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Surface Water Quality Monitoring Report Alachua County 2025

Prepared for
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GLOSSARY OF TERMS

ACEPD	Alachua County Environmental Protection Department
FDEP	Florida Department of Environmental Protection
LMM	Linear Mixed Model
MDL	Minimum Detection Limit
WIN	Watershed Information Network

EXECUTIVE SUMMARY

The Alachua County Environmental Protection Department (ACEPD) has conducted long-term water quality monitoring across groundwater and surface water systems to assess environmental and public health conditions. This report evaluates surface water data collected between 1998 and 2025, using statistical trend analysis and descriptive metrics to identify emerging patterns and inform future monitoring efforts.

A comprehensive dataset from multiple agencies was standardized, quality-checked, and analyzed using non-parametric Mann-Kendall Seasonal Trend Tests. Additional data processing included unit normalization, outlier review, and supplementation of missing total nitrogen values. Trend results were supported with time-series visualizations and contextual rainfall data.

Key findings of this analysis include:

Declines in Dissolved Oxygen (DO):
Multiple stations, including Blues Creek, Boulware Spring, Tumblin Creek, and Sweetwater Branch, show statistically significant declines in dissolved oxygen. While increasing water temperatures explain some trends (e.g., Boulware Spring), others suggest nutrient enrichment and potential eutrophication as contributing factors. See Appendix C for a summary table of significant trends and trend direction.

Nutrient Enrichment Trends:
Several sites exhibit increasing nutrient concentrations, particularly total phosphorus and ammonia. Blues Creek and Boulware Spring show notable increases, indicating potential impacts from sources such as fertilizer runoff, wastewater, or septic systems. In some cases, ammonia appears to be the primary driver of rising total nitrogen (Boulware Spring).

Indicators of Improved Water Quality in Select Areas:
Decreasing trends in chloride, total dissolved solids (TDS), and specific conductance in creeks such as Hogtown Creek and Cellon Creek suggests that improvements in stormwater management have reduced ionic pollutant inputs.

1.0 INTRODUCTION

ACEPD has been monitoring water quality throughout Alachua County since the 1970's. The current monitoring program includes sampling of groundwater (21 sites bi-annually), surface water (31 creeks and lake sites quarterly), and wastewater plants (15 facilities sampled quarterly).

Data from sampling activities are shared with various agencies including the Florida Department of Environmental Protection (FDEP). Data is available through the state Watershed Information Network, (WIN).

Water quality monitoring is an important aspect of public health. There are many human activities that impact surface water and can affect health directly or indirectly. In addition to monitoring public health concerns there is also elevated concern around the ecological impacts of increasing nutrients and other contamination in urban surface water. These impacts can have surprisingly far-reaching effects. Elevated nutrient concentrations are one of the main threats to water resources needed for future generations. In general, potential sources of surface water contamination include septic systems, underground tank leakage, sanitary sewer overflows, fertilizer, road runoff, and improper chemical disposal.

While monitoring data for coliform or other biological hazards is reviewed for public health concerns more regularly, other types of water quality data take at minimum 5 years of consistent records to evaluate trends and identify concerns. Monitoring Alachua County's surface water quality has been ongoing for over 20 years. This report will aim to analyze the emerging data trends and make recommendations for future monitoring. The period of record to be analyzed starts with data from 1998 and extends to 2025.

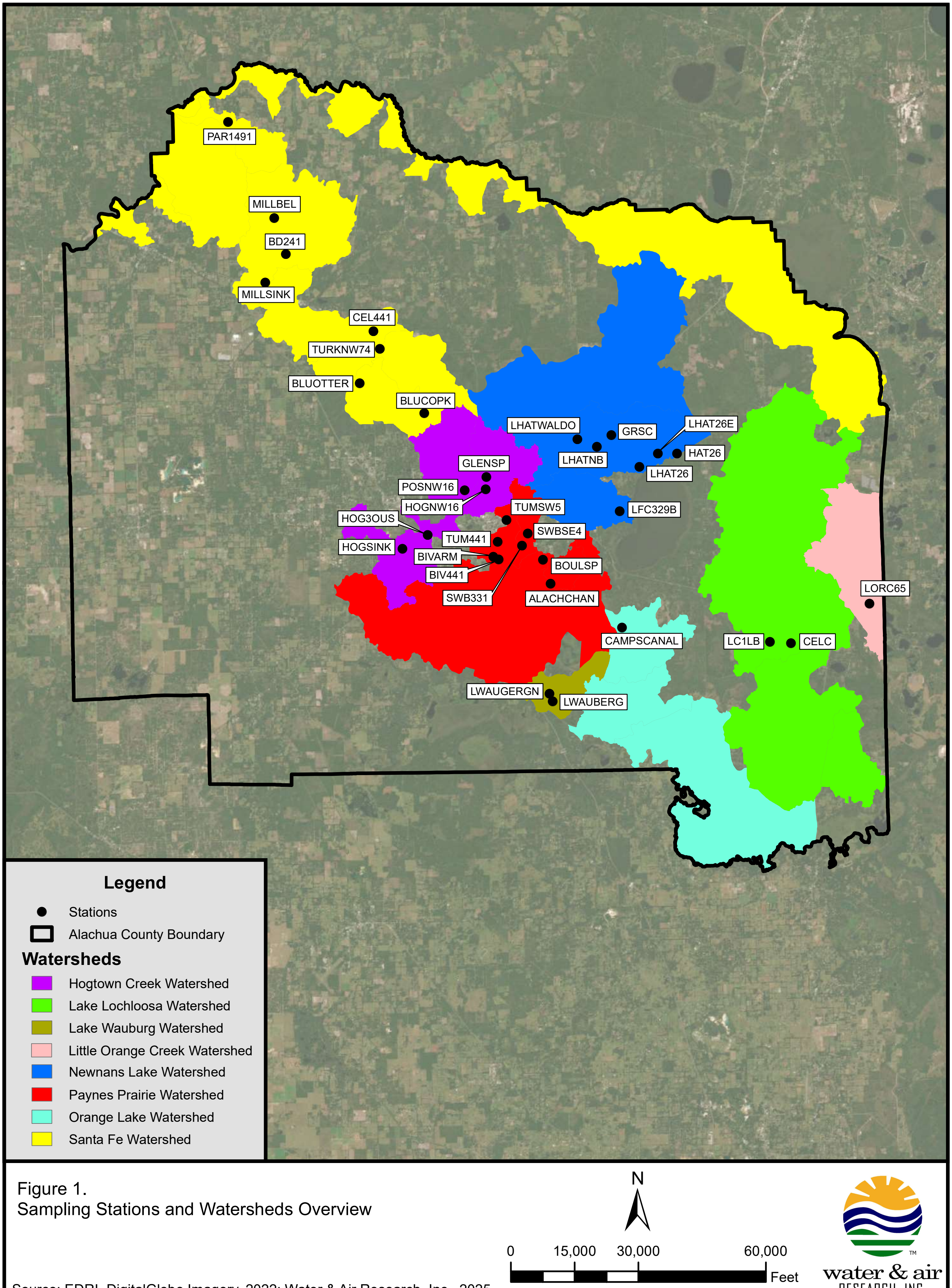

Figure 1.
Sampling Stations and Watersheds Overview

Source: EDRI, DigitalGlobe Imagery, 2022; Water & Air Research, Inc., 2025.

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Station Information

Station ID	Station Waterbody	Watershed	First Data Point	Latest Data Point	Number of Sampling Events
ALACHCHAN	Alachua Sink	Paynes Prairie	1/15/2004	3/4/2025	64
BD241	Mill Creek	Santa Fe	2/13/2023	2/18/2025	4
BIV441	Bivens Arm	Paynes Prairie	6/24/1998	2/24/2025	44
BIVARM	Bivens Arm	Paynes Prairie	2/12/2004	11/22/2016	23
BLUCOPK	Blues Creek	Santa Fe	2/12/1998	3/12/2025	72
BLUOTTER	Blues Creek	Santa Fe	2/12/1998	3/12/2025	97
BOULSP	Boulware Spring	Paynes Prairie	9/12/2000	3/4/2025	63
CAMPSCANAL	Camps Canal	Orange Lake	7/15/2008	2/20/2025	33
CEL441	Cellon Creek	Santa Fe	4/9/2002	3/5/2025	89
CELC	Lochloosa Creek	Lake Lochloosa	10/6/2003	2/25/2025	76
GLENSP	Glen Springs	Hogtown Creek	6/7/2005	2/20/2025	56
GRSC	Gum Root Swamp Creek (Hatchet Creek Tributary)	Newnans Lake	3/3/2009	2/26/2025	43
HAT26	Hatchet Creek	Newnans Lake	9/14/2016	12/17/2024	43
HOG30US	Hogtown Creek	Hogtown Creek	5/9/2005	2/26/2025	72
HOGNW16	Hogtown Creek	Hogtown Creek	2/11/1998	2/26/2025	115
HOGSINK	Hogtown Creek	Hogtown Creek	10/13/2003	3/5/2025	88
LC1LB	Lochloosa Creek	Lake Lochloosa	10/6/2003	2/20/2025	115
LFC329B	Lake Forest Creek	Newnans Lake	3/9/1998	2/20/2025	187
LHAT26	Little Hatchet Creek	Newnans Lake	3/14/2019	2/26/2025	25
LHAT26E	Little Hatchet Creek East Branch	Newnans Lake	11/13/2018	2/26/2025	25
LHATNB	Little Hatchet Creek North Branch	Newnans Lake	9/14/2005	2/26/2025	37
LHATWALDO	Little Hatchet Creek	Newnans Lake	10/14/2003	2/26/2025	45
LORC65	Little Orange Creek	Little Orange Creek	11/14/2018	2/20/2025	25
LWAUBERG	Wauberg Lake	Lake Wauburg	8/24/2020	5/1/2023	7
LWAUBERGN	Wauberg Lake	Lake Wauburg	3/21/2016	2/24/2025	29
MILLBEL	Mill Creek	Santa Fe	2/12/1998	2/18/2025	96
MILLSINK	Mill Creek	Santa Fe	6/8/1998	3/12/2025	35
PAR1491	Pareners Branch	Santa Fe	11/3/1998	2/18/2025	106
POSNW16	Possum Creek	Hogtown Creek	2/11/1998	2/26/2025	120
SWB331	Sweetwater Branch	Paynes Prairie	2/10/1998	3/4/2025	107
SWBSE4	Sweetwater Branch	Paynes Prairie	5/12/2005	3/4/2025	115
TUM441	Tumblin Creek	Paynes Prairie	6/24/1998	3/4/2025	124
TUMSW5	Tumblin Creek	Paynes Prairie	2/10/1998	3/4/2025	93
TURKNW74	Turkey Creek	Santa Fe	8/21/2014	3/5/2025	77

2.0 METHODS

A large dataset was pulled from two databases with the intent to analyze trends over time (Mann-Kendall Seasonal Trend Test) and pull basic statistics on the data (mean, max, etc.).

2.1 PREPARING THE DATA

The data was pulled from both the ACEPD and St. John's Water Management District databases and reduced into more concise columns. The data from both databases were then combined under the appropriate column headers. Water & Air received this data and began preparing it for analysis. Parameters that appeared to be identical but had discrepancies in the naming were combined (ie: "Ammonia (N)" and "Nitrogen, Ammonia as N" were combined). A record was kept of all entries that were altered from the original database download.

Conversion factors were used to convert all entries for a parameter to a common unit wherever required (i.e., mg/L instead of μg/L).

Several data entries had "T" qualifiers meaning that they tested below the detection limit for the laboratory method. These entries were altered from "0" to the database's reported minimum detection limit (MDL). This was done to avoid errors typically found when performing trend analysis on a dataset with many "zero" values. Entries that were altered were highlighted and kept in a separate document for reference, if required.

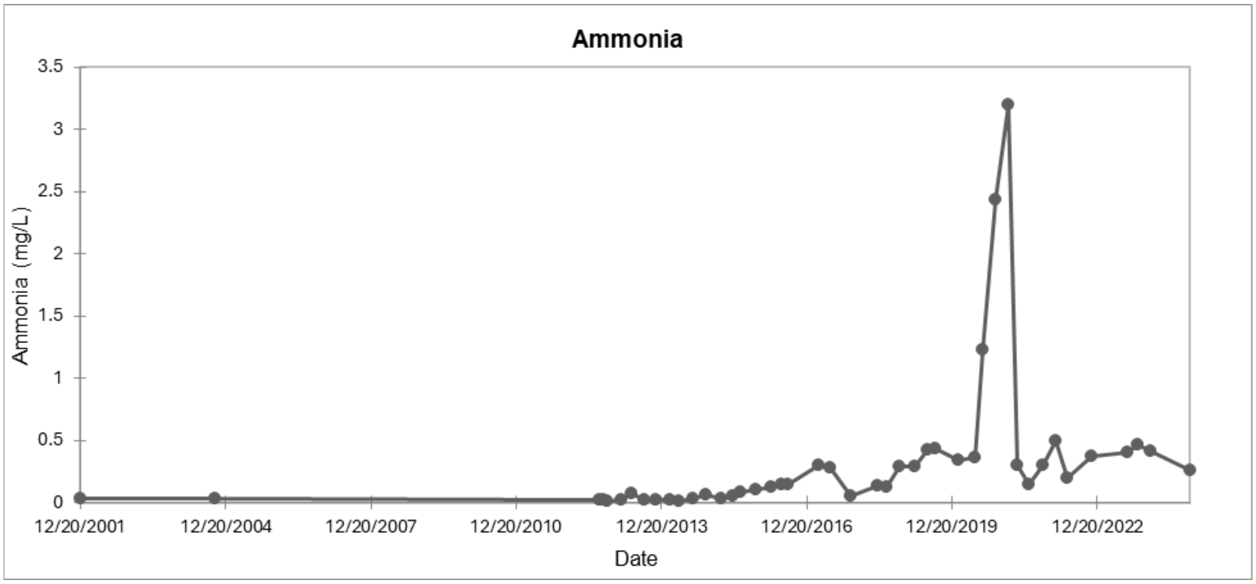
Grubb's test, a statistical test for identifying outliers, was performed for several of the station parameters. However, it seemed to be over-identifying outliers. The distribution of several of the datasets were investigated by plotting histograms. The data did not follow a normal distribution for any of the stations or parameters that were checked. As a result, Grubb's test could not be considered reliable as a method to identify outliers. Other, non-parametric methods were investigated but found to be too complex when performed on large sets. It should be noted that the Mann-Kendall Seasonal Trend Test is a non-parametric test and is noted to be resistant to outliers. With this in mind, we moved forward with generating scatterplots for all parameters to visually identify extreme outliers.

2.2 SCATTERPLOTS

Water quality data were analyzed in R (version 4.4.2) and R Studio (version 2025.09.2) to generate station-specific time series plots. For each monitoring station, only water quality parameters with at least ten observations were retained for trend visualization. Time series plots were created for each parameter and station using a custom plotting function (i.e., a small piece of code used to automatically generate the plots). Most parameters were displayed individually with scatterplots and linear trend lines except for dissolved oxygen and water temperature, which were plotted together (when both parameters were available) using a dual-axis format to allow visualization of both metrics along a common date axis. Scatterplots for all data can be found as Appendix B of this report.

Whenever a data point was found to be an obvious outlier the data entry was investigated to see if a unit error was feasible. In some cases, assuming an incorrect unit fixed the reasonableness of the data, and the point was still used (i.e., 750 μg/L of iron instead of 750 mg/L). If there was no obvious cause of an exceedingly unreasonable outlier the data point was removed from the dataset. Only datapoints that were obviously erroneous were removed (i.e., 10x greater than any relevant datapoint). Outliers that were not obviously erroneous but were perceived to be correct data were suppressed in the scatterplots to improve visualization of the data.

Figure: Example of a trend analysis with prominent outliers. It is odd for ammonia to be so high in a natural environment, the three data points that are excessively high were removed from analysis under suspicion of being erroneous entries (Possibly could have been 0.243 rather than 2.43). It should be noted that the trend test for this station/parameter was statistically significant both before and after the outliers were removed, further suggesting that the test is resistant to outliers. It is possible that this data is not in error, however the event seems anomalous and would not benefit the trend test.



While reviewing the dataset many of the stations lacked total nitrogen entries despite having all the components for a calculation of total nitrogen. A formula was written in Excel to identify stations that had ammonia, NOx, and TKN values with the same time stamp but did not have an entry for total nitrogen. Using this formula 1,319 additional total nitrogen entries were added to the dataset.

Later, a need for rainfall data for comparison with surface water trends was identified. Three potential weather station's data were pulled from the Suwanee River Water Management Districts online database. After reviewing the data only the Forest Grove station located at 29.740833, -82.608056 (north of Newberry off 41) was used due to missing data in the other two data sets. Additionally, Forest Grove had the longest period of record available. It should be noted that basing rainfall trends off a single weather station is not ideal and that the data displayed is intended only to provide general context on local conditions during the period of record. Using this data daily rainfall was incorporated into the significant scatterplots as a 30-day rolling total with a smoothed 7-day mean. Years were classified as "Wet" or "Dry" based on the 90th and 10th percentiles of annual rainfall and indicated with shading in the plots. The years 2000 and 2007 were filtered out of the percentile calculation since both years contained periods of missing data.

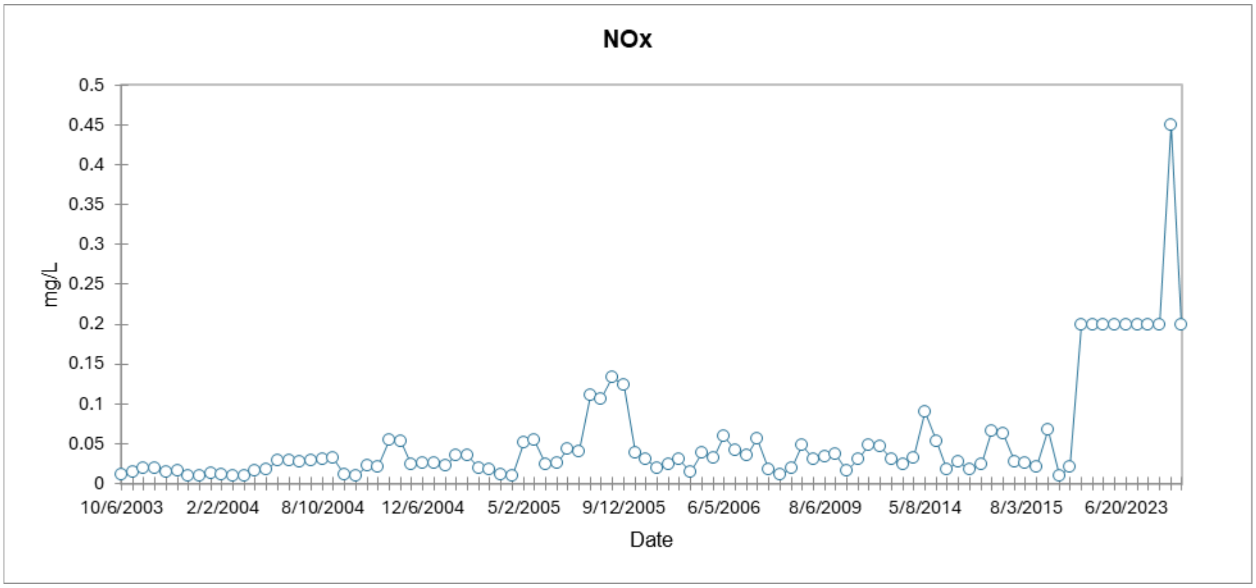
2.3 BASIC STATISTICS

Using Excel's pivot table feature, the count, average, standard deviation, maximum, minimum, and variance were calculated for every station and every parameter in the available dataset. The entirety of which is available as Appendix A of this report.

2.4 MANN-KENDALL TESTS

MK Tests were performed using XLStat Advanced, a statistical addon package for Excel. The tests were run with serial dependance adjustments, seasonality (period of 12), and Sen's Slope turned on. XLStat does not have the ability to run multiple stations at once so tests were performed for each station and parameter separately. The P-value, number of observations, and Sen's Slope were recorded for each test into the table located in Appendix C. The standard alpha level (a=0.05) was used to determine statistical significance. The plots for significant tests were reviewed for abnormalities. Several of the significant tests were found to be influenced by a change in the laboratory methodology used resulting in a change in the MDL. These results were not highlighted on the table but were still presented with an asterisk (*) adjacent to their P-value.

Figure: Example of a station that had a significant result in its trend analysis due to a change in laboratory methodology and subsequent change in MDL.



3.0 TREND ANALYSIS AND DISCUSSION

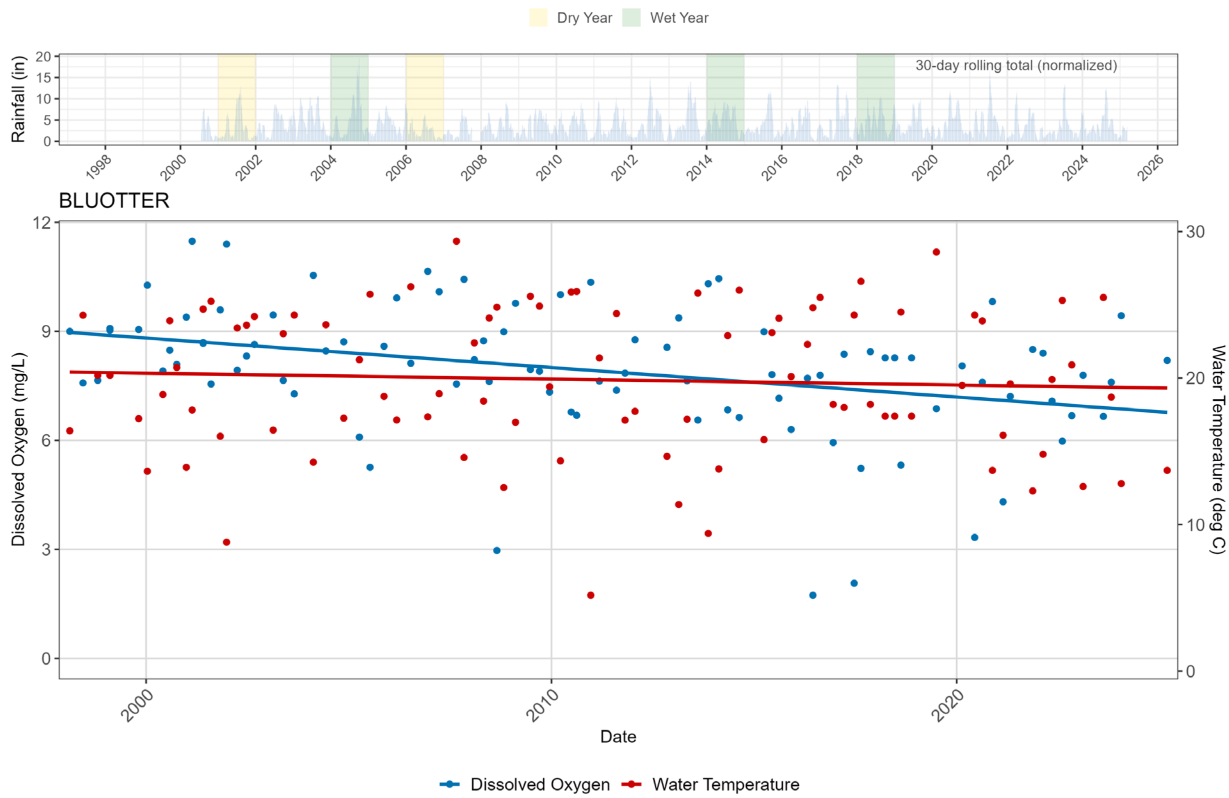
3.1 <u>BY STATION</u>

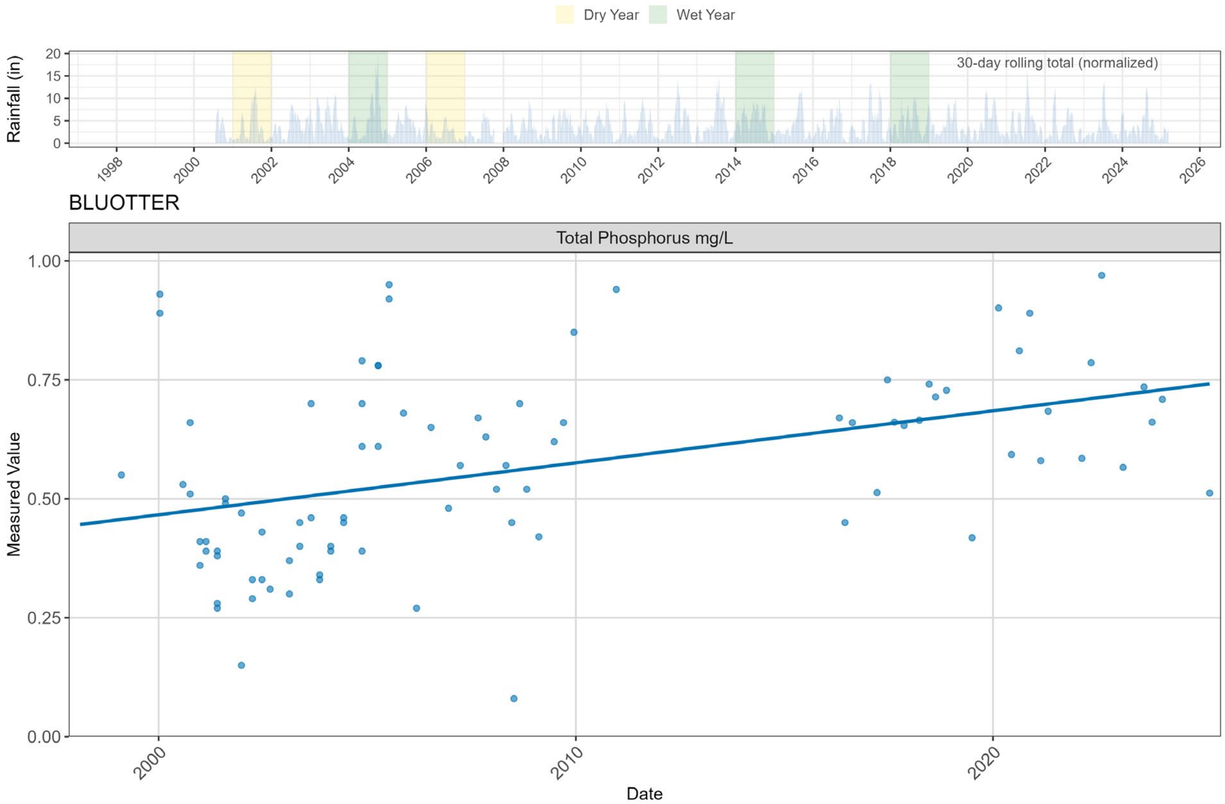
For discussion purposes only scatterplots for stations/parameters that were significant in the Mann-Kendall tests have been addressed in this section. For a complete table of all results from the trend tests please see Appendix C.

Throughout this discussion results that are "statistically significant" will be referenced. It should be noted that this does not indicate whether a trend is environmentally significant. The magnitude of change (or rate of change) would be the key to determining the environmental significance of the trend. "Statistically significant results" indicate that when the statistical trend test was run, the calculation exceeded the threshold to be considered "significant". In simpler terms, the trend test confirmed that a trend exists in the data and that the data points cannot be explained by random variation/chance alone.

BLUOTTER
Blues Creek was found to have a statistically significant downward trend in dissolved oxygen. The estimated rate of change is -0.254 mg/L annually. This is a trend seen in many of Florida's surface waters that can often be partially explained by rising temperatures. As water temperature rises its ability to hold dissolved gases decreases. However, when the station's data is plotted alongside the temperature readings taken at the time of measurement the temperature trend is both not statistically significant and very flat (little to no change). This would indicate that the trend is not explained by temperature. Speculatively, this could be due to several factors, but the most common cause would be increased nutrients changing community structure away from submerged aquatic vegetation and favoring algae and bacterial blooms

(eutrophication). This speculation is given more support by the fact that total phosphorus was found to have a statistically significant increasing trend at a rate of 0.06 mg/L annually. Blues Creek is noted by FDEP as being impaired for iron, however, a trend test did not indicate a statistically significant trend. The average iron concentration at the site for the period of record (N= 45) is 0.517 mg/L. Florida's criteria for iron impairment of class III waters is 1.0 mg/L. It should be noted that Florida waters can often have naturally occurring iron that is not linked to anthropogenic sources.



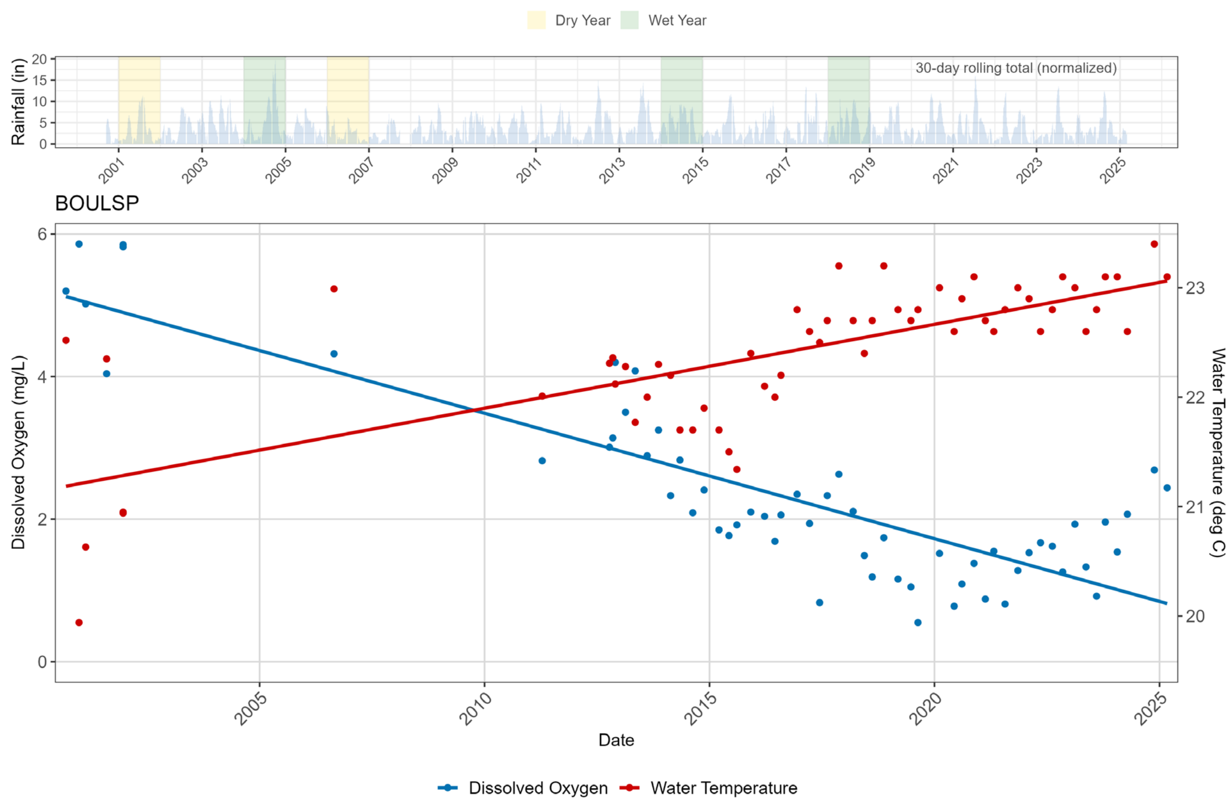


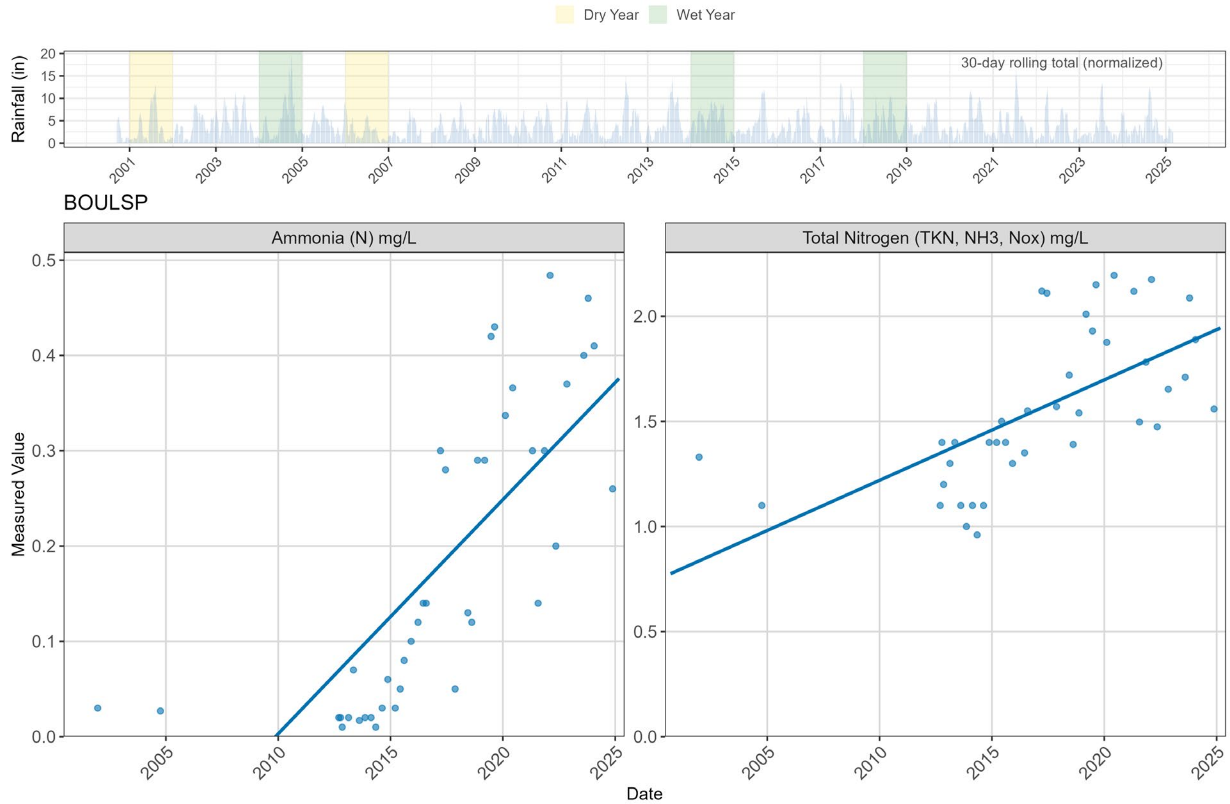
Dry Year
Wet Year
Rainfall (in)
30-day rolling total (normalized)
BLUOTTER
Total Phosphorus mg/L
Measured Value
Date

BOULSP

Boulware Spring is one of two springs included in this report. It should be noted that water chemistry at springs will differ greatly from the other surface water bodies included in this report. Boulware Spring's dissolved oxygen was found to have a statistically significant decreasing trend with an estimated slope of -1.015 mg/L annually. An additional trend test was performed for water temperature and found that there was a statistically significant trend ($p=0.042$) with an annual rate of change estimated at 0.27 C° annually. The trendlines are inversely proportional to each other indicating that temperature may be playing a key role in the trend of dissolved oxygen. Interestingly, there is an upswing in dissolved oxygen that can be visually found starting around 2021. With continued monitoring it may be found that dissolved oxygen is increasing again, possibly because of policy or management changes.

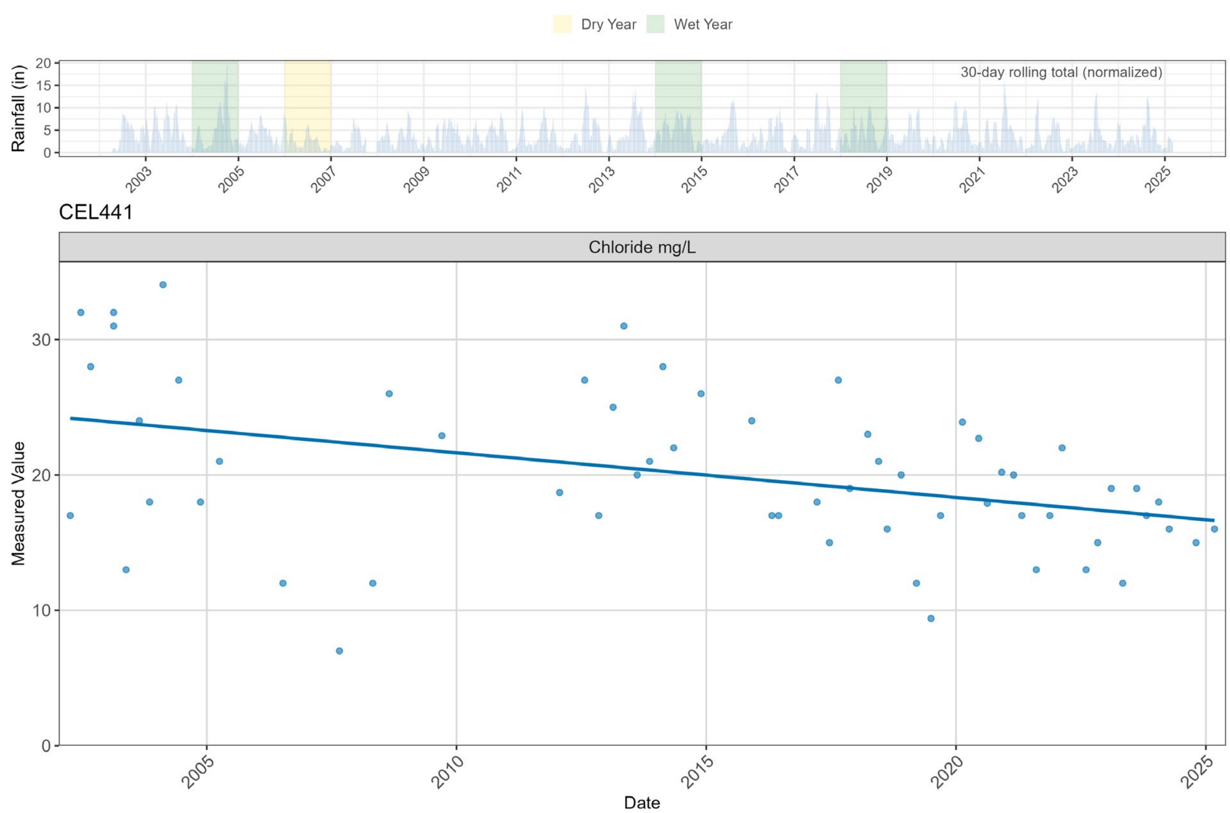
Total nitrogen is also increasing and may be contributing to reduced oxygen levels indirectly. Total nitrogen's trend test was borderline significant with outliers removed (significant with outliers in) with an estimated rate of 0.37 mg/L annually. Ammonia's trend was significant with a rate of 0.14 mg/L. NOx, however, did not have a significant trend. This would indicate ammonia as the nitrogen species primarily responsible for increasing total nitrogen. Possible ammonia sources should be evaluated. Boulware Springs is listed as impaired for nutrients (NOx) by FDEP. The criterion for impairment is 0.35 mg/L. The average NOx result for the dataset (N=43) is 1.015 mg/L.




Dry Year
Wet Year
Rainfall (in)
30-day rolling total (normalized)
BOULSP
Ammonia (N) mg/L
Total Nitrogen (TKN, NH3, Nox) mg/L
Measured Value
Date

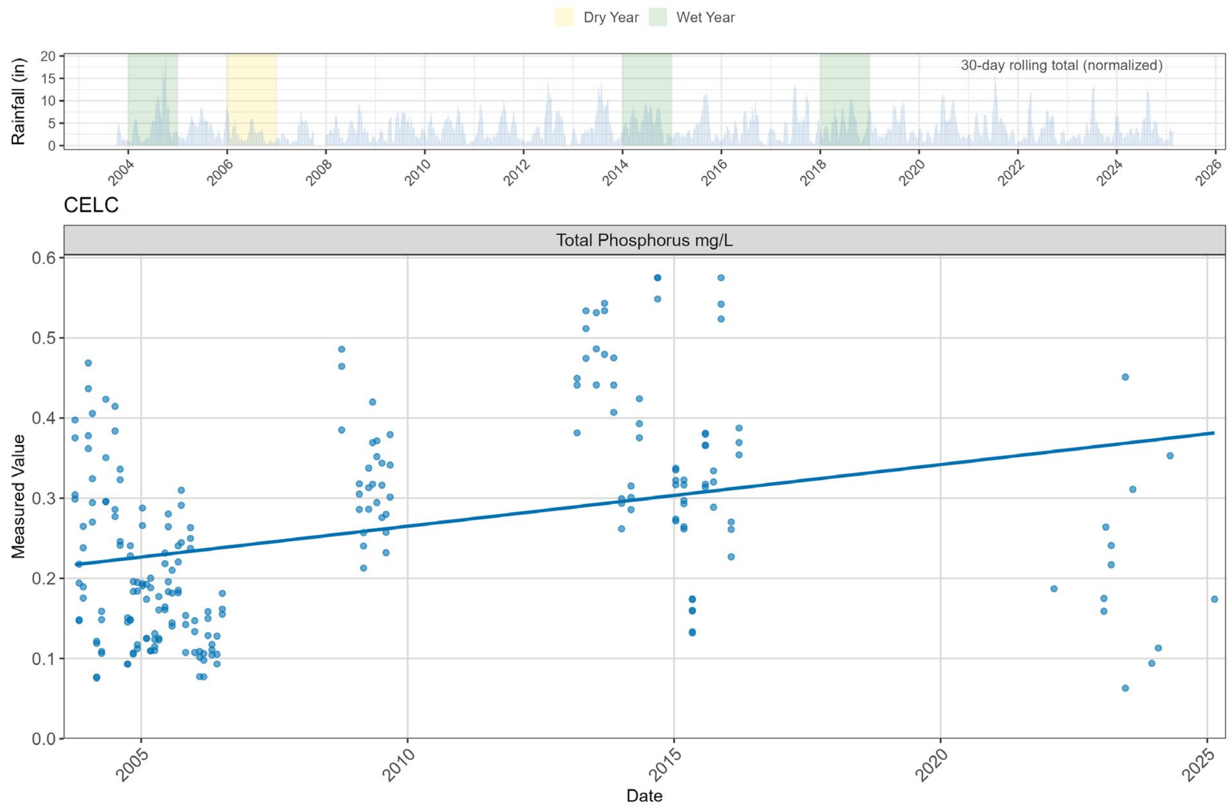
CEL441

Cellon Creek was found to have a statistically significant downward trend in chloride. While not environmentally significant at the low levels seen in Cellon Creek, the trend indicates that there could be more freshwater going to the stream than there was historically or could indicate improvements in stormwater management reducing salts in runoff. This is further supported by a borderline (meaning it did not cross the threshold for statistical significance but is likely still a trend, P=0.058) trend of decreasing total dissolved solids. There was also indication that a trend may exist for sodium (P=0.077). An additional trend test was performed for specific conductance for this station and was found to be significant (P=0.046) with an annual estimated rate of change of -17.883 uS/cm. These findings support either increased dilution or a reduction in pollution entering the waterbody. However, a trend test for discharge (flow) did not find any significant trends (N=62). A Linear Mixed Model (LMM) analysis would be better suited for identifying a possible relationship to flow and decreasing trends but is not included in this report. Regarding nutrients, there is a borderline result for increasing total phosphorus (P=0.055, rate=0.0385).



CELC

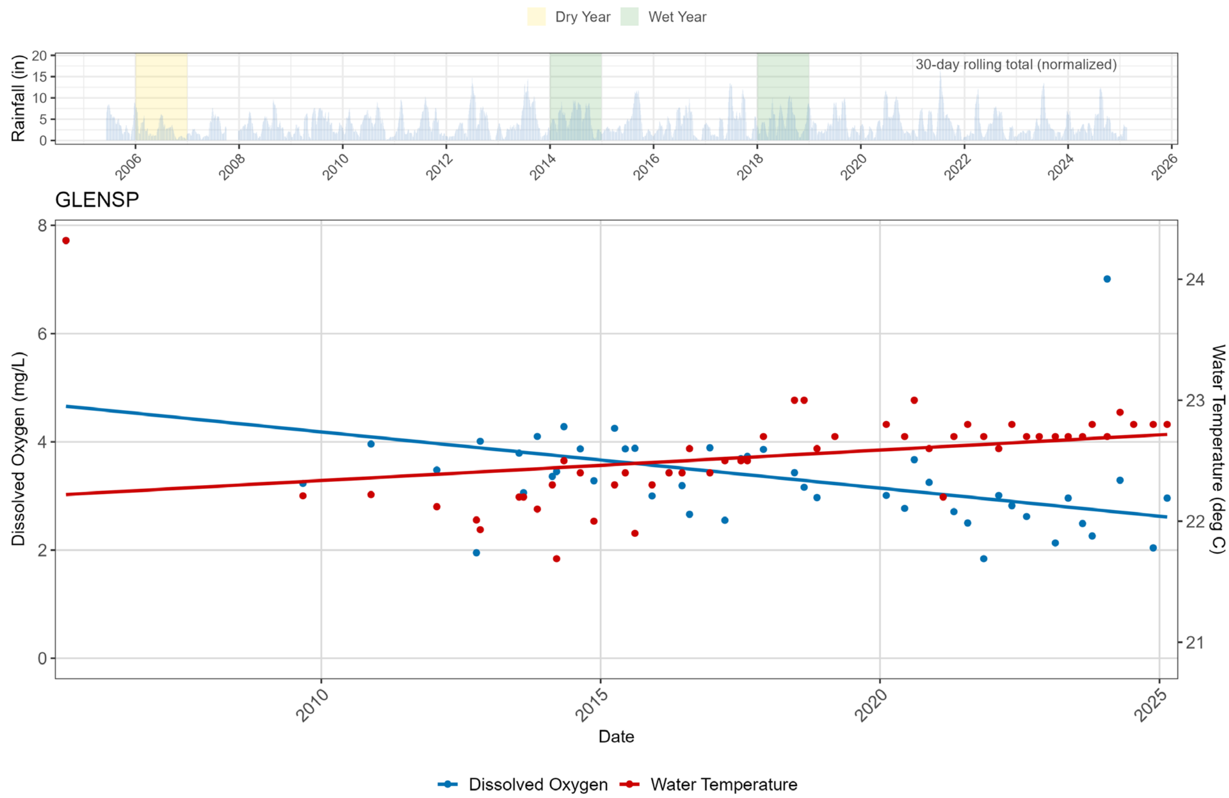
This station flows into Lochloosa Creek and shows a trend in increasing total phosphorus, although the scale is rather small with a rate of 0.011 mg/L annually. There is a visual short-term downward trend starting around 2015 that may indicate future monitoring could see a downwards trend.

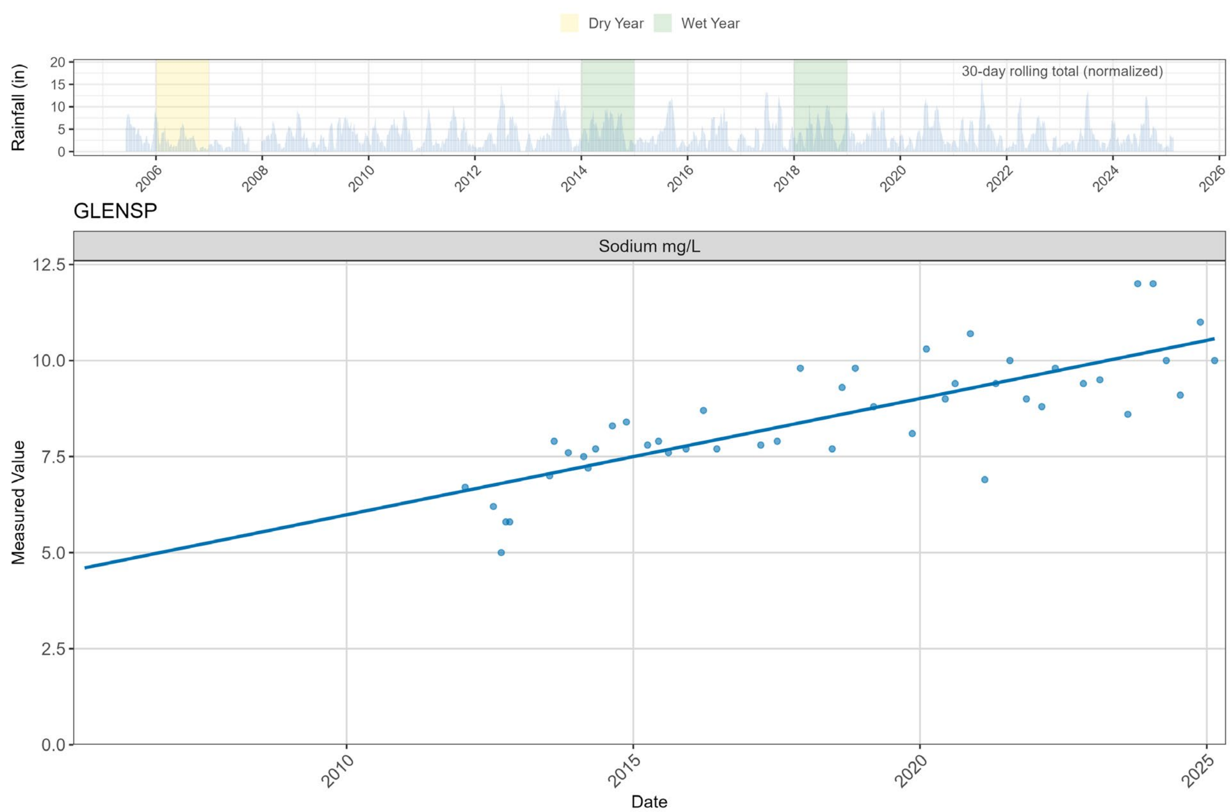


GLENSP

Glen Spring comes directly from groundwater and therefore will differ in its chemical traits from the other stations in this report. Glen Spring is listed as impaired for nutrients (NOx) by FDEP. Interestingly, the trend tests did not show a significant trend for NOx, but was approaching borderline (P=0.076) for a negative trend. Additional monitoring is needed to determine if a statistically significant trend is emerging and possibly indicating a trend toward recovery.

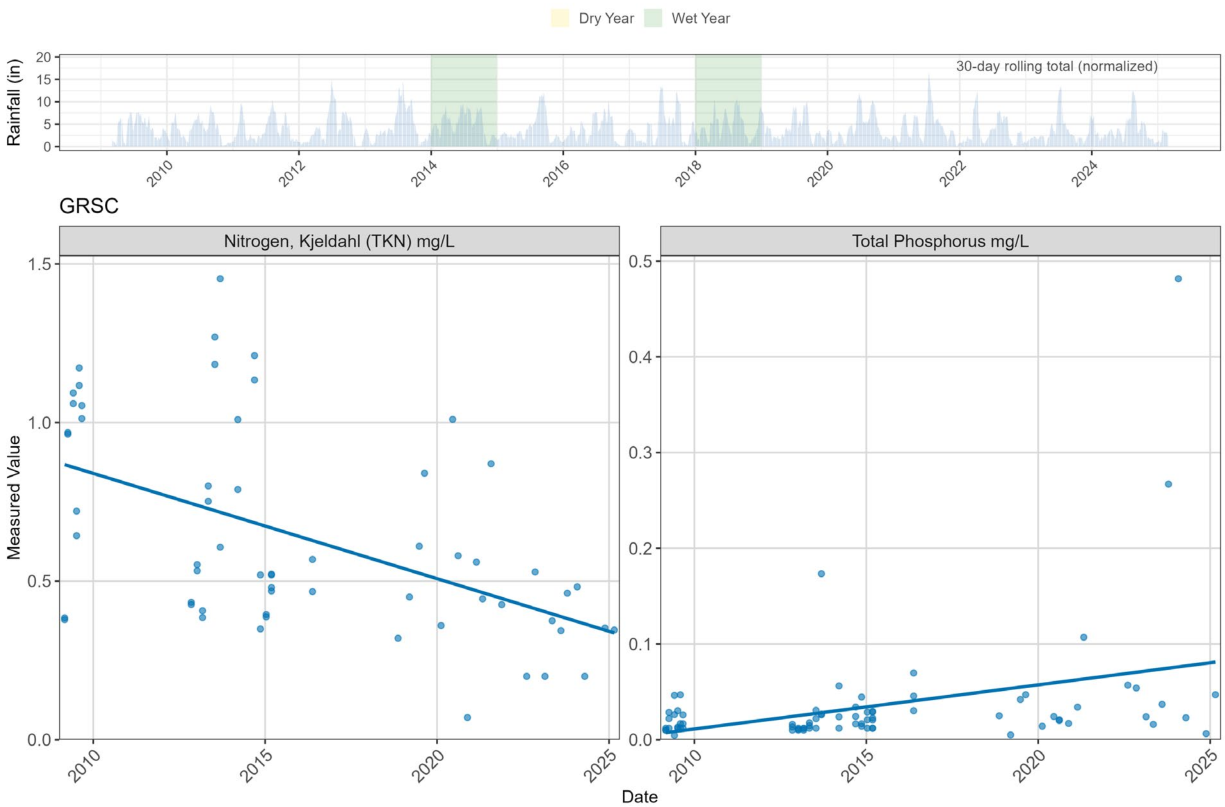
There was a significant trend for increasing sodium and decreasing dissolved oxygen. Increasing sodium may be because of less groundwater flow from pumping demands, however the flow data available did not indicate this trend. For now, sodium levels remain very low.


Dry Year
Wet Year
Rainfall (in)
30-day rolling total (normalized)
GLENSP
Dissolved Oxygen (mg/L)
Water Temperature (deg C)
Date
Dissolved Oxygen
Water Temperature


Dry Year
Wet Year
Rainfall (in)
30-day rolling total (normalized)
GLENSP
Sodium mg/L
Measured Value
Date

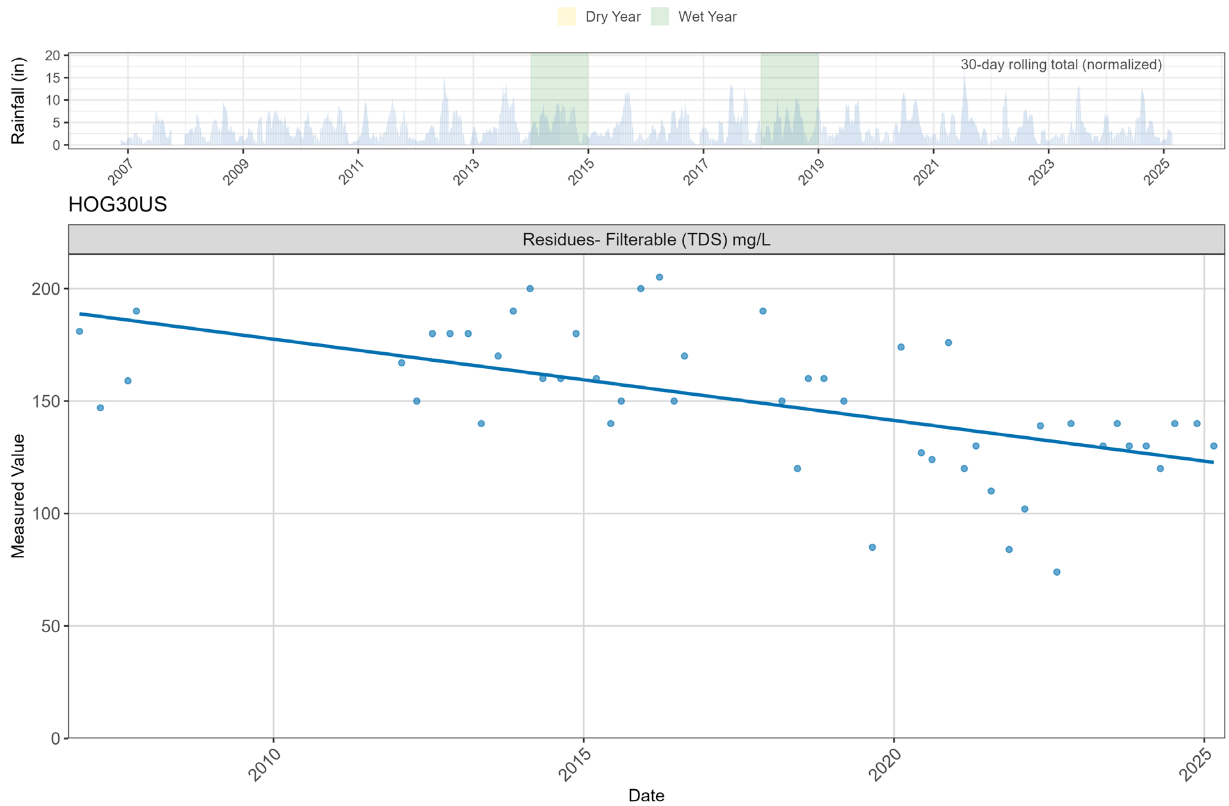
GRSC

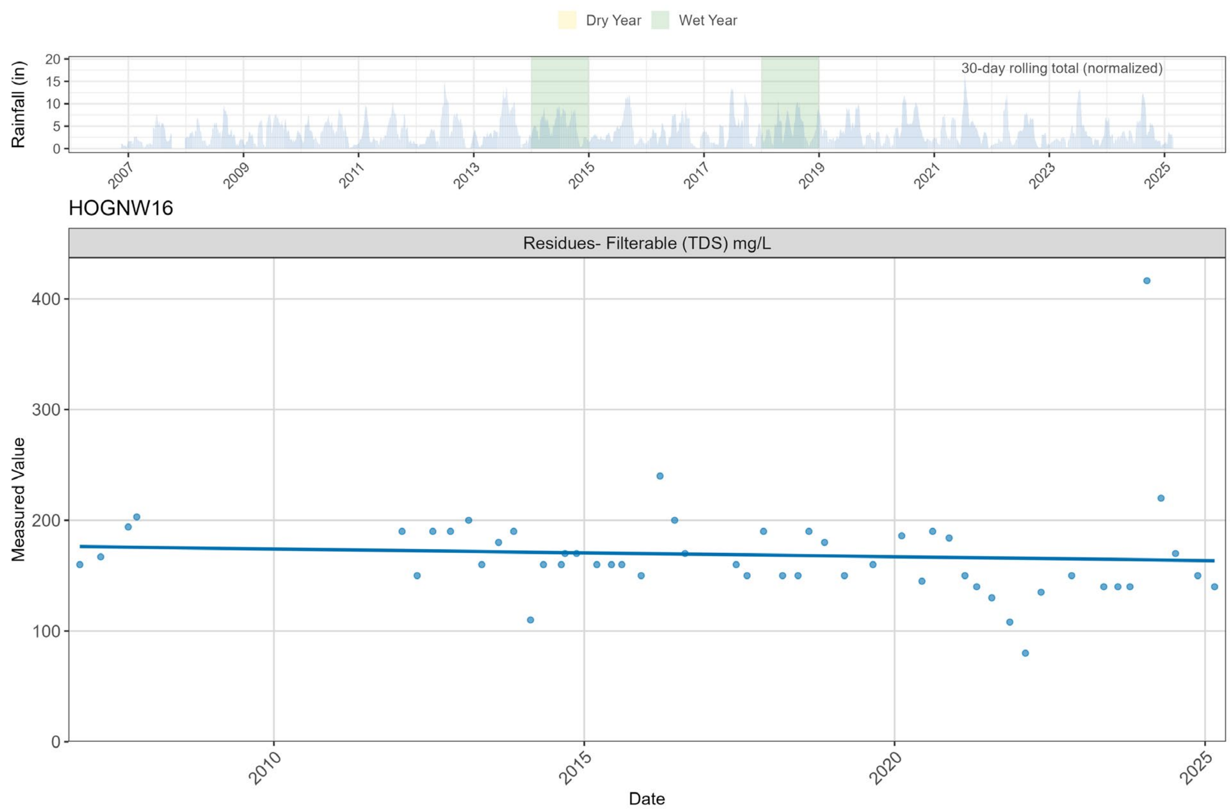
This station is noted as a Hatchet Creek Tributary (Gum Root Swamp Creek). Hatchet Creek is **not** noted by FDEP as being impaired for nutrients. Statistically significant trends were found for increasing phosphorus and decreasing TKN. Results were borderline for decreasing chloride (P=0.089) and dissolved oxygen (P=0.077) and may become statistically significant with more data. FDEP's impairment criterion for total phosphorus in class III streams is 0.12 mg/L (by annual average). The overall average for this site was 0.044 mg/L total phosphorus.



HOG30US and HOGNW16

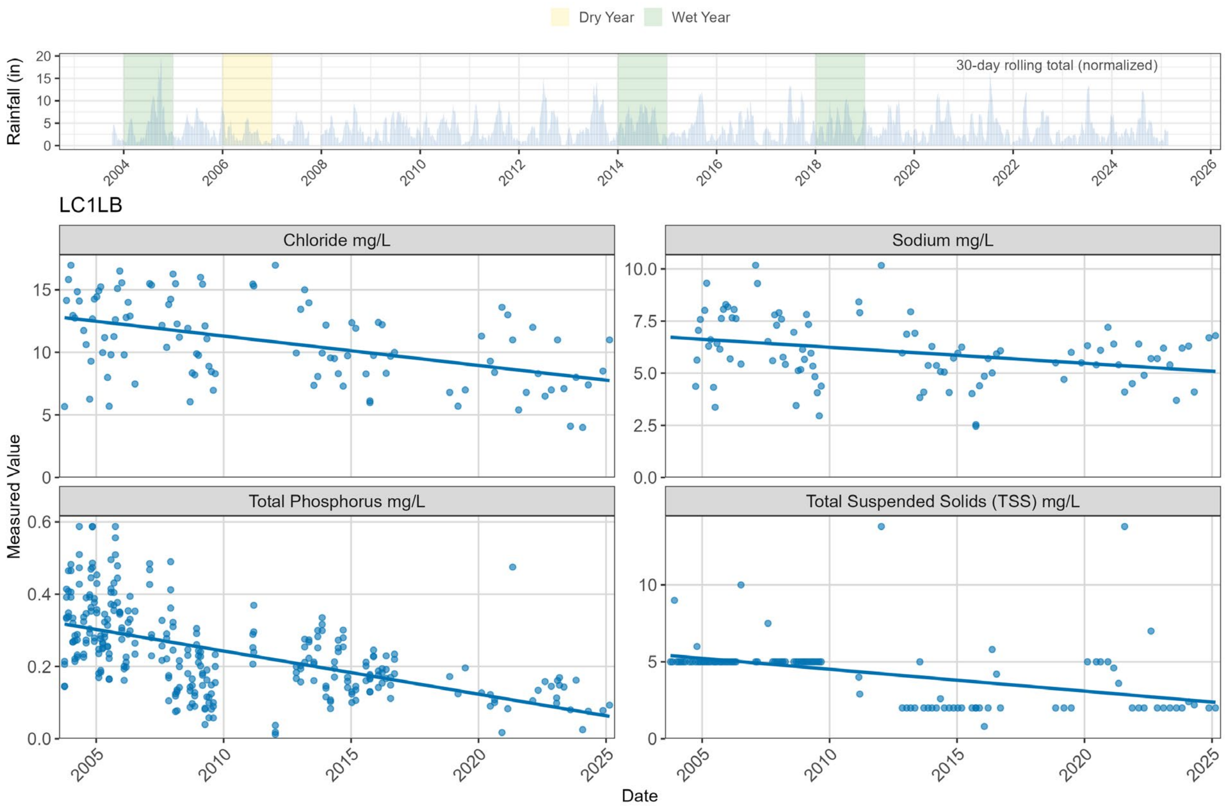
Analysis at Hogtown Creek showed a statistically significant decreasing trend for total dissolved solids (TDS). This trend was also found at the upstream station HOGNW16. Chloride was also borderline significant as a downwards trend (P=0.081) for HOG30US. This points towards effective improvements in stormwater management.

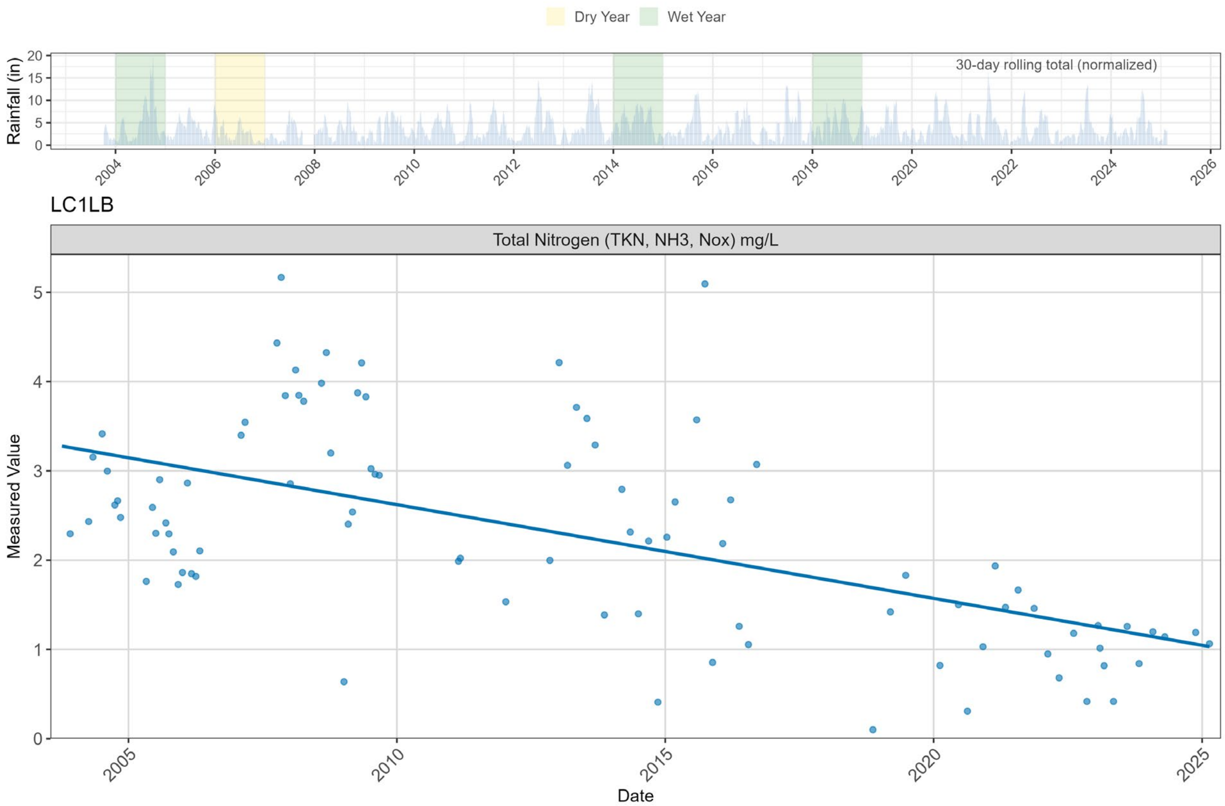

Dry Year
Wet Year
Rainfall (in)
30-day rolling total (normalized)
HOG30US
Residues- Filterable (TDS) mg/L
Measured Value
Date


Dry Year
Wet Year
Rainfall (in)
30-day rolling total (normalized)
HOGNW16
Residues- Filterable (TDS) mg/L
Measured Value
Date

LC1LB

Lochloosa Creek's station showed total nitrogen, total phosphorus, total suspended solids, chloride, and sodium all have clearly decreasing trends over the 20+ year period of record.

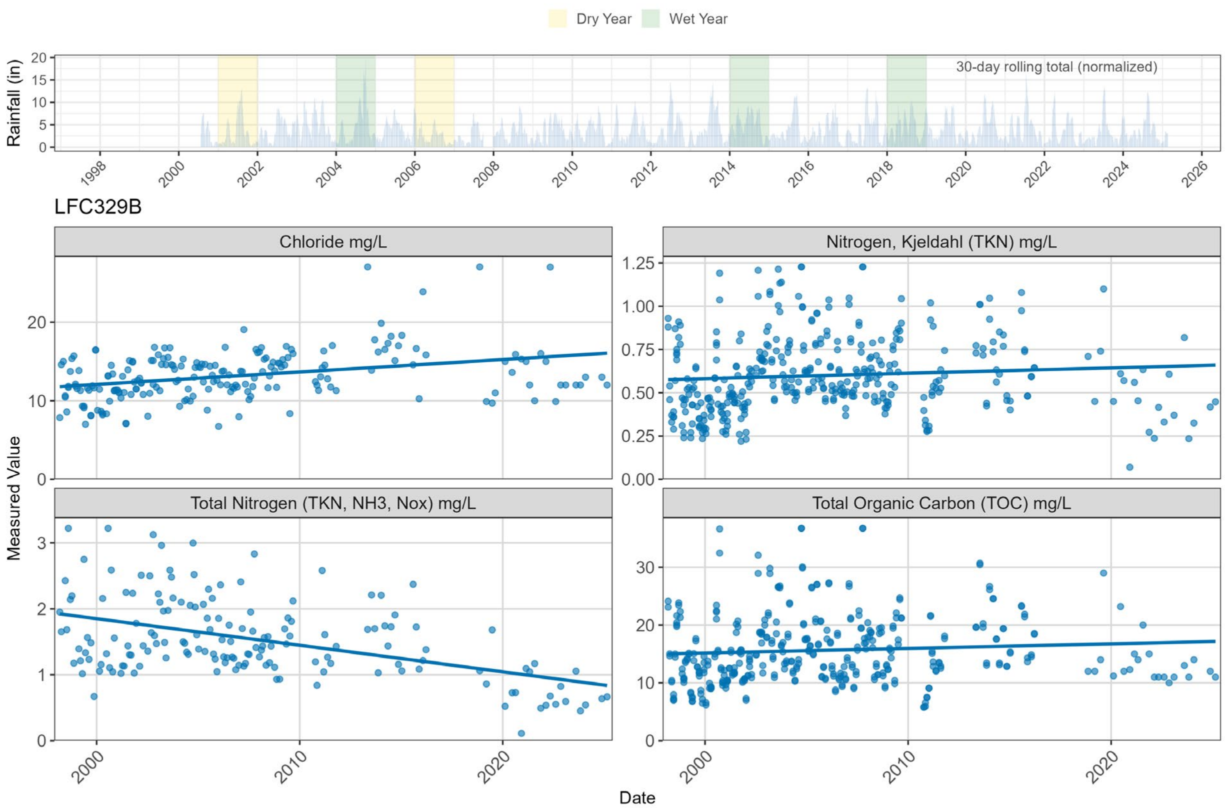



Dry Year
Wet Year
Rainfall (in)
30-day rolling total (normalized)
20
15
10
5
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
LC1LB
Total Nitrogen (TKN, NH3, Nox) mg/L
Measured Value
0
1
2
3
4
5
2005
2010
2015
2020
2025
Date

LFC329B

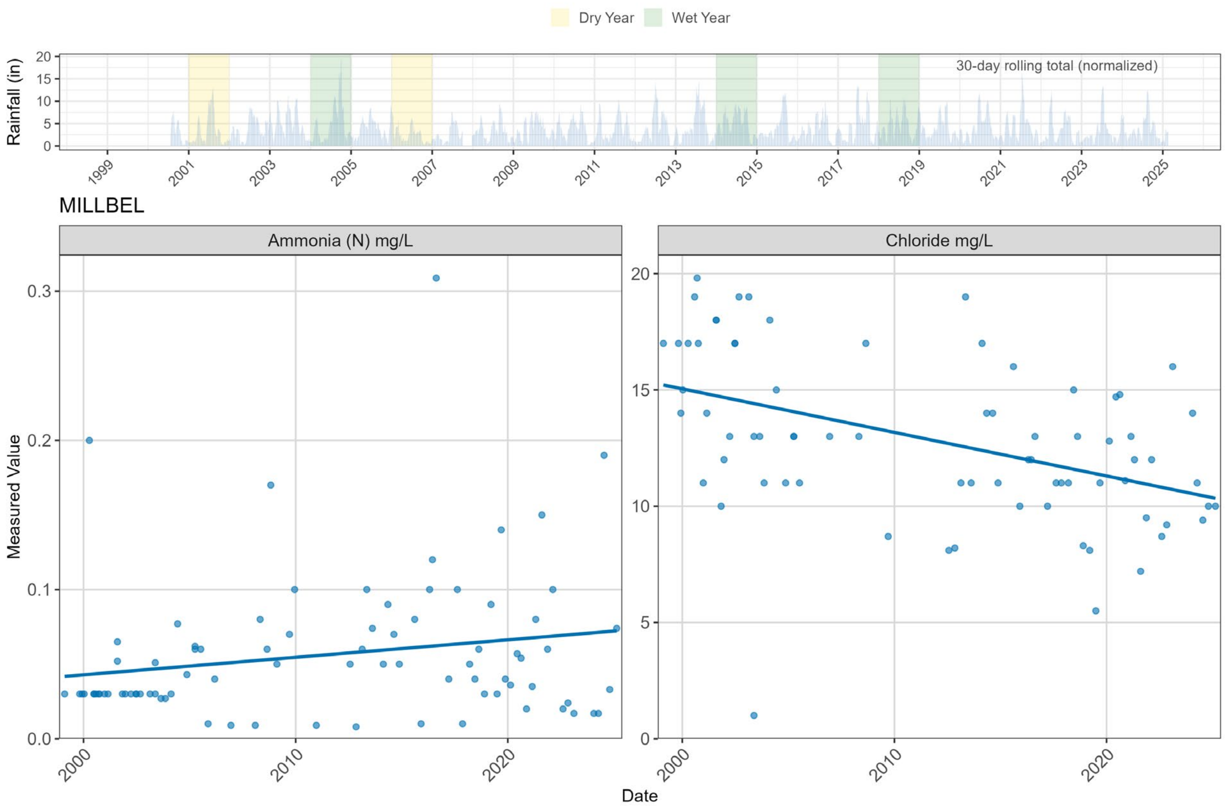
Lake Forest Creek displayed trends for increasing total organic carbon, chloride, TKN, ammonia and decreasing total nitrogen.

Ammonia's trend was very small at 0.0008 mg/L annually. TKN's rate of change was also small at 0.004 mg/L annually. A trend for NOx could not be determined due to a shift in laboratory method causing a change in the minimum detection limit and subsequently skewing the results of the trend test. *Total nitrogen tending down while the constituents of TN trend up is a suspicious result. The total nitrogen calculations were reviewed and re-analyzed for this station and found to be valid. Notably, the total count of data for total nitrogen for this site is much lower than the total count for the other parameters and may be cause for why the trend test is contrary to expectation.*



MILLBEL

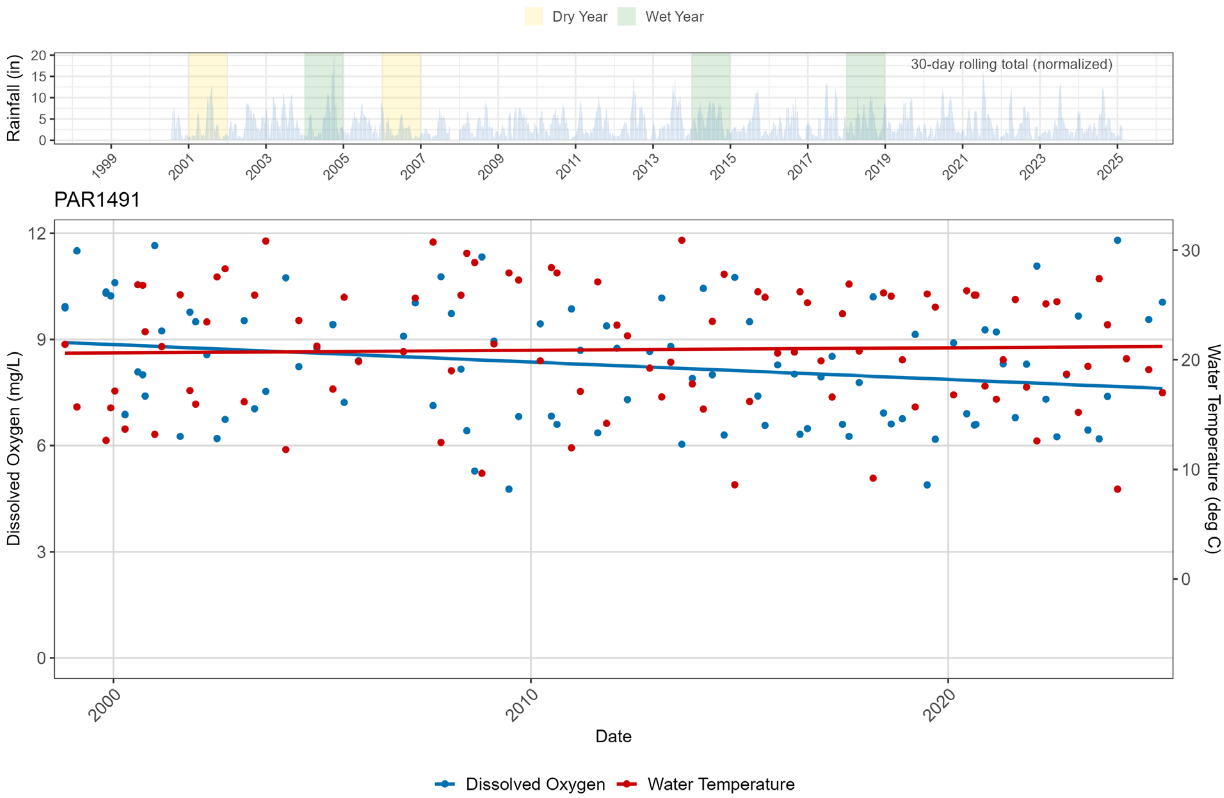
Mill Creek's results indicated an increasing trend for ammonia and a decreasing trend for chloride. An accurate rate of change could not be calculated due to the number of constants in the data set (reoccurring numbers consecutively). Ammonia's annual rate of change is estimated at 0.004 mg/L.



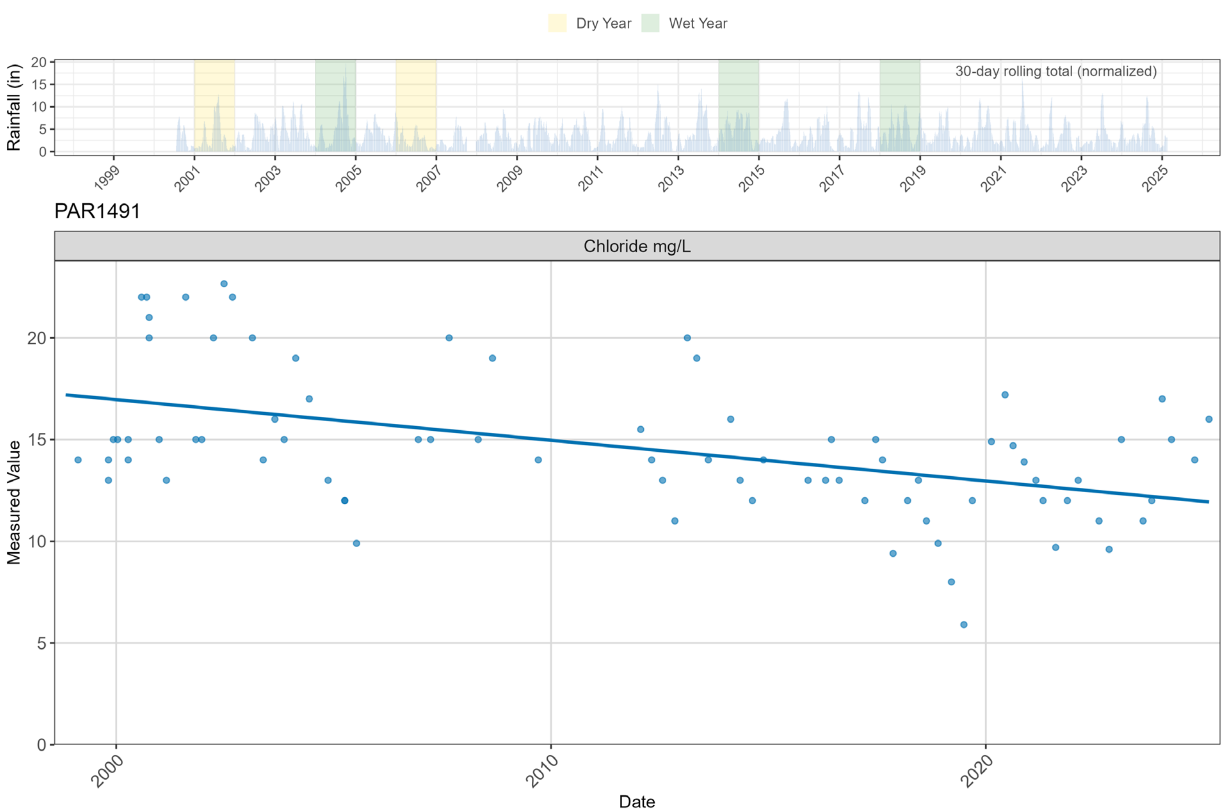
PAR1491

Pareners Branch station showed trends in decreasing dissolved oxygen and chloride. Temperature's trend slightly increased but did not account for the change seen in the DO trend. However, there is a large amount of variation in the data that would indicate other factors are at play for the DO values such as flow.

There were two borderline results that could emerge as trends with more data. These trends could indicate increasing NOx (P=0.076) and decreasing TP (P=0.065) with additional data.



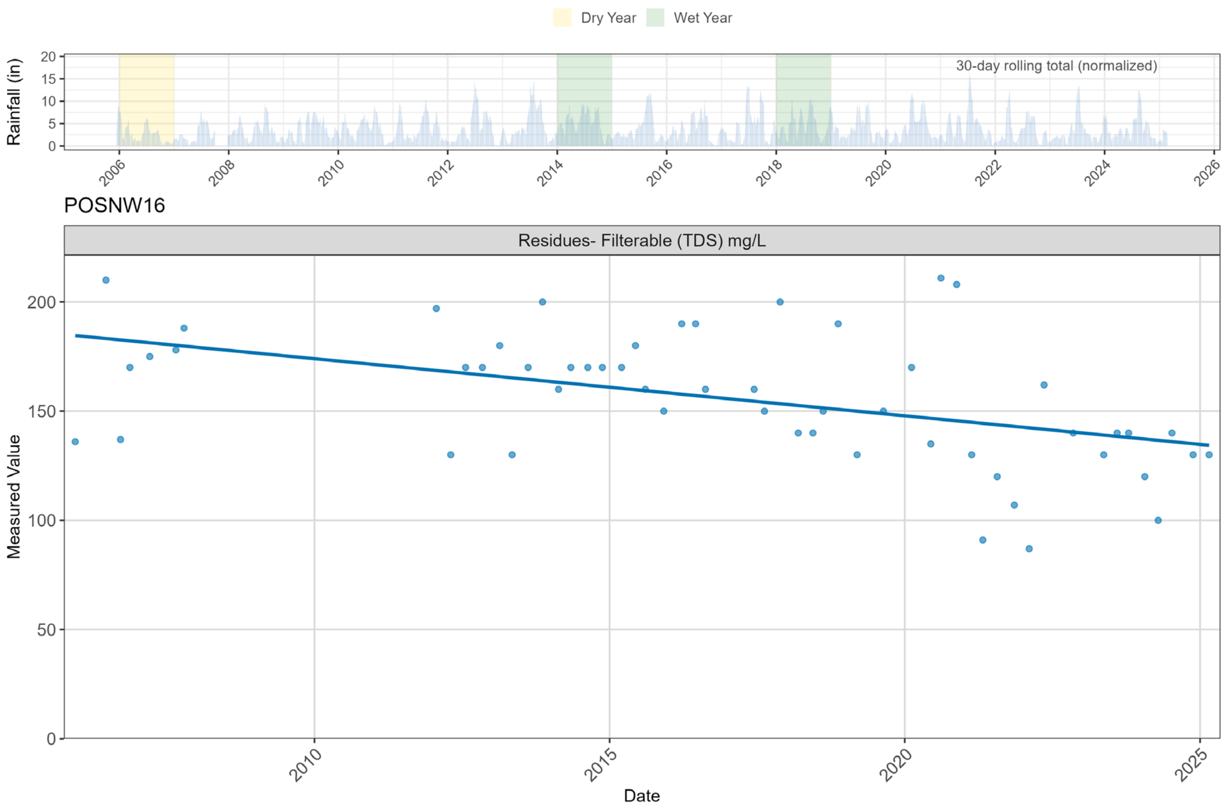
Dry Year
Wet Year
Rainfall (in)
30-day rolling total (normalized)
PAR1491
Dissolved Oxygen (mg/L)
Water Temperature (deg C)
Date
Dissolved Oxygen
Water Temperature



Dry Year
Wet Year
Rainfall (in)
30-day rolling total (normalized)
PAR1491
Chloride mg/L
Measured Value
Date

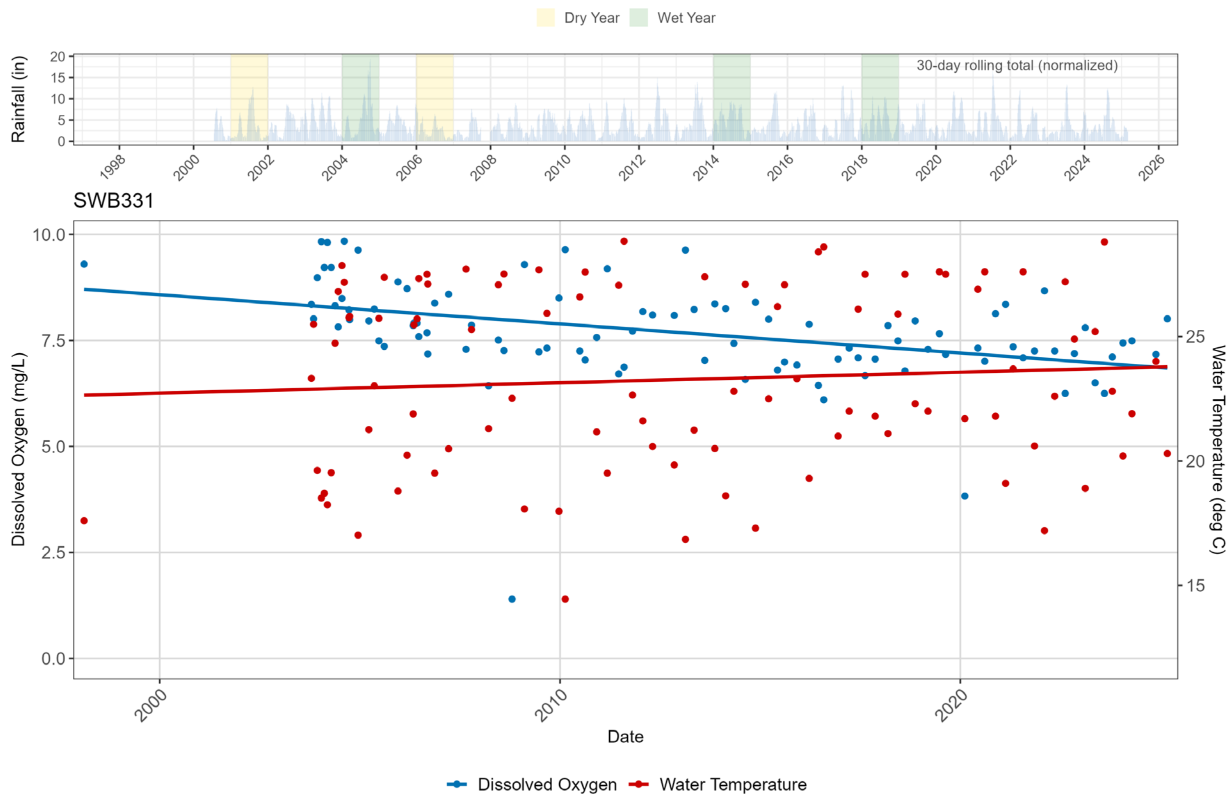
POSNW16

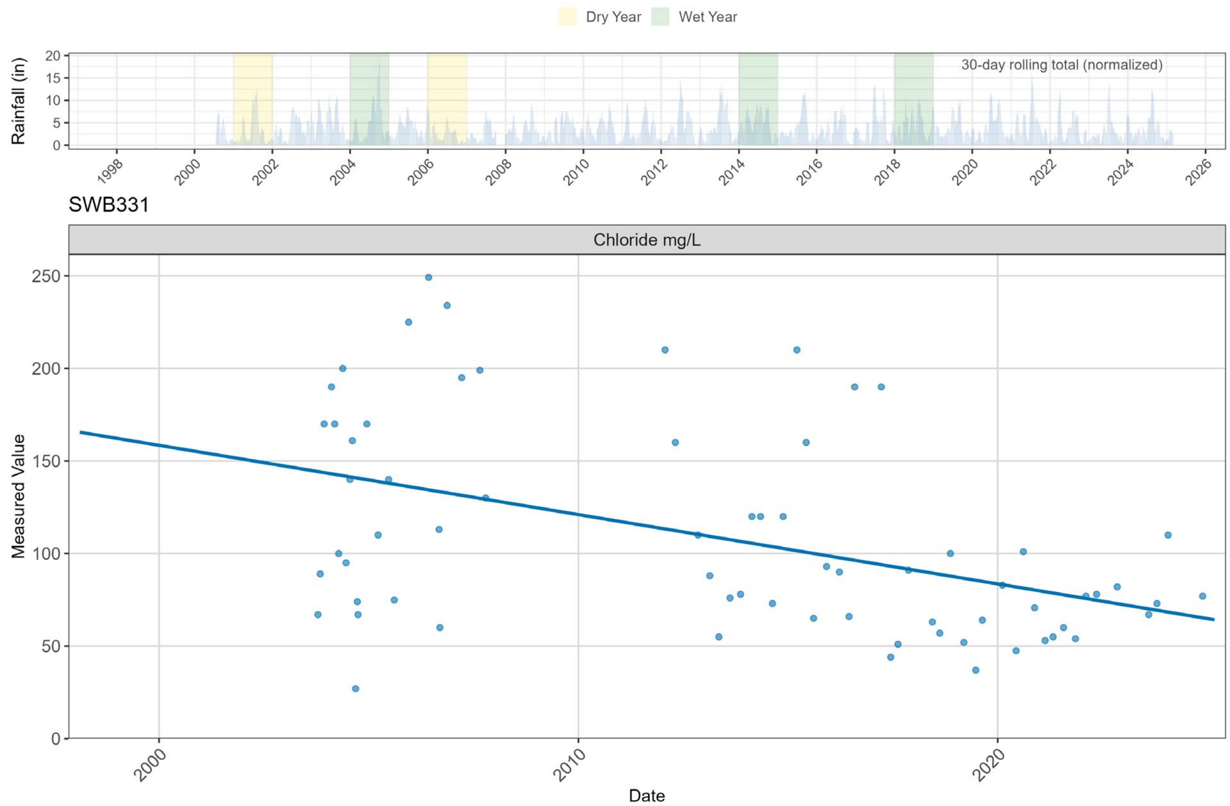
Possum Creek's station showed a statistically significant decreasing trend for total dissolved solids. Like other sites above, this could indicate increases in water inputs or possibly improvements in stormwater management reducing dissolved pollutants.



SWB331

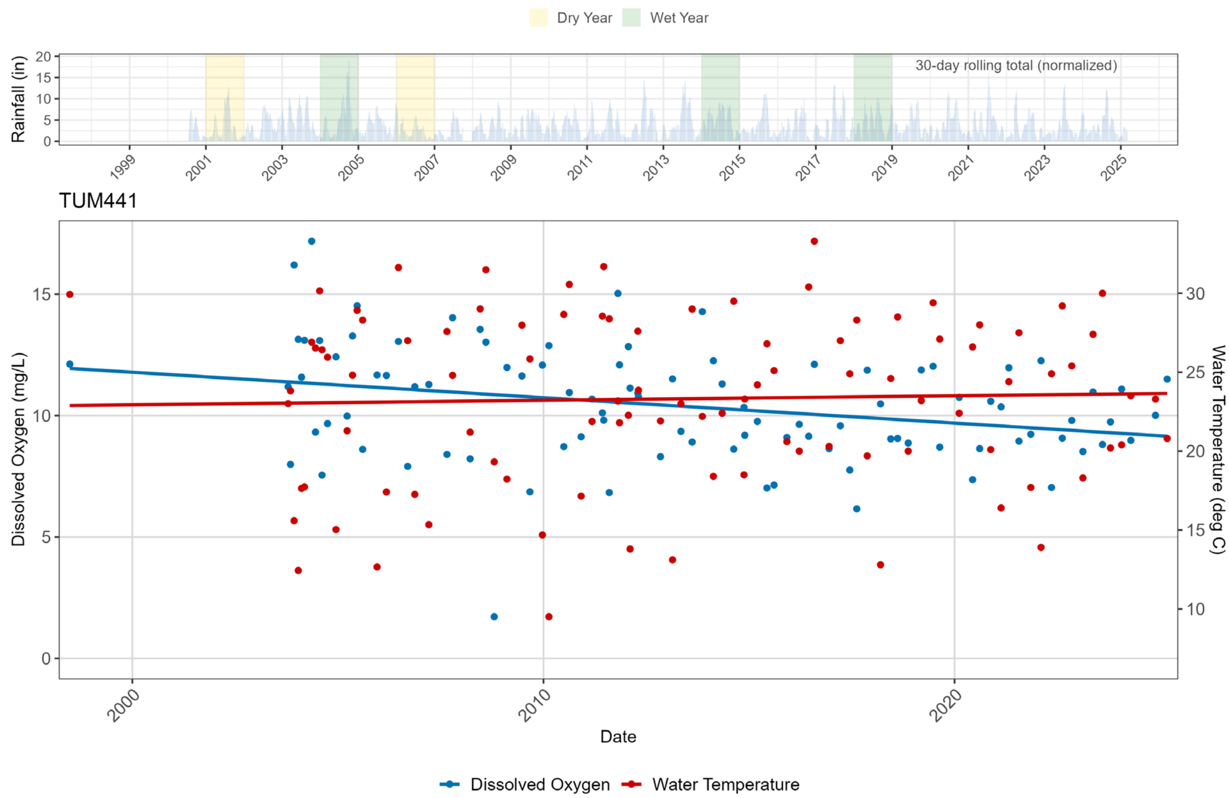
It should be noted that this station is downstream of a treated wastewater outflow, because of this, trends may be difficult to interpret. Statistically significant trends for this site include decreasing chloride and dissolved oxygen. Decreases in chloride could suggest improved wastewater treatment methods.




Dry Year
Wet Year
Rainfall (in)
30-day rolling total (normalized)
SWB331
Chloride mg/L
Measured Value
Date

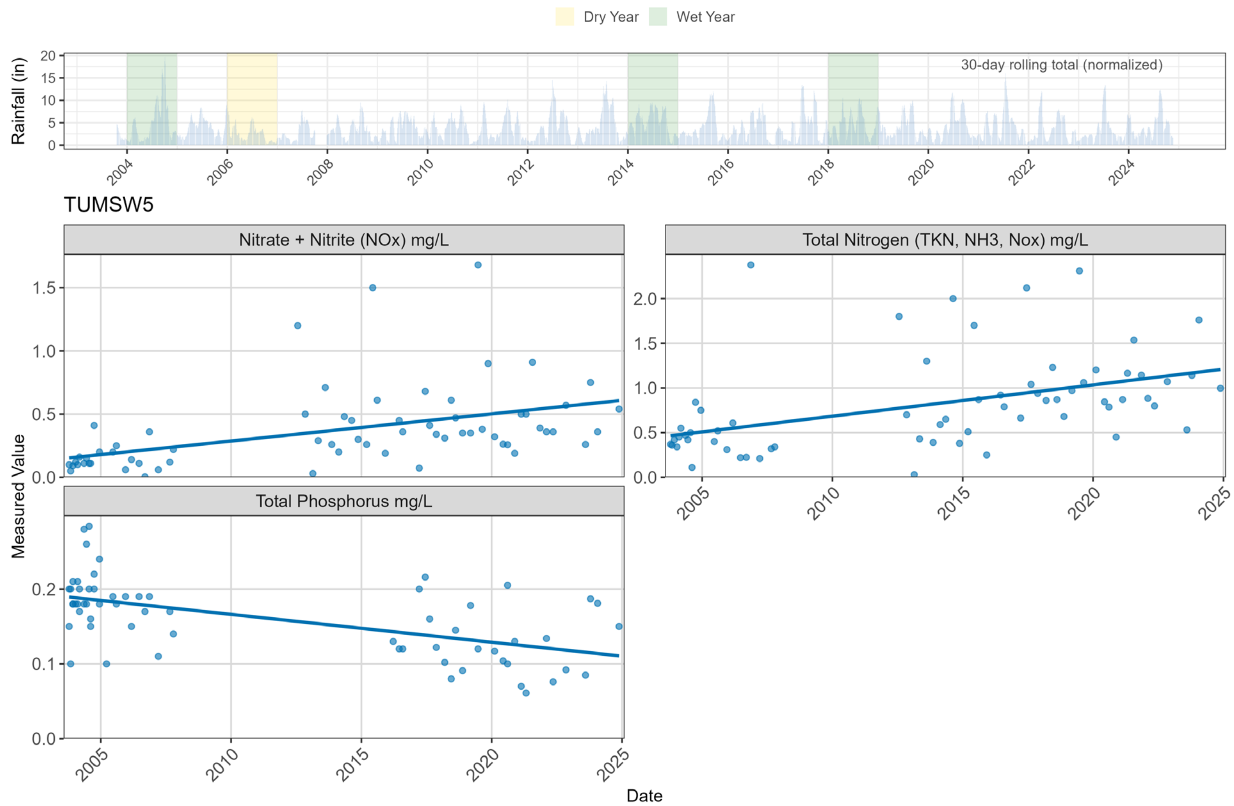
TUM441

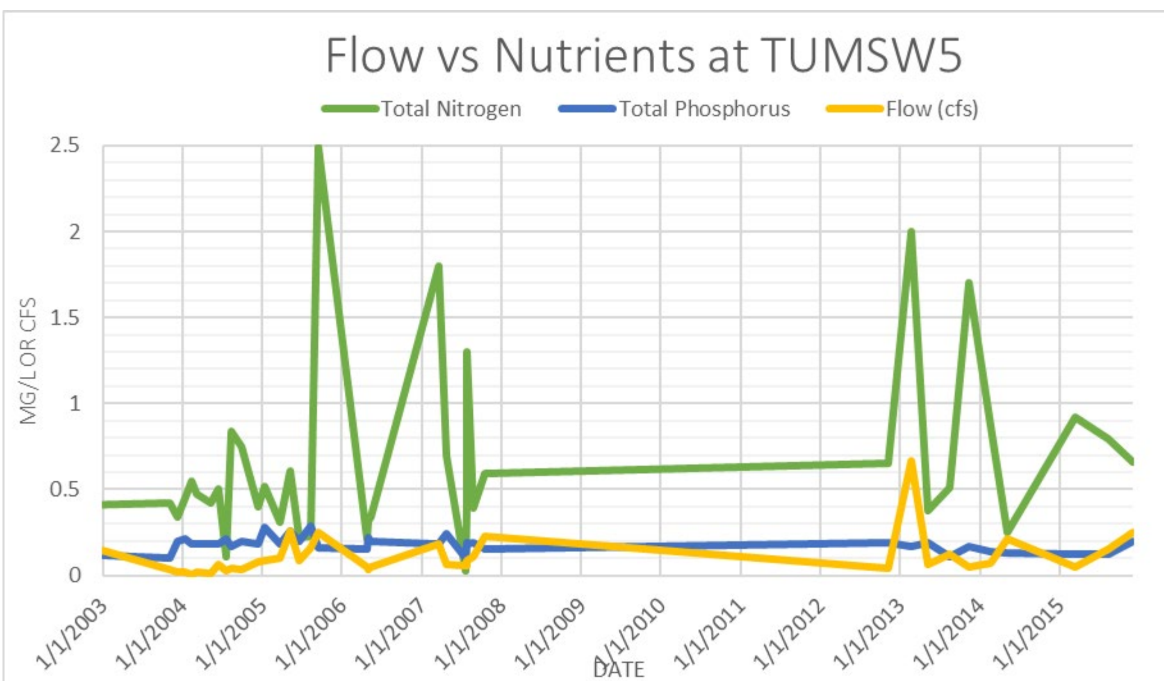
Tumblin Creek's station data found dissolved oxygen to have a statistically significant downward trend. There was a borderline result for decreasing TP (P=0.071) that could emerge as a trend with more data. Other borderline results included decreasing TOC, chloride and increasing NOx.

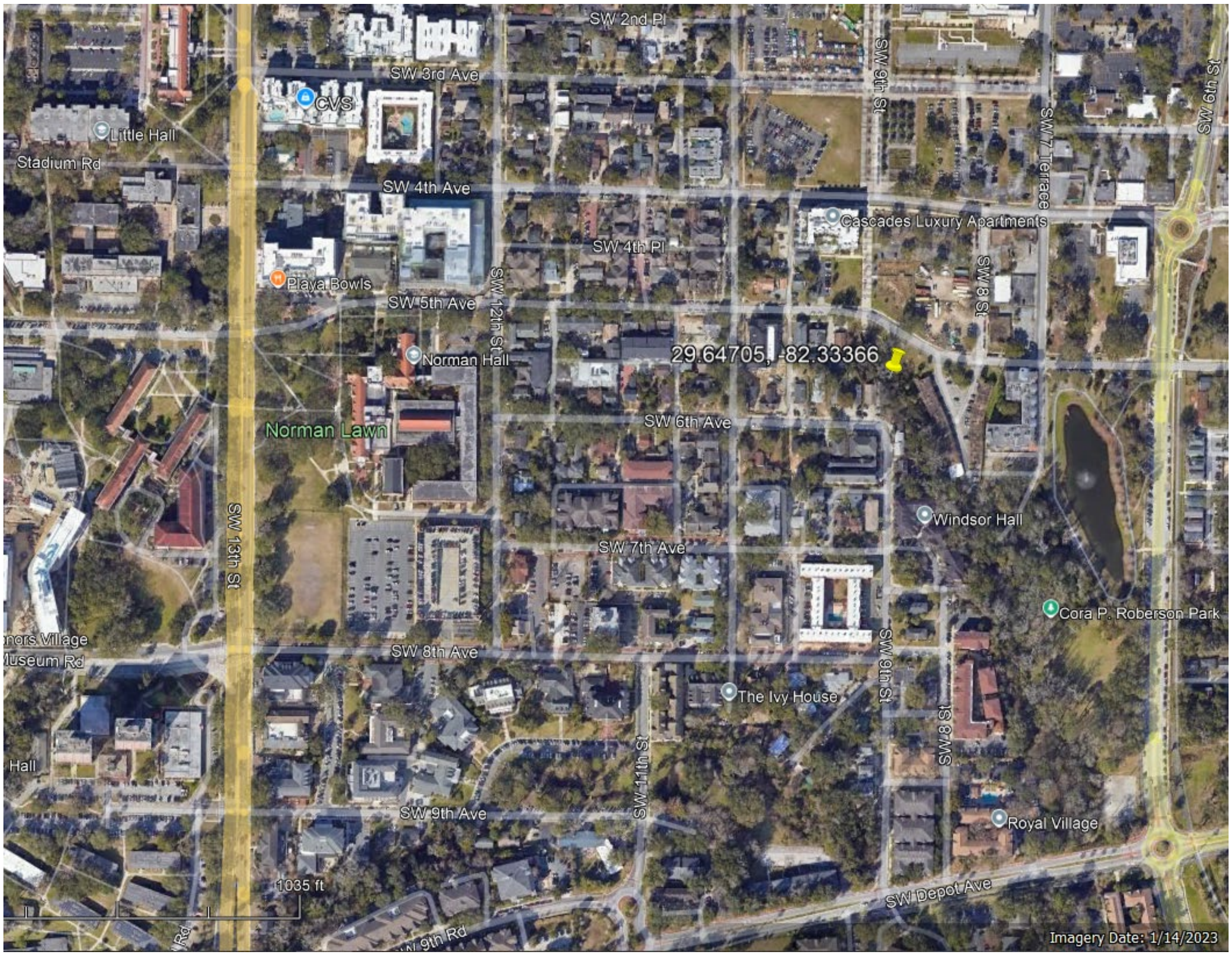


TUMSW5

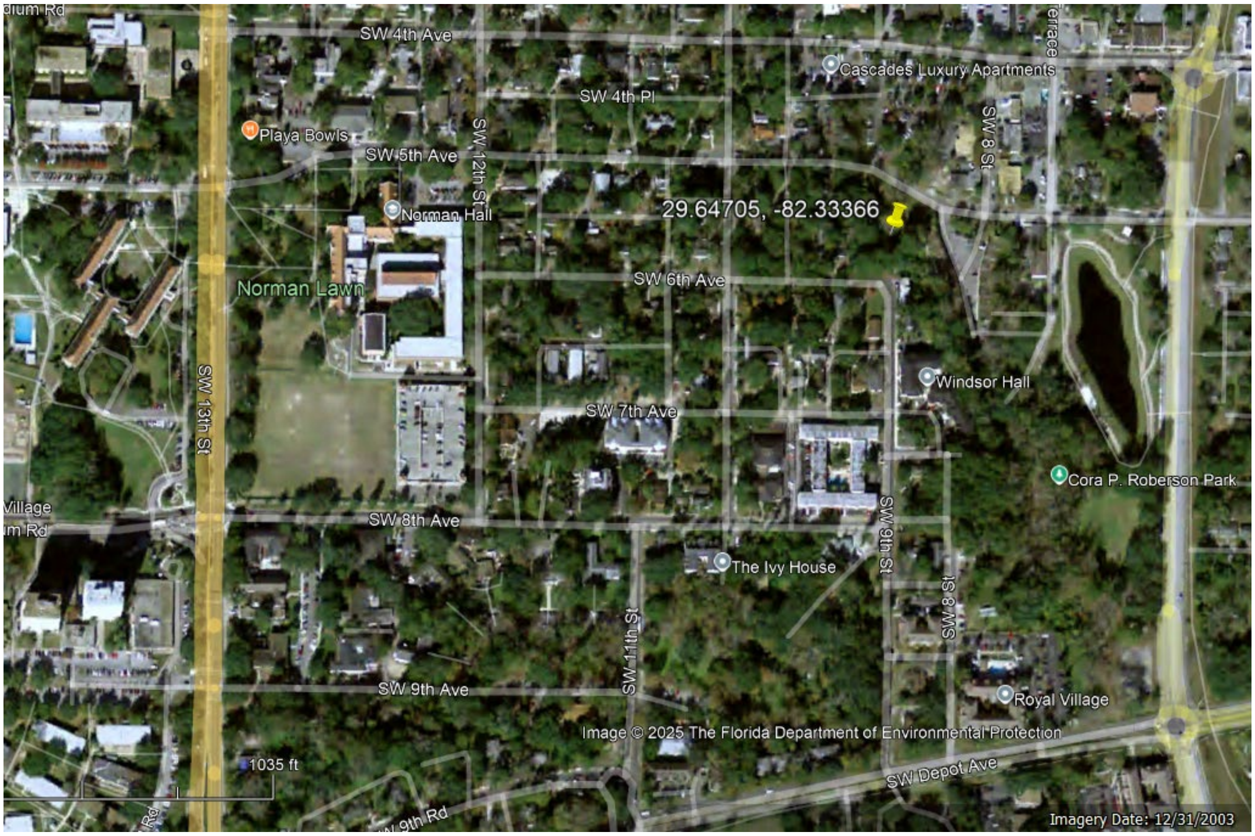
Another Tumblin Creek station, this one showing different trends than TUM441. Total nitrogen and NOx have an increasing trend while total phosphorus is decreasing. Flow data was plotted alongside total nitrogen and total phosphorus values to review how flow might affect nutrient load at the site. Visual review shows some peaks coinciding, but a linear mixed model (LMM) analysis would be better suited to identifying how much flow variation plays a part in nutrients at the site. It is important to consider the intense urbanization and development that has occurred over the course of monitoring which may be significant source of change for this station.


Dry Year
Wet Year
Rainfall (in)
30-day rolling total (normalized)
TUMSW5
Nitrate + Nitrite (NOx) mg/L
Total Nitrogen (TKN, NH3, Nox) mg/L
Total Phosphorus mg/L
Measured Value
Date


Flow vs Nutrients at TUMSW5
Total Nitrogen
Total Phosphorus
Flow (cfs)
MG/L OR CFS
DATE



Caption: Google Earth imagery of station 1/14/23.



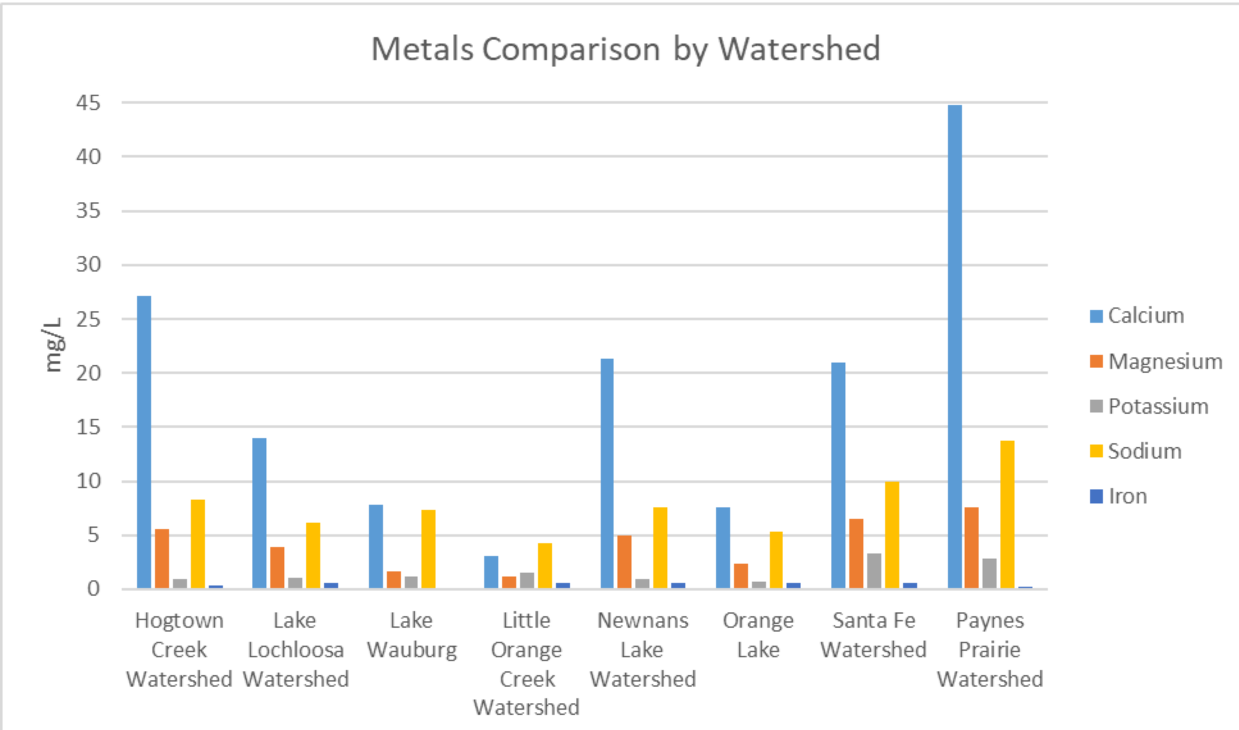
Caption: Google Earth imagery of station 12/31/2003.

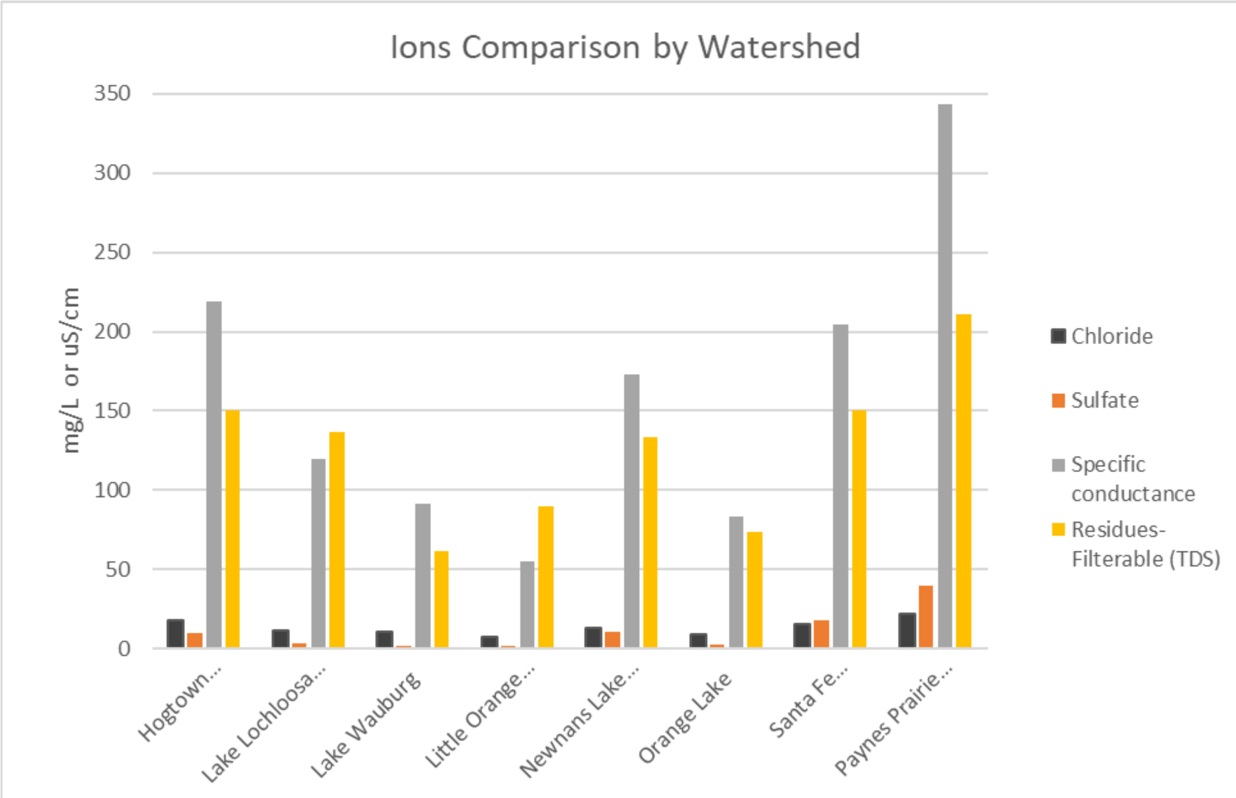
Other notable borderline trend tests that may become significant with more data:
ALACHCHAN – TP and TOC decreasing
BIVARM/BIV441 – Increasing TKN

Watershed Analysis

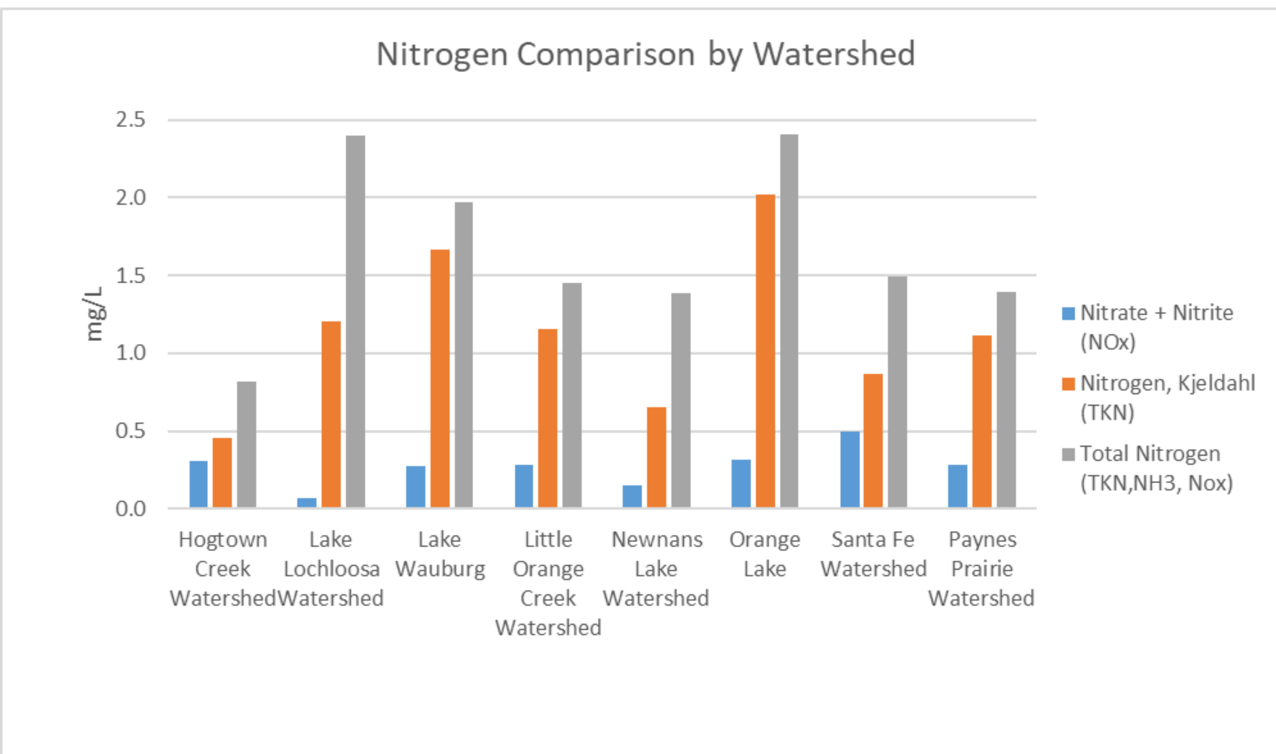
The bar charts below visualize how nutrients (N and P), metals, and ions are distributed in each of the watersheds. These are the averages based on the available station data in each watershed. Notably, Paynes Prairie watershed features the most calcium and sodium while remaining low in iron and moderate in nutrients. Also notable, is the high level of total phosphorus, comparatively, found in the Santa Fe watershed.

These graphs help capture a snapshot of how the watersheds in Alachua County differ. More detailed statistics for each of the watersheds are included in the table below.

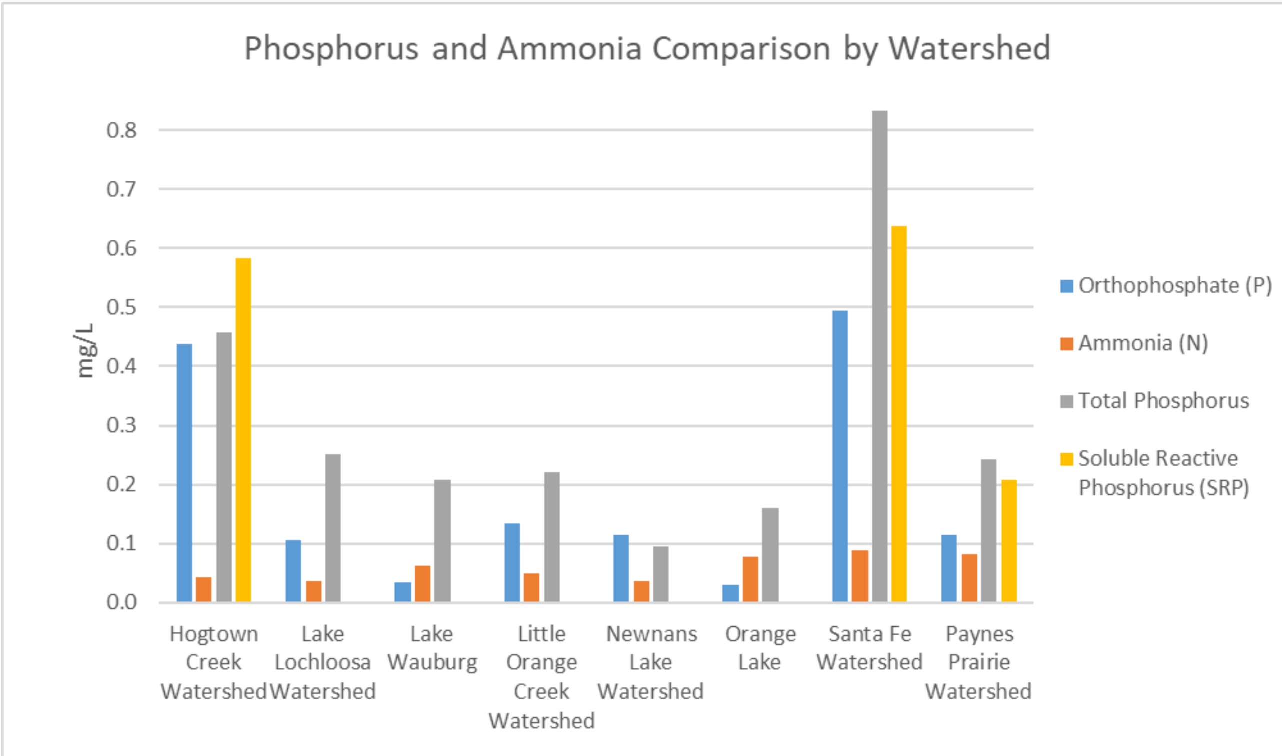




Ions Comparison by Watershed
350
300
250
200
150
100
50
0
mg/L or uS/cm
Hogtown...
Lake Lochloosa...
Lake Wauburg
Little Orange...
Newnans Lake...
Orange Lake
Santa Fe...
Paynes Prairie...
Chloride
Sulfate
Specific conductance
Residues-Filterable (TDS)



Nitrogen Comparison by Watershed
2.5
2.0
1.5
1.0
0.5
0.0
mg/L
Hogtown Creek Watershed
Lake Lochloosa Watershed
Lake Wauburg
Little Orange Creek Watershed
Newnans Lake Watershed
Orange Lake
Santa Fe Watershed
Paynes Prairie Watershed
Nitrate + Nitrite (NOx)
Nitrogen, Kjeldahl (TKN)
Total Nitrogen (TKN,NH3, Nox)



Phosphorus and Ammonia Comparison by Watershed
mg/L
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Hogtown Creek Watershed
Lake Lochloosa Watershed
Lake Wauburg
Little Orange Creek Watershed
Newnans Lake Watershed
Orange Lake
Santa Fe Watershed
Paynes Prairie Watershed
Orthophosphate (P)
Ammonia (N)
Total Phosphorus
Soluble Reactive Phosphorus (SRP)

Site/Analyte/Unit	Count	Average	Median	Max	Min	Standard Deviation
Hogtown Creek Watershed						
Alkalinity (CaCO3) mg/L	324	79.34	80.4	166.00	1.927	35.31
Ammonia (N) mg/L	331	0.04	0.0	0.65	0.005	0.05
Calcium mg/L	295	29.24	31.0	61.00	5.500	10.74
Chloride mg/L	288	18.61	19.0	31.00	0.030	5.65
Dissolved Oxygen mg/L	389	6.19	6.8	11.86	0.130	2.37
Dissolved oxygen saturation (%)	320	65.03	72.6	111.30	1.600	24.87
Flow CFS	88	6.01	2.7	67.74	0.003	10.04
Hardness, carbonate mg/L	251	102.63	103	210.00	20.000	43.83
Iron mg/L	263	0.26	0.19	1.70	0.000	0.25
Magnesium mg/L	295	7.17	6.50	19.00	1.400	4.26
Nitrate + Nitrite (NOx) mg/L	327	0.48	0.27	2.96	0.002	0.50
Nitrite (NO2) mg/L	7	0.02	0.01	0.05	0.010	0.02
Nitrogen, Kjeldahl (TKN) mg/L	350	0.42	0.37	1.72	0.050	0.28
Orthophosphate (P) mg/L	169	0.42	0.41	0.96	0.005	0.23
pH SU	406	7.17	7.32	8.26	4.820	0.74
Potassium mg/L	319	0.96	0.980	3.50	0.083	0.32
Residues- Filterable (TDS) mg/L	278	159.53	160.000	600.00	20.000	48.23
Salinity PSU	13	0.04	0.040	0.07	0.020	0.01
Sodium mg/L	263	8.35	8.30	15.20	2.800	1.88
Soluble Reactive Phosphorus (SRP) mg/L	111	0.54	0.57	0.97	0.140	0.20
Specific conductance uS/cm	425	239.13	249.00	764.50	69.800	87.10
Sulfate mg/L	289	10.93	12.00	24.00	0.070	5.50
Temperature, water °C	397	20.82	21.50	28.98	7.980	4.22
Total Nitrogen (TKN,NH3, Nox) mg/L	314	0.93	1	7.93	0.110	0.64
Total Organic Carbon (TOC) mg/L	331	10.80	9	58.66	0.310	9.58
Total Phosphorus mg/L	287	0.44	0	2.61	0.005	0.33
Total Suspended Solids (TSS) mg/L	319	5.21	2.2	160.00	0.200	12.44
Turbidity NTU	465	3.46	2.1	54.10	0.070	4.45
Lake Lochloosa Watershed						
Alkalinity (CaCO3) mg/L	179	29.76	15.1	140.59	0.010	34.21
Ammonia (N) mg/L	228	0.04	0.0	1.10	0.004	0.08
Calcium mg/L	176	13.93	11.2	41.66	4.147	8.27
Chloride mg/L	175	11.11	11.0	24.00	4.000	3.45
Dissolved Oxygen mg/L	186	6.06	6	13.70	0.950	1.98
Dissolved oxygen saturation (%)	86	64.38	65.25	83.50	18.200	10.48
Flow CFS	28	3.16	1.63	24.11	0.050	4.84
Hardness, carbonate mg/L	174	50.49	37.67	153.81	16.311	31.60
Iron mg/L	152	0.82	0.79	2.49	0.028	0.47
Magnesium mg/L	176	3.87	2.50	12.10	0.975	2.80
Nitrate + Nitrite (NOx) mg/L	228	0.07	0.03	0.96	0.002	0.13
Nitrogen, Kjeldahl (TKN) mg/L	327	1.21	1.18	2.92	0.050	0.45
Orthophosphate (P) mg/L	33	0.11	0.102	0.25	0.014	0.06
pH SU	236	6.42	6.520	7.99	4.250	0.78
Potassium mg/L	153	1.10	1.000	3.98	0.420	0.45
Residues- Filterable (TDS) mg/L	130	136.95	130.50	251.00	40.000	36.35
Salinity PSU	46	0.05	0.05	0.13	0.020	0.02
Sodium mg/L	154	6.11	5.98	10.85	2.455	1.66
Specific conductance uS/cm	287	120.02	104.00	303.30	44.000	58.88
Sulfate mg/L	175	3.55	3.00	24.17	0.925	2.85
Temperature, water °C	188	19.29	19	28.46	8.220	4.84
Total Nitrogen (TKN,NH3, Nox) mg/L	152	2.40	2	7.35	0.100	1.17
Total Organic Carbon (TOC) mg/L	322	44.51	43	106.00	0.650	19.92
Total Phosphorus mg/L	524	0.25	0.2	0.65	0.012	0.12
Total Suspended Solids (TSS) mg/L	175	4.41	5.0	35.40	0.400	3.30
Turbidity NTU	188	2.19	1.6	26.60	0.370	2.81

Site/Analyte/Unit	Count	Average	Median	Max	Min	Standard Deviation
Lake Wauburg						
Alkalinity (CaCO3) mg/L	23	23.85	24.0	32.00	20.000	2.55
Ammonia (N) mg/L	23	0.06	0.0	0.38	0.010	0.08
Calcium mg/L	23	7.84	7.9	10.00	6.100	1.03
Chloride mg/L	22	10.29	10	14.00	4.400	1.91
Dissolved Oxygen mg/L	34	7.79	7.50	11.59	3.080	2.09
Dissolved oxygen saturation (%)	34	91.61	85.85	154.00	39.200	26.00
Hardness, carbonate mg/L	22	26.16	26.00	34.00	21.000	3.51
Iron mg/L	22	0.12	0.07	1.00	0.007	0.21
Magnesium mg/L	23	1.61	1.68	2.10	1.300	0.20
Nitrate + Nitrite (NOx) mg/L	23	0.27	0.20	1.42	0.002	0.32
Nitrogen, Kjeldahl (TKN) mg/L	22	1.66	1.60	2.54	0.862	0.47
Orthophosphate (P) mg/L	24	0.03	0.021	0.17	0.002	0.04
pH SU	34	8.05	7.930	11.25	5.650	1.33
Potassium mg/L	23	1.14	1.100	2.20	0.720	0.35
Residues- Filterable (TDS) mg/L	22	61.23	62.00	100.00	22.000	20.56
Sodium mg/L	22	7.30	7.05	12.00	5.400	1.69
Specific conductance uS/cm	34	91.74	91.90	116.00	81.700	6.29
Sulfate mg/L	23	1.46	2.00	2.70	0.020	0.79
Temperature, water °C	35	23.58	23.60	31.70	12.700	5.96
Total Nitrogen (TKN,NH3, Nox) mg/L	22	1.97	2	3.08	1.160	0.54
Total Organic Carbon (TOC) mg/L	22	10.69	9	23.00	7.100	3.59
Total Phosphorus mg/L	21	0.21	0	1.00	0.017	0.22
Total Suspended Solids (TSS) mg/L	22	57.82	12.0	861.00	3.600	181.48
Turbidity NTU	30	14.77	11.6	52.20	4.200	9.95
Little Orange Creek Watershed						
Alkalinity (CaCO3) mg/L	22	5.00	5.0	5.00	5.000	0.00
Ammonia (N) mg/L	24	0.05	0.0	0.20	0.017	0.05
Calcium mg/L	24	3.01	3.0	3.80	2.200	0.41
Chloride mg/L	23	7.67	6.9	13.00	3.700	2.59
Dissolved Oxygen mg/L	23	0.49	0	2.60	0.070	0.55
Dissolved oxygen saturation (%)	23	5.46	3.20	28.20	0.900	6.00
Hardness, carbonate mg/L	21	12.95	12.00	20.00	8.800	2.72
Iron mg/L	24	0.62	0.61	0.92	0.390	0.14
Magnesium mg/L	24	1.15	1.10	1.70	0.820	0.19
Nitrate + Nitrite (NOx) mg/L	23	0.28	0.20	0.90	0.002	0.25
Nitrogen, Kjeldahl (TKN) mg/L	23	1.16	1.20	2.00	0.495	0.27
Orthophosphate (P) mg/L	21	0.13	0.10	0.33	0.037	0.08
pH SU	23	4.52	4.650	5.00	3.610	0.39
Potassium mg/L	23	1.48	1.300	4.50	0.450	0.98
Residues- Filterable (TDS) mg/L	21	89.67	91.000	140.00	35.000	25.35
Sodium mg/L	24	4.25	4.40	6.90	1.700	1.44
Specific conductance uS/cm	23	55.15	55.30	73.20	39.800	9.71
Sulfate mg/L	24	1.61	2.00	2.70	0.200	0.84
Temperature, water °C	23	20.80	20.60	29.10	12.800	4.85
Total Nitrogen (TKN,NH3, Nox) mg/L	22	1.45	1.36	2.04	0.733	0.33
Total Organic Carbon (TOC) mg/L	23	33.50	32	47.60	26.000	5.73
Total Phosphorus mg/L	23	0.22	0	0.83	0.017	0.20
Total Suspended Solids (TSS) mg/L	23	2.59	2	5.00	2.000	1.16
Turbidity NTU	23	0.87	0.8	1.94	0.100	0.49

Site/Analyte/Unit	Count	Average	Median	Max	Min	Standard Deviation
Newnans Lake Watershed						
Alkalinity (CaCO3) mg/L	340	53.62	55.0	130.00	5.000	19.93
Ammonia (N) mg/L	446	0.04	0.0	0.67	0.001	0.05
Calcium mg/L	341	21.27	22.0	74.00	3.416	6.84
Chloride mg/L	340	12.74	11.8	170.00	3.840	9.27
Dissolved Oxygen mg/L	348	6.25	6.3	13.02	0.140	1.95
Dissolved oxygen saturation (%)	171	65.29	70	101.80	1.500	21.22
Flow CFS	43	1.92	1.02	10.95	0.203	2.28
Hardness, carbonate mg/L	314	73.34	74.78	190.00	12.197	21.90
Iron mg/L	260	0.63	0.53	4.70	0.149	0.42
Magnesium mg/L	341	4.97	4.73	14.00	0.120	1.90
Nitrate + Nitrite (NOx) mg/L	446	0.15	0.12	0.90	0.003	0.15
Nitrogen, Kjeldahl (TKN) mg/L	562	0.66	0.61	1.77	0.070	0.28
Orthophosphate (P) mg/L	147	0.11	0.11	0.36	0.010	0.07
pH SU	379	6.93	7.000	8.31	4.850	0.54
Potassium mg/L	236	0.91	1.000	1.90	0.300	0.28
Residues- Filterable (TDS) mg/L	281	133.80	130.000	460.00	36.000	36.80
Salinity PSU	60	0.06	0.05	0.11	0.020	0.03
Sodium mg/L	238	7.53	7.08	110.00	0.800	6.92
Specific conductance uS/cm	563	172.98	180.40	344.00	45.500	50.86
Sulfate mg/L	341	10.66	8.68	108.17	0.020	10.51
Temperature, water °C	354	19.98	20.46	29.40	2.840	4.82
Total Nitrogen (TKN,NH3, Nox) mg/L	300	1.38	1	3.44	0.050	0.64
Total Organic Carbon (TOC) mg/L	560	18.77	16	67.04	5.800	10.20
Total Phosphorus mg/L	851	0.09	0	2.40	0.010	0.10
Total Suspended Solids (TSS) mg/L	341	4.76	5.0	37.00	0.020	4.09
Turbidity NTU	455	3.37	2.3	31.20	0.000	3.33
Orange Lake						
Alkalinity (CaCO3) mg/L	22	21.32	14.6	87.00	5.000	21.67
Ammonia (N) mg/L	24	0.08	0.0	0.27	0.010	0.08
Calcium mg/L	24	7.58	7.8	9.50	6.000	0.99
Chloride mg/L	23	8.69	8.6	13.00	6.100	1.78
Dissolved Oxygen mg/L	24	3.87	4	7.30	0.110	1.87
Dissolved oxygen saturation (%)	25	43.47	47.50	69.80	1.100	17.89
Flow CFS	3	14.67	17.90	26.11	0.000	13.35
Hardness, carbonate mg/L	22	29.00	29.50	37.00	22.000	4.19
Iron mg/L	24	0.63	0.55	1.30	0.420	0.23
Magnesium mg/L	24	2.37	2.40	3.00	1.700	0.34
Nitrate + Nitrite (NOx) mg/L	24	0.32	0.20	1.46	0.002	0.34
Nitrogen, Kjeldahl (TKN) mg/L	24	2.02	1.73	4.85	0.738	1.04
Orthophosphate (P) mg/L	23	0.03	0.014	0.14	0.005	0.03
pH SU	25	6.26	6.430	6.81	4.960	0.48
Potassium mg/L	23	0.73	0.710	1.00	0.510	0.14
Residues- Filterable (TDS) mg/L	22	73.82	76.50	118.00	6.000	24.90
Sodium mg/L	24	5.35	5.15	9.80	3.600	1.20
Specific conductance uS/cm	25	83.14	79.00	131.50	68.300	16.19
Sulfate mg/L	24	2.54	2.15	9.80	0.900	1.71
Temperature, water °C	25	22.17	22.20	30.80	13.300	5.48
Total Nitrogen (TKN,NH3, Nox) mg/L	23	2.40	2	4.92	0.987	1.03
Total Organic Carbon (TOC) mg/L	23	21.77	20	31.70	16.000	4.06
Total Phosphorus mg/L	24	0.16	0	0.34	0.005	0.10
Total Suspended Solids (TSS) mg/L	23	24.56	20.0	73.00	2.000	18.84
Turbidity NTU	30	17.21	12.6	43.60	2.690	11.12

Site/Analyte/Unit	Count	Average	Median	Max	Min	Standard Deviation
Paynes Prairie Watershed						
Alkalinity (CaCO3) mg/L	418	106.99	106.5	410.00	19.000	51.77
Ammonia (N) mg/L	437	0.10	0.1	3.20	0.008	0.22
Calcium mg/L	391	46.54	49.0	140.00	7.100	18.76
Chloride mg/L	377	36.87	22.0	280.00	2.900	43.77
Dissolved Oxygen mg/L	535	6.85	7	17.40	0.040	3.27
Dissolved oxygen saturation (%)	384	74.71	81.95	192.00	0.500	38.13
Flow CFS	201	2.17	0.46	78.37	0.006	6.33
Hardness, carbonate mg/L	276	163.76	170.00	540.00	1.700	79.63
Iron mg/L	329	0.18	0.11	4.40	0.000	0.30
Magnesium mg/L	391	11.22	9.00	48.00	2.000	7.98
Nitrate + Nitrite (NOx) mg/L	428	0.86	0.32	10.00	0.002	1.28
Nitrite (NO2) mg/L	4	0.06	0.05	0.07	0.050	0.01
Nitrogen, Kjeldahl (TKN) mg/L	432	0.99	0.556	7.19	0.050	1.17
Orthophosphate (P) mg/L	190	0.12	0.101	1.39	0.002	0.15
pH SU	536	7.70	7.580	9.89	5.440	0.83
Potassium mg/L	391	3.67	2.60	79.00	0.410	4.51
Residues- Filterable (TDS) mg/L	383	259.79	240.00	714.00	2.500	127.29
Sodium mg/L	295	21.33	14.00	150.00	3.200	22.17
Soluble Reactive Phosphorus (SRP) mg/L	143	0.31	0.15	4.39	0.002	0.57
Specific conductance uS/cm	597	440.83	404.00	1294.00	37.800	227.14
Sulfate mg/L	382	50.07	44	310.00	0.010	41.20
Temperature, water °C	537	22.91	23	35.40	6.200	4.79
Total Nitrogen (TKN,NH3, Nox) mg/L	423	1.89	1	10.76	0.030	1.64
Total Organic Carbon (TOC) mg/L	421	8.78	6.3	63.00	1.300	7.19
Total Phosphorus mg/L	379	0.30	0.2	4.66	0.017	0.40
Total Suspended Solids (TSS) mg/L	426	9.16	2.2	350.00	0.010	21.74
Turbidity NTU	651	6.65	1.5	378.00	0.350	20.25
Santa Fe Watershed						
Alkalinity (CaCO3) mg/L	372	54.27	33.7	206.00	0.010	48.41
Ammonia (N) mg/L	445	0.09	0.0	1.60	0.008	0.17
Calcium mg/L	310	20.77	18	64.00	4.900	11.99
Chloride mg/L	389	15.55	15.00	37.00	1.000	5.18
Dissolved Oxygen mg/L	514	6.61	7.28	11.82	0.180	2.93
Dissolved oxygen saturation (%)	310	71.29	81.80	133.80	2.700	29.34
Flow CFS	344	1.74	0.43	47.02	0.000	4.34
Hardness, carbonate mg/L	231	76.14	69.00	210.00	0.046	44.92
Iron mg/L	269	0.51	0.31	3.00	0.000	0.52
Magnesium mg/L	304	6.48	5.40	21.00	1.200	4.33
Nitrate + Nitrite (NOx) mg/L	440	0.50	0.200	5.90	0.002	0.77
Nitrite (NO2) mg/L	6	0.04	0.050	0.09	0.011	0.03
Nitrogen, Kjeldahl (TKN) mg/L	436	0.87	0.708	6.10	0.050	0.66
Orthophosphate (P) mg/L	195	0.49	0.52	2.17	0.005	0.29
pH SU	521	6.91	7.16	9.23	3.770	1.08
Potassium mg/L	333	3.26	1.40	54.00	0.010	4.95
Residues- Filterable (TDS) mg/L	291	150.70	140.00	490.00	24.000	65.73
Sodium mg/L	255	9.98	7.40	52.00	3.100	7.43
Soluble Reactive Phosphorus (SRP) mg/L	104	0.64	1	1.39	0.030	0.28
Specific conductance uS/cm	558	204.16	170	631.00	20.000	121.41
Sulfate mg/L	397	18.08	7	110.00	0.020	21.11
Temperature, water °C	522	20.18	20.1	30.90	5.180	4.92
Total Nitrogen (TKN,NH3, Nox) mg/L	415	1.49	1.2	13.80	0.100	1.25
Total Organic Carbon (TOC) mg/L	390	18.11	10.8	96.00	1.600	17.59
Total Phosphorus mg/L	478	0.83	0.6	108.00	0.017	4.92
Total Suspended Solids (TSS) mg/L	453	7.10	4.1	336.00	0.010	21.89
Turbidity NTU	552	4.75	3.6	40.90	0.300	4.84

RECOMMENDATIONS FOR FUTURE SAMPLING

- Continue and expand long-term monitoring, particularly at stations with emerging or borderline trends. Consider discontinuing certain parameters with little to no change at stations with extensive sampling history.
  - Borderline and emerging trends where monitoring could be increased can be found bolded/highlighted in Appendix C.
  - Stations/parameters with little to no change (ie: sen's slope ~0 on Appendix C and line is flat on scatterplot), no listed impairment, and sufficent data (ie: at least 10 years and 50 data points but this is a subjective call) could be considered for reduced monitoring frequency and/or reduced anaylte lists.
- The availability of flow data was sparse, with many stations having less than 20 data points. Improved flow monitoring could enable future nutrient loading analyisis.
- Investigate nutrient sources, especially ammonia and phosphorus, in areas showing increasing concentrations. Advanced techniques such as environmental DNA (eDNA) can be used to identify anthropgenic contributions and are cost effective.
- Future reports should consider incorporating improved analytical methods (e.g., linear mixed models) to better understand relationships between flow, rainfall, and water quality.
- Improve data consistency, including reviewing for significnat changes in MDLs, investigating extreme outliers, and improving consitency in standard procedures for data entry (ie: Reporting non-detects as the MDL value rather than as a zero value).
- Consider adding rainfall monitoring coverage to monitoring plan.
- Prioritize stations with declining dissolved oxygen for management action due to potential ecological impacts. Consider monitoing macroalgae in streams with decreasing dissolved oxygen.
  - Stations with decreasing dissolved oxygen: BLUOTTER, PAR1491, SWB331, TUM441.
  - Similarly, consider submerged aquatic vegetation surveying for BOULSP and GLENSP