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Assessing stream water quality for a system affected by livestock production in northeast Mississippi

Lorena Chavarro-Chaux, John Ramirez-Avila, Sandra Ortega-Achury, Timothy Schauwecker, Joby Czarnecki.



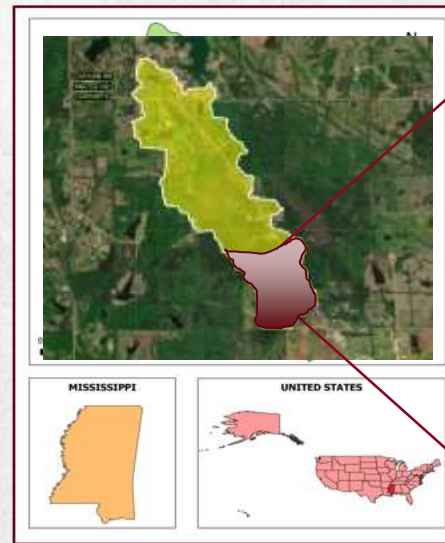
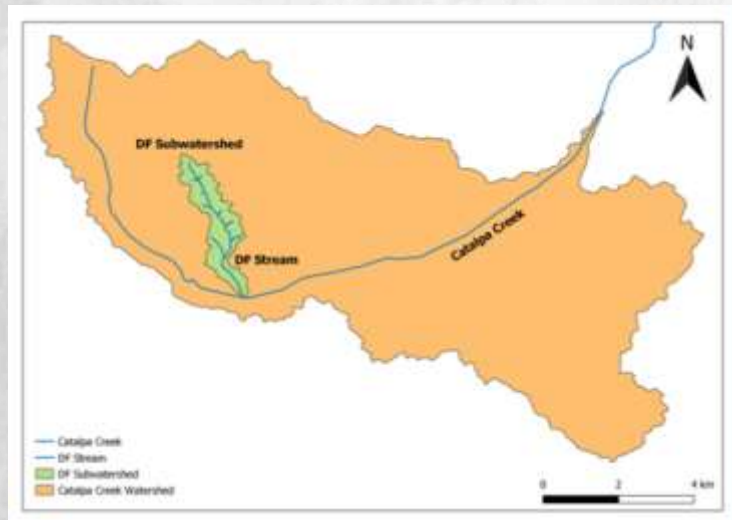
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1st Stream Restoration Conference
August 2, 2022

Study Area

- Sessums community NE – MS
- Sub-watershed headwater of Catalpa Creek
- Joey Bearden Dairy Research Center
- Designated Use: Fish & Wildlife
- Soils: 57% Type D (HSG)
- Land Use: Hay/Pasture
- Drainage Area: 0.25 km² (1.94 km²)
- Mainstream Length : 1.45 km (3.4 km)



Study Area:

**Implementation of Catalpa Creek
Water Management Plan**

**Identified as Critical Source Area
BMPs implementation**



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Study Area Issues

- Soil Compaction
- Reduced infiltration rates
- Runoff Volumes
- Sediment and Nutrients
- Low rates of DO
- Algae Bloom
- Streambank and bed erosion
- Upland, gully, rill erosion
- Concentrated flow



Watershed Function

WATERSHED ASSESSMENT				
Category / Parameter / Measurement Method	Description of Watershed Condition			Rating (G/F/P)
	Good	Fair	Poor	
1 Hydrology / Runoff / Watershed Impoundments	No impoundment upstream of project area	No impoundment within 1 mile upstream of project area. OR impoundment does not adversely affect hydrology or fish passage	Impoundment(s) located within 1 mile upstream of project area and/or has an adverse effect on hydrology and/or fish passage	P
2 Hydrology / Runoff / Concentrated Flow	No potential for concentrated flow/impairments from adjacent land use	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	Potential for concentrated flow/impairments to reach restoration site and no treatments are in place	P
3 Hydrology / Runoff / Land Use Change	Rural communities/slow growth or primarily forested (>70%)	Single family homes/suburban development occurring or active agricultural practices occurring, or commercial and/or industrial development starting, forested area 20 - 70%	Rapidly urbanizing/urban or primarily active agricultural practices (> 70%), forested area <20%	F
4 Hydrology / Runoff / Distance to Roads	No roads in or adjacent to site. No proposed major roads in or adjacent to site in 10 year DOT plans	No roads in or adjacent to site. No more than one major road proposed in 10 year DOT plans	Roads located in or adjacent to site boundary and/or major roads proposed in 10 year DOT plans	P
5 Hydrology / Runoff / Flashiness	Non-flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover less than 8%	Semi-flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover 7%- 15%	Flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover greater than 15%	F
6 Geomorphology / Riparian Vegetation	>80% of contributing stream length has >25 ft corridor width	50 - 80% of contributing stream length has >25 ft corridor width	<50% of contributing stream length has >25 ft corridor width	P
7 Geomorphology / Sediment Supply	Low sediment supply. Upstream bank erosion and bed load supply is minimal. There are few bars present in the channel	Moderate sediment supply from upstream bank erosion and bed load supply. There are some point bars and small lateral bars	High sediment supply from upstream bank erosion and bed load supply. There are numerous alternating point bars, transverse bars and/or mid-channel bars	P
8 Physiochemical / Water Quality / 303(d) List	Very clear, or clear but tea-colored; objects visible at depth 3 to 6 ft (less if slightly colored); no oil sheen on surface; no noticeable film on submerged objects or rocks. Clear water along entire reach; diverse aquatic plant community includes low quantities of many species of macrophytes; little algal growth present. Not on 303d list	Considerable cloudiness most of the time; objects visible to depth 0.5 to 1.5 ft; slow sections may appear pea-green; bottom rocks or submerged objects covered with green or olive-green film; or moderate odor of ammonia or rotten eggs. Greenish water along entire reach; overabundance of lush green macrophytes; abundant algal growth, especially during warmer months. On or downstream of 303d list and TMDLWS Mgmt plan addressing deficiencies	Very turbid or muddy appearance most of the time; objects visible at depth< 0.5 ft; slow moving water maybe bright green; other obvious water pollutants; floating algal mats, surface scum, sheen or heavy coat of foam on surface; or strong odor of chemicals, oil, sewage, or other pollutants. Pea-green, gray, or brown water along entire reach; dense stands of macrophytes clogging stream; severe algal blooms creating thick algal mats in stream. On or downstream of 303d list and no TMDLWS mgmt plan to address deficiencies	P
9 Biology / Landscape Connectivity	Channel upstream and downstream of project area has native bed and bank materials and is not impaired	Channel upstream and downstream of project area has native bed and bank materials but is impaired	Channel upstream and downstream of project area is concrete piped, or hardened	P



Reach Function

EXISTING CONDITION ASSESSMENT					
Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Condition
Hydrology	Catchment Hydrology	Curve Number	80	0.29	NF
		Concentrated Flow Points	36	0	NF
	Reach Runoff	Imperviousness - BMP Runoff Parameter	1.23	-	F
		Soil Compaction	1.70	-	FAR
Hydraulics	Floodplain Connectivity	Bank Height Ratio	2.91	>1.5	NF
		Entrenchment Ratio (alluvial state)	2.09	2 - 2.2	FAR
		Entrenchment Ratio (W/D) Width/Depth Ratio	4.94	>1.4	F
Geomorphology	Lateral Stability	Dominant BEHI/NBS	H/L (1.38)	≥ 0.3	FAR
	Riparian Vegetation	Right and Left Riparian Buffer Vegetation Width (ft)	6.89	≥0.29	NF
	Sinuosity	Plan Form (Condined Alluvial)	1.1	<1.5	NF



Goal

- Assess the spatial and temporal variation of water quality under base-flow conditions for Pre- and Post-implementation of BMPs in a receiving stream at a dairy farm.



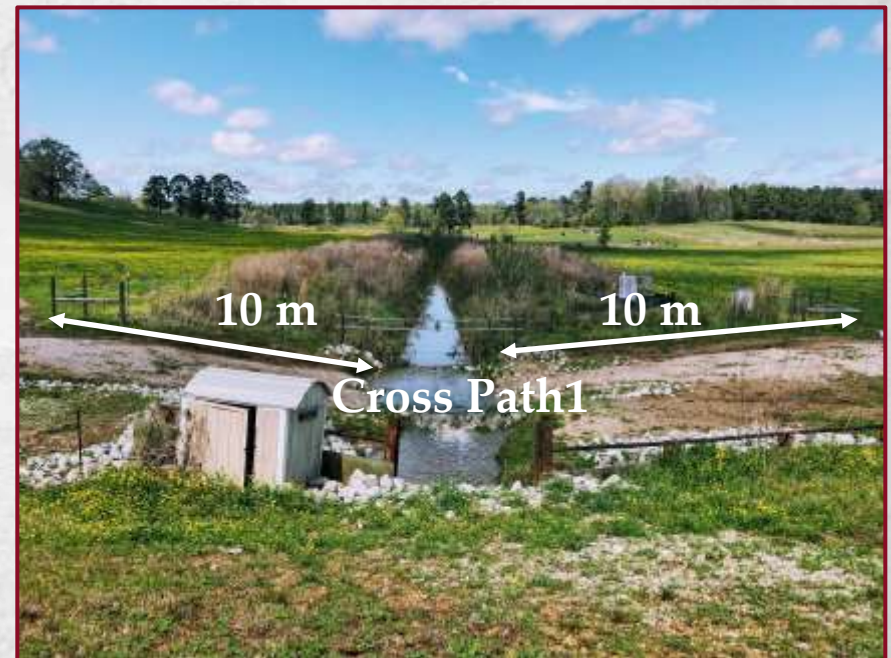
Scenarios of Evaluation

Pre-Implementation (July 2019 to March 2020)



No fenced stream
NRCS 381 - Stream Crossing

Post-Implementation (March 2021 to March 2022)



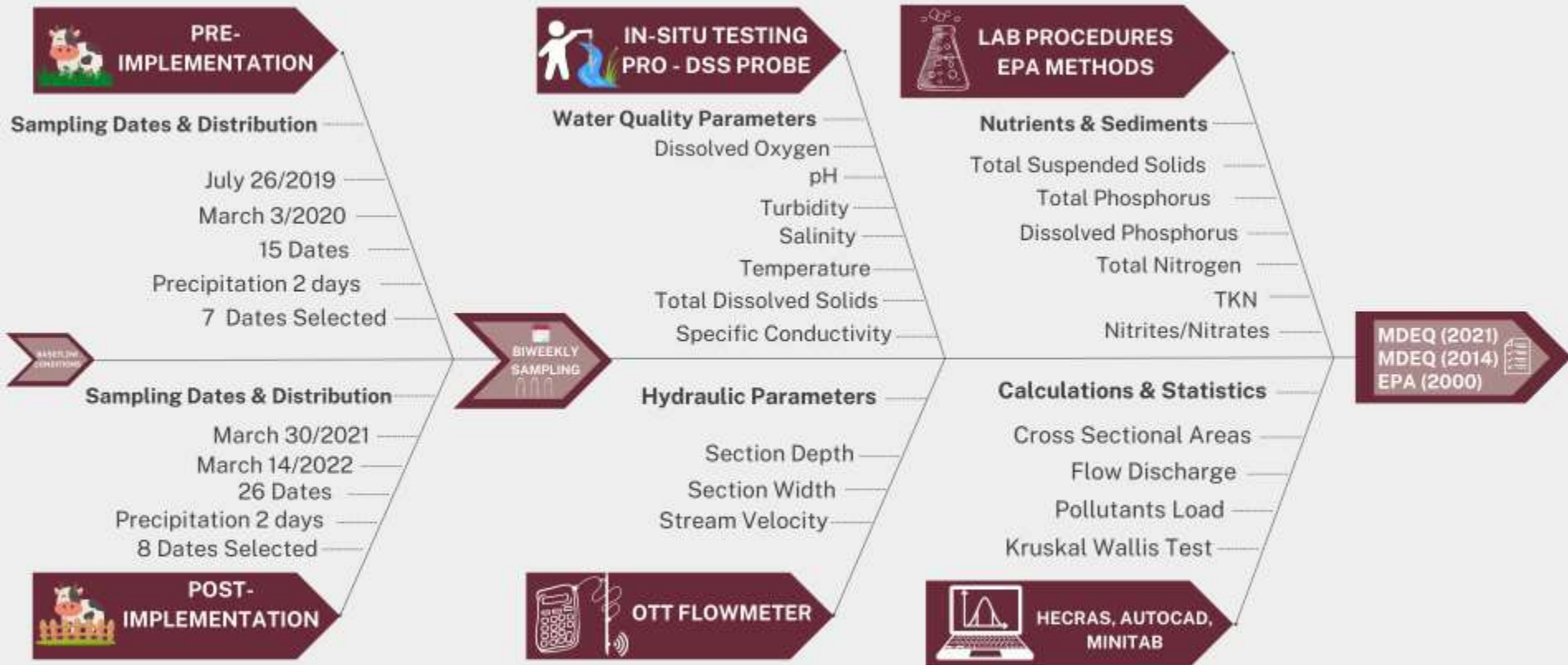
NRCS 381 - Stream Crossing
NRCS 382 - Fence (Animals Fenced out of the creek)
NRCS 391 - Riparian Forest Buffer

Sampling Stations Distribution

- 7 Monitoring Stations Mainstream
- 3 Cross paths: Before RZ 6, RZ 4, RZ 1
 - RZ 9 Upstream
 - RZ 1 Downstream
 - Fence closes upstream of CP1 & RZ1



Methods



Results & Discussions

- Temporal & Spatial Variation

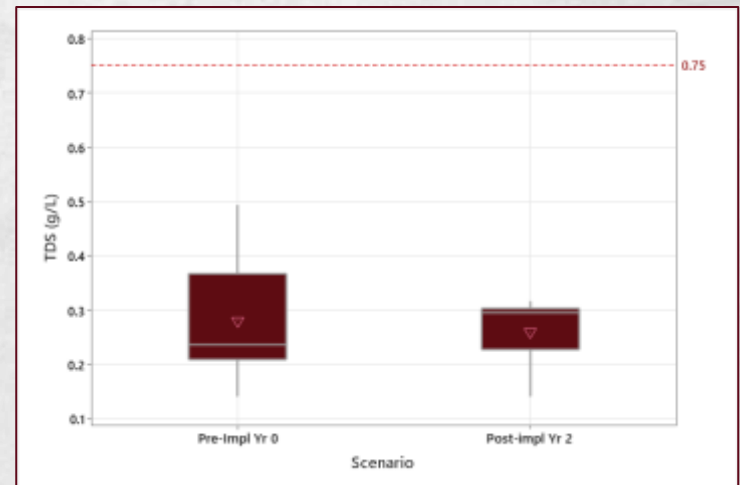
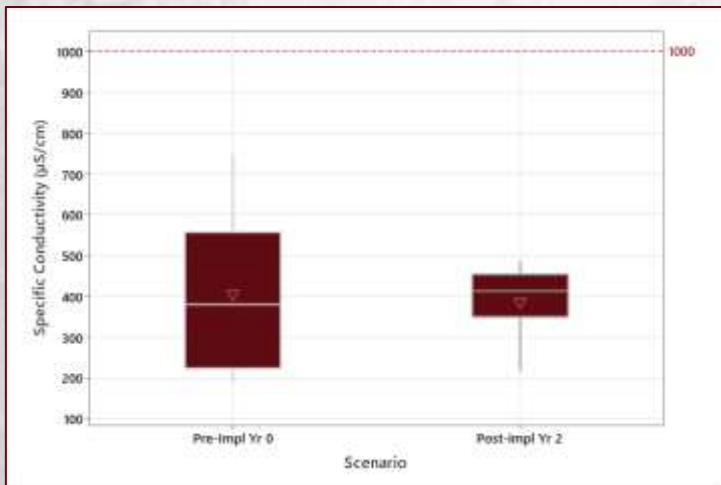
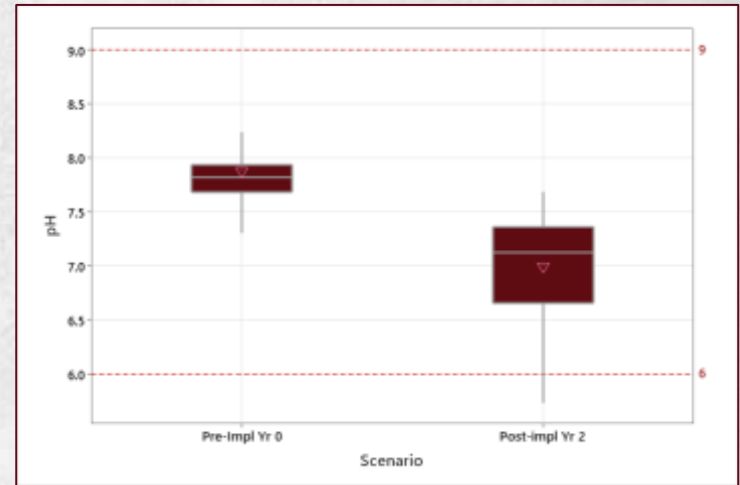
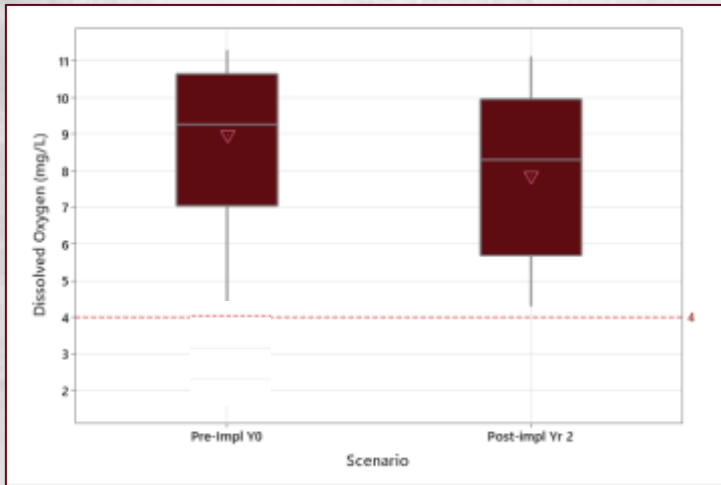
Parameter	Temporal (<i>p-value</i>)	Spatial (<i>p-value</i>)
pH (U of pH)	1.E-03*	1.E-03*
Turbidity (NTU)	1.E-03*	0.0005*
Temperature (°C)	1.E-03*	0.359
Total Suspended Solids (mg/L)	1.E-03*	0.015*
Dissolved Phosphorus (mg/L)	1.E-03*	0.002*
TKN (mg/L)	1.E-03*	1.E-03*
NO ₂ /NO ₃ (mg/L)	0.568	1.E-03*
Total Nitrogen (mg/L)	1.E-03*	1.E-03*

*Significant Differences *p-value*<0.05

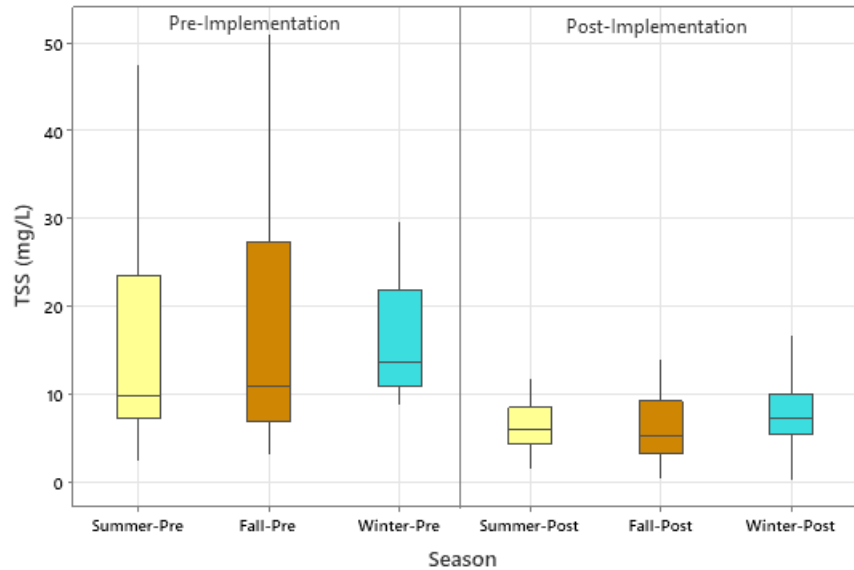


Water Quality Assessment

Water Quality Criteria for Intrastate, Interstate and Coastal Waters
(MDEQ 2021)

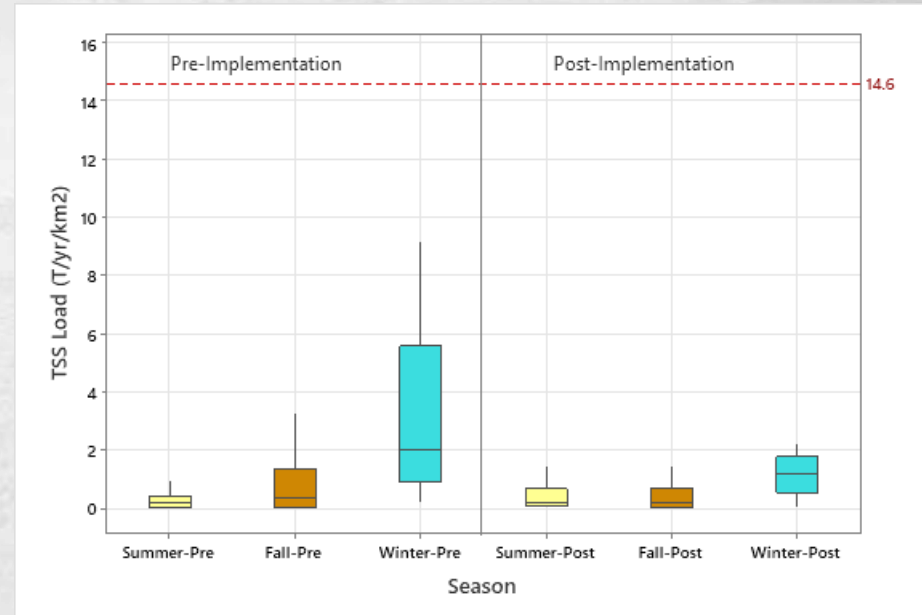


Temporal Variation TSS



Concentration - Total Suspended Solids

--- TSS Load (Sediments TMDL Tibbee Creek)
Reference conditions, 1.5 Yr Recurrence interval, BKF

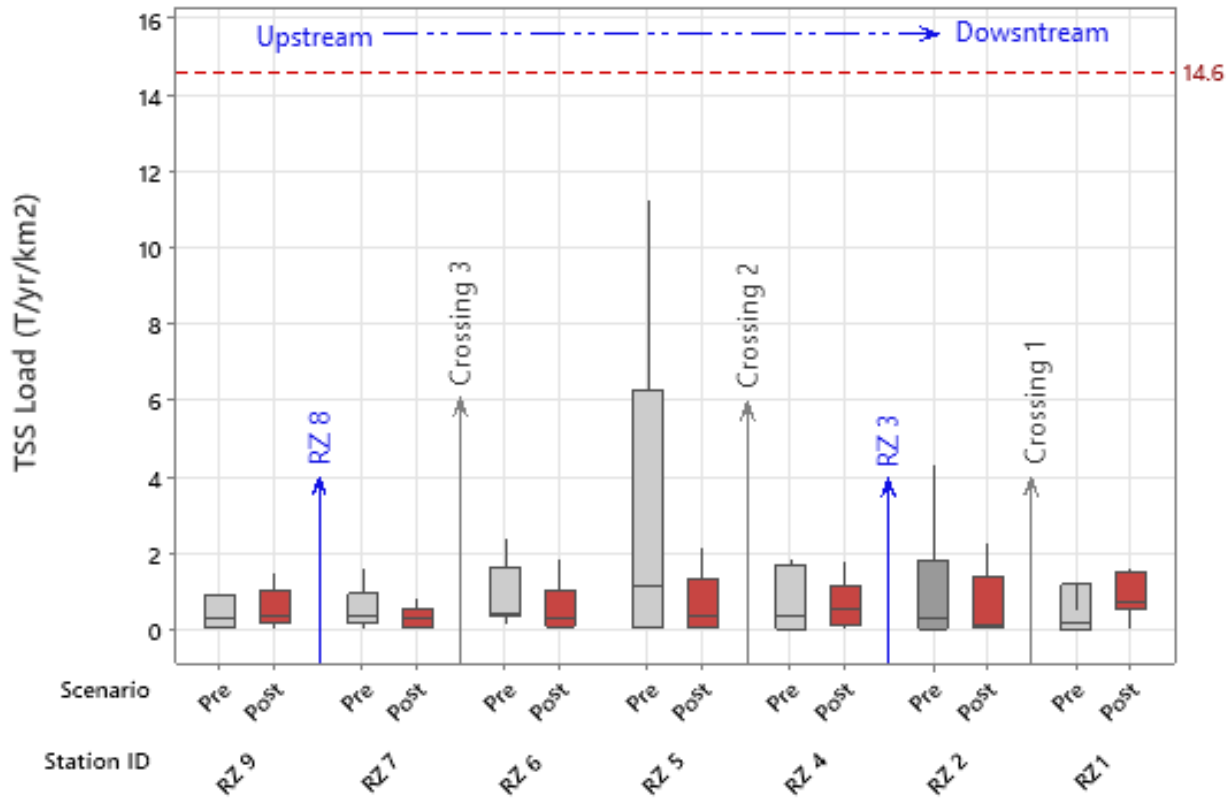


Yr 0= Pre-Implementation

Yr 2= Post-Implementation



Spatial Variation TSS

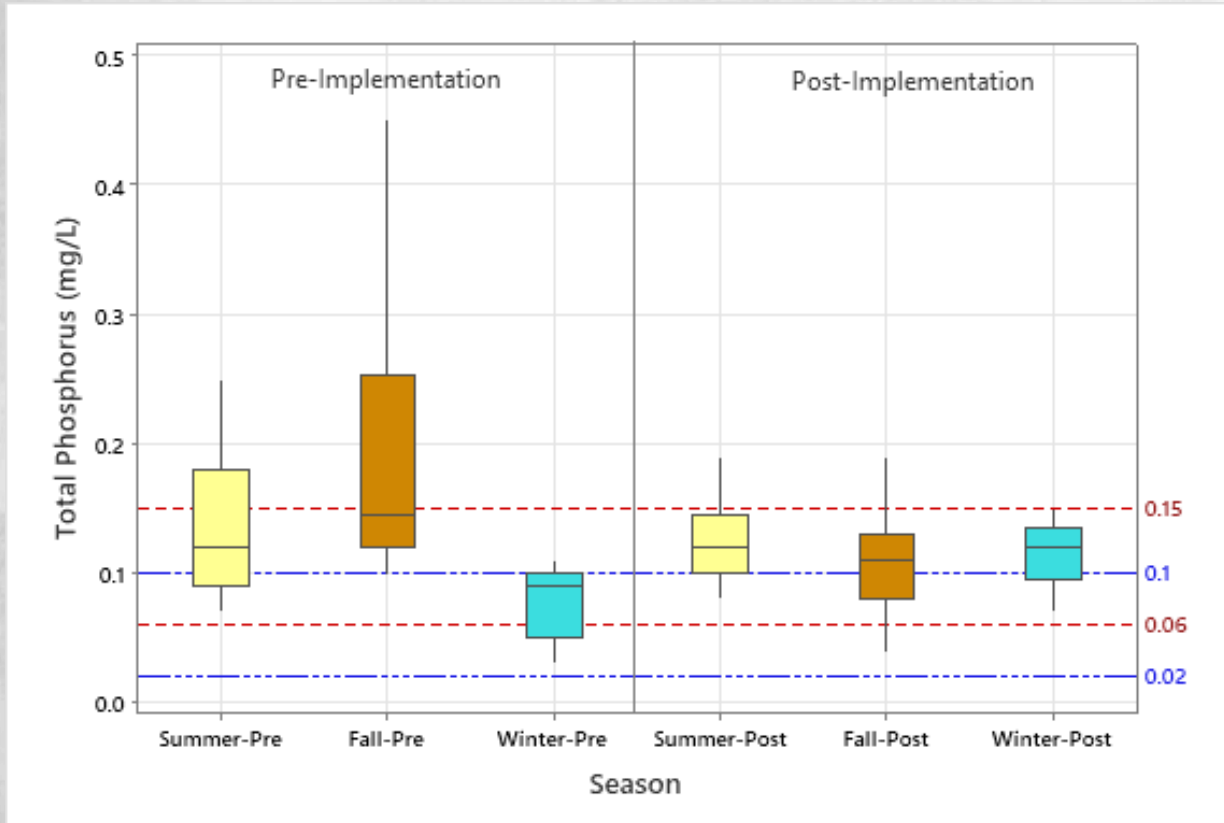


Y0=Pre-Implementation Y2=Post-Implementation

----- TMDL Tibbee Creek - Minimum TMDL(14.6 T/Yr/Km²)



Temporal Variation Total Phosphorus



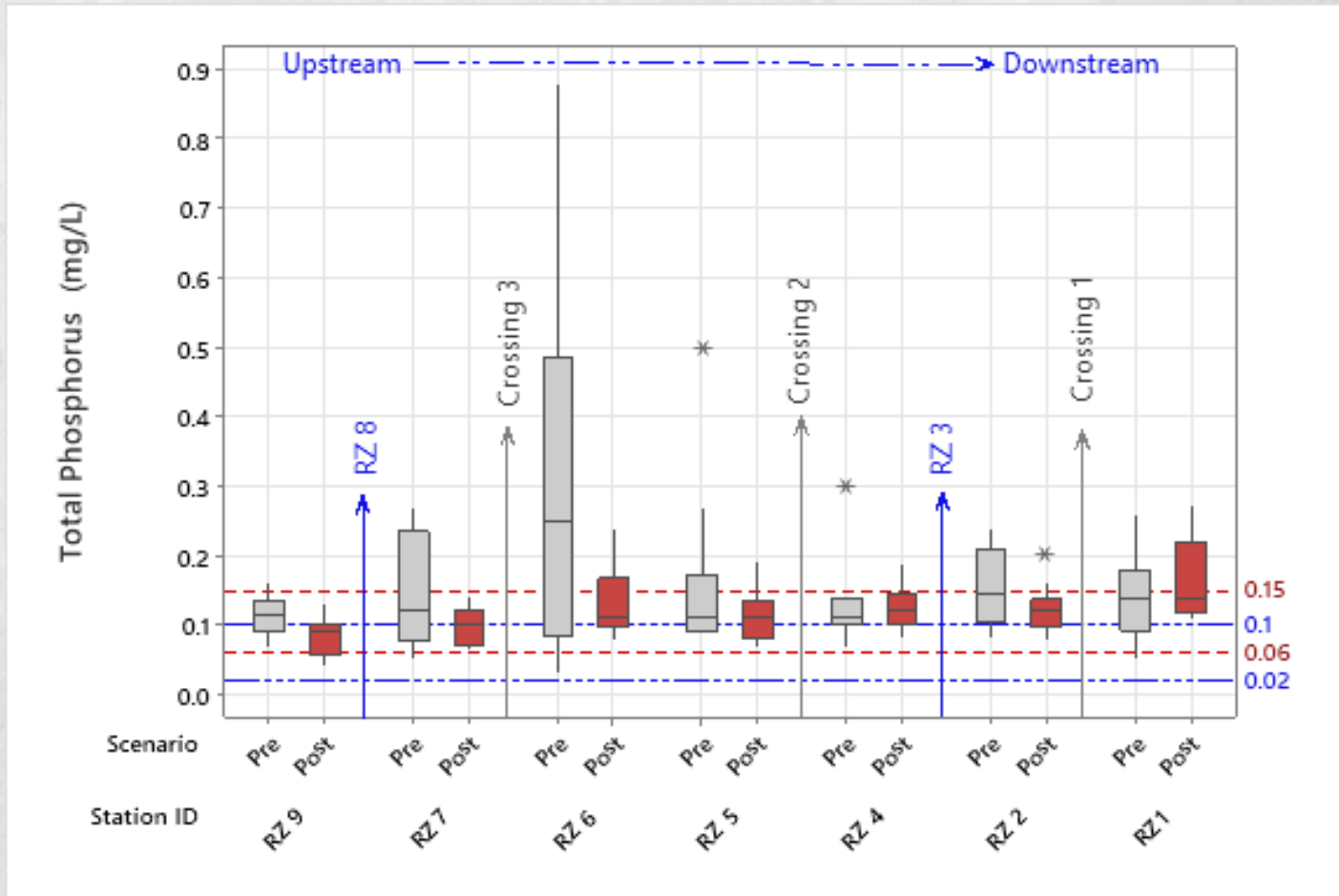
Yr 0=Pre-Implementation Yr 2=Post-Implementation

----- MDEQ 2014

----- EPA 2000



Spatial Variation Total Phosphorus



Y0=Pre-Implementation

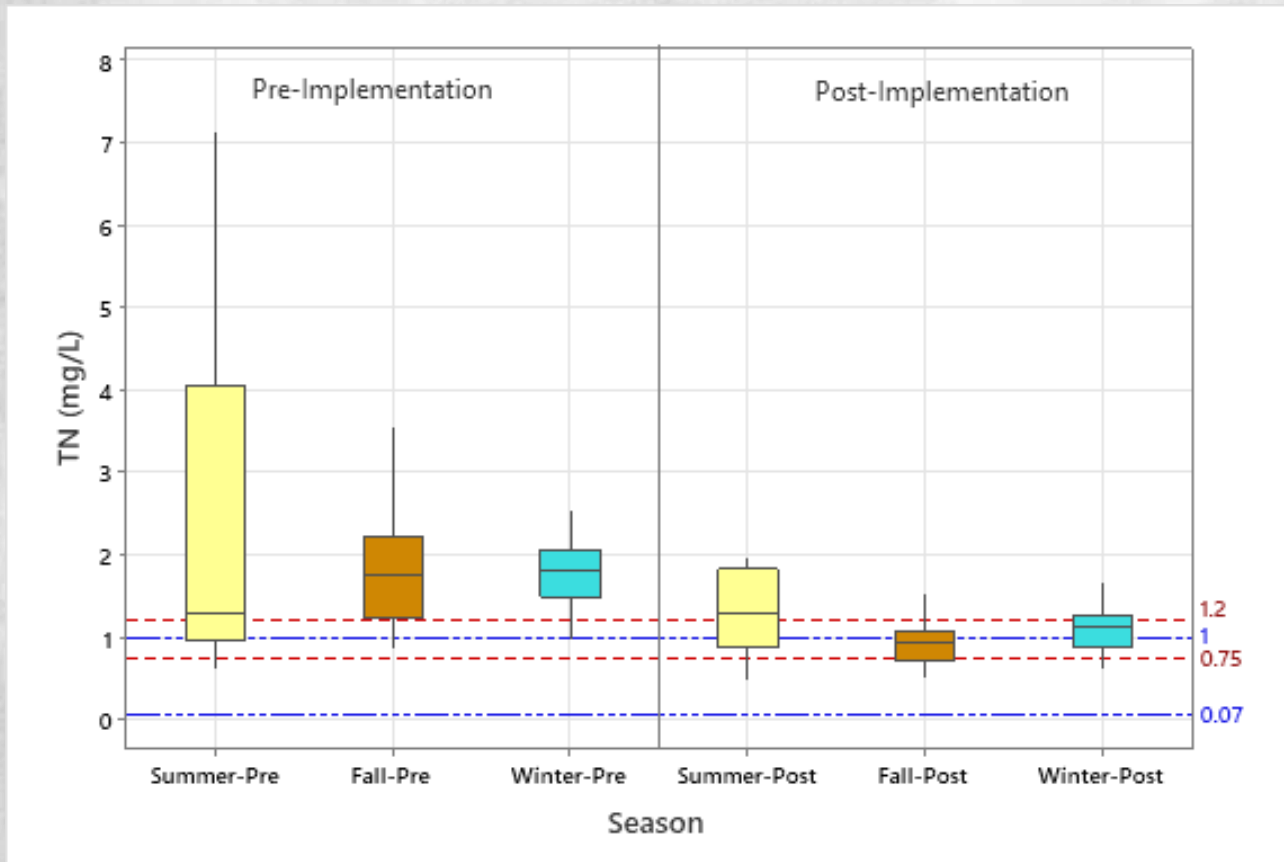
Y2=Post-Implementation

--- MDEQ 2014

--- EPA 2000



Temporal Variation Total Nitrogen



Y0 = Pre-Implementation

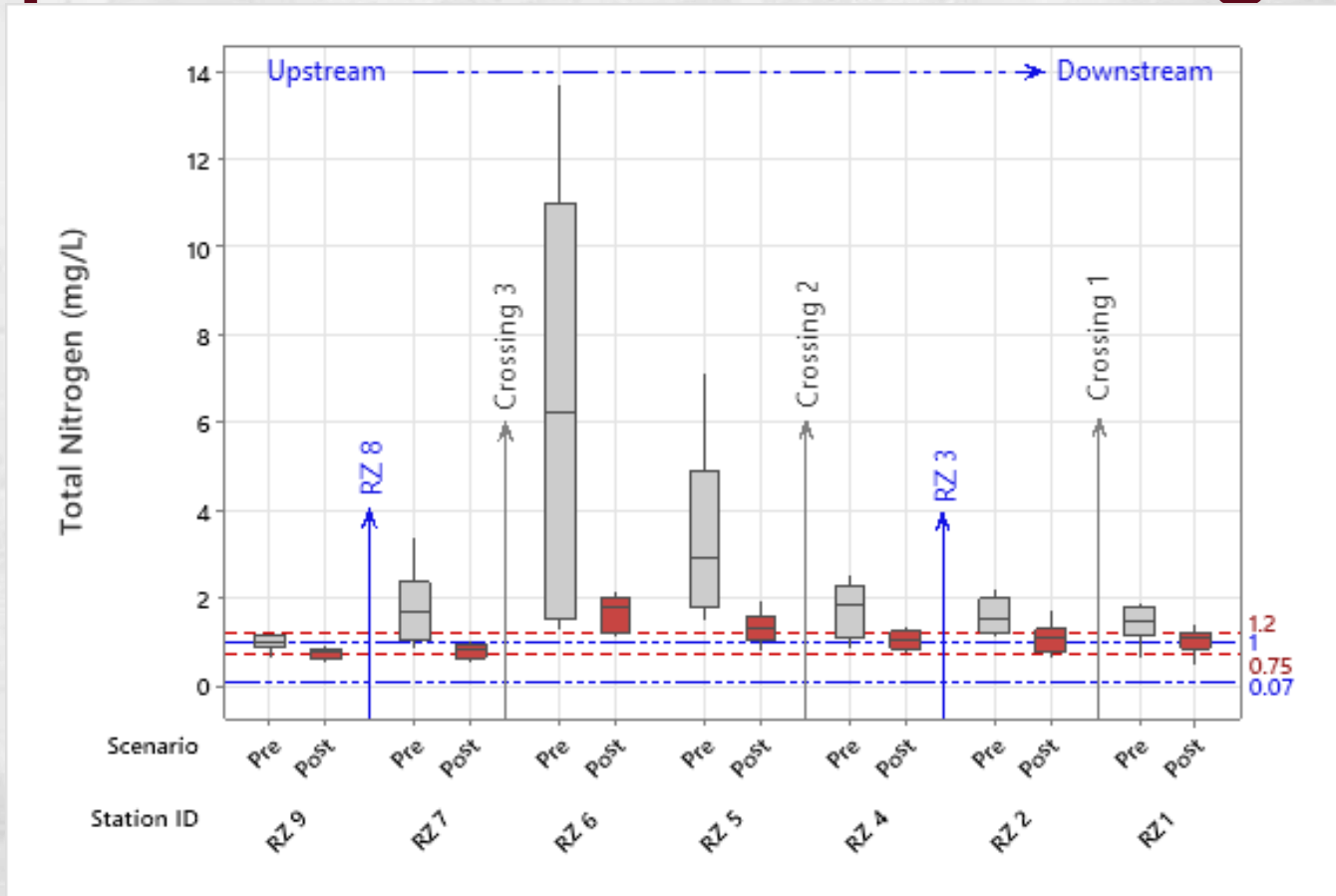
Yr 2 = Post-Implementation

--- MDEQ 2014

--- EPA 2000



Spatial Variation Total Nitrogen



Y0= Pre-Implementation

Y2= Post-Implementation

--- MDEQ 2014

--- EPA 2000



Conclusions

- Livestock production at the J.B. Dairy Farm affects WQ of receiving stream.
- The combination of NRCS practices (crossings, fencing, riparian), have been partially effective to protect and enhance WQ and stream health along the study reach:
 - decreasing concentrations of N, P, TSS
 - regulating DO, T and turbidity which has reduced the presence of algae blooms and allowing the presence of indicators of good WQ
- Despite reductions, TP, TN concentrations along the study reach exceed values above established nutrient criteria for streams in MS.
- Additional BMPs, inside and probably above the Dairy Farm land, are needed to guarantee the accomplishment of the attained use along the study reach.



Future Goals

- Complete assessment of tributaries' contribution to develop a more comprehensive comparison.
- Complete macroinvertebrates and pathogens assessment to determine stream health condition.
- Phosphorus determination in soils and groundwater
- Analyze results to consider additional BMPs that help to reduce pollutant concentrations carried into the creek to meet the designated use.



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QUESTIONS?

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Sources	Sediment (kg)	TN (kg)	TP (kg)
Hay/Pasture	32045,2	218,6	69,1
Stream Bank Erosion	9276	4	2
Cropland	7082,9	65,7	10
Wooded Areas	500,5	33,6	2,1
Low-Density Open Space	283,2	5,9	0,6
Low-Density Mixed	27,0	0,0	0,1

Water Body	Nutrients	WLA	LA	MOS	TMDL	Reduction	%
Dairy Farm Scenario 1	TN (lb/dia)	0	2,67	Implicit	4,88	Not reduction required	
	TP (lbs/day)	0	2,00	Implicit	0,70	1,31	65,21
	Sediments (T/day/km ²)	0	0,80	Implicit	1,30	Not reduction required	
Dairy Farm Scenario 2	TN (lb/dia)	0	3,62	Implicit	4,88	No reduction Required	
	TP (lbs/day)	0	0,68	Implicit	0,70	No reduction Required	
	Sediments (T/day/km ²)	0	0,10	Implicit	1,30	No reduction Required	

Point Sources	0	0	0
Septic Systems	0	0	0
Total Loads (kg/yr)	49239,1	600	111,9
Total Loads (lb/day)	297,46	3,62	0,68
Total Loads (T/day/km²)	0,103		

