Final UNRBA Transition Monitoring Report
November 2018 to June 2020

Prepared for

Upper Neuse River Basin Association, NC

Prepared by

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Section 1: Introduction and Background

Falls Lake (Falls of the Neuse Reservoir) was created by the U.S. Army Corps of Engineers (USACE) in 1981. Prior to construction of the Falls Dam, the proposed lake was predicted to be hyper-eutrophic. Not surprisingly, twenty-seven years after construction, in 2008, the NC Division of Water Quality listed Falls Lake as not-attaining the water quality standard for chlorophyll-*a*. This decision resulted in a Clean Water Act Section 303(d) listing that required a nutrient management strategy or a TMDL. The North Carolina Environmental Management Commission (EMC) passed the Falls Lake Nutrient Management Strategy ("the Rules") requiring two stages of nutrient reductions within the watershed (N.C. Rules Review Commission 2010). The Rules established a Nutrient Management Strategy to be implemented in two stages: Stage I is described in 15NCAC 02B .0275 (4)(a), and Stage II is described in 15NCAC 02B .0275 (4)(b). The Rules recognized uncertainty associated with the water quality modeling used to establish the Stage II requirements. Because of this uncertainty, the Rules allow for re-examination of the Stage II nutrient loading reduction requirements after additional data collection, as specified in Section 5(f) of the Rules. The original modeling conducted by DWR was based on limited data collection in the watershed. The UNRBA Monitoring Program was specifically designed to reduce the uncertainty and to re-examine the scientific assessment and modeling predictions used by DWR to support these Rules.

In 2011, the UNRBA began a re-examination process of the regulatory framework for Stage II of the Rules. Full implementation of the nutrient reduction strategy, which is more stringent than any other nutrient strategy in the State, will require extremely costly actions on the part of UNRBA member governments and other regulated parties. In addition to the DWR modeling uncertainty, the practical ability to achieve the mandated reductions is also uncertain. In light of the financial impact of the Rules and the regional importance of Falls Lake, the UNRBA began examining the technical bases and regulatory framework of Stage II requirements. Local governments within the UNRBA agreed that protecting Falls Lake as a water supply and public resource was paramount. Moving forward into a sustainable future, UNRBA members want to ensure that the Rules applied to the watershed sufficiently protect the lake's beneficial uses. The UNRBA members also desire any Falls Lake nutrient control strategies to be reasonable, fiscally responsible, and to improve the beneficial uses of this vital regional resource.

In 2014, the UNRBA initiated the Monitoring Plan that described the locations, parameters, frequencies, and other program elements (Cardno 2014b; http://www.unrba.org/monitoring-program). The Monitoring Plan is maintained and updated to reflect changes in the program over time. As established in Section 5(f) of the Falls Lake Nutrient Management Strategy, http://portal.ncdenr.org/web/fallslake/home, the UNRBA Monitoring Plan was initially approved by North Carolina Division of Water Resources (DWR) on July 16, 2014. The UNRBA Monitoring Quality Assurance Project Plan (QAPP) was developed specifically for the program to ensure that data are reliable and suitable for consideration for regulatory purposes. The QAPP describes the protocols and methodologies to be followed by field and laboratory staff to ensure data precision and accuracy. The QAPP was initially approved by the North Carolina Division of Water Resources (DWR) on July 30, 2014 and again on January 18, 2017. The final, comprehensive 2019 Annual Monitoring Report can be found online at https://www.unrba.org/monitoring-program.

The UNRBA Transition Monitoring Program began in November 2018 following completion of the full UNRBA Monitoring Program in October 2018. This Final UNRBA Transition Monitoring Report summarizes data collected in the Falls Lake watershed between November 2018 and June 2020. This report compares data collected during the Transition Monitoring effort to data collected over the entire monitoring period (August 2014 through June 2020) to determine if observations were within previous observed ranges.

Section 2: UNRBA Transition Monitoring

The UNRBA Routine Monitoring effort ended in October 2018, completing the intensive water quality data acquisition for the re-examination effort. Beginning in November 2018, a much-reduced "Transition Monitoring" effort was initiated to continue obtaining data from a smaller set of stations. The purpose of the Transition Monitoring is to continue to track water quality conditions at locations on tributaries to Falls Lake that are not monitored by other organizations. The Transition Monitoring program was authorized by the UNRBA through June 2020. Transition Monitoring continued monthly sample collections at 12 stations (Table 2-1, Figure 2-1) until the end of June 2020.

Other entities continue to monitor both Falls Lake and its larger tributaries (e.g., USGS, DWR, City of Durham, CAAE). Thus, beneficial data will continue to be made available to the UNRBA into the future for assessment and management purposes.

Table 2-1. UNRBA Transition Monitoring Stations

Name[a] (Station Type[b])	Stream Name	Parameters[c]
FLR-25(JB)	Flat River	TP, TKN, NH3, NO2+NO3
DPC-23(JB)	Deep River	TP, TKN, NH3, NO2+NO3
NLR-27(JB)	North Fork Little River	TP, TKN, NH3, NO2+NO3
SLR-22(JB)	South Fork Little River	TP, TKN, NH3, NO2+NO3
ENR-49(JB)	Eno River	TP, TKN, NH3, NO2+NO3
ENR-23(JB)	Eno River	TP, TKN, NH3, NO2+NO3
LGE-5.1(LL)	Ledge Creek	TP, TKN, NH3, NO2+NO3, TOC
ROB-2.8(LL)	Robertson Creek	TP, TKN, NH3, NO2+NO3, TOC
BDC-2.0(LL)	Beaverdam Creek	TP, TKN, NH3, NO2+NO3, TOC
NLC-2.3(LL)	New Light Creek	TP, TKN, NH3, NO2+NO3, TOC
LBC-2.1 (LL)	Lower Barton Creek	TP, TKN, NH3, NO2+NO3, TOC
HSE-1.7(LL)	Horse Creek	TP, TKN, NH3, NO2+NO3, TOC

[a] *Name combines an abbreviation for the stream with the approximate distance from the station to Falls Lake (km).*

[b] *JB refers to a Jurisdictional Boundary station and LL refers to a Lake Loading station.*

[c] *TP refers to total phosphorus, TKN to total Kjeldahl nitrogen, NH3 to total ammonia, NO2+NO3 to nitrite plus nitrate, TOC refers to total organic carbon.*

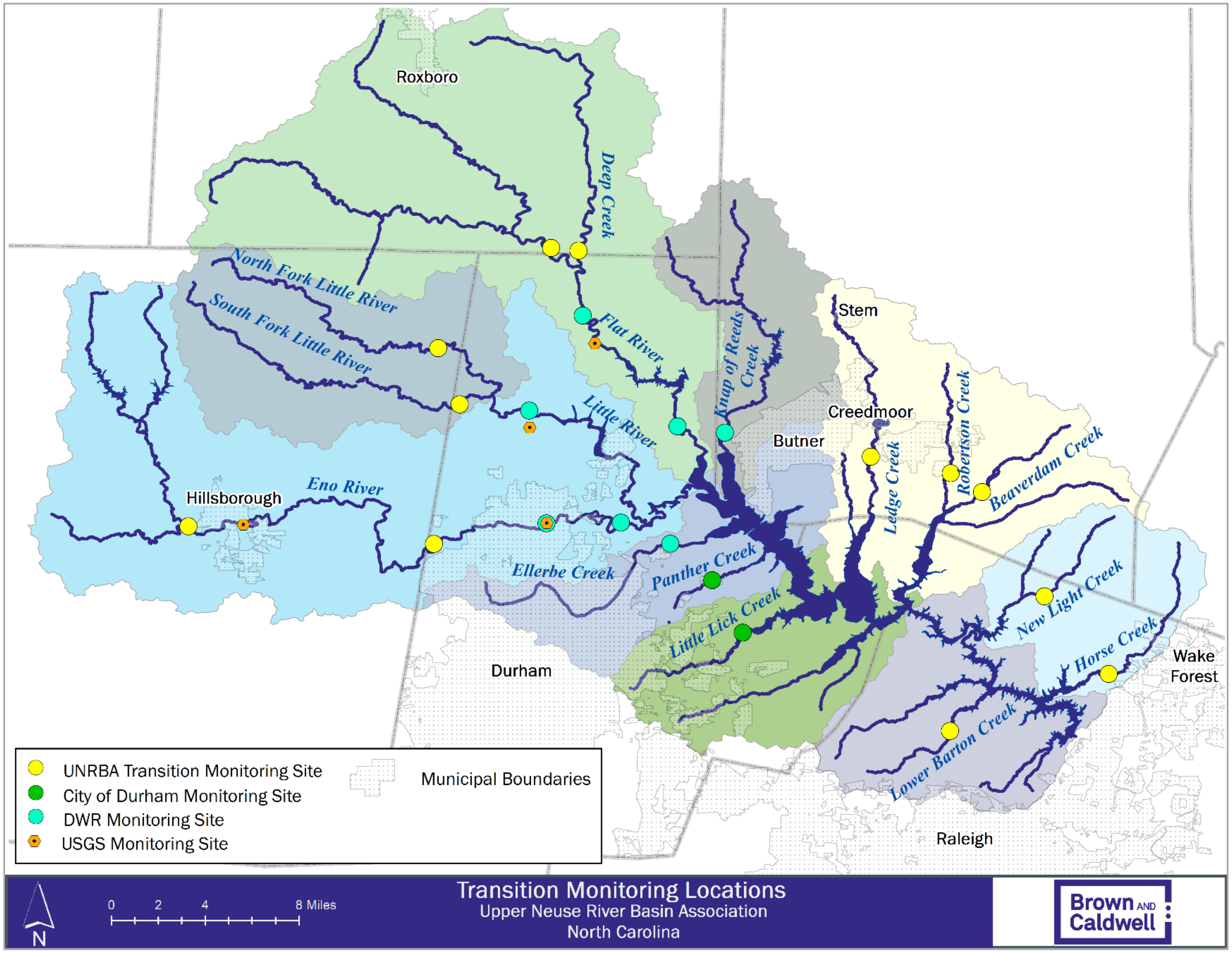

Figure 2-1. Transition Monitoring Stations in the Falls Lake Watershed

Section 3: Results

Table 3-1 and Table 3-2 summarize the data collected under the Transition Monitoring Program for FY2019 (November 2018 to March 2019) and FY2020 (April 2019 to June 2020). The observations collected during the entire Transition Monitoring period are similar in distribution to the previous monitoring conducted by the UNRBA as summarized in the UNRBA 2019 Annual Monitoring Report. Transition Monitoring results (November 2018 through June 2020) were compared to data collected over the entire monitoring period (August 2014 through June 2020) including Routine and Transitional Monitoring to determine if observations were within previous observed ranges. Figure 3-1 and Figure 3-2 show the monitoring results using an arithmetic scale and logarithmic scale, respectively for comparison to the figures in the UNRBA 2019 Annual Monitoring Report. Total organic carbon is only collected at LL stations under the Transition Monitoring Program, so JB sites on these figures do not have results for November 2018 to June 2020. Results from samples collected under the Transition Monitoring generally fall within the same range as those collected from 2015 to 2018. Samples collected in Lower Barton Creek had higher concentrations than previous values for TKN and TP (May 2019) and ammonia (June 2019), but otherwise samples collected here were within the range of previously collected samples. The May and June 2019 sampling events occurred during 0.5-inch to 1-inch storms observed at the USGS Gage at Crabtree Creek in Raleigh (USGS 02087275). These sampling events may have detected elevated concentrations associated with runoff from these storm events.

Table 3-1. Nutrient Data Summary (November 2018 to June 2020)

Name (Station Type)	Statistic	Total Kjeldahl Nitrogen (mg/L)	Total Nitrate+nitrite (mg/L)	Total Ammonia (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
FLR-25 (JB)	n	20	20	20	20	20
	Min	0.18	0.02	0.01	0.43	0.01
	Avg	0.51	0.41	0.08	0.92	0.05
	Max	1.00	0.72	0.26	1.45	0.14
DPC-23 (JB)	n	20	20	20	20	20
	Min	0.24	0.01	0.01	0.34	0.01
	Avg	0.43	0.30	0.07	0.73	0.04
	Max	0.76	0.53	0.31	1.29	0.12
NLR-27 (JB)	n	20	20	20	20	20
	Min	0.26	0.01	0.01	0.32	0.01
	Avg	0.52	0.30	0.08	0.82	0.06
	Max	0.87	0.98	0.36	1.78	0.22
SLR-22 (JB)	n	20	20	20	20	20
	Min	0.23	0.01	0.01	0.30	0.01
	Avg	0.45	0.54	0.09	0.98	0.05
	Max	0.73	0.89	0.33	1.41	0.16
ENR-49 (JB)	n	20	20	20	20	20
	Min	0.30	0.07	0.02	0.56	0.01
	Avg	0.54	0.32	0.09	0.86	0.06
	Max	0.82	0.50	0.28	1.13	0.18

Table 3-1. Nutrient Data Summary (November 2018 to June 2020)						
Name (Station Type)	Statistic	Total Kjeldahl Nitrogen (mg/L)	Total Nitrate+nitrite (mg/L)	Total Ammonia (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
ENR-23 (JB)	n	20	20	20	20	20
	Min	0.24	0.01	0.01	0.33	0.01
	Avg	0.42	0.28	0.07	0.70	0.05
	Max	0.76	0.48	0.16	1.13	0.21
LGE-5.1 (LL)	n	17	17	17	17	17
	Min	0.66	0.01	0.02	0.69	0.05
	Avg	0.89	0.07	0.18	0.96	0.09
	Max	1.16	0.15	0.44	1.31	0.15
ROB-2.8 (LL)	n	20	20	20	20	20
	Min	0.63	0.01	0.03	0.65	0.02
	Avg	0.97	0.05	0.13	1.02	0.12
	Max	1.80	0.34	0.38	1.87	0.40
BDC-2.0 (LL)	n	20	20	20	20	20
	Min	0.37	0.01	0.02	0.37	0.03
	Avg	0.79	0.04	0.12	0.83	0.10
	Max	1.36	0.13	0.47	1.3	0.24
NLC-2.3 (LL)	n	20	20	20	20	20
	Min	0.18	0.16	0.03	0.41	0.01
	Avg	0.31	0.36	0.12	0.67	0.03
	Max	0.61	0.62	0.60	1.01	0.14
LBC-2.1 (LL)	n	20	20	20	20	20
	Min	0.18	0.37	0.02	0.94	0.01
	Avg	0.46	0.91	0.14	1.37	0.06
	Max	2.78	1.61	1.28	3.15	0.72
HSE-1.7 (LL)	n	20	20	20	20	20
	Min	0.08	0.09	0.02	0.31	0.01
	Avg	0.33	0.28	0.08	0.60	0.03
	Max	0.59	0.50	0.29	1.09	0.13

Table 3-2. Total Organic Carbon Data Summary (November 2018 to June 2020)

Name (Station Type)	Statistic	Total Organic Carbon (mg/L)[a]
LGE-5.1 (LL)	n	17
	Min	7.79
	Avg	11.19
	Max	18.40
ROB-2.8 (LL)	n	20
	Min	6.60
	Avg	12.21
	Max	18.50
BDC-2.0 (LL)	n	20
	Min	8.53
	Avg	11.20
	Max	14.99
NLC-2.3 (LL)	n	20
	Min	1.84
	Avg	2.79
	Max	6.06
LBC-2.1 (LL)	n	20
	Min	2.04
	Avg	3.44
	Max	10.60
HSE-1.7 (LL)	n	20
	Min	1.88
	Avg	2.91
	Max	5.94

[a] *Total organic carbon is not collected at JB stations.*

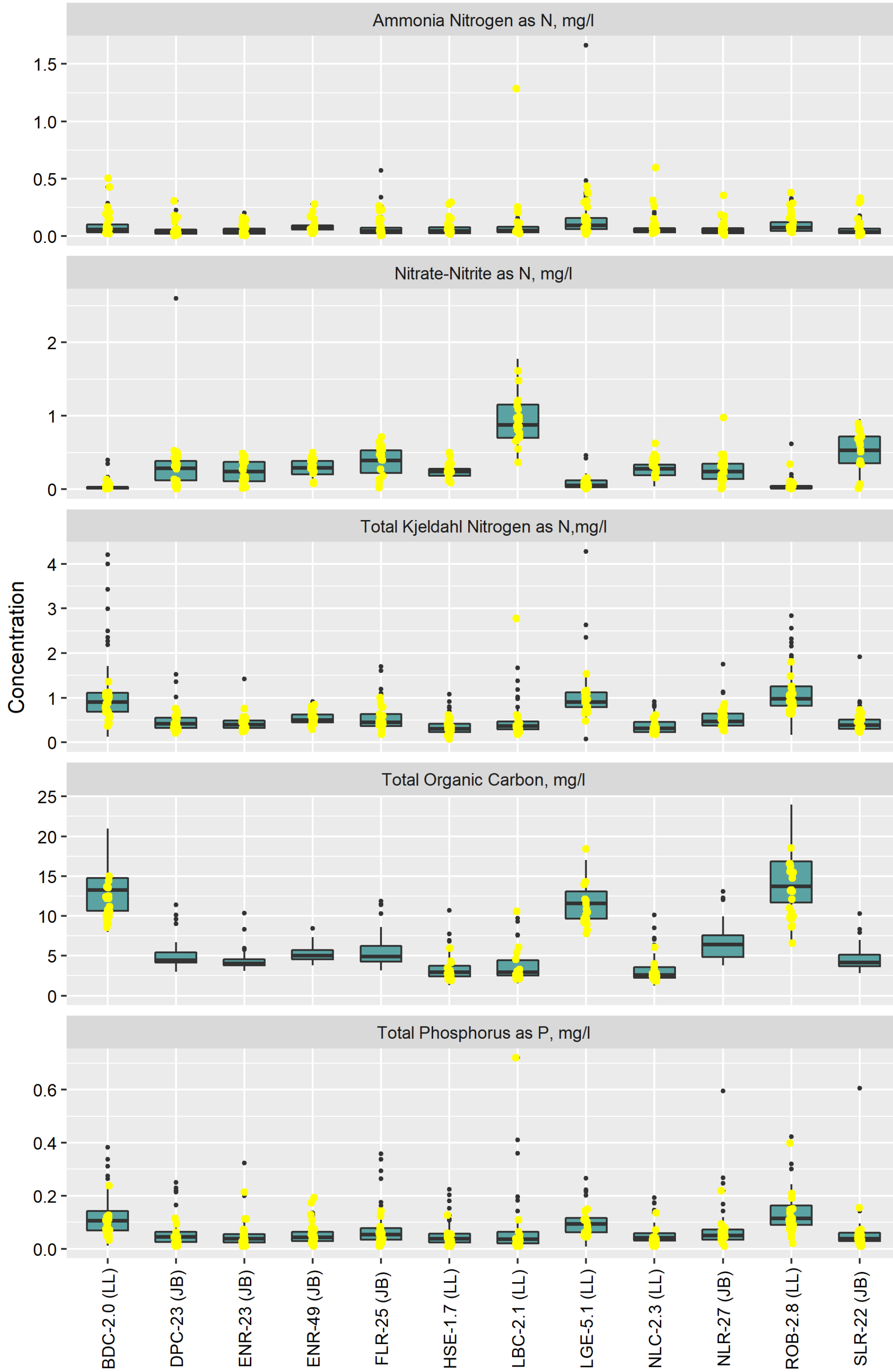

Figure 3-1. Comparison of Transition Monitoring Data Using Arithmetic Scale

Results from the entire monitoring period (August 2014 – June 2020) displayed using boxplots and results from the transition monitoring (November 2018 – June 2020) displayed using yellow points. Total Organic Carbon is not sampled at JB sites.

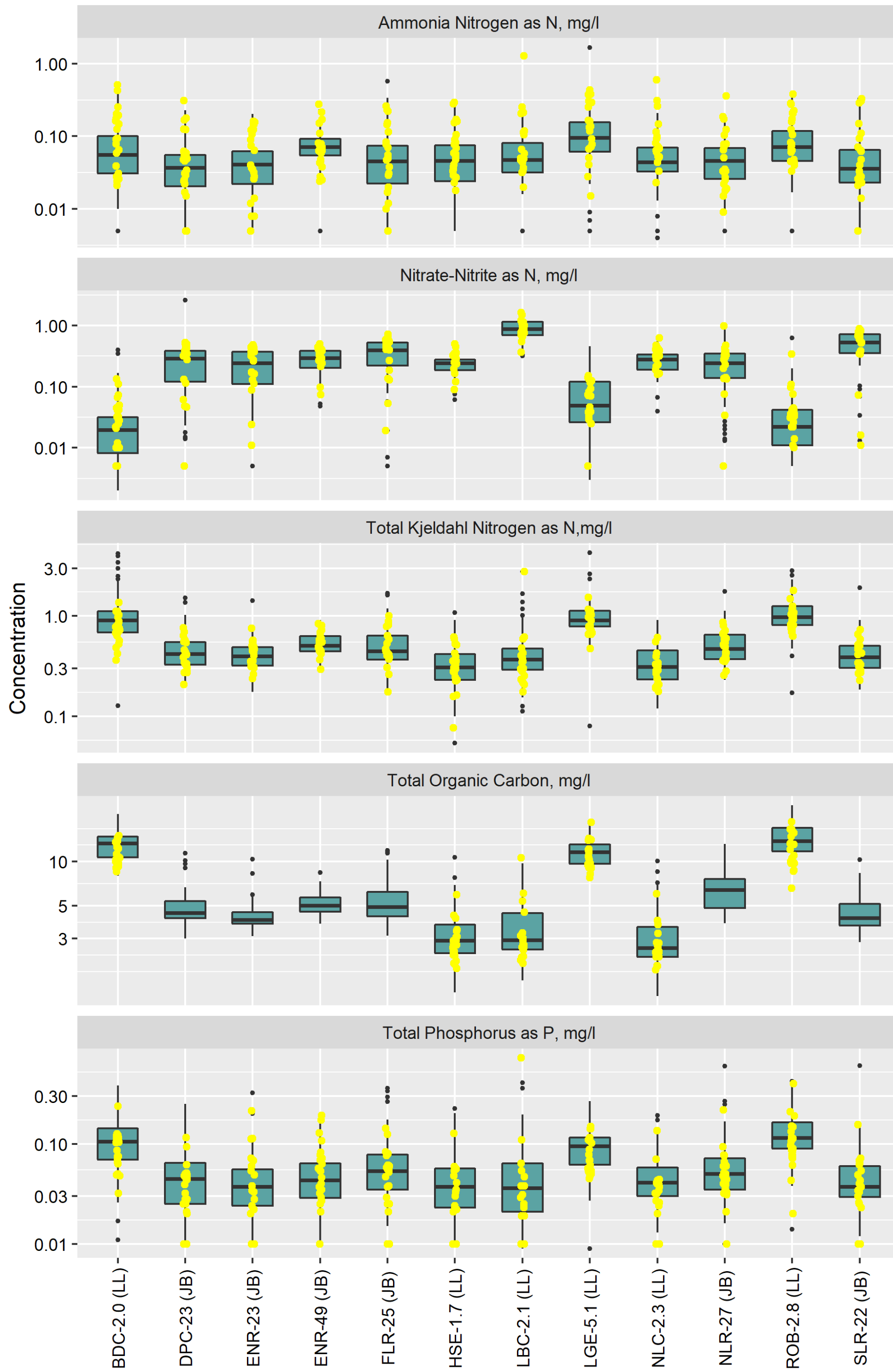

Figure 3-2. Comparison of Transition Monitoring Data Using Logarithmic Scale

Results from the entire monitoring period (August 2014 – June 2020) displayed using boxplots and results from the transition monitoring (November 2018 – June 2020) displayed using yellow points. Total Organic Carbon is not sampled at JB sites.

Section 4: Quality Assurance

All analytical data collected through the UNRBA Transition Monitoring Program are evaluated for compliance with the quality objectives outlined in the UNRBA QAPP. Data accuracy, precision, and completeness reviews are performed following each monitoring event.

4.1 Representativeness and Completeness

Data accuracy, precision, and completeness reviews are performed on a regular basis. Reviews of field and laboratory practices are performed on a routine basis. Since the beginning of the UNRBA Monitoring Program, more than 98 percent of all planned sampling events in which the sampling location had flowing water were completed as planned. The following summarize the representativeness and completeness of the most recent period associated with the Transition Monitoring Program (November 2018 through June 2020).

- There have been no cases of samples where results for Laboratory Control Samples (samples of known concentration analyzed along with field samples) associated with UNRBA data were out of compliance with method criteria.
- There were three instances where a sample could not be collected at site LGE-5.1 due to low flow conditions. Otherwise, all planned sampling events were completed as planned.
- No samples needed to be analyzed outside of specified holding times.

4.2 Accuracy, Precision, and Measurement Uncertainty

All environmental measurements are subject to uncertainty owing to a variety of sources which may be related to sampling (natural heterogeneity in the ecosystem, environmental conditions), preservation and storage conditions, analytical factors (sample processing, equipment errors, purity of reagents and labware, operator error), or computational factors (selection of calibration model, result truncation, and round off). When properly quantified and documented, measurement uncertainty does not imply that data are unreliable or invalid. In fact, clearly documenting the range of values that could reasonably represent each environmental measurement can improve user confidence in data and allow end users to properly evaluate how well the dataset fulfills their intended purpose.

The UNRBA quality assurance project plan specifies accuracy and precision targets based upon specific project goals as well as limits of analytical capabilities. Because these objectives were specified *a priori*, continued evaluation has been necessary to assess the degree to which these targets have been met and to which they have been achievable with samples collected outside of controlled laboratory conditions. The monitoring program was therefore designed to collect the necessary quality assurance samples to calculate and document the true accuracy and precision of the analytical methods under variable field conditions, and these data have been continued to be collected as part of the Transition Monitoring Program. Tables 4-1 and 4-2 present information on the blanks and duplicates collected during the Transition Monitoring Program.

None of the field blanks for total nitrate plus nitrite and total phosphorus were above their respective reporting limits. Eight out of twenty of the ammonia blanks were above the ammonia reporting limit of 0.01 mg/L, and the maximum value of the ammonia blanks was 0.02 mg/L. These blank values are similar to those obtained throughout the monitoring program which have been discussed in detail in the final UNRBA Monitoring report. For the Transition Monitoring period, the average ammonia concentration in stream samples was 0.10 mg/L, so even the maximum ammonia blank concentration of 0.02 mg/L was only 20 percent of the average concentration.

Results for field precision of duplicate samples are also in line with those achieved during the UNRBA Monitoring Program. All duplicate pairs for total organic carbon and total nitrate plus nitrite were below the target relative percent difference of 30 percent. Ten duplicate pairs for ammonia had relative percent differences (RPD) greater than 30 percent, and one duplicate pair each for total Kjeldahl nitrogen and for total phosphorus had an RPD greater than 30 percent. Over the entire monitoring program, about 6 percent of TKN duplicate pairs exceeded the RPD target while 20 percent of TP pairs exceed the RPD target. With 20 duplicate pairs collected as part of the Transition Monitoring Program, one elevated pair each for TKN and TP is not out of line with previous samples.

Table 4-1. Field Blank Concentrations Greater than the Reporting Limit

Parameter	N[a] (Blanks)	N > RL	Maximum Blank Concentration	Nominal Reporting Limit
Total Organic Carbon, mg/L	0	-	-	1.0
Total Phosphorus as P, mg/L	20	0	0.02	0.02
Total Nitrate-Nitrite as N, mg/L	20	0	0.01	0.01
Total Kjeldahl Nitrogen as N, mg/L	20	1	0.22	0.2
Total Ammonia Nitrogen as N, mg/L	20	8	0.02	0.01

[a] *Total organic carbon is only collected at 6 LL stations, and no TOC blanks were collected. Throughout the entire UNRBA Routine Monitoring Program (2014 – 2018), none of the blanks had TOC concentrations above the reporting limit.*

Table 4-2. Field Duplicate Precision Targets and Number of Duplicate Pairs with RPD Greater than the Target from November 2018 to June 2020

Parameter	RPD Target %	No. of Pairs Collected	N > Target
Total Organic Carbon, mg/L	30	9	0
Total Phosphorus as P, mg/L	30	20	1
Total Nitrate-Nitrite as N, mg/L	30	20	0
Total Kjeldahl Nitrogen as N, mg/L	30	20	1
Total Ammonia Nitrogen as N, mg/L	30	20	10

Section 5: Summary

The UNRBA initiated the Transition Monitoring Program in November 2018. The purpose of the Transition Monitoring was to track water quality conditions at locations on tributaries to Falls Lake that are not monitored by other organizations. Based on the samples collected during the Transition Monitoring period, water quality in the watershed does not appear to be substantially different from conditions observed during the period of UNRBA's routine monitoring from 2015 to 2018. The Transition Monitoring program was discontinued at the end of the 2020 fiscal year, and there are no current plans to restart the program. The UNRBA shifted resources allocated to the Transition Monitoring Program toward the re-examination modeling effort in Fiscal Year 2021. The UNRBA may consider future monitoring activities in the watershed if necessary or beneficial.