19-400 Middle White River Watershed Monitoring Project
Final Report
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1. Executive Summary

The objective of this project was to water quality data in the Middle White River Watershed. The Middle White River is the middle subwatershed of the White River, which is divided into the Upper, Middle and Lower subwatersheds. The Middle White River (HUC #11010004) is listed on the 303d list of impaired waterways for excess turbidity, dissolved oxygen, and total dissolved solids (ADEQ, 2018). Nonpoint source input is listed as the major source of contamination.

Sampling sites were established by Arkansas Natural Resource Division and ASU ERF personnel for four sampling sites within the Middle White River Watershed. These sampling sites were located at the outfall of the subwatershed and near the lower section of the Middle White River Watershed. (Figure 1). Sampling sites included Spring Creek, Greenbriar Creek, Miller Creek and Lower Salado Creek. (Table 1).

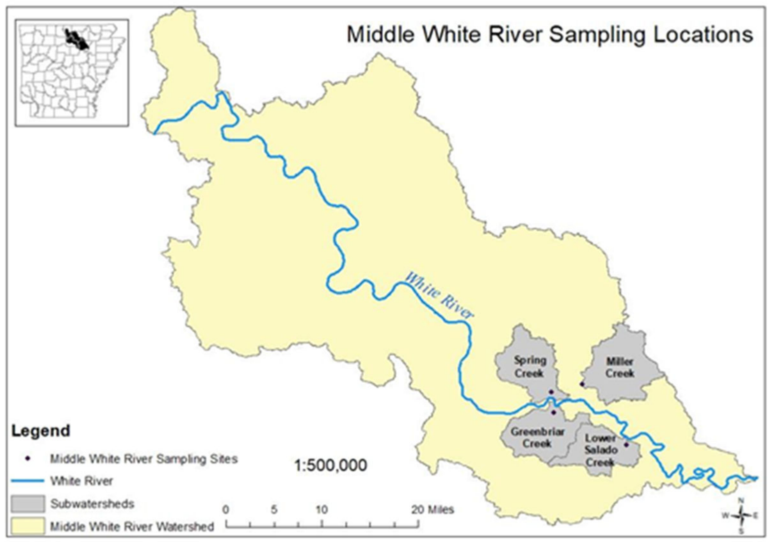


Figure 1. Sampling sites for the Middle White River Watershed.

Subwatershed	Acronym	HUC#	% Pasture	% Forest	% Urban	% Rowcrop
Miller Creek	MIC	110100040504	37%	49%	10%	<1%
Spring Creek	SPC	110100040605	44%	45%	7%	1%
Greenbriar Creek	GBC	110100040604	34%	49%	8%	5%
Lower Salado Creek	LSC	110100040703	41%	44%	10%	2%

Table 1. Sampling sites, acronym, HUC #, % pasture, % forest, % urban, and % rowcrop for each sampled subwatershed in the Middle White River Watershed. Data from www.modelmywatershed.org.

The A-State Ecotoxicology Research Facility (ERF) began measuring weekly water quality parameters on October 2, 2019 and completed three years of water quality sampling on September 30, 2022. These analytes included total suspended solids (TSS), turbidity, dissolved oxygen, pH, conductivity, dissolved nitrates, nitrites, orthophosphates, and total nitrogen (N) and phosphorus (P).

Lower Salado Creek (LSC) followed by Greenbriar Creek (GBC) subwatersheds had greater measured TSS and turbidity than the other two sampled sites, thus they contribute to the sediment load in the main channel of the Middle White River. Sediment movement tended to follow a seasonal pattern in LSC with the greatest values in the fall/winter rainy season. However, GBC did not follow the same seasonal pattern and tended to record high TSS and turbidity values throughout the year. The lowest TSS and turbidity was measured at Spring Creek (SPC) followed closely by Miller Creek (MIC). Neither of the measured parameters from these sites followed a distinct seasonal pattern of increased TSS and turbidity as was noted in LSC.

SPC, the site with the lowest TSS and turbidity, also had the lowest dissolved PO_4 but the greatest three-year mean dissolved NO_3 and NO_2. The low PO_4 value is not surprising as phosphorus tends to attach to sediment particles and often mimics instream sediment concentrations. The source of high nitrogen values (NO_3, NO_2 and Total N) in SPC is of concern as this typically clear-running stream has the greatest percent pasture of all the subwatersheds in this study. All subwatersheds in the study had an increase in dissolved PO_4 and Total P during the last 9 months of sampling which increased the three-year means for each site.

This present project was funded at $403,968 with 44% match from A-State ($189,295) and federal funds from the ANRD ($214,673).

2. Project Chronology

Following confirmation of sampling sites, weekly collections began on October 2, 2019. Samples were collected from each site using a bucket rinsed in the respective site water, followed by filling the acid-washed sample bottles (1-L Nalgene bottles) as recommended by the ERF Standard Operating Procedure (SOP) and based on American Public Health Association methods (APHA, 2005). Filtered samples for nutrient analyses were accomplished on-site with a syringe and 0.45 µm filter filling two 15-mL centrifuge tubes and unfiltered samples were collected in a 50-mL conical tube for Total N and P. All samples were immediately labeled with site name, collection date and time, and initials of person(s) collecting sample; samples were then placed immediately on ice. Upon returning to the ERF, samples were warmed to room temperature and tested for TSS and turbidity while filtered samples for dissolved nutrients and unfiltered 50-mL subsamples for total N and P were frozen until analyzed. TSS was measured in triplicate using the filtration technique and 100-mL of sample and nutrients were measured using the Skalar SANS++ nutrient analyzer. All water quality tests followed the American Public Health Association (APHA 2005) guidelines.

Quality control and quality assurance was accomplished in this project as outlined in the QAPP and the ERF SOP. The ERF is EPA certified (AR#00917) for TSS and nutrients (nitrate, nitrite, orthophosphates) and certification requires bi-annual unknowns by the Arkansas Department of Environmental Quality (ADEQ). Annual re-certification requires reporting acceptable results on EPA unknowns for these parameters.

3. Results & Discussion

The three-year means of TSS and turbidity were greatest at Greenbriar Creek (GBC; Figure 2). Landuse adjacent to the sampling site is a mix of forest (49%) and pastureland (34%; Table 1). The greatest % rowcrop landcover is in this subwatershed at 5% (www.modelmywatershed.org); other sampled subwatersheds have minimal rowcrop landuse (<1-2%). Cropped land was visible immediately adjacent to this sampling site and may have contributed to sediment movement into the waterway. The seasonality of high TSS and turbidity at Lower Salado Creek (LSC) indicates a possible lack of riparian buffer adjacent to the stream. The sampling site was located near an often-used public boat ramp with a cattle pasture adjacent to the ramp. These land disturbances and the frequent use of the boat ramp most likely resulted in this site having consistently high measured TSS and turbidity values.

GBC and LSC had similar three-year average dissolved nutrient values (Figure 3). Spring Creek (SPC) had the lowest dissolved PO_4 values but significantly greater NO_2 and NO_3 values than the other sites. The low PO_4 value in SPC is not surprising as phosphorus tends to attach to sediment particles and often mimics instream sediment concentrations. The unusually high and unknown source of nitrogen in this site is also reflected in the three-year Total N values (Figure 3). It was noted that SPC had significant growth of *Lemnoideae* (duckweed) and *Ceratophyllum demersum* (coontail) covering the creek bed; the presence of these particular aquatic macrophytes indicate sustained high nutrient waters (Lombardo and Cooke, 2003; Ferdoushi et al., 2008). Miller Creek (MIC) had the greatest dissolved PO_4 and Total P values and the 2nd greatest dissolved NO_3 and Total N values (Figure 4). Algal mats were present throughout the sampling period at MIC indicating nutrient-enriched waters. MIC sampling site was located adjacent to a public soccer field which also supports seasonal rodeo activities. Excess nutrients could possibly be leaching from lawn maintenance of this area. It was noted that the riparian vegetation was partially cleared each year near the sites. Riparian vegetation is known to filter sediment and nutrients from runoff (Bouldin et al., 2004), thus perhaps improved maintenance surrounding this site may alleviate much of the nutrients and sediments entering the Miller Creek.

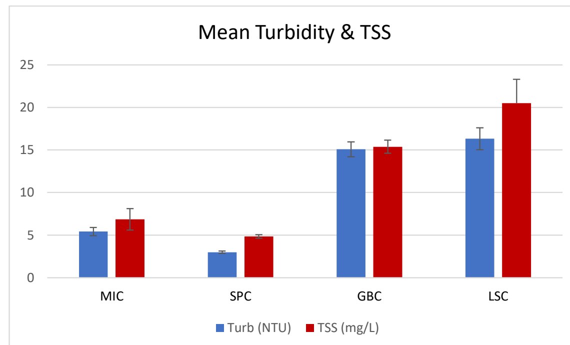


Figure 2. 3-year means of turbidity and TSS from Middle White River subwatershed sites.

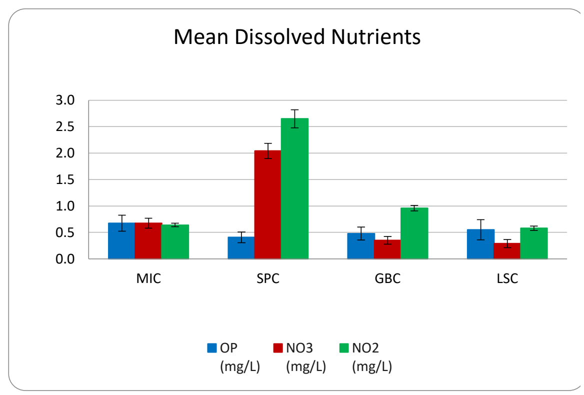


Figure 3. 3-year means of dissolved nutrients from Middle White River subwatershed sites.

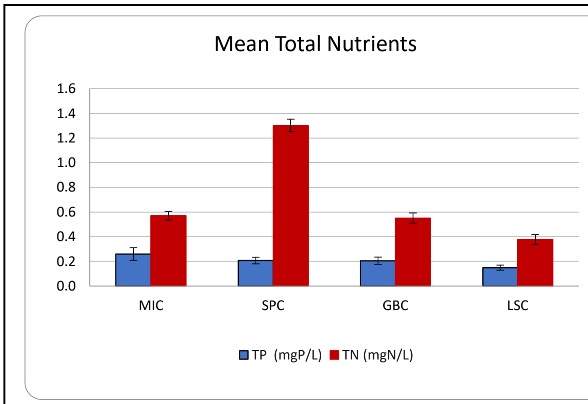


Figure 4. 3-year means of total nutrients from Middle White River subwatershed sites.

Two sites, SPC and GBC, had the greatest NO_2 values with the three-year mean of 2.65mg/L at SPC. High NO_2 levels are often associated with low dissolved oxygen (DO) and an instability in the denitrification process. However, measured DO levels showed sufficiently oxygenated waters in both SPC and GBC. The disposal of poultry body parts was noted on many occasions in SPC however it is unknown that this added to the high values. An unknown upstream source may have resulted in these NO_2 concentrations in SPC and to a lesser extent, GBC. SPC has the greatest % pasture (44%) and the least amount of landuse remaining in forests (45%); GBC has the least amount of pasture (34%) of all the sampled subwatersheds and the greatest cropland (5%). Cattle pasture land has been cited as resulting in increased NO_2 values in surface waters (Singh et al., 2019), thus landuse may be a factor in these subwatershed's increased NO_2 values.

The increased dissolved PO_4 and Total P during the last 6-9 months of sampling significantly increased the three-year means for each site (see appendices).

Numerous dissolved PO_4 values were below detectable limits until the last several months. The same phenomena were reflected in Total P values but was not reflected in TSS and turbidity values as phosphorus often attaches to soil particles and mimics the TSS and turbidity spikes.

4. Lessons Learned

As indicated from the results of the three years of monitoring in the subwatersheds of the Middle White River, sediment movement does not seem to be a great issue in any of the monitored sites. MIC and SPC had consistently low TSS and turbidity values, however consistent spikes at these sites resulted in slightly greater overall values. Riparian maintenance could have resulted in spikes in nutrients and sediment movement at MIC, thus maintenance of the public land adjacent to this site could address some of these issues.

The site with the greatest pasture land, SPC, had consistently high NO_2 values. Upstream areas which may be contributing to these values should be investigated for their contribution as pasture land can directly affect NO_2 values in adjacent streams (Singh et al., 2019) and could potentially contribute to nitrate contamination of underlying shallow aquifers. This subwatershed warrants further investigation to prevent groundwater contamination. GBC also recorded measurable NO_2 values which should be investigated as well.

Nutrient values fluctuated for all sampling sites with notable NO_2 values measured at GBC but more notably at SPC, which had the least TSS and turbidity measurements of any of the other sampled sites. SPC had greater NO_2 values than NO_3 which typically is indicative of a reduced environment. However, DO was within acceptable limits at SPC with the minimum measured value of 5.3mg/L.

5. Technical Transfer

Results from this data are part of Rainee DeRoin’s thesis with a graduation date of May 2023. These data have also been presented at local, regional and national/international meetings including the Arkansas Soil & Water Conservation meeting, Create@AState, MidSouth SETAC, SETAC North America and Young Environmental Scientists (YES) meeting. All data will be published in peer-reviewed publications. Published data are lacking in current literature that report water quality information from this economically-valuable watershed supporting unique fisheries. All data from this three-year project has been entered into WQX and thus is available through that website.

6. EPA Feedback Loop

To provide a complete assessment of this study and the biological surveys performed, data will be available in publications, WQX, and MS thesis at A-State. Data analyses will be available through these publications and a fish community assessment are important as providing and protecting natural habitat also protects our waterways for other aquatic life and recreation.

7. Conclusions / Outcomes

This project monitored changes in water quality parameters over a three-year period. During this time, various flow and weather regimes were sampled. The overall goal is to reduce non-point source contamination and supply these data to identify subwatersheds needing additional monitoring and adding the database of previously unsampled locations. A few of the sampled subwatersheds stand out with notable measured values.

Sediment movement does not seem to be a great issue in any of the monitored sites. MIC and SPC had consistently low TSS and turbidity values, however consistent spikes at these sites resulted in slightly greater overall three-year mean values. A single high TSS value in March 2020 (371 mg/L) was the highest measured at any site during the three-year period.

Nutrient values fluctuated for all sampling sites with notable NO_2 values measured at GBC but more notably at SPC, which had the least TSS and turbidity measurements of any of the other sampled sites. SPC had greater NO_2 values than NO_3 which typically is indicative of a reduced environment. However, DO was within acceptable limits at SPC with a minimum measured value of 5.3mg/L. Upstream landuse which includes 45% pasture is a possible contribution as cattle pasturing had been cited as increasing NO_2 contributions to adjacent waterways. Investigating the source and subsequent reduction of NO_2 in SPC and GBC would protect fisheries in these waterways and the Middle White River.

An increase in phosphorus values during the last 6-9 months of sampling is of concern. Higher dissolved PO_4 values are reflected in the Total P values for each site. Further investigation and monitoring to see if these phenomena continue or was related to weather or some other environmental change in the subwatersheds.

Protecting the Middle White River and its subwatersheds is of environmental and economic concern for the state. The world-class trout fisheries supported in the White River warrant protection. Retaining good water quality through sustainable practices, either pasture, rowcrop or urban, are of utmost importance in a mixed-use watershed such as the Middle White River.

8. References

ADEQ. 2018. Arkansas Department of Environmental Quality. 2018 Integrated water quality monitoring and assessment report. Prepared pursuant to sections 305(b) and 303(d) of the Federal Water Pollution Control Act.

APHA. 2005. Standard methods for the examination of water and wastewater. 21st ed. American Public Health Association, Washington D.C.

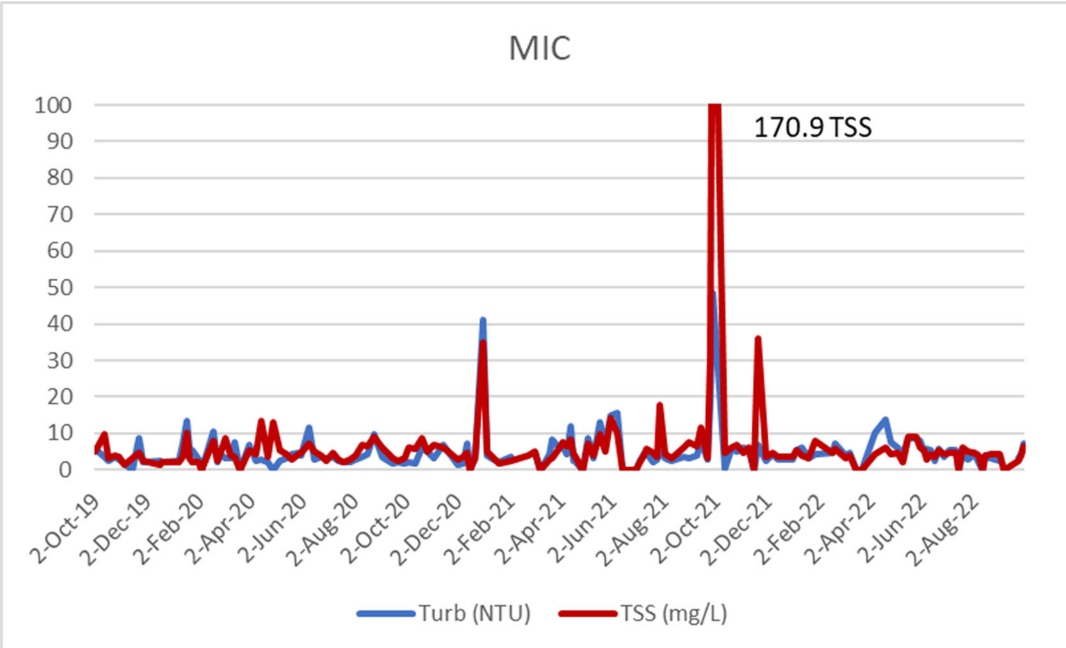
Bouldin, J.L., Farris, J.L., Moore, M.T., Cooper, C.M. 2004. Vegetative and structural characteristics of agricultural drainages in the Mississippi Delta landscape. Environmental Pollution 132: 403-411.

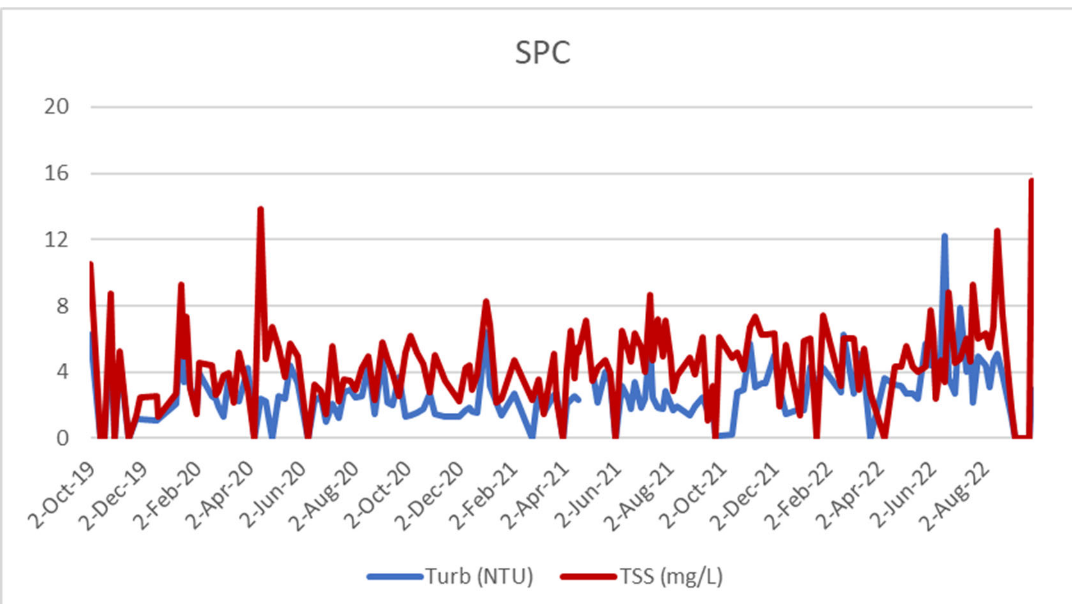
Ferdoushi, Z., Haque, F., Khan, S., & Haque, M. (2008). The effects of two aquatic floating macrophytes (Lemna and Azolla) as biofilters of nitrogen and phosphate in fish ponds. Turkish Journal of Fisheries and Aquatic Sciences, 8(2).

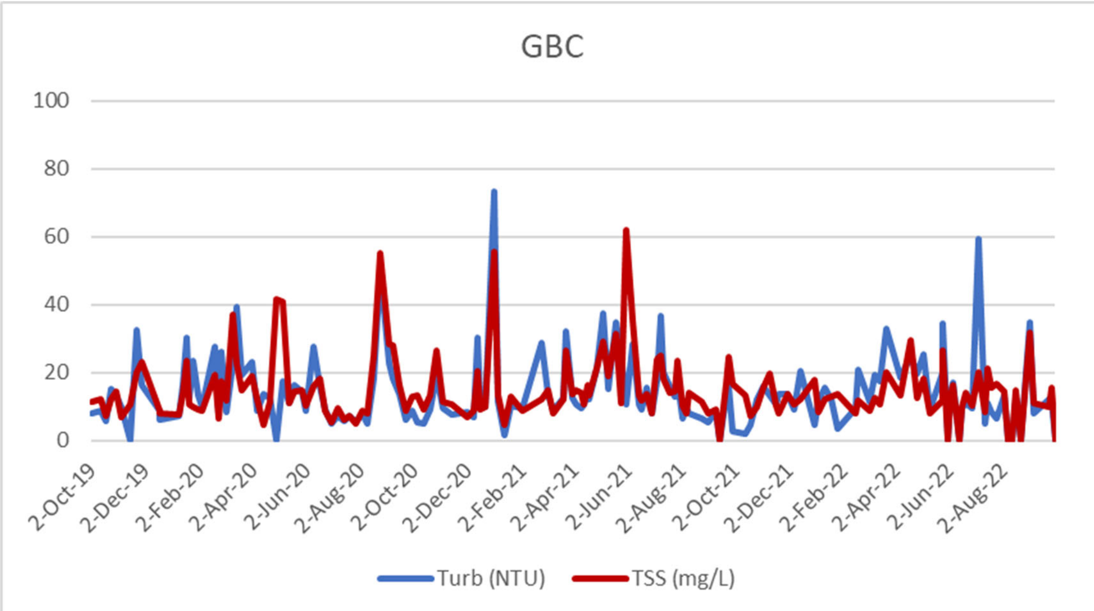
Lombardo, P., & Cooke, G. D. 2003. Ceratophyllum demersum–phosphorus interactions in nutrient enriched aquaria. Hydrobiologia, 497, 79-90.

Singh, S., Coppi, L., Wang, L., Tenuta, M., Holländer, H.M. 2019. Regionalisation of nitrate leaching on pasture land in Southern Manitoba. Agricultural Water Management (222) 286-300.

Appendix 1.
Turbidity and TSS figures for subwatersheds in the Middle White River. Note figures do not reflect the same scale.






GBC
100
80
60
40
20
0
2-Oct-19
2-Dec-19
2-Feb-20
2-Apr-20
2-Jun-20
2-Aug-20
2-Oct-20
2-Dec-20
2-Feb-21
2-Apr-21
2-Jun-21
2-Aug-21
2-Oct-21
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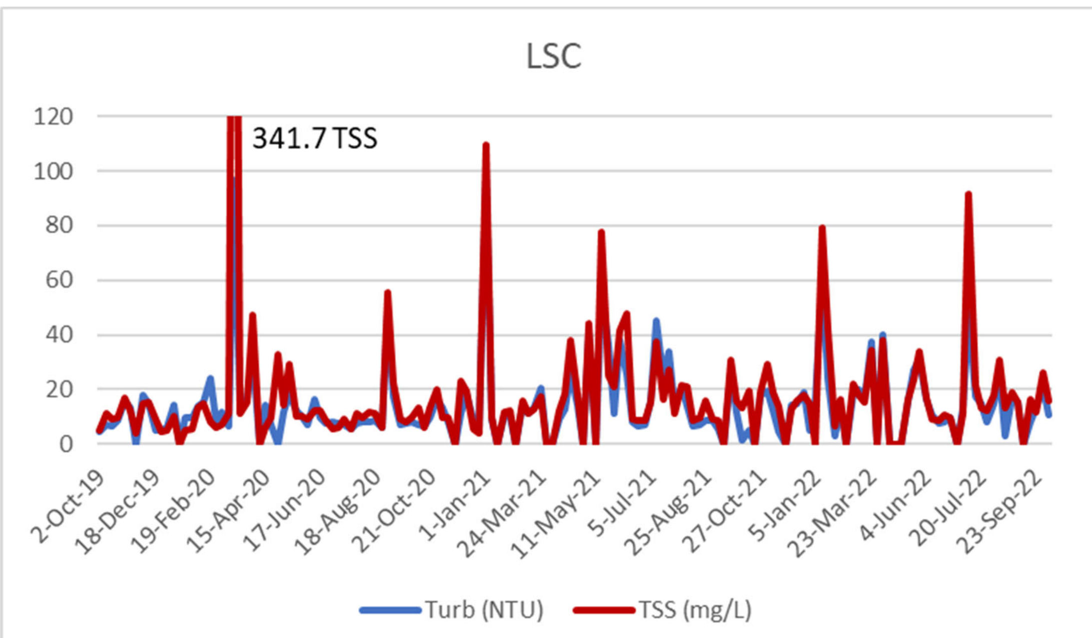
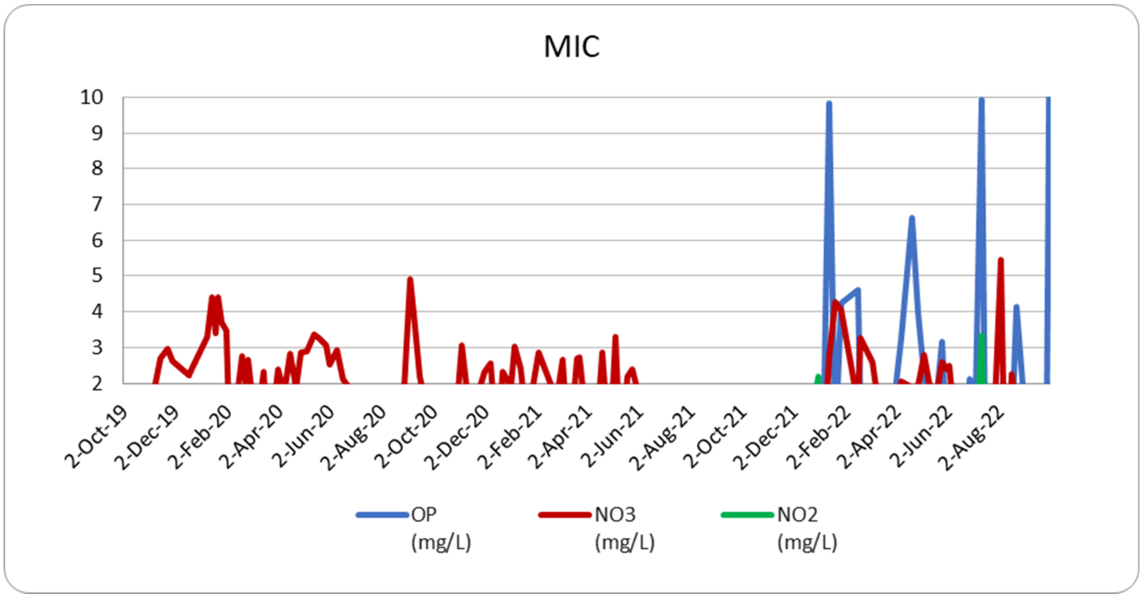
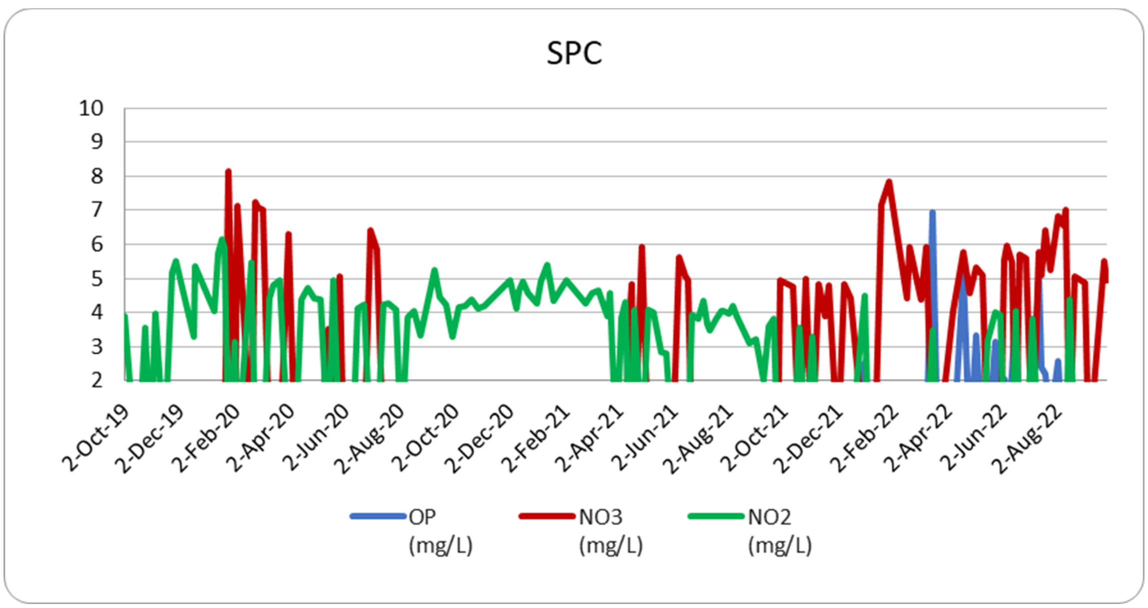
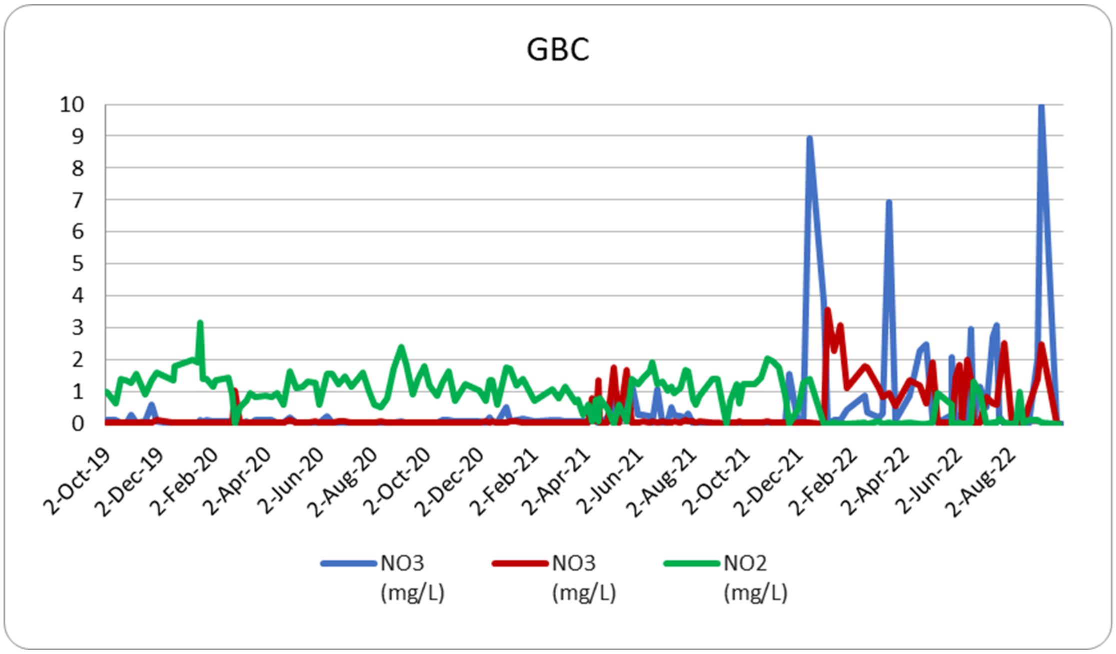
2-Feb-22
2-Apr-22
2-Jun-22
2-Aug-22
Turb (NTU)
TSS (mg/L)

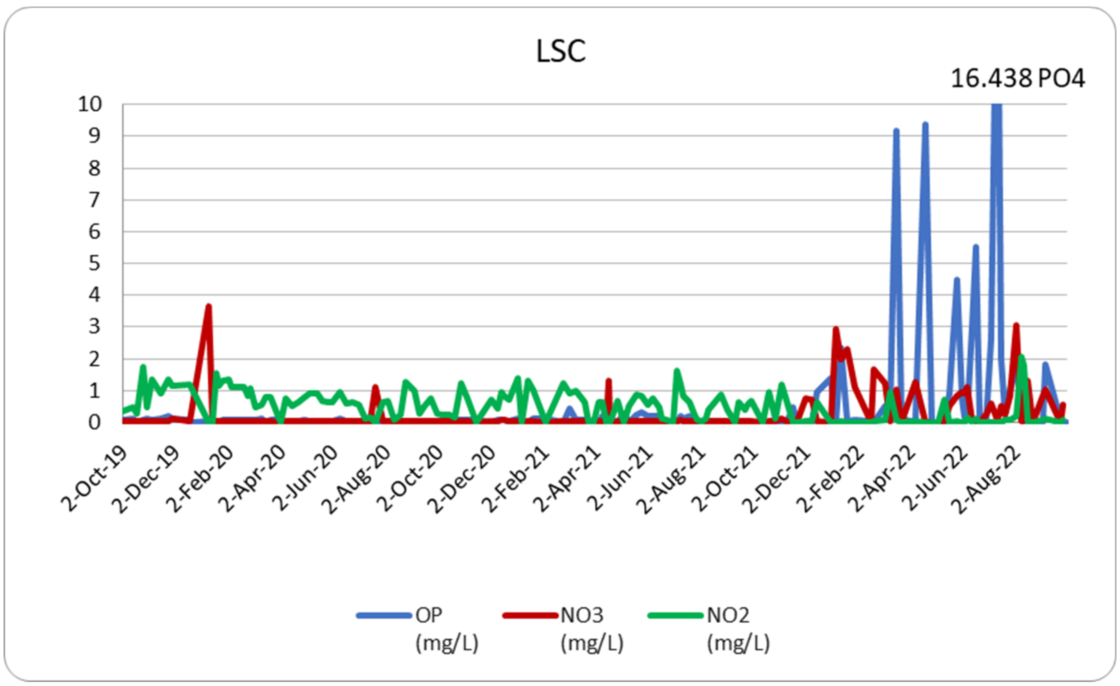

LSC
341.7 TSS
120
100
80
60
40
20
0
2-Oct-19
18-Dec-19
19-Feb-20
15-Apr-20
17-Jun-20
18-Aug-20
21-Oct-20
1-Jan-21
24-Mar-21
11-May-21
5-Jul-21
25-Aug-21
27-Oct-21
5-Jan-22
23-Mar-22
4-Jun-22
20-Jul-22
23-Sep-22
Turb (NTU)
TSS (mg/L)

Appendix 2.
Dissolved nutrient figures for subwatersheds in the Middle White River. All figures reflect the same scale for easy comparison.

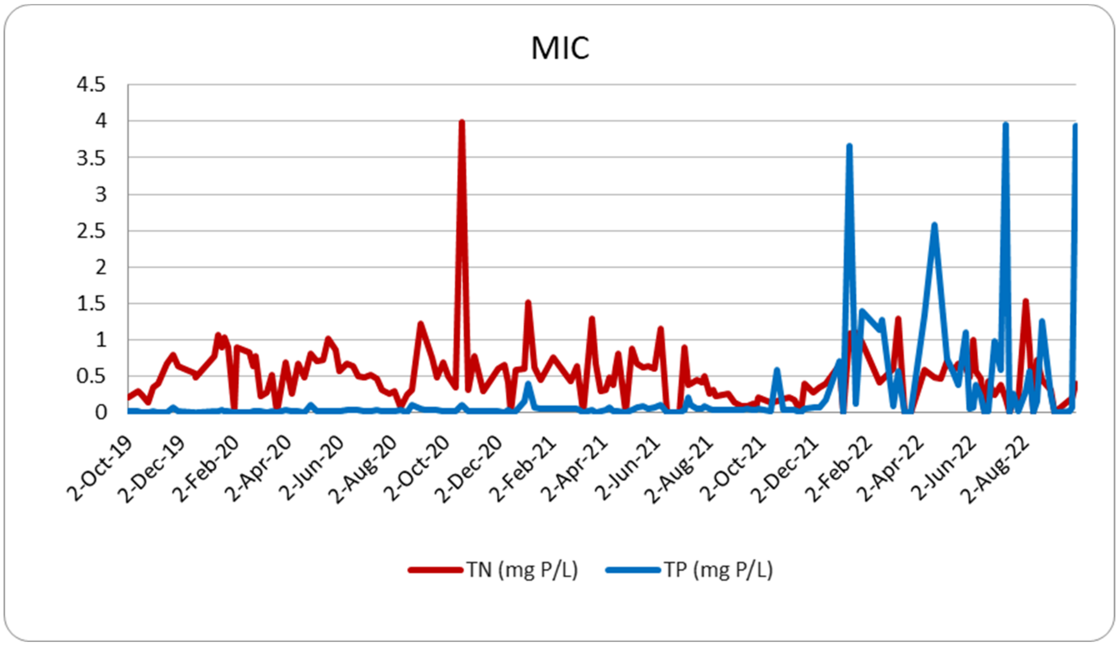


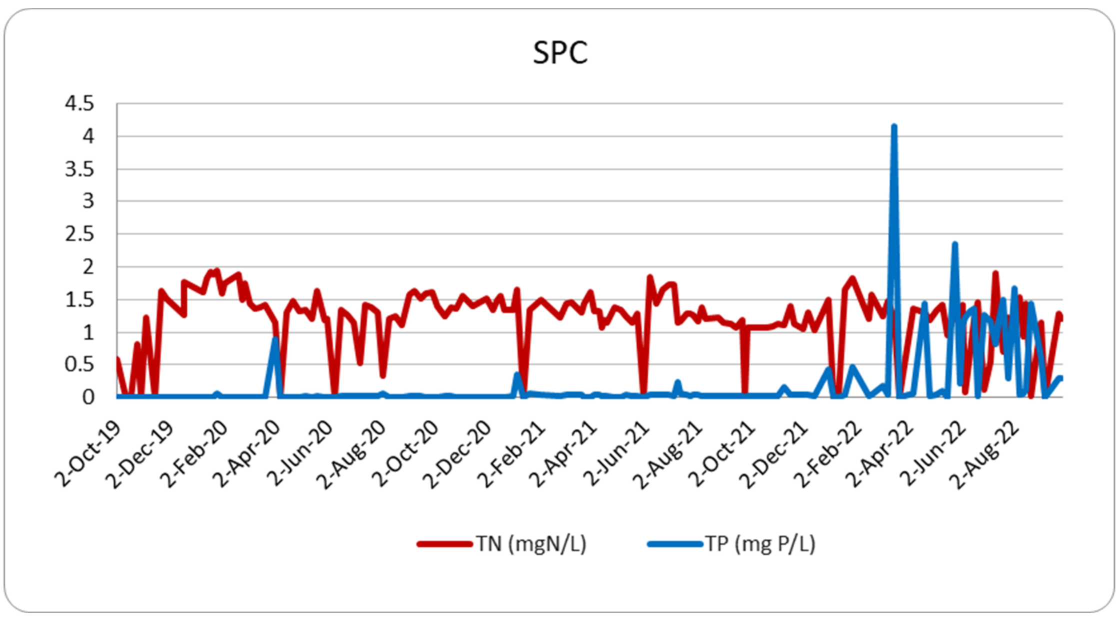


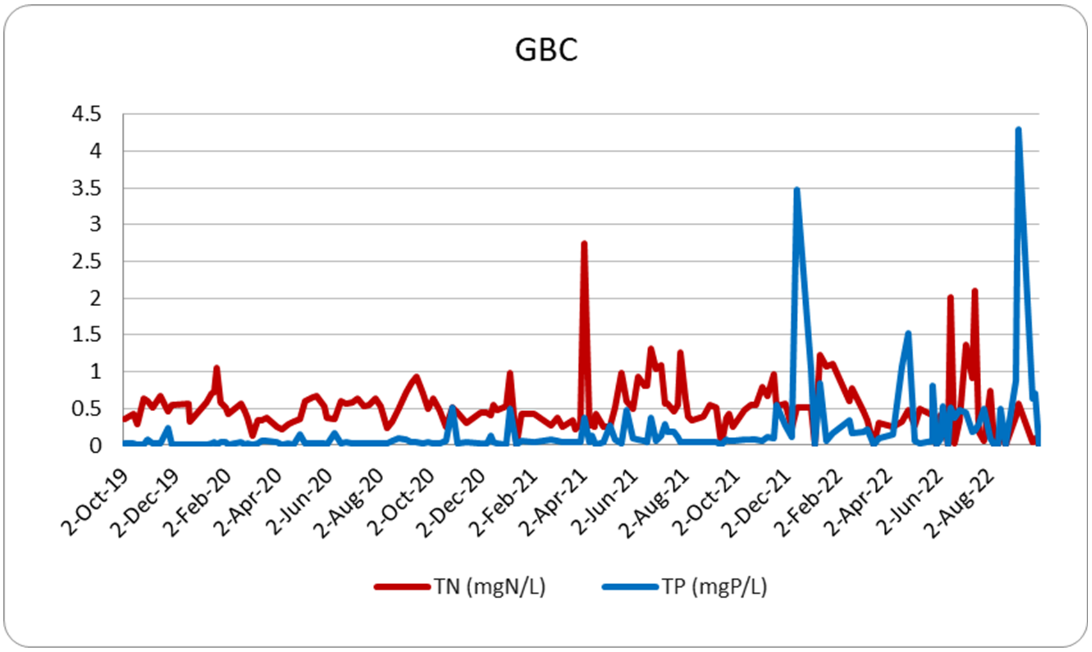

GBC
10
9
8
7
6
5
4
3
2
1
0
2-Oct-19
2-Dec-19
2-Feb-20
2-Apr-20
2-Jun-20
2-Aug-20
2-Oct-20
2-Dec-20
2-Feb-21
2-Apr-21
2-Jun-21
2-Aug-21
2-Oct-21
2-Dec-21
2-Feb-22
2-Apr-22
2-Jun-22
2-Aug-22
NO3 (mg/L)
NO3 (mg/L)
NO2 (mg/L)

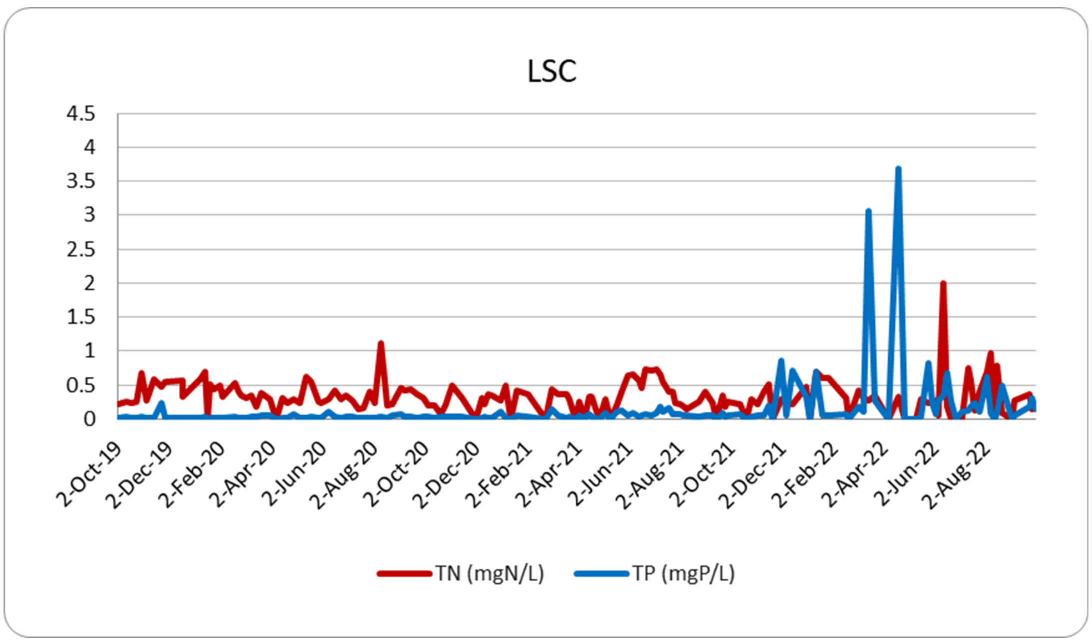

LSC
16.438 PO4
10
9
8
7
6
5
4
3
2
1
0
2-Oct-19
2-Dec-19
2-Feb-20
2-Apr-20
2-Jun-20
2-Aug-20
2-Oct-20
2-Dec-20
2-Feb-21
2-Apr-21
2-Jun-21
2-Aug-21
2-Oct-21
2-Dec-21
2-Feb-22
2-Apr-22
2-Jun-22
2-Aug-22
OP (mg/L)
NO3 (mg/L)
NO2 (mg/L)

Appendix 3.
Total N and P figures for subwatersheds in the Middle White River. All figures reflect the same scale for easy comparison.









Appendix 4.
Excel spread sheet of all measured water quality parameters.