Rockfish Creek watershed which has 30,981 acres. Muddy creek monitoring site is located in the Muddy Creek watershed with 30,718 acres. Sikes Mill Run monitoring site is located in Six Runs Creek watershed with 14,548 acres. The background monitoring site is located in Harrisons Creek watershed located in Pender county with 23,433 acres.

Water quality parameters most commonly analyzed to investigate water quality impacts from AFOs are nutrients and pathogens. These parameters along with a suite of other physical and chemical water quality parameters were monitored on a monthly basis between April 2018 and October 2019. The full list of parameters and the sample type are listed in Table 2.

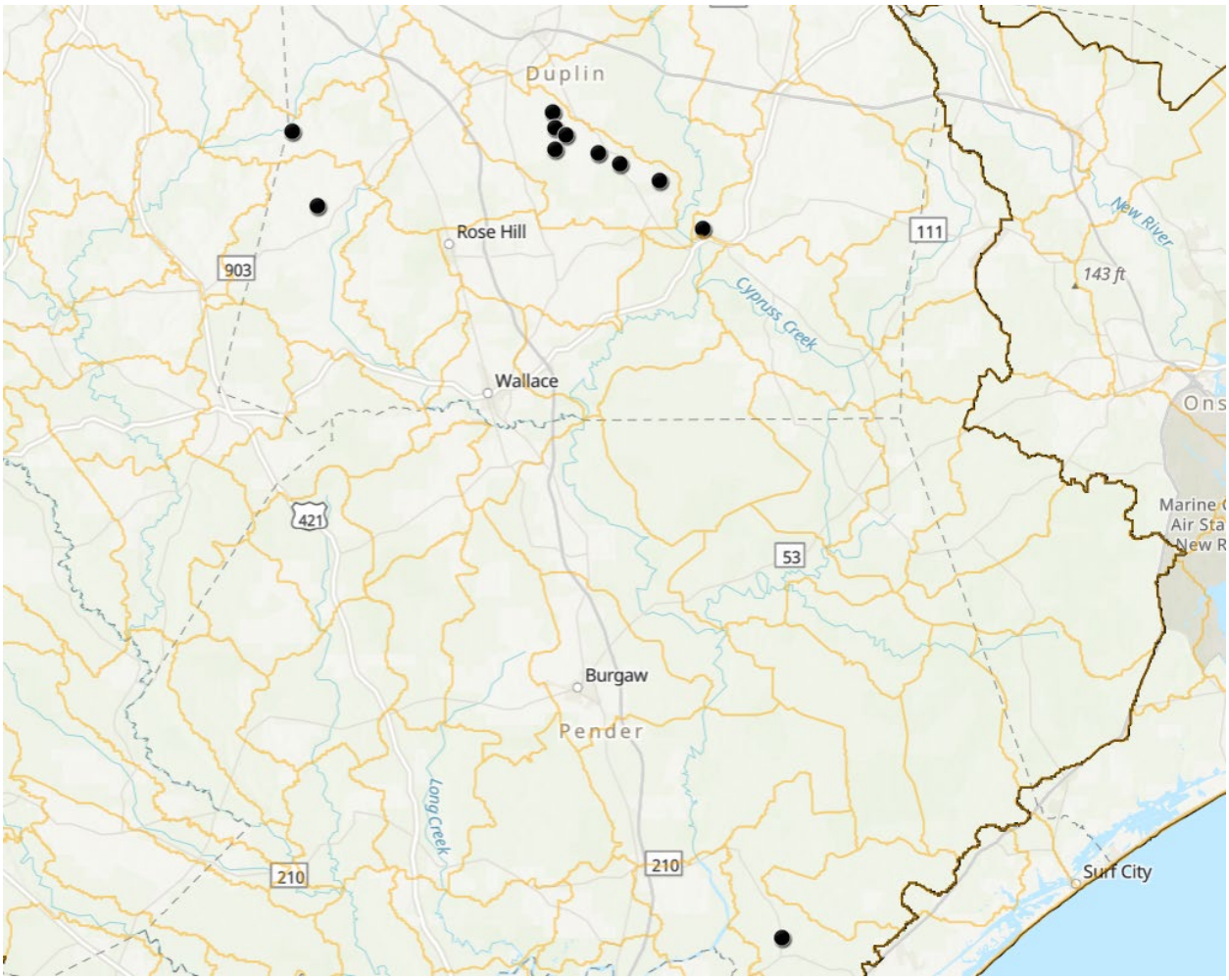

Figure 1. Map showing the watersheds and water quality monitoring sites.

Stream Name	Stream Index	Monitoring Location	Watershed Characteristics	County
Stocking Head Creek	18-74-24	Graham Dobson Road (SHC_GDR)	Several Crossroads throughout this high density CAFO watershed. This is a headwaters stream crossing.	Duplin
		Cool Spring Road (Unnamed Tributary) (TR_CSR)		
		S. Dobson Chapel Road (SHC_SDCR)		
		S. Dobson Chapel Road (Unnamed Tributary) (TR_SDCR)		
		Stocking Head Road (SHC_SHCR)		
		S NC Highway 50 (SHC_50)	Fish station at this crossroads.	
		Pasture Branch Road (SHC_PBR)	Benthic macroinvertebrate station at this crossroads.	
Murpheys Creek	18-74-29-0.5	Waycross Road (MC_WR)	High density CAFO watershed.	Duplin
Muddy Creek	18-74-25	Durwood Evan Road (MC_DER)	Medium density CAFO watershed. Impaired biological station at this location.	Duplin
Sikes Mill Run	18-68-2-10-4	Beasley Mill Road (SMR_BMR)	High density CAFO watershed with stream originating on hog farm.	Duplin
Harrisons Creek	18-74-49	Hwy 210 (HC_210)	Largely undeveloped watershed with some row crop and silviculture operations.	Pender

Table 1. Water quality monitoring locations with stream index number, watershed description and county name.

Parameter	Sample Type
Dissolved Oxygen (mg/L and percent saturation)	Surface
pH (SU)	Surface
Specific Conductance (µmhos/cm)	Surface
Temperature (°C)	Surface
Ammonia as N (NH_3) (mg/L)	Grab Sample
Nitrate+Nitrite (NO_3+NO_2) (mg/L)	Grab Sample
Total Kjeldahl Nitrogen (TKN) (mg/L)	Grab Sample
Total Phosporus (TP) (mg/L)	Grab Sample
Turbidity (mg/L)	Grab Sample
Fecal coliform (CFU/100 mL)	Grab Sample
Colored Dissolved Organic Matter (CDOM) (mg/L)	Grab sample

Table 2. Water quality analysis parameters and sampling type used for collecting and analyzing water samples.

Water samples were collected, stored, and transported from monitoring stations following approved monitoring standard operating procedures (SOPs) (AMS QAPP, 2017). Chemical analyses of all parameters except CDOM were conducted by the NC Water Sciences Section Chemistry Laboratory using EPA-approved methods (40CFR Part 136).

In April 2019, DWR began collecting samples for the stable isotope and excitation-emission matrix (EEM) fluorescence analysis. Samples were collected monthly for six months from all monitoring stations in accordance with the NC State University Osburn Biogeochemistry Laboratory (Osburn Lab) sampling protocol (CDOM Sampling SOP_DWR.pdf) and analyzed by the Osburn Lab.

NCDEQ also investigated any potential impacts that underground drain tiles located in fields receiving animal waste may have on water quality. Regional office field staff conducted intensive inspections on farms located in the study area to identify fields that had drain tiles (See Inspection Notes in Appendix 1).

Results

The mean and median concentrations for nutrient parameters and pathogens were calculated for the data between April 2018 and October 2019. The results are shown below in Figures 2-6 by parameter for each monitoring station.

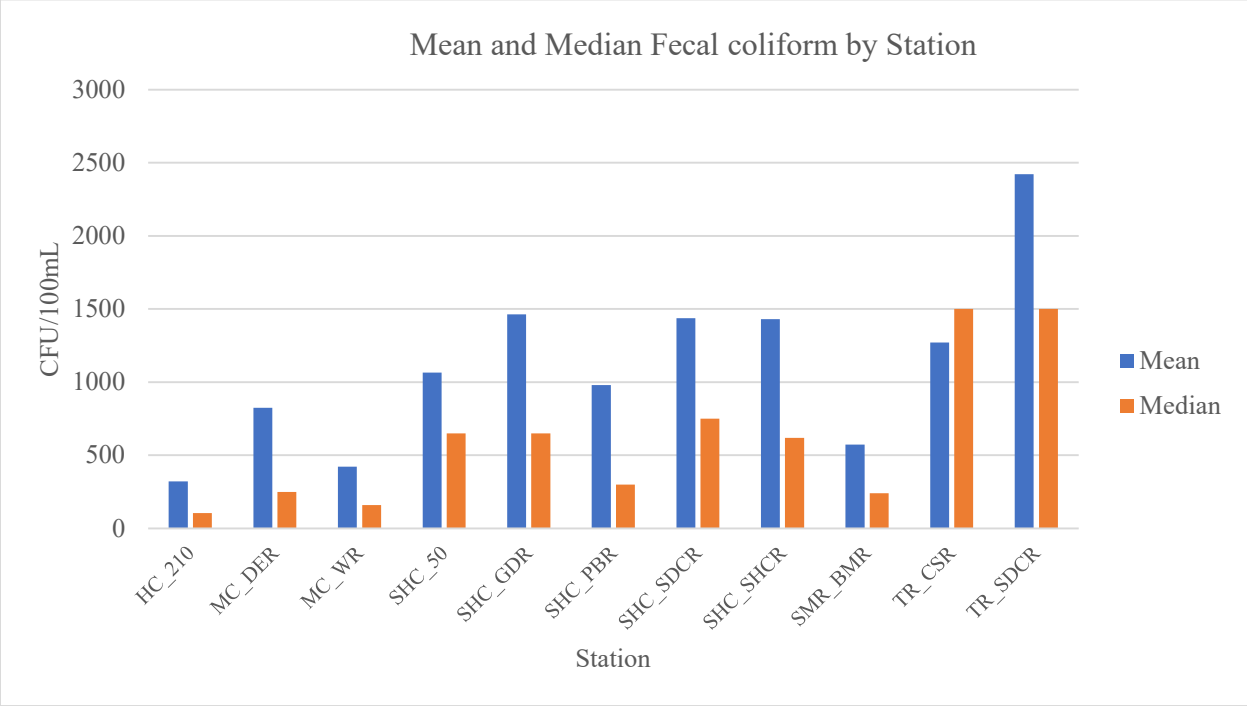

Figure 2. Mean and median concentrations for Fecal coliform (April 2018-October 2019).

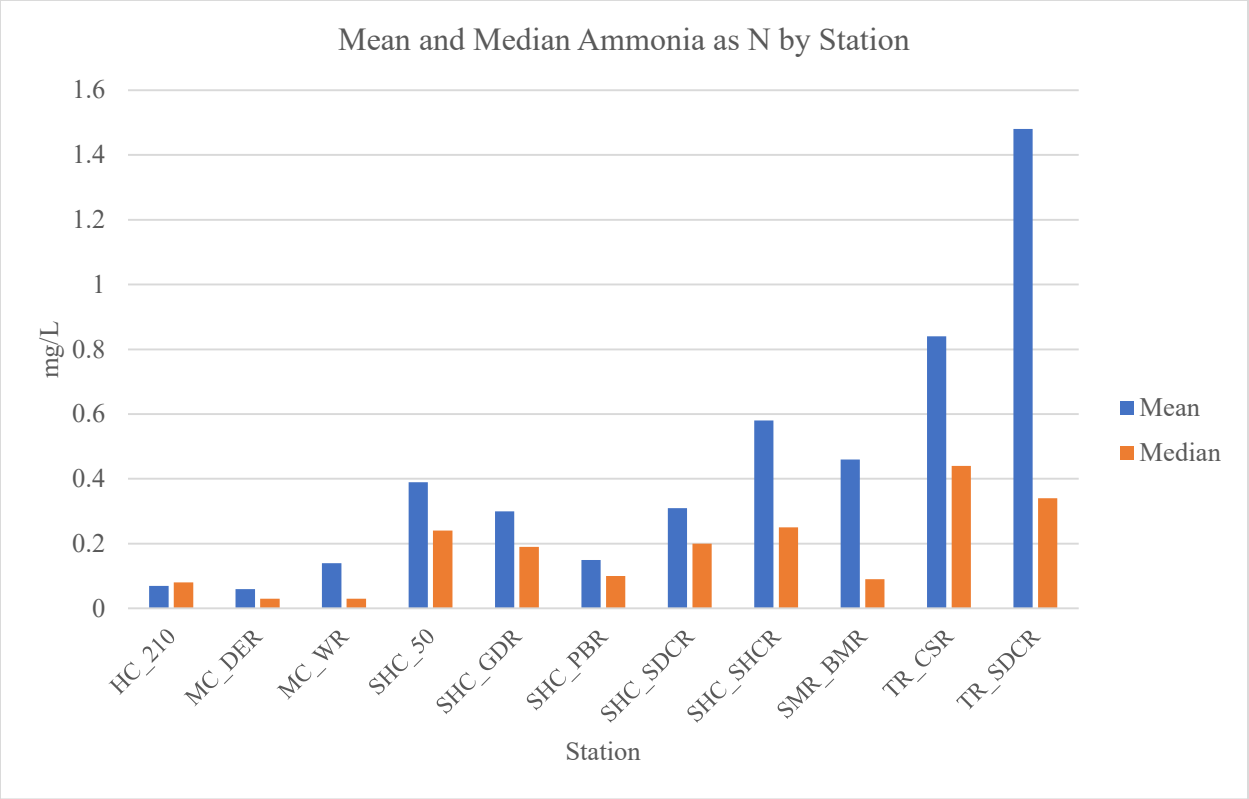

Figure 3. Mean and median concentrations for Ammonia as N (April 2018-October 2019).

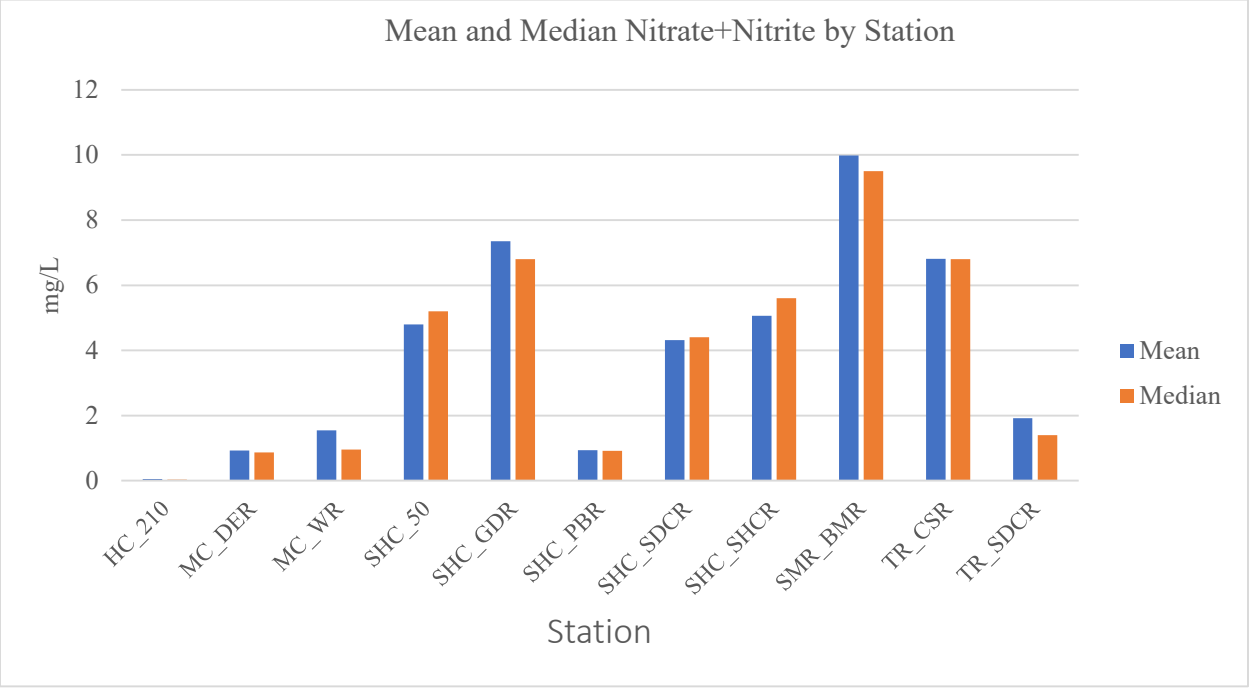

Figure 4. Mean and median concentrations for Nitrate+Nitrite (April 2018-October 2019).

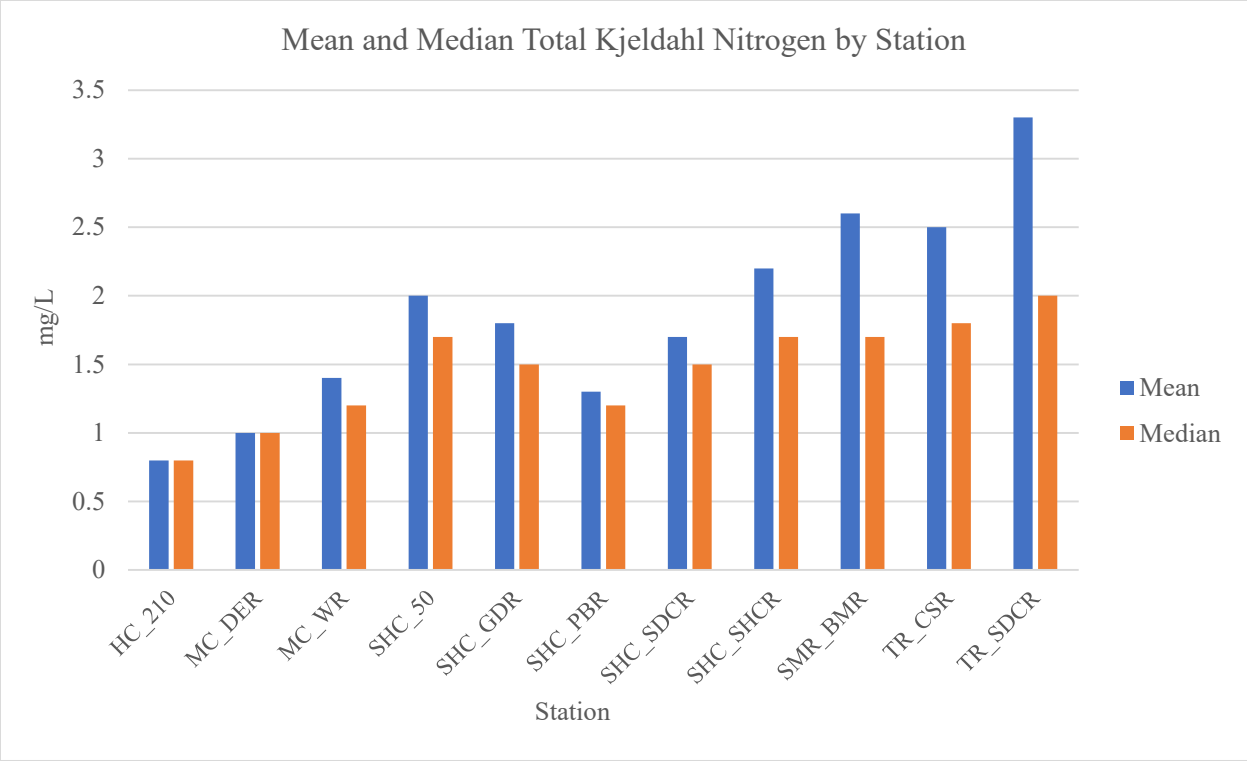

Figure 5. Mean and median concentrations for Total Kjeldahl Nitrogen (April 2018-October 2019).

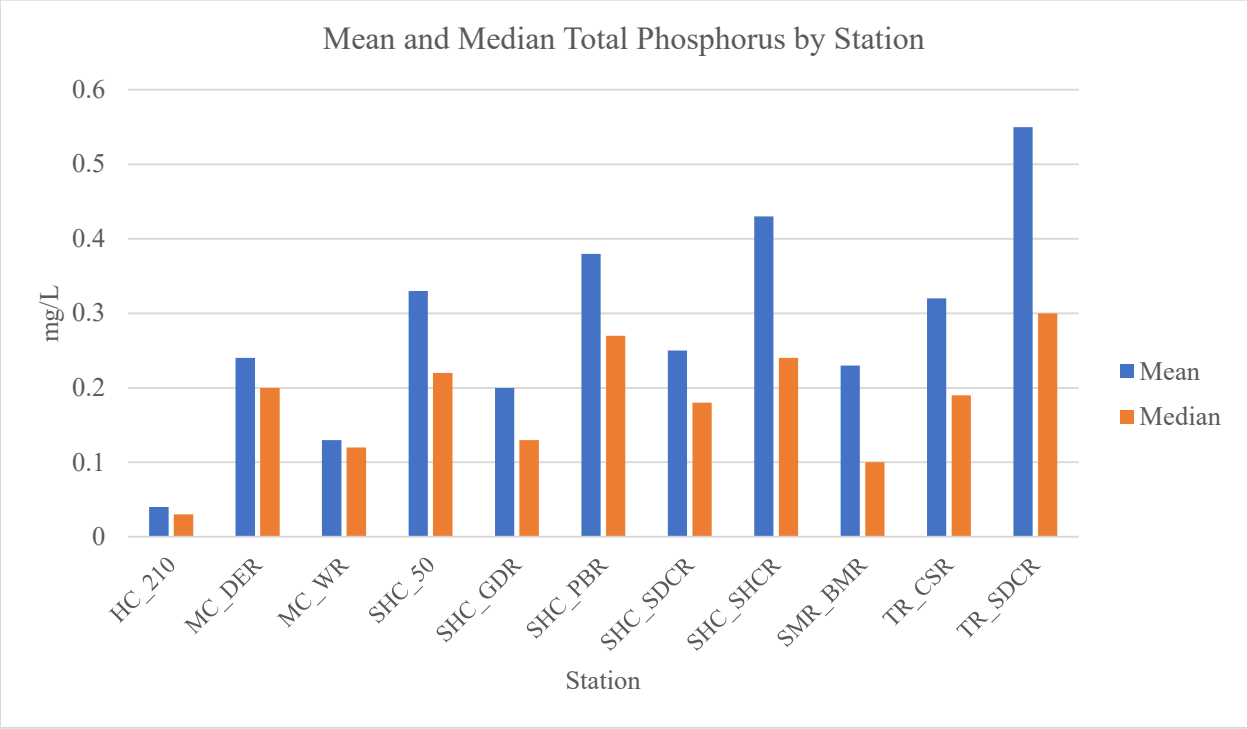

Figure 6. Mean and median concentrations for Total Phosphorus (April 2018-October 2019).

As shown in almost all cases in the tables above, the reference station (HC_210) had much lower mean and median concentrations by parameter than the test stations. To evaluate whether the parameter concentrations are significantly different in the test stations as compared to the reference

stations, Kruskal-Wallis tests (2-sided) were conducted to compare the medians. The null hypothesis was that all medians are the same or not significantly different. Low p-values in the tables (highlighted in green) below indicate significant differences between the respective stations in the matrix.

	HC_210	MC_DER	MC_WR	SHC_50	SHC_GDR	SHC_PBR	SHC_SDCR	SHC_SHCR	SMR_BMR	TR_CSR
MC_DER	0.2309	-								
MC_WR	0.847	0.3176	-							
SHC_50	0.0255	0.2309	0.0683	-						
SHC_GDR	0.019	0.3176	0.0728	0.9862	-					
SHC_PBR	0.1575	0.6962	0.2735	0.5992	0.5992	-				
SHC_SDCR	0.0121	0.0683	0.019	0.5992	0.6401	0.2811	-			
SHC_SHCR	0.0172	0.1934	0.034	0.8029	0.7903	0.4845	0.7796	-		
SMR_BMR	0.2087	0.8946	0.3464	0.3352	0.3352	0.7374	0.1266	0.2054	-	
TR_CSR	0.0071	0.019	0.0121	0.3176	0.3176	0.1305	0.5554	0.5274	0.019	-
TR_SDCR	0.0222	0.2309	0.0641	0.5554	0.5992	0.3773	0.847	0.7903	0.166	0.8946

Table 3. Kruskal-Wallis tests results for Fecal coliform (p-value ≤0.05 indicates significant difference).

	HC_210	MC_DER	MC_WR	SHC_50	SHC_GDR	SHC_PBR	SHC_SDCR	SHC_SHCR	SMR_BMR	TR_CSR
MC_DER	0.32517	-								
MC_WR	0.97248	0.69489	-							
SHC_50	0.00023	0.00019	0.00679	-						
SHC_GDR	0.00227	0.00103	0.0256	0.22747	-					
SHC_PBR	0.17512	0.00438	0.1066	0.01689	0.1066	-				
SHC_SDCR	0.00265	0.00045	0.01382	0.2438	0.97248	0.11461	-			
SHC_SHCR	0.00018	0.00018	0.00454	0.45943	0.07447	0.00727	0.06768	-		
SMR_BMR	0.1964	0.00587	0.0966	0.00587	0.05041	0.97248	0.06676	0.00435	-	
TR_CSR	0.000057	0.000057	0.00046	0.00727	0.00142	0.00019	0.00436	0.04441	0.00088	-
TR_SDCR	0.00045	0.00034	0.00438	0.21572	0.0437	0.00587	0.06267	0.48405	0.00727	0.34634

Table 4. Kruskal-Wallis tests results for Ammonia as N (p-value ≤0.05 indicates significant difference).

	HC_210	MC_DER	MC_WR	SHC_50	SHC_GDR	SHC_PBR	SHC_SDCR	SHC_SHCR	SMR_BMR	TR_CSR
MC_DER	0.0000255	-								
MC_WR	0.03362	0.92381	-							
SHC_50	0.0000051	0.0000057	0.00038	-						
SHC_GDR	0.0000051	0.0000051	0.0000091	0.00781	-					
SHC_PBR	0.0000051	0.99049	1	0.0000051	0.0000051	-				
SHC_SDCR	0.0000051	0.0000093	0.00025	0.60106	0.00123	0.0000083	-			
SHC_SHCR	0.0000051	0.0000051	0.00014	0.69204	0.01154	0.0000051	0.26084	-		
SMR_BMR	0.0000051	0.0000051	0.0000051	0.00022	0.05127	0.0000051	0.0000337	0.0004	-	
TR_CSR	0.0000051	0.0000051	0.0000127	0.05437	0.71768	0.0000051	0.00401	0.12249	0.01816	-
TR_SDCR	0.0000051	0.03457	0.49163	0.00025	0.0000222	0.02251	0.00035	0.00021	0.0000091	0.000071

Table 5. Kruskal-Wallis tests results for Nitrate+Nitrite (p-value ≤0.05 indicates significant difference).

	HC_210	MC_DER	MC_WR	SHC_50	SHC_GDR	SHC_PBR	SHC_SDCR	SHC_SHCR	SMR_BMR	TR_CSR
MC_DER	0.38359	-								
MC_WR	0.00036	0.00313	-							
SHC_50	0.00017	0.00022	0.03036	-						
SHC_GDR	0.00019	0.00036	0.08316	0.60385	-					
SHC_PBR	0.00337	0.06051	0.28497	0.00407	0.01125	-				
SHC_SDCR	0.0002	0.00039	0.17128	0.28027	0.87142	0.01776	-			
SHC_SHCR	0.00017	0.00023	0.01737	0.96982	0.52844	0.00337	0.30209	-		
SMR_BMR	0.00019	0.00039	0.08316	0.96982	0.77717	0.01466	0.60385	0.91308	-	
TR_CSR	0.00017	0.0002	0.01116	0.72909	0.38359	0.00337	0.15221	0.79256	0.72909	-
TR_SDCR	0.00036	0.00138	0.08146	0.82468	0.60385	0.03363	0.39746	0.88527	0.88527	0.89921

Table 6. Kruskal-Wallis tests results for Total Kjeldahl Nitrogen (p-value ≤0.05 indicates significant difference).

	HC_210	MC_DER	MC_WR	SHC_50	SHC_GDR	SHC_PBR	SHC_SDCR	SHC_SHCR	SMR_BMR	TR_CSR
MC_DER	0.000053	-								
MC_WR	0.000092	0.02403	-							
SHC_50	0.000053	0.27671	0.00017	-						
SHC_GDR	0.000053	0.31549	0.40585	0.0434	-					
SHC_PBR	0.000053	0.13777	0.0003	0.59956	0.02403	-				
SHC_SDCR	0.000053	0.98624	0.00933	0.15584	0.20016	0.15584	-			
SHC_SHCR	0.000053	0.27671	0.00048	0.96254	0.03767	0.73428	0.2158	-		
SMR_BMR	0.00044	0.14304	0.84618	0.02327	0.4406	0.02327	0.11305	0.02403	-	
TR_CSR	0.000053	0.94835	0.04743	0.26193	0.34641	0.15584	0.84824	0.2862	0.15224	-
TR_SDCR	0.000053	0.23572	0.01076	0.61807	0.09569	0.90644	0.23572	0.73428	0.0555	0.2862

Table 7. Kruskal-Wallis tests results for Total Phosphorus (p-value ≤0.05 indicates significant difference).

For all parameters, a majority of the test stations (six or more) were significantly different from the reference station. For NO_3+NO_2, TKN, and TP, nine of more of the test stations were significantly different than the reference station.

Discussion

Based on the results of this study to date, it appears that nutrient and pathogen concentrations are higher for the test stations in the concentrated AFO areas as compared to the reference station with no AFOs in the drainage area. The next step for this study is to determine the source of the nutrients and pathogens. Source identification for ubiquitous parameters such as nutrients and pathogens can be difficult. However, technological advances have made the identification of organic nitrogen and specific pathogens sources much more reliable. Two specific enhanced analytical techniques will be used to assist in source identification, excitation-emission matrix (EEM) fluorescence analysis and quantitative polymerase chain reaction (qPCR) analysis

EEM

NCDEQ has pursued enhanced analysis of surface water samples for the purpose of nutrient source identification. Analytical techniques such as stable isotope and EEM fluorescence analyses were used to identify organic nitrogen sources in ambient waters. Organic nitrogen sources such as wastewater effluent, fertilizers, and animal wastes have different ranges of isotope ratios. These ratio ranges can act as fingerprints for sources of the nitrogen. Excitation-emission matrix fluorescence analysis can also be used to identify the fluorescent properties of dissolved organic nitrogen (Osburn et al. 2016). Organic nitrogen exhibits different fluorescence signatures depending on the source of the nitrogen. These signatures are modeled in a parallel factor analysis to identify

sources such as wastewater, animal waste, and septage and the relative nitrogen contributions of the sources (Ibid.).

NCDEQ contracted with North Carolina State University's Osburn Lab to conduct stable isotope and EEM fluorescence analyses (FLUORMOD) for samples collected as part of this study. Dr. Osburn's FLUORMOD analysis was designed to analyze a variety of organic nitrogen sources such as septage, poultry, swine, and wetlands/soil. Swine was of particular interest to this study. However, results from the preliminary analyses detected only minimal organic nitrogen from swine sources. Tables 8-11 show the results from the analyses. Samples collected in June were lost in transport, so only four sets of samples (March, April, May and July) were analyzed. Further discussion with Dr. Osburn revealed that the FLUORMOD analysis used at that time could have been misidentifying the organic nitrogen sources. FLUORMOD was developed using swine waste sampled directly from a lagoon. FLUORMOD would be likely to detect this fluorescence signature in ambient waters only in the event of a direct discharge from a swine lagoon to surface waters. Current regulatory requirements for inspection and management make direct discharges from lagoons to surface waters unlikely except in catastrophic events. The more likely path of a discharge to surface waters is during spray irrigation of waste onto sprayfields due to overspray, ponding and runoff, or infiltration into groundwater or underground drain tile. Chemical changes that occur in waste during spray irrigation, infiltration into soil, and residence time in surface waters can significantly change the fluorescence signature (Osburn personal communication). Therefore, it is unlikely that FLUORMOD as designed would detect contributions of organic nitrogen from swine through these pathways.

Dr. Osburn is currently revising his analytical model to detect the fluorescence signatures from swine waste applied to sprayfields. Once the revisions are completed, NCDEQ will begin collecting samples concurrently with nutrient and pathogen samples from all eleven stations for analysis using FLUORMOD in an attempt to identify organic nitrogen sources in these surface waters.

March 2019	Reference	Poultry	Swine	Septic	Soil
HC_210	66%	1%	0%	0%	32%
MC_DER	73%	3%	0%	1%	24%
MC_WR	64%	2%	0%	0%	34%
SHC_50	76%	4%	0%	1%	20%
SHC_GDR	77%	4%	0%	1%	18%
SHC_PBR	72%	2%	0%	1%	25%
SHC_SDCR	73%	3%	0%	1%	23%
SHC_SHCR	76%	4%	0%	1%	20%
SMR_BMR	66%	2%	0%	0%	31%
TR_CSR	74%	5%	0%	1%	20%
TR_SDCR	73%	3%	0%	1%	24%

Table 8. FLUORMOD results for March 2019.

April 2019	Reference	Poultry	Swine	Septic	Soil
HC_210	71%	2%	0%	0%	27%
MC_DER	71%	2%	0%	1%	26%
MC_WR	78%	4%	0%	1%	17%
SHC_50	77%	4%	0%	1%	18%
SHC_GDR	73%	5%	0%	1%	21%
SHC_PBR	73%	2%	0%	1%	25%
SHC_SDCR	83%	4%	0%	5%	8%
SHC_SHCR	75%	4%	0%	1%	20%
SMR_BMR	61%	1%	0%	0%	38%
TR_CSR	63%	2%	0%	0%	35%
TR_SDCR	74%	3%	0%	1%	22%

Table 9. FLUORMOD results for April 2019.

May 2019	Reference	Poultry	Swine	Septic	Soil
HC_210	77%	3%	0%	1%	19%
MC_DER	76%	4%	0%	1%	19%
MC_WR	75%	5%	0%	1%	19%
SHC_50	76%	5%	0%	1%	18%
SHC_GDR	69%	4%	0%	1%	25%
SHC_PBR	70%	3%	0%	1%	27%
SHC_SDCR	74%	3%	0%	1%	22%
SHC_SHCR	74%	6%	0%	2%	18%
SMR_BMR	63%	2%	0%	0%	35%
TR_CSR	73%	13%	0%	4%	10%
TR_SDCR	41%	4%	2%	19%	34%

Table 10. FLUORMOD results for May 2019.

July 2019	Reference	Poultry	Swine	Septic	Soil
HC_210	75%	2%	0%	1%	22%
MC_DER	79%	4%	0%	4%	13%
MC_WR	70%	10%	0%	2%	18%
SHC_50	73%	7%	0%	2%	18%
SHC_GDR	65%	7%	0%	2%	26%
SHC_PBR	78%	4%	0%	1%	18%
SHC_SDCR	71%	6%	0%	2%	21%
SHC_SHCR	74%	7%	0%	2%	17%
SMR_BMR	67%	3%	0%	1%	29%
TR_CSR	55%	2%	0%	0%	42%
TR_SDCR	60%	8%	0%	12%	19%

Table 11. FLUORMOD results for July 2019.

Quantitative Polymerase Chain Reaction (qPCR)

qPCR is a genetic identification analysis often used to identify bacterial markers (Kralik and Ricchi, 2017). This highly sensitive analysis can identify down to specific genus and species of bacteria. This is useful in pathogen source identification in surface waters where bacteria found only in specific animals (e.g., swine, poultry, cattle, humans) can be selected for analysis as identifying markers (Ibid). NCDEQ is establishing collaboration with researchers at North Carolina universities who conduct this analysis to participate in the CFRAFOMS. Samples for this analysis will be collected concurrently with nutrient and pathogen samples.

Once the FLUORMOD model has been revised and the qPCR collaborator has been identified, sample collection will begin again. The explicit purpose of this sampling will be to attempt source identification using the target parameters organic nitrogen and pathogens. It is anticipated that the source identification monitoring will provide insight to NCDEQ on nutrient and pathogen sources in the Cape Fear River basin in areas populated with high concentrations of animal waste facilities.

References

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Appendix:1

The Department of Environmental Quality inspected 23 swine facilities as part of the Stocking Head Creek Watershed Study which could potentially impact surface water quality. During the inspections, NCDEQ looked for any unpermitted discharges coming from waste storage structures.

Notes from inspections conducted on the AFOs in the surrounding areas of water quality monitoring sites with corresponding subsurface drain tiles and average values for NH4-N and Fecal coliform.

Permit No.	Farm Name	Inspection Date	Notes	Nearest SHC Location	Average NH4-N (mg/L)	Average Fecal Coliform (CFU/100ml)	Subsurface Drains (Y/N)
AWS310466	Sands Farm	3/11/2019	DWR inspectors visited the farm on 3/11/2019. We rode and inspected the lagoons, fields and drainages. There are no subsurface drains on this farm and we did not see any areas of concern. This farm has no hogs or hog houses, and the representative on-site indicated that it has been approximately 2 years since they've land-applied wastewater. The facility is in the process of being converted to a truck wash.	MC_WR	0.19	436.46	No
AWS310445	Terry Miller Farm sites 1&2	3/14/2019	DWR inspected facility on 3/14/2019. Rode lagoon and viewed fields. No bad eroded areas. (Note: Farm was overtopped/inundated during Hurricane Florence)	SHC_PBR	0.16	1139.09	No
AWS310692	Liberty Farm	3/20/2019	DWR inspected facility on 3/20/2019. Lagoon and field was walked and some rode. No erosion or runoff issues. Subsurface drains are in field, currently waiting for a better map. Supposedly	SHC_SDCR	0.41	1727.27	Yes

			there are 2 laterals that go through the pivot pumping field and are run to the ditch on North side of the property. Farm didn't use correct Wa on some of the IRR2's and was missing calibration.				
AWS310386	**William Edward Brock Farm**	**3/20/2019**	**DWR inspected facility on 3/20/2019. Walked lagoons and fields on creekside of farm. No drain tiles in field that owner is aware. FB is noncompliant currently but POA is submitted. Discussed options and cost share "Pump and Haul". Instructed owner to communicate with DWR on FB. (Note: farm was inundated during hurricane Florence).**	**SHC_PBR**	**0.16**	**1139.09**	**No**
AWS310086	**ABS Family Farms, Inc.**	**3/26/2019**	**DWR on site 3/26/2019 to inspect farm for SHC study. Fields and records okay, fixing foundation cracks soon. Walked and rode fields looking for drains, found 1 in the ditch that leads to the pond, owner said there should be 2 more but could not find them.**	**SHC_SHCR**	**0.76**	**1979.09**	**Yes**
AWS310455	**Randy & Anna Harrell**	**3/26/2019**	**DWR inspected the facility on 3/26/2019 with a consultant. Numerous issues were discovered, including but not limited to, a lack of irrigation visible equipment (permitted for a solid set system), suspected equipment/pipe failure issues, suspected runoff from irrigation field, leaking from house and/or flush tank, multiple high and unreported FB events, no irrigation**	**SHC_50**	**0.49**	**1373.64**	**No**

			records for review, flooded irrigation field that is overgrown with trees/shrubs (has not been used), lack of suitable crop on the irrigation field that is used, etc. The consultant did not know if there were subsurface drains on the fields, and we did not locate any during the inspection. DWR will conduct a follow-up inspection with the farm owner or his son.				
AWS310035	**Waters Farm 1-5 M&M Rivenbark**	**3/11/2019**	**DWR inspectors visited the site on 3/11/2019. We rode and inspected the lagoons, fields, drainages and subsurface drains at the farms. We did not see any areas of concern other than one area in the center pivot field on the Waters 3,4,5 farm. There was a low spot where wastewater had the potential to pond and possibly runoff in the event of an over application event. DWR suggested that additional dirt be brought to address this area.**	**MC_WR**	**0.19**	**436.46**	**Yes**

AWS310160	**Carter and Sons Hog Farm 1&2**	**3/7/2019**	**David Powell inspected the farm on 3/7/2019. A pile of mulch was placed near a UT of SHC. Eroded areas from some fields had straw/hay around and in them to reduce erosion. Lagoons out of compliance currently with POA submitted. Amended POA coming to account for new lagoon levels. Summary of Findings: 1) Discharge to UT of SHC of <1000 gals leaving back of houses/piping, then running between lagoons and across small field to UT. Onsite observations show green grass in area of runoff and a drainage "swath", from stormwater mixed with nutrients from around lagoon and houses, have been doing this for a while 2) Mulch/hay bales in eroded areas. This can add nutrients into water of UT. Please replace soil in eroded areas and remove hay/mulch. Crop should be removed from fields irrigated on and disposed of properly. 3) Lagoon levels not in compliance; POA submitted and notification received 4) Fix leak at back of houses and eroded areas around farm. Replace soil, grass and reduce erosion. Replace also on dike walls and have markers reshot. Keep documentation. 5) Crop needs improvement. The fields are wet and are grazed. DWR**	**SHC_SDCR**	**0.41**	**1727.27**	**No**

			suggested having additional acreage for wet winters and additional pumping needs. Samples/pics taken. Sample 1 at 11:50 am; Sample 2 at 11:55 am; Sample 3 at 12:00; Sample 4 at 12:20 pm; Sample 5 at 1:40 pm; Sample at Envirochem at 3:05 pm. Suggest fixing stormwater runoff areas around lagoon/houses.				
AWS310321	**James E. King Farm**	**3/7/2019**	**DWR Michael Meilinger and Robb Marris visited farm on 3/7/2019 in response to SHC study, rode lagoons and walked fields, drain tiles in two fields that lead to SHC, marked on map. Some erosion from storm, fix spots and re-plant or re-seed field that was flooded from storm. Farm has cows and cow paths leading from the corrals and fields lead towards the ditches, told farmer to get grass cover and improve grass cover on dike wall. While riding the lagoon's saw signs of wild hogs rooting around the toe of the dike and in the edge of the woods next to the creek.**	**SHC_SHCR**		**1979.09**	**Yes**
AWS310451	**Otis Brown Farm**	**3/4/2019**	**DWR visited the farm as part of the SHC study. Rode roads along ditches and along field edges. Subsurface drains are known to be on the farm and marked on**	**SHC_SHCR**	**0.76**	**1979.09**	**Yes**

			the map. Water flowing out of the pipe into the ditch beside the road was a little dirty from all of the rain water. Farm and records look good, owner lost wheat crop after/during Hurricane in fields 1-4 has cover crop on fields now.				
AWS310254	**Bobby Brown Farm**	**3/4/2019**	**DWR visited farm in response to SHC study, farm had severe erosion after storm, fields have been fixed, farm has drain tiles and marked on map. Re-planting fescue where fields where flooded from hurricane Florence. Drain tiles that we say were flowing clear water and the ditches/creek was clear and flowing.**	**SHC_SHCR**	**0.76**	**1979.09**	**Yes**
AWS310371	**James P. Brown Farm**	**3/4/2019**	**DWR inspected the farm, farm looks well maintained, no drain tiles were found in fields, farm and records look good. Improve grass cover on dike wall.**	**SHC_SHCR**	**0.76**	**1979.09**	**No**
AWS310239	**Melvin Bostic Farm**	**3/7/2019**	**DWR Michael Meilinger visited the farm on 3/7/2019 in response to SHC study, rode lagoon's and farm fields, looked at the outfall of drain tiles, drain tiles marked on the map, farm and records look good**	**SHC_SDCR**	**0.41**	**1727.27**	**Yes**
AWS310017	**DM Farms Sec 2 Sites 1-4**	**2/28/2019**	**DWR inspectors visited farm on 2/28/2019, rode farm fields and looked at ditches and field edges that border Murpheys Creek. All water in the ditches and creek appeared to be clean. No drain tiles were found on the farm, and farm**	**MC_WR**	**0.19**	**436.46**	**No**

			looks well maintained.				
AWS310476	Greg Brown 1&2	2/11/2019	Soil analysis due 2019. Noticed few subsurface drains, water that we saw coming out of the drains and in the ditches was clear. DWR road farm, fix erosion spots in fields, fill in holes. When you resume pumping monitor to make sure nothing is running off from eroded areas. Farm looks well maintained.	SHC_SHCR	0.76	1979.09	Yes
AWS310077	Circle K I and II	2/12/2019	DWR onsite for compliance inspection and to survey streams, ditches, fields in support of SHC study. Numerous subsurface drains were documented, the drains observed were flowing clean/clear water. DWR requested the permittee to provide a map of drains located in the irrigation fields. Severe erosion along creek on south side of pivot 4 field. Permittee continues working on erosion from hurricane Florence.	SHC_GDR	0.36	1654.55	Yes
AWI310082	Vestal 1 and 2	2/12/2019	Visited for SHC study. DWR looked for erosion in fields, around lagoons and houses. Hurricane Florence has caused some areas to erode which are still being or need to be fixed when fields allow. Farm looks properly maintained. DWR requested the permittee to provide a map of drains located in the irrigation fields. Numerous subsurface	SHC_GDR	0.36	1654.55	Yes

			drains were documented, the drains observed were flowing clean/clear water.				
AWI310015	Magnolia III, DM Section 4 Sites 1-4, Section 3 Sites 4-5	2/21/2019	DWR inspectors visited farm on 2/21/2019, rode farm fields and looked at ditches and field edges that border Sikes Mill Run. All water in the ditches and creek appeared to be clean. No drain tiles were found on the farm, and farm looks well maintained.	SMR_BMR	0.66	569.46	No
AWS310048	Stocking Head Creek Farm	2/11/2019	DWR walked the fields, looked for erosion and few subsurface drains were found coming from the fields, documented on the overview farm map that is in Laserfiche, water coming out of the drains was clear. Farm looks well maintained. Have been working on fixing eroded areas from Hurricane Florence. Soil analysis due 2019.	SHC_GDR	0.36	1654.55	Yes
AWS310407	JBJ Kilpatrick Farms Inc	2/6/2019	DWR rode farm and completed annual inspection, farm looks well maintained. DWR walked fields and creek ditches. Found few subsurface drain leading to ditch from irrigation field. Ditches/drain looked clean. Farm looks well maintained.	SHC_SHCR	0.76	1979.09	Yes
AWS310725	Kilpatrick Farms Inc	2/6/2019	DWR inspected the farm. Ditches and fields were walked and evaluated to find any eroding or bad areas. Farm has numerous subsurface drains. Need to fix eroded areas along irrigation fields. Farm looks good cover exposed PV	SHC_SHCR	0.76	1979.09	Yes

			pipe and suggest pilings placed around it to ensure it doesn't get hit by a tractor.				
AWS310812	**Bowles and Sons Farm #3**	**2/7/2019**	**DWR visited the farm as part of the SHC study. Walked ditches along field edges. No subsurface drains are known to be on the farm, none seen. Permittee was recommended to (1) work on any areas in the fields/field edges that have eroded from Hurricane Florence; (2) Owner has removed cows from the farm on 2/18/2019. Check backs of houses for any possible leaks (grass is very green).**	**TR_SDCR**	**2.03**	**2783.09**	**No**
AWS310152	**Bowles & Sons Farm Inc Farm 2**	**2/7/2019**	**DWR walked fields, looking for erosion issues, 4 areas of severe erosion located on the left field that flow to SHC. Few subsurface drains were found in the application field and water coming out of the drain was clear. Permittee is waiting on approval for removing cows & fixing drainage issues. Storm water drain tiles on other side of ditch coming from neighbors fields flow into the UT beside the farm which flows to SHC. Check back of houses for leaks.**	**SHC_SDCR**	**0.41**	**1727.27**	**Yes**